Achatina (*Lissachatina*) *fulica* BOWDICH: ITS MOLECULAR PHYLOGENY, GENETIC VARIATION IN GLOBAL POPULATIONS, AND ITS POSSIBLE ROLE IN THE SPREAD OF THE RAT LUNGWORM *Angiostrongylus cantonensis* (CHEN)

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Thesis submitted to the University of Nottingham
for the degree of Doctor of Philosophy

JULY 2010

ABSTRACT

The Giant African Snail, *Achatina* (*Lissachatina*) *fulica* Bowdich, 1822, is a tropical crop pest species with a widespread distribution across East Africa, the Indian subcontinent, Southeast Asia, the Pacific and the Caribbean. It is also a known intermediate host of the rat lungworm, *Angiostrongylus cantonensis*, which can infect humans and cause eosinophilic meningitis. The phylogenetic position of *A. fulica* within the Achatinoidea and the Achatinidae was investigated using segments of the nuclear ribosomal (r) RNA cluster, actin and histone 3 genes and the mitochondrial CO1 and 16S rRNA genes. Results from molecular data support the monophyly of the Achatinidae based on the taxa surveyed as well as the morphological distinction of the Eastern *Achatina* (*Lissachatina*) from the Western and Central *Achatina* (*Achatina*); *Lissachatina* should therefore be elevated to genus status. The results also show non-monophyly of the Coeliaxidae, Ferussaciidae and Subulinidae; the taxonomy of these families must therefore be reassessed. The extent of genetic diversity in global *A. fulica* populations was also determined using an SSCP molecular marker developed from the 16S rRNA gene. Results reveal only one haplotype (C) emerged from East Africa and spread globally. The rat lungworm (*Angiostrongylus cantonensis*) has a parallel distribution with *A. fulica*, and the possible role of the snail in the spread of the parasite is investigated using a molecular marker derived from the small subunit (SSU) rRNA gene. A survey of the parasite within the route of dispersal of *A. fulica* detected *A. cantonensis* only in the Philippines and the French Polynesian territory of Tahiti, the latter of which being the first reported case of *A. cantonensis* infection for *Achatina fulica* in that territory. Due to the limited sampling of the snail and the patchy distribution of the parasite, there are insufficient data at this time to assess the role of *Achatina fulica* in the spread of *Angiostrongylus cantonensis*.

ACKNOWLEDGEMENTS

My sincerest gratitude to the following:

Chris Wade, my supervisor, for taking the risk of accepting me, for giving me the opportunity to work in his lab, for all the engaging conversations about anything under the sun, and for making my stay in the UK pleasant and memorable;

Cendrine Hudelot, my unofficial second supervisor, for teaching me a lot of things, from running computer programs and aligning sequences to cloning, for help with soliciting samples, for showing me how to manage time wisely in the lab, and for all the dinners and trips and doughnuts and muffins and films together;

Angus Davison and Robert Cowie, for their critical appraisal of my manuscript and for being patient with me;

The University of the Philippines System for funding my PhD in the UK;

The Leverhulme Trust (Ref: F/00114U) for partially funding my PhD work;

Fred Naggs for his helpful comments on my manuscript and for the help in soliciting samples;

All the collectors for generously providing us with specimens to work on;

Heidi Seears, Rachel Clark, Jonathan Rowlinson, James Folwell, Mohammad Bakkali, Morito Hayashi, Matt Carroll and Wan Omar for all the good times together;

Sheila Keeble and the rest of the A-team for making our work in the lab less stressful;

Brenda Hernandez, Jonas Quilang, Lala Espanola, Neil Ramirez, Maan Guzman, Lillian Rodriguez, Reynand Canoy, Kring Soriano, Dino Ramos, Ellen Catap, John Yason, Bai Basiao, Windell Rivera, Thucy Salunga, Perry Ong and Remedios Roderos for all the help with my teaching load, for proof-reading my manuscript, and for all the much needed distraction.

My family, for their kind words, financial support and understanding.

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CHAPTER 1 – Introduction

The tropical Giant African Land Snail *Achatina* (*Lissachatina*) *fulica* Bowdich, 1822 is one of the most extensively studied snails because of its economic, ecological and medical importance (Mead, 1979). It belongs to a family of African snails, the Achatinidae (Mollusca, Gastropoda, Stylommatophora, Achatinoidea), that includes more than 200 species in 13 genera (Schileyko, 1999). *Achatina fulica* is a major crop pest species that originated in East Africa but has been spreading across the globe since before the 1800's primarily through human activities (Mead, 1961, 1979; Raut & Barker, 2002). The World Conservation Union (IUCN) has listed *Achatina fulica* as one of the world's 100 most invasive species (Lowe *et al.*, 2000). The snail also serves as an intermediate host of the rat lungworm *Angiostrongylus cantonensis* (Chen) (see Alicata, 1966). Humans get accidentally infected by ingesting the 3rd juvenile stage of this parasite, derived from the snail intermediate host, which leads to eosinophilic meningoencephalitis (EME) or angiostrongyliasis, a disease of the central nervous system (Marquardt *et al.*, 2000). Although much is already known about *Achatina fulica*, many issues regarding the snail remain unaddressed. These include its phylogenetic relationship with other members of the Achatinoidea and the Achatinidae, the validity of the subgenus *Lissachatina* based on molecular data, the genetic variation present in introduced populations of *A. fulica* across the globe, and its potential role in the spread of the parasite *Angiostrongylus cantonensis*.

1.1. Taxonomy of *Achatina fulica*: Mollusca, Gastropoda, Stylommatophora, Achatinoidea, Achatinidae

Achatina fulica belongs to the phylum Mollusca, the second largest animal phylum in the world, with an estimated total species diversity ranging from less than 50,000 to as much as 200,000 and inhabiting freshwater, marine and terrestrial habitats (van Bruggen, 1995). Although members of this phylum exhibit diversity in form as exemplified by snails, clams, octopods, squids, chitons and the tusk shells, this group possesses three unique hallmarks that distinguish its members from other animal phyla. These hallmarks are: (1) a muscular foot for locomotion; (2) a fleshy skin fold called a mantle that secretes a calcareous shell; and (3) a feeding organ called a radula. Some molluscan groups may have lost one or more of these hallmarks during the course of evolution, but their ancestors clearly had all three as shown by fossil records (Ruppert *et al*., 2004). Other characteristics of molluscs are the lack of true segmentation, the reduction of the body cavity, and the presence of spiral cleavage during early development (van Bruggen, 1995).

Terrestrial slugs and snails like *Achatina fulica* belong to the Gastropoda, the largest taxonomic class in the Mollusca, in which members have a characteristic head-foot region and a visceral mass (Ruppert *et al*., 2004). Gastropods undergo torsion during larval development that leads to the 180^0 rotation of the visceral mass and brings the ctenidia or gills and the excretory organs to the anterior region above and behind the head (Barker, 2001). There are an estimated 30,000-35,000 species of terrestrial snails and slugs (Solem, 1984), and many of these have become very important to Man either as a food source, parasite vectors, ornaments or even tools (Barker, 2001). The majority of terrestrial snails and slugs, including *A. fulica*, do not have gills but instead have a vascularised chamber or a ‘lung’ within the mantle cavity, a characteristic of the subclass Pulmonata. The groupings within the pulmonates are still in a state of flux as disagreements still persist regarding interpretations of evolutionary pathways based on conchological and anatomical characters, but most workers agree on the monophyly of the (sub)order Stylommatophora. Stylommatophorans like *A. fulica* characteristically have two pairs of caudal tentacles, with the upper pair bearing eyes at the tip (Ruppert *et al.*, 2004); a contractile pneumostome that minimises contact between the environment and the pallial cavity that houses the lung, kidney and ureter; and the lack of an operculum that covers the aperture (Barker, 2001). Around 71-92 families constitute the Stylommatophora (Emberton *et al.*, 1990). Recent molecular evidence from (1) sequences from the rRNA cluster (Wade & Mordan, 2000); (2) primary sequence data of mitochondrial genes, particularly the absence of entire stem/loop structures in some domains of the mitochondrial 16S rRNA gene (Lydeard *et al.*, 2000); (3) sequence data provided by the cytochrome c oxidsase subunit I (COI) gene (Remigio & Hebert, 2003); and (4) rare genomic changes in the trnP and COI genes (Grande *et al.*, 2004) all support the monophyly of the Stylommatophora.

1.2.1. Classification of the Stylommatophora based on morphological data

There is considerable debate as to how the Stylommatophora should be subdivided into groups that reflect true evolutionary relationships. The widely used but criticised Pilsbry-Baker System divides the Stylommatophora into four infraorders based on the excretory system (Pilsbry, 1900; Baker, 1955). The main excretory organ is made up of three parts: (1) a neprhidium or neprhidial sac (=kidney); (2) a distal ureteric pouch or orthureter; and (3) a separate ureter represented either as an open ciliated groove or a closed tube. Based on variations of these structures, the four infraorders are as follows: (1) Orthurethra (those with nephridium, orthureter with an anterior nephropore, and a ureter developed as a groove, the proximal part of which lies along the rectal face of the nephridium, Figure 1.1A); (2) Mesurethra (those with neither an orthureter on the nephridium nor a closed ureter, Fig. 1.1B); (3) Sigmurethra (those without an orthureter but with a ureter that runs along the anterior portion of the nephridium and connects to the pallial cavity before terminating at the pneumostome, Fig. 1.1C); and (4) Heterurethra (those without an orthureter, with the nephridium extending transversely, and a ureter that runs along the face of the kidney before following the rectum and terminating at the pneumostomal opening Fig. 1.1D). It has been hypothesised that the orthurethran type of excretory system is the most 'primitive' or ancient while the other types are derived from it (Pilsbry, 1900; Baker, 1955; Barker, 2001). Based on this classification system¸ *A. fulica* is included in the Sigmurethra.

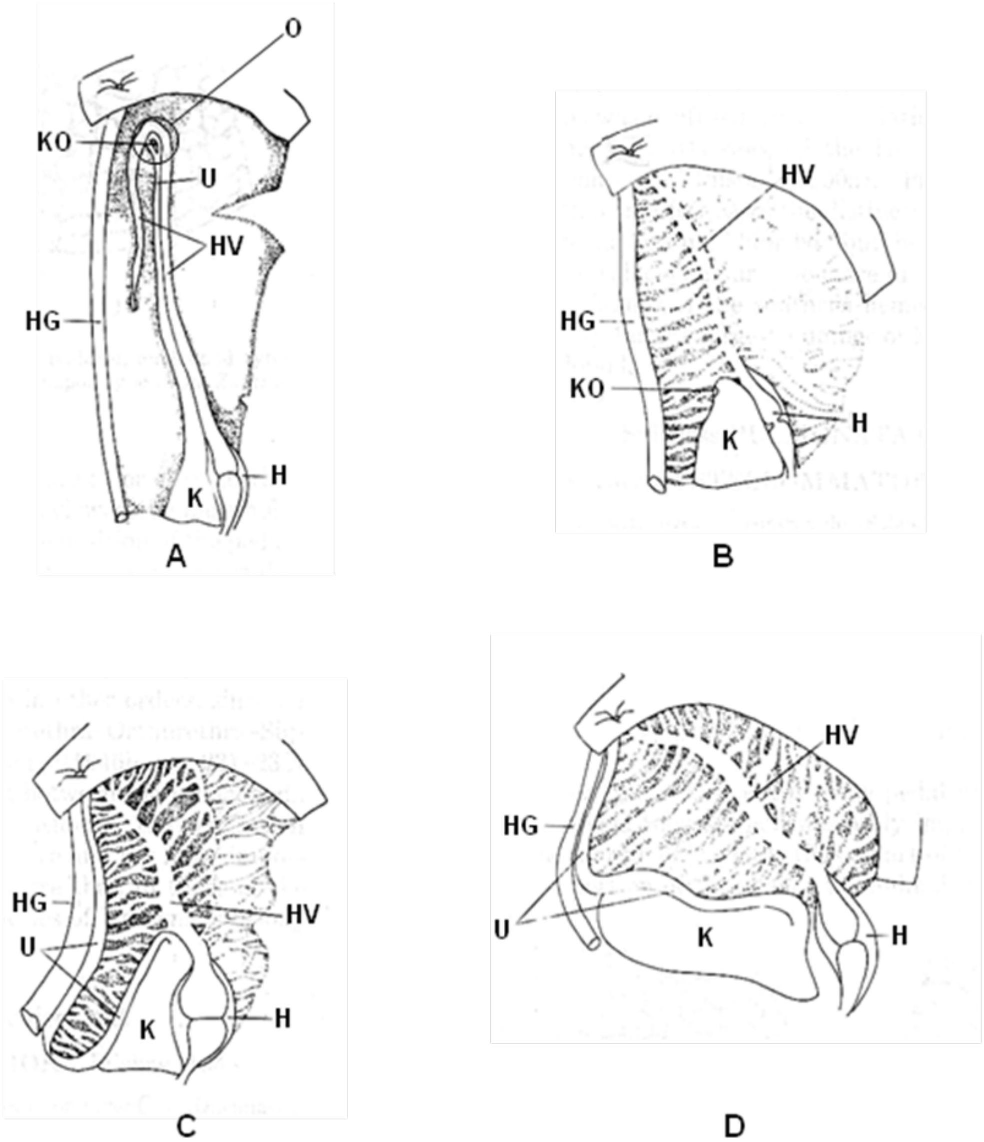

Figure 1.1: The Pilsbry-Baker system of classification of the Stylommatophora based on the structures of the excretory organ. K – neprhidium (=kidney); U – ureter; KO – renal orifice or nephropore; O – orthureter; HG – hindgut; HV – principal pulmonary vein; H – heart. The four infraorders of the Stylommatophora are (**A**) – Orthurethra; (**B**) – Mesurethra; (**C**) – Sigmurethra; (**D**) – Heterurethra. (From Solem, 1959)

Pilsbry's classification system is not without its critics (Simroth & Hoffmann, 1908-1928; Thiele, 1929-1935). Tillier (1989) proposed an alternative classification system based on the differentiation within the renal organ. He retained the Orthurethra as one suborder but divided the other stylommatophorans into two different suborders: the Brachynephra in which the shortening of the kidney took place followed by closure of the ureter; and the Dolichonephra, in which the ureter closed first before the kidney shortened. He also based his classification scheme on the various groups' current distributions that corresponded to regions that were once part of either of the two hypothetical supercontinents that resulted from the breakup of the Pangaean landmass 200 million years ago. The Orthurethra have a mixed Laurasian (Europe, North America and Asia) and Gondwanian (South America, Africa, India, Australia) distribution, the Brachynephra includes representatives that are wholly or partly Gondwanian, and the Dolichonephra have members with Laurasian links. In this classification scheme, *A. fulica* is placed in the Dolichonephra. However, Nordsieck (1992) criticised Tillier's system and believed that overemphasis was given to the differentiation within the renal organ. Instead, he divided the Stylommatophora into two suborders: the Orthurethra that bear an orthurethran excretory system and have a primarily Laurasian origin, and the Sigmurethra with a non-orthurethran system and mixed Laurasian and Gondwanan origins. He agreed with Pilsbry's assumption of the basal position of the Orthurethra. Nordsieck's Sigmurethra also includes *Achatina fulica*.

1.2.2. Relationships within the Stylommatophora based on molecular data

Molecular markers are increasingly being used to infer phylogenetic relationships among groups of taxa because of the advantages they provide. Molecular data are derived from discrete heritable characters, are unambiguous, can easily be subjected to quantitative analyses and homology assessment, may provide characters that can be used to compare distantly related taxa, and are abundant (Graur & Li, 2000).

Although stylommatophoran taxa have been used in a variety of molecular studies examining evolutionary relationships within the Mollusca, relatively few studies have focused on the relationships within the Stylommatophora themselves. Studies that include a handful of representative stylommatophorans, with emphasis on relationships at deeper levels within the Mollusca and the position of the Stylommatophora therein, include those of Winnepenninckx *et al*. (1998) on the small subunit (SSU) ribosomal (r) RNA gene; Thollesson (1999) on the 16S rRNA gene; Lydeard *et al.* (2000) on the secondary structures of the 16S rRNA gene; Wade & Mordan (2000) on the rRNA cluster; Remigio & Hebert (2003) on the COI gene; Colgan *et al.* (2003) on the SSU rRNA, COI and histone 3 genes; Grande *et al*. (2004) on the rare genomic changes in the trnP and COI genes; and Passamaneck *et al*. (2004) on the LSU and SSU rRNA genes.

Studies focusing on the evolutionary relationships within the Stylommatophora include those of Armbruster *et al*. (2005) and Wade *et al.* (2001; 2006). Armbruster *et al*. (2005) surveyed 18 species from eight families of the Stylommatophora using the combined coding regions of the histone 3 and histone 4 genes. Their study demonstrated the basal position of the Helicidae relative to Punctidae, Clausiliidae, Pupillidae, Enidae, Vertiginidae, Cochlicopidae, and Valloniidae. *Achatina fulica* was not represented in their study. Wade *et al*. (2001, 2006) conducted a more comprehensive phylogenetic study of the Stylommatophora with initially 104 species from 50 families including *A. fulica* (2001), which they expanded to 160 species encompassing 61 families (2006). They utilised DNA sequence data from the nuclear rRNA gene cluster spanning a 1460 bp region of the 5.8S rRNA gene, the internal transcribed spacer (ITS) 2 region and the large subunit (LSU) ribosomal (r) RNA gene and comprising 823 unambiguously aligned nucleotides used for phylogenetic analysis (Figure 1.2). Although the results they obtained were in general agreement with currently accepted taxonomic families, a clear and unexpected dichotomy of the

Stylommatophora into two clades was also revealed: the strongly supported 'achatinoids' (99% NJ bootstraps for both the 2001 and 2006 studies) and the weakly supported 'non-achatinoids' (65% NJ bootstraps for the 2001 study and 63% NJ bootstraps for the 2006 study). Both clades included members with Laurasian and Gondwanian distributions, implying that the radiation of the Stylommatophora predated the breakup of Pangaea into Laurasia and Gondwana some 200 million years ago. This also implies that the sigmurethran type of excretory system is ancestral with all the other types being derived from it, contradicting Pilsbry's assumption of a basal Orthurethra and suggesting that the Orthurethra is a derived group.

Additionally, several studies have focused on specific taxonomic groups within the Stylommatophora, as exemplified by Dutra-Clarke *et al.* (2001) on the Succineidae using the SSU rRNA gene; Holland & Hadfield (2004) on endemic Hawaiian Achatinellinae using the COI gene; Steinke *et al.* (2004) on the western Palearctic Helicidae also using the COI gene; and Tongkerd *et al*. (2004) on the Thai Pupillidae using the LSU and the 16S rRNA genes.

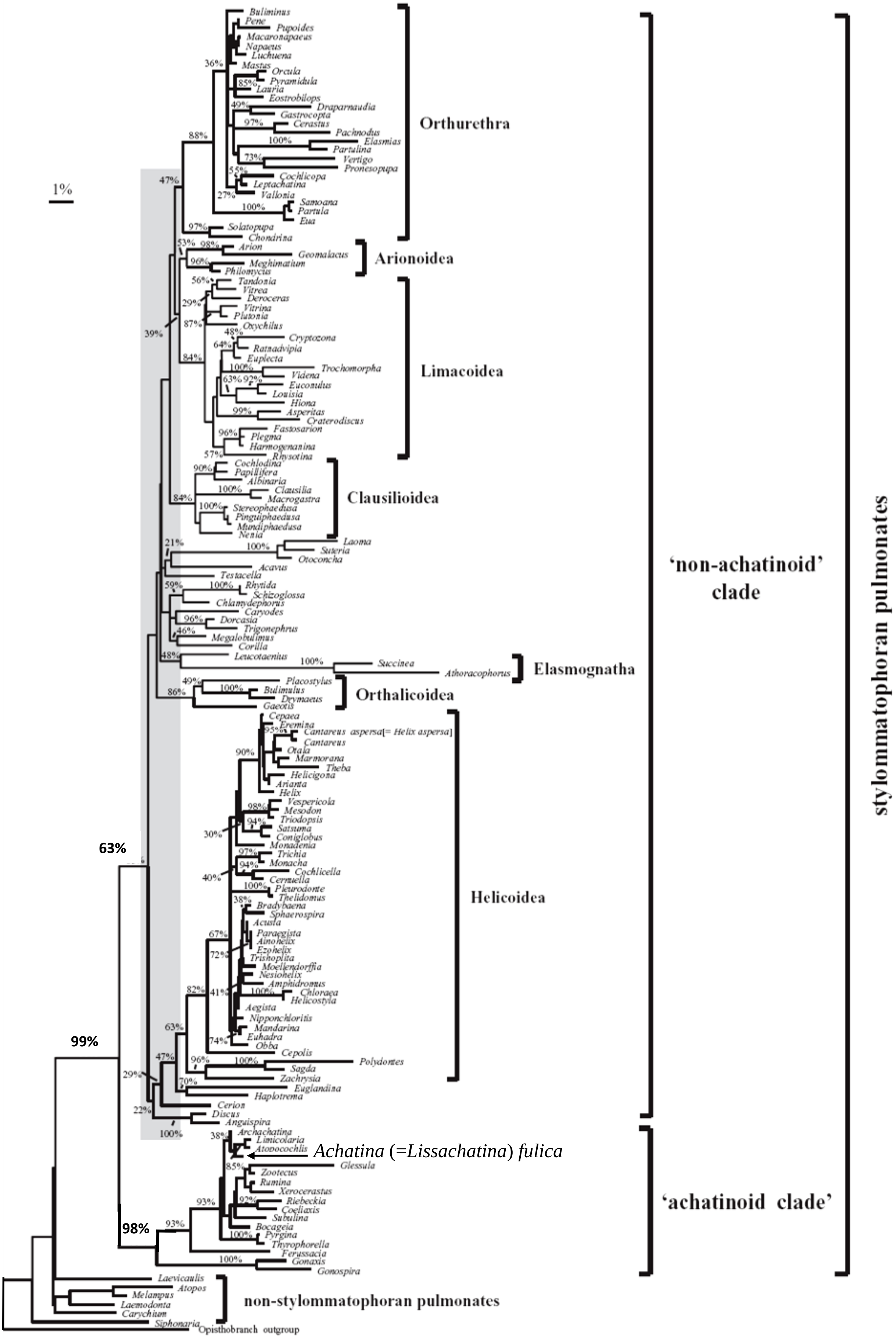

Figure 1.2: Neighbor-joining phylogenetic tree of the Stylommatophora based on the large subunit rRNA gene (823 unambiguously aligned nucleotide sites). The phylogeny shows dichotomy of the group into the 'achatinoid' (bootstrap support=99%) and the 'non-achatinoid' (bootstrap support=63%) clades. (From Wade *et al*., 2006.)

1.2.3. The ‘achatinoid clade’ and the Achatinoidea

The ‘achatinoid clade’ of Wade *et al.* (2001, 2006) based on the rRNA cluster consisted of two superfamilies: the Streptaxoidea and the Achatinoidea. Traditionally, the Streptaxoidea comprises only a single family, the Streptaxidae. They are the only carnivorous group within the ‘achatinoid clade,’ and have a long buccal mass and short oesophagus reflecting their carnivorous adaptation (Tillier, 1989). The other families in Wade *et al.*’s ‘achatinoid clade’ belong to the superfamily Achatinoidea, which included representatives of the Achatinidae, Coeliaxidae, Ferussaciidae, Subulinidae, Glessulidae and Thyrophorellidae. Various authors have different views as to which families constitute the Achatinoidea. Solem’s (1978) Achatinacea (=Achatinoidea) comprised the Achatinidae, Ferussaciidae, Megaspiridae, Spiraxidae and Subulinidae (including the coeliaxids and glessulids as the subfamilies Coeliaxinae and Glessulinae, respectively) while Abbott (1989) regarded Coeliaxidae as a family in its own right while additionally including the monotypic Thyrophorellidae. Tillier’s (1989) Achatinoidea comprised the Achatinidae, Ferussaciidae, Subulinidae (including the subfamilies Coeliaxinae and Glessulinae), Thyrophorellidae as well as the Streptaxidae, Succineidae and the Oleacinidae (Spiraxidae and Testacellidae). Tillier treated the Achatinoidea as those with a closed ureter, symmetrical cerebro-pedal connectives, short cerebral commissure, and contiguous left parietal and visceral ganglia; however, he also included the Succineidae because of superficial features it shares with the Ferussaciidae and the presence of a heterurethran type of excretory organ. Vaught (1989) incorporated the Achatinidae, Coeliaxidae, Ferussaciidae, Subulinidae, (including the Glessulidae which Vaught regarded as subfamily Glessulinae) and Thyrophorellidae in her Achatinoidea. Schileyko (1999) placed only the Achatinidae in the Achatinoidea, whereas Bouchet & Rocroi (2005) included the Achatinidae, Ferussaciidae, Subulinidae (which also incorporated the coeliaxids and glessulids as the subfamilies Coeliaxinae and Glessulinae) and Micractaeonidae. In Wade *et al.*'s (2006) study, the Spiraxidae (represented by *Euglandina*) and Succineidae (represented by *Succinea*) fell within the 'non-achatinoid' clade and not within the Achatinoidea, thus contradicting Solem (1978) and Abbott (1989) for their inclusion of the Spiraxidae in the Achatinoidea and Tillier (1989) for his inclusion of the Oleacinidae (Spiraxidae and Testacellidae) and the Succeinidae. The Micractaeonidae, which are presumably distantly related to the Ferussciidae (Schileyko, 1999), were not represented in the Wade *et al.* study. Table 1.1 summarises the various authors' groupings of the Achatinoidea.

Table 1.1: The Achatinoidea according to various authors in comparison with the Achatinoidea by Wade *et al.* (2006) based on molecular data (rRNA cluster).

Solem (1978)	**Abbott (1989)**	**Tillier (1989)**	**Vaught (1989)**	**Schileyko (1999)**	**Bouchet & Rocroi (2005)**	**Wade *et al.* (2006)**
Achatinidae Ferussaciidae Megaspiridae Spiraxidae Subulinidae (including Coeliaxinae & Glessulinae)	Achatinidae Coeliaxidae Ferussaciidae Spiraxidae Subulinidae Thyrophorellidae	Achatinidae Ferussaciidae Oleacinidae* Streptaxidae Subulinidae (including Coeliaxinae & Glessulinae) Succineidae Thyrophorellidae	Achatinidae Coeliaxidae Ferussaciidae Subulinidae (including Glessulinae) Thyrophorellidae	Achatinidae	Achatinidae Ferussaciidae Micractaeonidae Subulinidae (including Coeliaxinae & Glessulinae)	Achatinidae Coeliaxidae Ferussaciidae Glessulidae Subulinidae Thyrophorellidae

* Oleacinidae – Spiraxidae + Testacellidae

The Achatinoidea in Wade *et al.*'s (2006) study were represented by 14 taxa, and their relationship was evaluated using only a short fragment (823 unambiguously aligned nucleotides) of the rRNA cluster. Increasing the number of taxa and using more genes could shed more light on the relationships of the various achatinoid groups and the validity of the taxonomic designation of the families under the Achatinoidea.

1.2.4. The Achatinidae

The family Achatinidae is a group of land snails confined to Sub-Saharan Africa, with the exception of *Achatina fulica*, which has been introduced by Man to areas outside Africa (Mead, 1979; Raut & Barker, 2002). Their shells are mostly dextral, higher than wide and are fusiform, ovoid or pillar-shaped (Schileyko, 1999). Classification within the family is based on conchological features (Bequaert, 1950) and the highly variable reproductive tract (Mead, 1991). There are three subfamilies within the Achatinidae: (1) the Callistopeplinae in which members have medium sized shells with a truncated columellar margin and a vas deferens that is not attached to the penis sheath (Mead, 1994); (2) the Limicolariinae in which members also have medium sized shells but with a non-truncated columellar margin and a vas deferens that is attached to the penis sheath (Schileyko, 1999); and (3) the Achatininae with medium to large shells with truncated columellar margin and a vas deferens that is also attached to the penis sheath (Mead, 1994). Variation also exists within the subfamilies. In the Achatininae, for instance, the East African *Achatina* (*Lissachatina*), to which *A. fulica* belongs, has a smooth nepionic whorl (Bequaert, 1950) and a half-dome apex (Mead, 1995) as well as a muscular bulboid enlargement of the basal vagina (Mead, 1991; 1995) while the West and Central African *Achatina* (*Achatina*) has a sculptured nepionic whorl (Bequaert, 1950), a plateaued apex (Mead, 1995) and no muscular bulboid enlargement in the basal vagina (Mead, 1991; 1995).

Despite the huge amount of morphological data available on the Achatinidae, no systematic molecular approach has yet been attempted to correlate molecular data with the morphological data, in particular to assess the designation of *Achatina fulica* under the subgenus *Lissachatina* based on conchological and anatomical features.

1.3. The biology of *Achatina fulica*

Achatina fulica is a large snail with a shell length ranging from 5 to 10 cm, with some specimens even reaching 20 cm. The conical shell is light brown in colour, though the colour pattern may vary (Schotman, 1989). The presence of streaks is associated with a dominant allele such that homozygous recessive individuals have unstreaked shells (Allen, 1983). However, variation in shell morphology in terms of size, shape and colour exists and has been largely attributed to environmental conditions (Mead, 1961).

A typical *A. fulica* has a life span of 5-6 years, becoming sexually mature as early as five months. Although hermaphroditic, *A. fulica* cross-fertilises and lays eggs 8-20 days after mating. The number of eggs laid can vary depending on the age of the snail but can reach up to 1800 in a year in a tropical setting. If conditions become unfavourable, the snail can aestivate by burrowing underground and covering its shell opening with a calcareous membrane, called an epiphragm, until such time as the environment improves (Mead, 1979, Raut & Barker, 2002).

1.4. The biology of introduced species

Achatina fulica is a classic example of an introduced species. Introduced species, also known as exotic species, are those found outside their natural range due to human activity (Primack, 2006). Species may be introduced deliberately to benefit Man, with examples including agricultural plants and animals for human consumption, decorative plants for gardening, and animals for hunting or fishing. Other species may be introduced unintentionally such as parasites or pests found in deliberately introduced species and those that “hitchhike” with transported goods (Freeland, 2005).

Species introduced by Man to new areas can have a profound effect on the ecosystem of that area as well as on the introduced species itself. They can prey upon, infect, outcompete or hybridise with native species or alter the habitat at the expense of the native species (Simberloff *et al*., 2005), thus providing additional selective pressure on the native species (Suarez & Tsutsui, 2008). A balancing act must therefore come into play between the native species and the introduced species, and sometimes even between the introduced species and the local environment of the invaded habitat; otherwise, either the native or introduced species will face displacement or extinction (Suarez & Tsutsui, 2008). The disturbance caused by introduced species has become problematic in many areas such that they have been regarded as the second greatest threat to biodiversity, next only to habitat loss (Freeland, 2005). In some cases, however, introduced species simply spread into new areas that are human-disturbed from which most native species have already disappeared due to habitat loss (Cowie & Robinson, 2003).

Not all species become easily established once translocated into a new area, but characteristics such as a rapid reproduction rate, high fecundity and generalist food and habitat requirements can increase the success of an introduced species (Cowie, 2000). Organisms that become invasive are also most likely to possess traits that facilitate their transport by humans, the ability to withstand the rigours of transport, the capacity to tolerate varying environmental conditions, and the predilection to thrive in human disturbed areas (Suarez & Tsutsui, 2008). As mentioned previously, species may be introduced deliberately or inadvertently, although those in the former category may have a greater chance of being established, particularly if the introduction is perceived to have some economic benefits. Deliberate introductions involve individuals that are cared for and are brought to new areas in large numbers, thus improving their chance of survival once they are released in the wild (Cowie & Robinson, 2003).

The success of an introduced species in a new area can also be influenced by the genetic composition of its population. In many cases, introduced species are represented by a few individuals with a reduced amount of genetic variation when compared to their source population, a phenomenon called a founder effect. After many generations, a population bottleneck ensues where genetic variation is considerably reduced and allele frequencies undergo massive shifts (Dlugosch & Parker, 2008). As a consequence, some beneficial adaptive traits that could otherwise improve the survival and fitness of the species in the new habitat may be lost (Kolbe *et al*., 2007). However, this low genetic variability as a result of founder events and bottlenecking could be counteracted by multiple introductions from different source populations (Dlugosch & Parker, 2008), as was shown in the cheatgrass *Bromus tectorum* (Novack & Mack, 1993) and the *Anolis* lizards (Kolbe *et al.*, 2007).

1.5. *Achatina fulica* as an introduced species and its dispersal from East Africa

Man has always been drawn to the Giant African Land Snail for reasons including its large size, supposed medicinal properties and its potential as a human or animal food source (Mead, 1979; Kliks & Palumbo, 1992; Raut & Barker, 2002). It is for these reasons that *Achatina fulica* has been spreading globally primarily through human factors, and its success as an introduced species can be attributed to several factors.

First, the biology of *Achatina fulica* makes it eminently suitable as an introduced species. The snail has a high reproductive capacity, producing between 10 and 400 eggs per clutch and as many as 1800 eggs per year; they also become sexually mature between 5 and 8 months (Raut & Barker, 2002). *Achatina fulica*'s high reproductive capacity, in addition to the tendency of people to release the snails into the wild, would help to explain the rapid spread of *Achatina fulica* into new areas, as in Brazil where it was introduced as recently as 1988 but has since spread (Thiengo *et al*., 2007). The Giant African Land Snail is a voracious herbivore that feeds on a wide range of cultivated plants and even weeds and indigenous plants, thus making it a serious crop pest (see Raut & Barker, 2002 for a comprehensive list of economically important food crops and ornamental and medicinal plants that are susceptible to *Achatina fulica*). It also scavenges its food from detritus and decaying plant material, which may comprise up to 75% of its diet (Raut & Barker, 2002). Its non-specific food requirements further leads to its success as an introduced species.

Second, *Achatina fulica* possesses traits that facilitate its transport by humans. For instance, the snails can easily be transported in consigned cargoes, whether accidentally or on purpose, and survive the journey of several days with little adverse effect on the "hitchhikers." This was demonstrated by a tourist who came from Hawaii and inadvertently brought a live snail to the mainland USA over a period of ten days (Mead, 1979). During these periods of long distance travel, the snails can undergo aestivation to avoid desiccation (Mead, 1961). Furthermore, *A. fulica* has a wide tolerance for different environmental conditions despite being a tropical snail (Mead, 1979; Raut & Barker, 2002). They have been found to survive temperatures as low as 2^0 C in India and altitudes as high as 1500 meters in Malaysia (Raut & Barker, 2002). In addition, they can thrive in a range of soil pH, moisture and plant cover conditions as well as withstand a diverse group of predators (Mead, 1979). Lastly, *A. fulica* has frequently been associated with human disturbed areas such as agricultural lands and gardens, though they have also been found in primary and secondary forests in Hawaii, the Bonin Islands, India, Southeast Asia and New Caledonia (Raut & Barker, 2002).

Third, *Achatina fulica* is commonly introduced deliberately and is therefore transported in large numbers and properly cared for, which then increases its chance of survival. In Brazil, *Achatina fulica* was introduced in 1988, probably from Indonesia, when it was heralded as an alternative source of meat. These snails were then distributed for commercial purposes but were subsequently released when people eventually lost interest. As a consequence, Brazil is currently experiencing an explosive stage of the invasion that is characterised by large individuals that are prevalent in urban areas, particularly in gardens (Thiengo *et al*., 2007). Other deliberate introductions include those in Borneo where duck farmers used the snails as feed (Jarrett, 1931), those in Nepal where the snails were introduced in local gardens and venerated for their religious significance (Budha & Naggs, 2008) and those in the Indo-Pacific where Japanese soldiers and merchants before and during the Second World War used the snails as food and sometimes as pets (Kliks & Palumbo, 1992; Civeyrel & Simberloff, 1996).

Although currently distributed in many areas around the globe, it is possible to elucidate the route of dispersal of *Achatina fulica* since before the 1800's. The snail is thought to be indigenous to East Africa, specifically Kenya and Tanzania. It is believed to have been introduced into Madagascar and Mauritius in the early 19th century (Bequaert, 1950) and subsequently to have spread to the Indian subcontinent, Southeast Asia, most islands of the Pacific (Mead, 1961; Kliks & Palumbo, 1992), the Caribbean (Schotman, 1989) and South America (Paiva, 1999; Thiengo *et al*., 2007; Borrero *et al*., 2009). It has also been recently detected in West Africa (Raut & Barker, 2002). There are several pathways or activities that are available to the snail that enables it to spread quickly to new areas. These are the accidental transfer by humans, usually by hitchhiking onto agricultural machinery and even in cars and trucks (Cowie & Robinson, 2003) and the intentional transfer by humans as pets, for food consumption or for other uses (Mead, 1979; Kliks & Palumbo, 1992; Cowie & Robinson, 2003).

To date, no systematic evaluation of the genetic variation of *Achatina fulica* across global populations has been undertaken. Such data could indicate the number of genetic types that have been introduced in the snail's new range. Furthermore, results from such a global survey would reveal if introduced populations of *A. fulica* are undergoing genetic bottlenecks as a consequence of a lack of genetic variation, or if multiple introductions from various source populations took place that could potentially counteract the effects of bottlenecking.

1.6. Parasites of molluscs

Parasitism is a relationship between two organisms where the parasite thrives on or within the host, which is harmed in some way (Roberts & Janovy, 2005). Many organisms are known to parasitise molluscs. These parasites use molluscs either as intermediate hosts, where the parasite develops but does not reach sexual maturity, as definitive or final hosts where the parasite reaches the adult stage, or as permanent hosts where the entire development of the parasite takes place in the host (Malek & Cheng, 1974; Roberts & Janovy, 2005). Examples of known parasites of molluscs include bacteria such as *Mycobacterium* in the gastropod *Helisoma anceps* (Malek & Cheng, 1974) and *Aeromonas hydrophila* in *Achatina fulica* (Dean *et al.*, 1970), protozoa such as *Hartmanella* sp. in the gastropod *Biomphalaria* (Malek & Cheng, 1974), trematodes such as *Schistosoma japonicum* in the gastropod *Oncomelania quadrasi* (Malek & Cheng, 1974) and *Echinostoma* in the apple snail *Pomacea* (Hollingsworth & Cowie, 2006), and copepod arthropods such as *Mytilocola intestinalis* in the blue mussel *Mytilus edulis* (Malek & Cheng, 1974) and nematodes such as *Oslerus ostratus* in the pulmonate slug *Laevicaulis alte* and *Nemhelix bakeri* in the pulmonate snail *Helix aspersa* (Grewal *et al.*, 2003). Molluscs act as intermediate hosts for several medically important parasites, as exemplified by trematodes such as *Schistosoma* that leads to schistosomiasis (a liver disease characterised by an enlarged liver and spleen, diarrhea, and bloody urine) (Roberts & Janovy, 2005), *Fasciola* that induces fasciolariasis (necrosis of the liver) (Roberts & Janovy, 2005), *Echinostoma* that causes echinostomiasis (an intestinal disease that leads to headache, dizziness, gastic pain, anemia and diarrhea) (Hollingsworth & Cowie, 2006) as well as nematodes such as the rat lungworm *Angiostrongylus cantonensis* that leads to eosinophilic meningioencephalitis (see below).

1.7. Nematode parasites of *Achatina fulica*

Various nematodes are associated with molluscs (Grewal *et al*., 2003; Morand *et al*., 2004), including *Achatina fulica*. Members of the phylum Nematoda are typically bilaterally elongated and tapering at both ends. They also have a characteristic body cavity called a pseudocoelom that is derived embryologically from the blastocoel, which normally disappears during gastrulation in eucoleomate animals but not in nematodes. These animals possess a non-cellular body covering called the cuticle that is shed four times during their lifetime through moulting; these worms therefore have four juvenile stages (sometimes incorrectly referred to as larval stages) that resemble the final adult stage in form. Nematodes include sexually dimorphic species (e.g. the rat lungworm *Angiostrongylus cantonensis*) as well as hermaphroditic species (e.g. the soil nematode *Caenorhabditis elegans*). Other characteristics include a complete digestive system, absence of circular muscles in the body cavity, and in the case of sexually dimorphic species, the presence of females that are generally larger and males that have a more curled tail (Roberts & Janovy, 2005).

Molluscs are infected by nematodes either as intermediate hosts of the juvenile worms or as definitive or final hosts of the adult worms (Grewal *et al*., 2003; Morand *et al*., 2004). In total, 108 species have been found to infect gastropods, with 61 using these gastropods as intermediate hosts and 47 using gastropods as final hosts (Grewal *et al*., 2003). Evolutionarily speaking, it has been postulated that parasitic nematodes started out as facultative parasites in which free-living forms accidentally infected animals (Adamson, 1986). Morand *et al*. (2004) used Blaxter *et al*.'s (1998) phylogeny of the Nematoda to map the occurrence of parasitism in terrestrial molluscs among the different nematode groups. They hypothesised that nematode parasitism in terrestrial molluscs occurred independently at least five times.

Very limited data are available on nematode species associated with *Achatina fulica*. Nematodes shown to be associated with *A. fulica* include *Oslerus ostratus*, which uses *A. fulica* as an intermediate host (Grewal *et al*., 2003), *Rhabditis* sp., most likely a facultative parasite of the snail (Viyada, 2005), and the medically important *Angiostrongylus cantonensis*, the rat lungworm, which uses the snail as an intermediate host (see Mead, 1979 for a detailed list of *A. fulica* survey for *A. cantonensis*).

1.8. *Angiostrongylus cantonensis*: the nematode that hitched along

Angiostrongylus cantonensis is a parasite of rodents that requires a gastropod intermediate host such as *Achatina fulica* to complete its life cycle. The nematode's definitive or final hosts are murid rodents such as the black rat (*Rattus rattus*), the brown rat (*Rattus norgevicus*), the Pacific rat (*Rattus exulans*), the oriental house rat

(*Rattus tanezuni*), the Philippine forest rat (*Rattus everetti*) and the malabaric bandicoot rat (*Bandicota malabarica*) (Alicata, 1966; Westerlund & Chamberlain, 1969; Marquardt *et al*., 2000). Humans can also get infected by acquiring the 3rd juvenile stage of the worm from several of its snail or slug intermediate hosts, including *Achatina fulica* (Alicata, 1966; Marquardt *et al.*, 2000), which leads to a disease of the nervous system called eosinophilic meningoencephalitis (EME) or angiostrongyliasis (Marquardt *et al*., 2000).

1.8.1. The taxonomy of *Angiostrongylus cantonensis*: Nematoda, Rhabditea, Strongylida, Metastrongyloidea, Angiostrongylidae

Angiostrongylus cantonensis belongs to the phylum Nematoda, a group including some of the most abundant animals in the world. There are more than 25,000 described species of nematodes, with 10,000 known to be free-living and more than 15,000 known to be parasitic on animals (Poulin & Morand, 2000; Hugot *et al*., 2001). Roberts & Janovy (2005) predicted that current figures pertaining to the diversity of the Nematoda are underestimates and that there may be more species of nematodes than there are of insects, which Ruppert *et al*. (2004) estimate to be around 30 million. Nematodes can be divided into two main classes, the Enoplea and the Rhabditea, based on the presence of certain sensilla or small sense organs. Members of the Enoplea possess pouch-like anterior sensilla called amphids whereas members of the Rhabditea, including *Angiostrongylus*, have ventrally coiled amphids; many rhabditeans also possess sensilla called phasmids near the posterior end. Within the Rhabditea is the order Strongylida that includes long, slender worms with males having the characteristic copulatory bursa supported by sensory rays (Roberts & Janovy, 2005). Within the Strongylida is the superfamily Metastrongyloidea whose members utilise mammals as definitive hosts, with many occupying the host lungs during the adult stage (Anderson, 2000).

The genus *Angiostrongylus* belongs to the family Angiostrongylidae in the Metastrongyloidea. Members of this family have an adult stage that possesses a posterior vulva (Anderson, 2000) but not a buccal cavity or lips at the mouth. They reside in the lungs of the mammalian final hosts and require an invertebrate intermediate host (Roberts & Janovy, 2005). *Angiostrongylus* itself was regarded by Ubelaker (1986) as a heterogeneous group, and he suggested that, on the basis of the morphological differences in the copulatory bursa in adult males as well as differences in their mammalian final host specificity, the genus should be split into five distinct genera including *Parastrongylus* (which Ubelaker was resurrecting and was first described by Baylis in 1928 using *Parastrongylus tateronae* as the type species) as well as *Angiostrongylus* (first described by Baillet in 1866 using *Angiostrongylus vasorum* as type species). In *Parastrongylus*, the lateral rays of the copulatory bursa arise from a single common trunk in adult males whereas those in *Angiostrongylus* arise separately (Fig. 1.3). In terms of their final hosts, *Parastrongylus* utilises murid rodents whereas *Angiostrongylus* infects carnivores like dogs, foxes and cats (Ubelaker, 1986). Based therefore on these characteristics, Ubelaker reclassified *Angiostrongylus cantonensis* as *Parastrongylus cantonensis*. Other members of *Parastrongylus*, according to Ubelaker, include *Parastrongylus costaricensis* (Central and South America, Cuba and southern North America), *P. dujardini* (Europe) and *P. malaysiensis* (Malaysia). Species retained by Ubelaker in the genus *Angiostrongylus* are *A. vasorum* in foxes and dogs (Africa, Europe, North America and South America) (Anderson, 2000) and *A. chabaudi* in wild cats (central Italy) (Ubelaker, 1986).

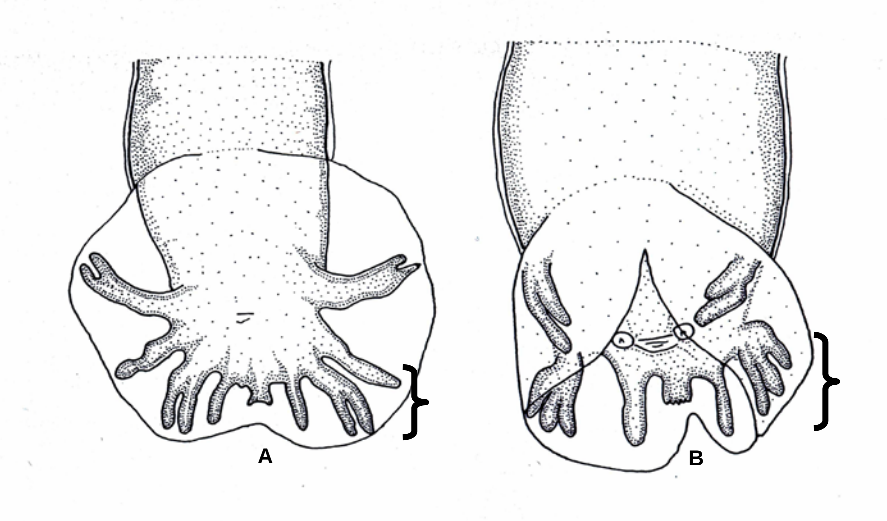

Figure 1.3: Adult male bursa of (**A)** *Angiostrongylus*, i.e. *A. vasorum*, and (**B)** *Angiostrongylus* (=*Parastrongylus*), i.e. *A. cantonensis*. Brackets show lateral rays. Note that the lateral rays arise from a common trunk in (B) but not in (A). From Ubelaker (1986).

The recognition of *Parastrongylus* as a separate genus, however, is not widely accepted and the name *Angiostrongylus* is still used to refer to the genus of *A. cantonensis* and the other species mentioned in the previous paragraph (Kliks & Palumbo, 1992). Molecular data to confirm or refute Ubelaker's designation are also wanting.

1.8.2. Morphology of *Angiostrongylus cantonensis*

Adult female *A. cantonensis* range from 17 to 33 mm long and 0.28 to 0.5 mm wide, whereas the males tend to be smaller, being only 15 to 22 mm long and 0.25-0.35 mm wide. The worms feed on blood, thus giving a red appearance to their intestines. In females, the intestines intertwine with the uterine tubules, which lend a characteristic barber pole appearance (Marquardt *et al.,* 2000; Roberts & Janovy, 2005). The infective 3rd juvenile stage of the parasite is considerably smaller, around 425-524 μm long and 23-34 μm wide. Although the juvenile is similar morphologically to other species of lungworms like *Aulurostrongylus abstrutus* and *Anafilaroides rostratus*, it can be subtly distinguished by the fine point termination of the tail (Ash, 1970).

1.8.3. The life cycle of *Angiostrongylus cantonensis* (Figure 1.4)

The mature adult worms reside for approximately two weeks in the subarachnoid space separating the meninges of the rat brain. After that period, they move into the circulatory system through the venous system until they reach the heart where the females begin laying their eggs. The arterial blood then brings these eggs to the lungs where they get lodged in the alveoli. As the 1st juvenile stage emerges from the eggs, they are passed from the lungs into the trachea until they reach the gut and stay there for 42-45 days before being eliminated through the faeces (Marquardt *et al*., 2000; Kliks & Palumbo, 1992). A snail or slug intermediate host then gets infected by these juveniles either by ingesting contaminated rodent faeces or by burrowing of the nematodes through the gastropod body wall or respiratory pores (Hollingsworth & Cowie, 2006). These nematodes then progress into the 2nd and 3rd juvenile stages after about 18 days (Marquardt *et al.*, 2000) where they reside mostly in the head-foot region of the gastropod intermediate host, although they can also be found in the lungs, liver and kidneys (Hollingsworth & Cowie, 2006). The 3rd stage juveniles are passed on to definitive hosts such as rats when they ingest infected gastropod intermediate hosts. In the absence of a definitive host ingesting the intermediate host, the 3rd stage juveniles can become quiescent and remain in the intermediate host tissue for months (Hollingsworth & Cowie, 2006). Occasionally, crabs, prawns and planarians act as paratenic hosts in which they passively carry 1st to 3rd juvenile stage worms; consumption of such paratenic hosts can pass on the 3rd stage juvenile worms (Kliks & Palumbo, 1992; Hollingsworth & Cowie, 2006). Once inside the definitive host, the nematodes normally take only one to two days before they reach the central nervous system through the blood where they mature into adult worms after about 13 days (Kliks & Palumbo, 1992; Marquardt *et al.*, 2000).

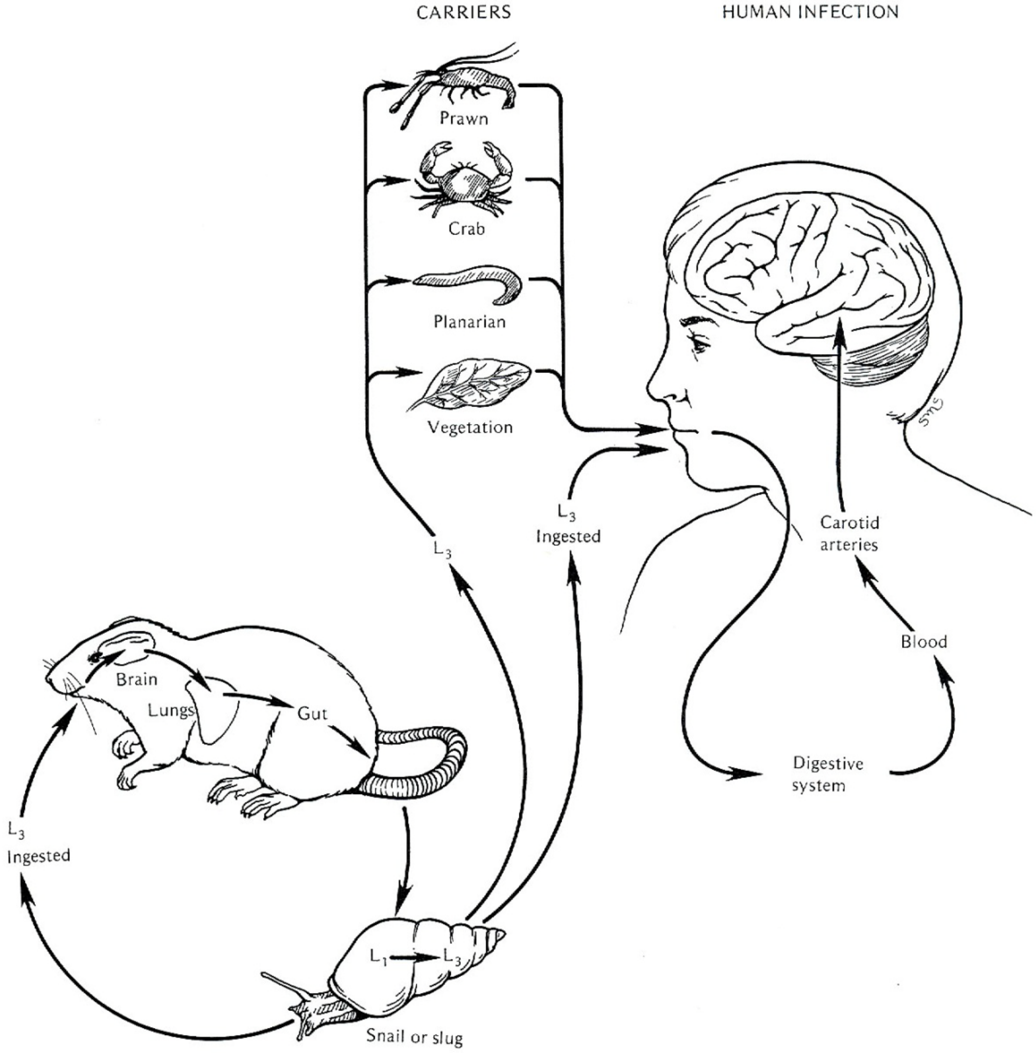

Figure 1.4: Life cycle of *Angiostrongylus cantonensis*. (From Marquardt *et al.*, 2000).

1.8.4. Natural intermediate hosts of *Angiostrongylus cantonensis*

Apart from *Achatina fulica*, there are several other gastropods that serve as natural intermediate hosts of *A. cantonensis* (Anderson, 2000). Gastropods so far identified as hosts include the following: *Hemiplecta sagittifera*, *Helicostyla* *macrostoma*, *Cyclophorus* sp., *Chlorea fibula* (Westerlund & Chamberlain, 1969), *Imerinia plebia* (Salazar & Cabrera, 1969), *Bellamya ingallsiana*, *Bradybaena similaris*, *Cipangopaludina chinensis*, *Deroceras laeve*, *Euglandina rosea*, *Girasia peguensis*, *Indoplanorbis exustus*, *Laevicaulis alte* (also referred to by the name of *Veronicella altae* in the literature), *Macrochlamys resplendens*, *Microparmarion malayanus, Opeas japonicum*, *Pupina complanata*, *Pila ampullacea*, *P. scutata*, *Quantula striata*, *Sarasinula plebeia* (=*Vaginalus plebeius* in the literature) *Subulina octona* (Anderson, 2000) and *Pomacea canaliculata* (=*Ampullarium canaliculatus* in the literature) (Tsai *et al.*, 2001b). Other gastropods that were found experimentally to be susceptible to *A. cantonensis* infection could potentially become intermediate hosts. They are: *Biomphalaria* spp. *Bithynia* sp., *Bradybaena oceania*, *Bulinis* spp., *Deroceras reticulatum*, *Drepanotrema simmonsi*, *Euglandina rosea*, *Euhadra hickonsis*, *Ferrissia tenuis*, *Fossaria ollula*, *Fruticola despecta*, *Helicina orbiculata*, *Helisoma* sp., *Indoplanorbis exustus*, *Lanistes carinatus*, *Limax arborum*, *L. flavus*, *L. maximus*, *L. marginalis*, *Lymnaea* spp., *Marisa cornuarietis*, *Mesodon thyroidus*, *Onchidium* sp., *Physa acuta*, *Planorbis planorbis*, *Plesiophysa hubendicki*, *Segmentina hemisphaerula*, *Semisalcospira libertina*, *Stagnicola elodes* and *Succinea lauta* (Anderson, 2000).

1.8.5. Medical importance of *Angiostrongylus cantonensis*

Angiostrongylus cantonensis is the causative agent of eosinophilic meningoencephalitis (EME) or angiostrongyliasis in humans. In recent years, the geographic range of the nematode and the number of types of animal it infects have been growing rapidly, making EME an 'emerging' disease (Prociv *et al.*, 2000). People accidentally acquire the 3rd juvenile stage through any of the following routes of infection: (1) eating raw or undercooked snails or slugs (Marquardt *et al.*, 2000); (2)

drinking water or food such as raw vegetables or salads contaminated with the parasite such as raw vegetables for salads (Wallace & Rosen, 1969; Marquardt *et al.*, 2000); (3) eating raw or undercooked paratenic hosts like crabs, prawns and (by accident) planarians such as *Platydemus* (Kliks & Palumbo, 1992; Marquardt *et al.*, 2000); or (4) handling infected snails followed by failure to wash hands (Wan & Weng, 2004). Since humans are not the natural definitive hosts of *A. cantonensis*, these worms do not mature into adults inside the human body; however, their presence elicits a whole range of clinical manifestations typical of eosinophilic meningoencephalitis. Symptoms of this disease include headaches, stiffness of the neck, vomiting, paresthesia or abnormal sensation, fever, paralysis and tremors. In response to the presence of the worm, there is also a marked increase in the cerebrospinal fluid and peripheral blood of eosinophils, white blood cells responsible for combating infection and parasites (Kliks & Palumbo, 1992; Marquardt *et al.* 2000; Lee, 2002). Cases of EME are rarely fatal, with patients recovering after the symptoms subside within ten weeks (Hollingsworth & Cowie, 2006). It is not known how many infective 3rd stage juveniles are necessary to elicit EME in humans (Prociv *et al.*, 2000), although fatal cases often involve infection of hundreds or thousands of nematodes, as in the case of one Korean fisherman who died after consuming infected *Achatina fulica* in Pago Pago, American Samoa (Kliks *et al.*, 1982). To date, there is no known antihelminthic drug against *A. cantonensis*, although it is possible to treat infection at an early stage using thiabendazole (Roberts & Janovy, 2005). Most doctors are wary of recommending this drug, however, since worms may be more dangerous dead than alive as they tend to elicit a strong inflammatory reaction that could lead to the formation of a large granuloma and cause further damage (Marquardt *et al.*, 2000; Roberts & Janovy, 2005). On the other hand, mebendazole combined with corticosteroids have been successfully used to treat the symptoms of *A.*

cantonensis-induced meningoencephalitis and shorten the course of infection (Tsai *et al.*, 2001a; Wan & Weng, 2004). Aside from humans, other mammals such as dogs (Mason, 1987), horses (Costa *et al.*, 2000), tamarins (Carlisle *et al.*, 1998) and even a captive white-handed gibbon (Duffy *et al.*, 2004) have also been reported to be susceptible to *A. cantonensis* infection.

1.8.6. The dispersal of *Angiostrongylus cantonensis*

The expanding range of *Angiostrongylus cantonensis* has been attributed largely to the global distribution of rats, although the role of the intermediate hosts such as the Giant African Land Snail should not be ignored. The nematode is believed to have originated either in East Africa (Alicata, 1966) or South or Southeast Asia (Drozdz *et al.*, 1975). Alicata (1966) noted the nearly parallel distribution of *A. cantonensis* and *A. fulica* and postulated that the rapid dispersal of the snail brought about the current geographical distribution of the parasite. Drozdz *et al.* (1975), on the other hand, argued that murid rats were responsible, owing to the long association of the worm with its definitive hosts and the dispersal of the murid rats from tropical Asia. It would be valuable to determine which hypothesis is correct as this would identify which host is primarily responsible for the expanding range of the nematode; hence, appropriate measures could be set in place to control the host. Testing the hypothesis could be addressed by conducting a comprehensive survey to identify *A. cantonensis* among global populations of the nematode’s definitive and intermediate hosts.

1.8.7. Molecular identification of *A. cantonensis* and other nematodes

It is, however, difficult to identify nematodes such as *A. cantonensis* to named species. Few taxonomic experts are available (Floyd *et al.*, 2002), and many worms lack suitable morphological characters to facilitate identification, particularly in the infective juvenile stages (Newton *et al*., 1998). An alternative to morphological identification is the use of DNA 'barcodes' that are unique to individual species. DNA barcoding makes use of a small section of a DNA sequence from a standardised region of the genome to identify species (Dasmahapatra & Mallet, 2006). A 650-bp fragment of the 5' end of the mitochondrial cytochrome *c* oxidase subunit I gene (COI) is most commonly used for barcoding in animals (Hajibabaei *et al*., 2007), although other genes have also been used. For instance, the small subunit (SSU) rRNA gene was employed to rapidly identify individual free-living marine nematodes in Southwest England (Bhadury *et al*., 2006); the gene was likewise used on the parasitic nematodes of the sardine *Sardinella pilchardus* (Santos *et al*., 2006). Through DNA barcoding, unidentified individuals of nematodes such as *Angiostrongylus cantonensis* could be assigned to species, irrespective of life cycle stage. This tool is applied here to rapidly identify 3rd stage juvenile *A. cantonensis* from their gastropod intermediate hosts.

1.9. Major objectives

This thesis will address five major issues concerning *Achatina fulica* over five chapters. A separate chapter, Chapter 2, will summarise all the general protocols to be used for the five chapters.

In Chapter 3, the phylogenetic relationships of the six achatinoid families (Achatinidae, Coeliaxidae, Ferussaciidae, Glessulidae, Subulinidae and Thyrophorellidae) will be evaluated using an expanded coverage of the rRNA gene cluster as well as the nuclear actin and histone 3 genes and the mitochondrial cytochrome c oxidase subunit I and the 16S rRNA genes. The monophyly and validity of these taxonomic families will likewise be assessed.

In Chapter 4, comprehensive molecular-based phylogenetic analyses will be provided for the first time on the Achatinidae using the same molecular markers to be used in Chapter 3 in order to correlate molecular data with the available morphological data and to provide evidence of relationships among the members of this family. The designation of *Lissachatina* as a subgenus of *Achatina* will likewise be evaluated based on molecular data.

In Chapter 5, genetic variation among global populations of *Achatina fulica* will be examined using the 16S rRNA gene. This study will investigate the movement of *A. fulica* out of Africa and its subsequent spread throughout the tropics. It will establish if more than one genetic type has been introduced in the snail's new range and whether genetic bottlenecking is taking place in these populations. The lack of genetic variation, if any, could have a profound impact on the success of *A. fulica* as an invasive species.

In Chapters 6 and 7, focus will be on the nematode parasite of *A. fulica*, *Angiostrongylus cantonensis*. A survey of global populations of *A. fulica* for the parasite will be conducted to determine the possible role of the snail in the spread of the parasite. In Chapter 6, a rapid molecular method of identification for *A. cantonensis* from Philippine samples of *A. fulica* as well as the black slug *Laevicaulis alte* will be developed using a segment of the small subunit (SSU) rRNA gene. Using the same marker, a phylogenetic analysis will also be conducted on representative taxa of the genus *Angiostrongylus* to assess if Ubelaker's designation of *Parastrongylus* has merit based on molecular data. In Chapter 7, global populations of *A. fulica* will be screened for the nematode parasite using the molecular marker developed in Chapter 6. The role of the snail in spreading the parasite will be evaluated in this chapter. In addition, the presence of other types of nematodes in global populations of *A. fulica* will also be reported.

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CHAPTER 2 - General Protocols

Summarized in this chapter are general protocols that are referred to in the succeeding chapters. A brief description, along with some basic concepts, accompanies each method.

2.1. DNA extraction methods

DNA from fresh or preserved samples of snails and nematodes was extracted using several extraction protocols. Each method is described below, along with details of the rationale for their use. As the DNA extracts were used for subsequent PCR amplification, the methods emphasized the removal of polysaccharides and other PCR inhibitors (Demeke & Adams, 1992) as well as nuclease enzymes that could cleave DNA (Rolfs *et al.*, 1992).

2.1.1. DNA extraction of snail tissues using the CTAB protocol (modified from Hillis *et al.* (1996)

This standard and cost-effective protocol was used to extract DNA from snail tissues used for phylogenetic analyses in Chapters 3 and 4. The protocol was applied to fresh, fresh frozen and ethanol-preserved specimens. Traditionally, this technique also includes phenol (Rolfs *et al.*, 1992) but this was excluded here as phenol is a very toxic substance.

1. For ethanol preserved tissues, the tissue slices were soaked in 1 ml TE buffer (10 mM Tris-HCl, 1mM EDTA) for approximately 1 hour in order to remove excess ethanol to soften the tissue prior to DNA extraction.
2. Tissue was cut into small pieces, placed into 500 µl of CTAB solution [100mM Tris-HCl pH 8, 20mM EDTA pH 8, 1.4 mM NaCl, CTAB 2% (w/v)] and ground

using sterile glass beads and a plastic pestle. CTAB (cetyltrimethylammonium bromide) is a non-ionic detergent that precipitates polysaccharides and lyses cells (Richards *et al.*, 1995).

3. 20 µl of Proteinase K (10mg/ml), an enzyme that digests proteins such as nucleases that cleave naked DNA, was added to each tube. This was followed by 10 µl of β-mercaptoethanol, which precipitates polyphenolics (Rolfs *et al*., 1992). The tubes were then vortexed then incubated at 55^0 C for at least one hour until the tissue slices were completely digested.
4. 500 µl of ice-cold chloroform-isoamyl alcohol (24:1) was added, after which the tubes were inverted several times for 5 minutes. This separated the DNA from proteins (Rolfs *et al*., 1992). The tubes were then centrifuged for 10 minutes at 13,000 rpm, after which the aqueous phase was transferred to a new tube (~400 µl). When necessary (i.e. there were a lot of proteins), step 4 was repeated.
5. 2.5 volumes (~1 ml) of ice-cold 95% ethanol and 1/10 volume (~40 µl) of 3M sodium acetate (NaOAc) were added to the mix followed by overnight incubation at -80^0 C to precipitate the DNA (Rolfs *et al.*, 1992). The tubes were centrifuged for 15 minutes at 13,000 rpm, then the supernatant was carefully removed.
6. The remaining pellets were washed with 500 µl of ice-cold 70% ethanol and centrifuged for five minutes at 13,000 rpm to remove salts and small organic molecules. The ethanol was carefully removed afterwards.
7. The remaining pellets were air-dried on a heat block at 45°C for a maximum of 15 minutes. The pellets were then resuspended in 150 µl TE buffer (10 mM Tris-HCl, 1 mM EDTA, pH 8.5).

8. Each suspension was then boiled for 15 min at 100°C to denature any remaining enzymes in order to prolong the life of the DNA extract.
9. The DNA extracts were stored at -80^0 C until use.

2.1.2. DNA extraction of snail tissues using the Nucleon® PhytopureDNA™ Purification Kit

Because of its relatively fast and simple use, the Nucleon® PhytopureDNA™ kit was used as an alternative to the CTAB protocol (Section 2.1.1) in extracting DNA from snail tissues used for phylogenetic analyses (Chapters 3 and 4) as well as for the global genetic survey of *A. fulica* populations (Chapter 5). It produced no discernible difference in DNA quality in comparison to the CTAB method. Like CTAB, this kit allowed for the precipitation of polysaccharides. The protocol below generally followed the manufacturers' instructions except that volumes indicated were half of what was recommended while the times prescribed were lengthened.

1. 300 μl of reagent 1 was added to a tube containing approximately 0.1 g snail tissue from the foot muscle that was previously ground using sterile glass beads and plastic pestle. After mixing thoroughly, 100 μl of reagent 2 was added. The tubes were inverted several times until a homogenous mixture was obtained.
2. The tubes were placed in a 65^0 C water bath for at least 30 minutes with regular manual agitation until the tissues were fully digested.
3. The tubes were then placed in ice for at least 30 minutes.
4. 250 μl of ice-cold chloroform was added followed by 50 μl Phytopure DNA extraction resin suspension that was thoroughly shaken prior to use. The tubes were inverted for 10 minutes followed by centrifugation at 13,000 rpm for 10

minutes. The DNA-containing phase above the resin layer was then transferred into a fresh tube.

5. An equal volume (~400 µl) of cold isopropanol was added, after which the tubes were gently inverted several times to precipitate the DNA. The tubes were centrifuged at 13,000 rpm for 5 minutes to pellet the DNA. The isopropanol was pipetted out and discarded.
6. The DNA pellet was washed with 1.0 ml 70% ethanol, then centrifuged at 13,000 rpm for 5 minutes. The ethanol was pipetted out and discarded.
7. The remaining DNA pellets in the tubes were air-dried for a maximum of 15 minutes at 45-55^0 C on a heat block.
8. The DNA pellets were resuspended in 150 µl TE buffer (10 mM Tris-HCl, 1 mM EDTA, pH 8.5) and boiled for 15 minutes at 100°C.
9. The DNA extracts were stored at -80^0 C until further use.

2.1.3. DNA extraction of snail tissues using the NaOH-lysis method

This method was used on the *Achatina fulica* population samples (Chapter 5) and was chosen over the two previous methods because it was considerably cheaper to use even if the quantity of DNA extracted was slightly less than that extracted in the previous methods. This disadvantage was offset by using more tissue, which could be readily obtained when using *A. fulica* population samples.

1. Tissue slices were ground in microfuge tubes containing 200 µl of 0.1 N NaOH using sterile glass beads and a plastic pestle. The samples were boiled at 95-100^0 C for 20 minutes to lyse the cells.
2. 100 µl of sterile distilled water and 300 µl of chloroform-isoamyl alcohol (24:1) were added. The tubes were vortexed, then centrifuged at 13,000 rpm for 10

minutes. The upper phase (~300µl) was collected and transferred into new tubes.

3. An equal volume of isopropanol (~300µl) was added to precipitate the DNA. The tubes were inverted several times, then stored at -80^0 C for at least one hour.
4. The tubes were centrifuged at 13,000 rpm for 15 minutes, after which the isopropanol was carefully removed.
5. The pellets were washed with 500 µl of 70% ice cold ethanol then centrifuged for 5 minutes at 13,000 rpm to remove salts and small organic molecules. The ethanol was carefully removed.
6. The DNA pellets were air dried on a heat block at 45°C for a maximum of 15 minutes, after which they were resuspended in 150 µl TE buffer (10 mM Tris-HCl, 1 mM EDTA, pH 8.5). Each suspension was then boiled for 15 minutes at 100°C.
7. The DNA extracts were stored at -80^0 C until further use.

2.1.4. DNA extraction of single nematodes using NaOH digestion

This method is a modification of the NaOH lysis method used to extract DNA from individual nematodes (Floyd *et al.*, 2002). The method was used on nematodes extracted from the gastropod intermediate hosts (Chapters 6 and 7) as well as on the adult angiostrongylid nematodes used for phylogenetic analyses and as references for molecular barcoding (Chapter 6).

1. Each nematode was placed in a separate tube containing 20 µl 0.25 M NaOH to digest the cuticle and cells. The tubes were centrifuged briefly to ensure that the nematodes were fully immersed in NaOH. This was followed by overnight

incubation at 25^0 C (or 3-16 hours; beyond that, over-digestion could lead to less intense or infrequent bands during PCR amplification).

2. The tubes were heated for three minutes at 95^0 C, then cooled to room temperature. The tubes were centrifuged briefly to collect any liquid along the sides and the lid.
3. The following were added in succession: 4 µl 1.0 M HCl to neutralize the NaOH; 10 µl 0.5 M Tris-HCl, and 5 µl 2% Triton X-100, a strong detergent that disrupts the cell membranes and effectively lyses the cells.
4. The tubes were mixed and centrifuged briefly, then heated for 3 minutes at 95^0C. The samples were cooled to room temperature (pH of digest should be between 8 and 9).
5. The DNA extracts were stored at -80^0 C until further use.

2.2. Polymerase chain reaction (PCR)

Polymerase chain reaction (PCR) entails the rapid amplification *in vitro* of specific DNA segments using the same principles involved in DNA replication. This technique was used to amplify fragments of the nuclear ribosomal (r)RNA cluster, actin and histone 3 genes of snails and the small subunit (SSU) rRNA of nematodes as well as the mitochondrial cytochrome c oxidase subunit I (COI) and 16S rRNA genes of snails. Crucial in any successful PCR is the pair of primers that bind to specific regions of the complementary strands and the DNA polymerase that facilitates the amplification. Other components of PCR are the deoxynucleotide triphosphates (dNTPs) that are incorporated in the growing chain, and $MgCl_2$ that acts as the enzyme co-factor of the DNA polymerase. There are three stages in PCR that are repeated over a number of cycles; these are: (1) denaturation of the double stranded DNA at 94^0 C; (2)

annealing of the PCR primers to target sites in the DNA at specific temperatures; and (3) extension of the growing strand of synthesized DNA at 72^0 C through the activity of the DNA polymerase (Reece, 2004).

2.2.1. PCR primers

Primers are short oligonucleotides (17-30 nucleotides) that bind to specific targets in the DNA (Reece, 2004). Several factors need to be considered for PCR primers to successfully amplify their intended targets. First, the melting temperature (T_m) of each primer in the primer pair, calculated as 2(A+T)+4(C+G), where A, C, G and T refer to the nitrogenous bases of the oligonucleotide, should be approximately equal so that they anneal to their target sites at almost the same time (Reece, 2004). Second, primers should not have strings of repeated nucleotides within their sequences in order to prevent annealing to non-specific targets that exhibit strings of complementary repeated nucleotides (Reece, 2004). Third, primers should not contain complementary sequences with each other or within themselves as these would result in primer dimers and secondary structures, respectively, which would lead to non-amplification (Reece, 2004). Fourth, the 3’ end of the primers should match perfectly the target region for the polymerase enzyme to properly extend the primer beginning at the 3’ end (Reece, 2004). Fifth, provided that the 3’ ends of the primers match with their targets, some mismatched pairing could form partial bonds between the primer and the target. For example, G-T bonds also occur with some stability. Such a phenomenon could be taken advantage of when designing primers that need to be applied across many taxa in which ambiguous positions could potentially be present in the primer-binding sites. If a position in the target region could either be a C or a T, then the primer would be assigned a G for that position in order to bind to either C or T of the target. Likewise, if the target contains a position that could either be an A or a G, then the primer that binds to it should preferentially contain a T for that corresponding position (Palumbi, 1996). Sixth, the length of the product being amplified by the primer pair would determine the duration of the extension step of the PCR. For instance, 30 seconds are generally needed to amplify products less than 500 bp, 60 seconds for products between 500 and 1500 bp, and 90 seconds for products longer than 1500 bp (Palumbi, 1996). Lastly, more than one round of PCR could be undertaken to ensure the success of amplification of the target segment. For instance, the product of the first round of PCR using one set of primers could be used as template for the second round using an internal set of primers in a two-step process called nested PCR (Aurelius *et al*., 1991). This was applied to the rRNA cluster and the actin gene in which the first pair of primers amplified a larger fragment (approximately 4000 bp for the rRNA cluster and around 900 bp for the actin) while the second round made use of primer pairs that bound to targets within the larger fragments. This process facilitated the annealing of the primers in the second round where the target regions were more readily available.

2.2.1.1. Snail PCR primers

2.2.1.1.1. Nuclear genes

2.2.1.1.1.1. Ribosomal RNA (rRNA) gene cluster

The nuclear ribosomal RNA gene family encodes the small and large subunit rRNA genes that are incorporated into the small subunit and large subunit, respectively, of the ribosome that facilitates gene translation into amino acid sequences (Lewin, 2008). The gene family consists of five parts that are transcribed as a single unit: (1) the small subunit rRNA gene (SSU or 16-18S); (2) the first internal transcribed spacer (ITS 1); (3) the 5.8S gene; (4) the second internal transcribed spacer (ITS-2); and (5) the LSU rRNA gene (26-28S). A 5S gene found downstream of the LSU gene is separated from this array by an intron or a non-transcribed spacer and is independently transcribed in eukaryotes (Graur & Li, 2000; Lafontaine & Tollervey, 2001; Klug *et al.*, 2007). The ribosomal RNA gene cluster is repeated in a tandem array over the genome, with the actual number of copies varying across different taxa; for instance, nematodes have 50 to 100 copies, some mammals up to several hundred copies, while plants have up to thousands (Long & Dawid, 1980). The function of these genes in protein translation means that the genes are required in many copies and that these copies should be homogenous. The identity of these copies within a species is maintained by concerted evolution through purifying selection in which new variants are eliminated, thus leading to sequence homogeneity within a species (Gasser & Newton, 2000; Graur & Li, 2000). Variation between copies of the rRNA array in a species is rare; in land snails, variation has only ever been found in the ITS as detected by ambiguous positions in direct sequences of the ITS (Wade, pers comm.). The choice of this gene cluster for phylogenetic study is ideal for several reasons: (1) it is easy to PCR amplify because more copies are available for the PCR primers to anneal to; (2) the genes are present in all animal taxa because of their conserved function in RNA translation into proteins; and (3) regions within the genes exhibit variable evolutionary rates, with some regions that are very conserved and are thus ideal for primer binding sites, while other regions are variable enough to be phylogenetically informative (Hillis & Dixon, 1991).

The primers listed in Table 2.1 were used to amplify an approximately 4000 nucleotide fragment of the rRNA gene cluster that was employed as a marker for the snail phylogenetic analyses (Chapters 3 and 4). The amplified region included nearly the entire large subunit (LSU) rRNA gene as well as the internal transcribed spacer 2 (ITS 2) region and about 80 nucleotides of the 5.8S rRNA gene (Figure 2.1). Actual differences in length of the amplified products among taxa were predominantly due to variations in length in the ITS 2 region and to a lesser extent the minor variations in the variable regions in the LSU. The rRNA cluster was amplified using nested PCR. The first round made use of the LSU-1 and LSU-12 or the LSU-2 and LSU-12 primer pairs. This served as the 1^0 PCR for the rRNA gene fragment. Using the primary PCR products as template, the succeeding rounds of PCR (2^0 PCR) amplified the internal rRNA fragments (fragment A using primers LSU-1/1iii and LSU-3/3iii; fragment B using LSU-2 and LSU-5; fragment C using primers LSU-4ii and LSU-7/7i; fragment D using LSU-6/6ii and LSU-9/9ii; fragment E using LSU-8/8ii and LSU-11/11ii; and fragment F using LSU-10/10i and LSU 12/12i; see also Table 2.1).

Table 2.1: Summary of the rRNA primers

LSU Fragment	Primers	Reference	Fragment Size (bp)
A	LSU-1 (sense): 5′–CTAGCTGCGAGAATTAATGTGA-3′ LSU-3 (anti-sense): 5′-ACTTTCCCTCACGGTACTTG-3′	Wade & Mordan (2000); Wade *et al.* (2001); Wade *et al.* (2006)	~900-1200 (difference due mostly to variable size of the ITS2 region; see also Fig. 2.1)
	LSU-1iii (sense): 5′-TGCGAGAATTAATGTGAATTGC-3′ LSU-3iii (anti-sense): 5′-ACGGTACTTGTCCGCTATCG-3′	designed by C. Wade	
B	LSU-2 (sense): 5′-GGGTTGTTTGGGAATGCAGC-3′ LSU-5 (anti-sense): 5′-GTTAGACTCCTTGGTCCGTG-3′	Wade & Mordan (2000); Wade *et al.* (2001); Wade *et al.* (2006)	~580
C	LSU-4ii (sense): 5′-GTCGGCATTCCACCCGACC-3′ LSU-7 (anti-sense): 5′- GCAGGTGAGTTGTTACACACTC-3′ LSU-7i (anti-sense): 5′-GTTGTTACACACTCCTTAGCGG-3′	designed by C. Wade	~700
D	LSU-6 (sense): 5′-AAGGTGCCAAACGCTGACGC-3′ LSU-6ii (sense): 5′-GTGCCAAACGCTGACGCTCA-3′ LSU-9 (anti-sense): 5′-CAGTCCTCAGAGCCAATCCTT-3′ LSU-9ii (anti-sense): 5′-ACCCAGTCCTCAGAGCCAATC-3′	designed by C. Hudelot	~850
E	LSU-8 (sense): 5′-CCATATCCGCAGCAGGTCTC-3′ LSU-8ii (sense): 5′-GTGCACAGCCTCTAGTCGATA-3′ LSU-11 (anti-sense): 5′-CTGAGCTCGCCTTAGGACAC-3′ LSU-11ii (anti-sense): 5′-TCCTCCTGAGCTCGCCTTAG-3′	designed by C. Hudelot	~850
F	LSU-10 (sense): 5′-ATCCGCTCTGAAGACAGTGTC-3′ LSU-10i (sense): 5′-GGCCGCGATCCGTCTGAAGA-3′ LSU-12 (anti-sense): 5′-TTCTGACTTAGAGGCGTTCAG-3′ LSU-12i (anti-sense): 5′-GGCTTCTGACTTAGAGGCGTT-3′	designed by C. Hudelot	~500

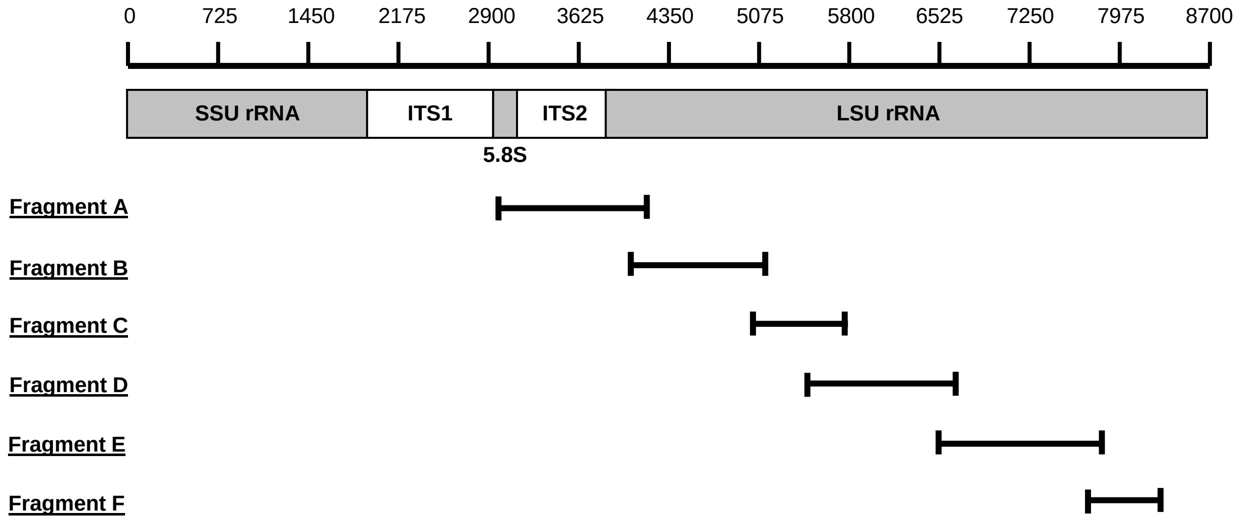

Figure 2.1: Schematic diagram of the rRNA gene cluster based on the complete sequence of *Rattus norgevicus* (GenBank X00133) and showing the position of the primers used in this study.

2.2.1.1.1.2. Actin gene

Actin is a protein involved in various functions such as muscle contraction, cell division and differentiation (Hightower & Meagher, 1986; Hernan, 1993) and is highly conserved across animal groups (Hightower & Meagher, 1986; Palumbi, 1996). Actin is coded by several genes that arose from gene duplication and divergence, resulting in the presence of different forms (isoforms) of the actin protein within an organism (Hightower & Meagher, 1986). These protein isoforms can be classified into two broad categories: the muscle (α) type and the cytoplasmic (β) type (Vandekerckhove & Weber, 1978; Adema, 2002), with the number of isoforms for each category varying between animal groups. In mammals, there are two cytoplasmic actins and four muscle-type actins (Vandekerckhove & Weber, 1978); the same numbers were also found in *Drosophila* (Fyrberg *et al.*, 1981). In molluscs, the number and type of actin isoforms appear to vary among taxa based on the few that have been evaluated to date. DesGroseillers *et al*. (1994) found between three and five genes in the sea hare *Aplysia* *californica* that probably coded for the muscle type actin, while Patwary (1996) found 12-15 genes in the bivalve *Placopecten magellanicus* that were also of the muscle type. Carlini *et al*. (2000) surveyed 44 taxa among the coleoid cephalopods and found at least one gene each of the muscle type and cytoplasmic type actins and a third that was most probably a pseudogene. Adema (2002) sequenced one gene of a cytoplasmic actin isoform in each of six planorbid basommatophoran species using cytoplasmic actin-specific primers. However, Southern blotting and hybridization experiments using probes specific for actin yielded up to five genes in *Biomphalaria glabrata* and *Helisoma trivolis*, prompting Adema not to discount the possibility that some of these genes could code for muscle type actin isoforms. Morgan *et al*. (2002) extended the actin survey of the planorbids to 38 taxa using the cytoplasmic actin to correlate the relationship of these snails to the evolution of their *Schistosoma* trematode parasite. Using actin for phylogenetic analyses could pose a problem if the sequences being compared are paralogous, which resulted from gene duplication, rather than orthologous, as in the case of muscle and cytoplasmic actins that arose from gene duplication in the distant past or even within each type due to more recent duplications. Using paralogous sequences could lead to inferring incorrect relationships; awareness of their presence in the sequence data is therefore crucial in any phylogenetic analysis (Bailey *et al*., 2003). Donald *et al*. (2005) acknowledged the problem of paralogs in actin, but they justified the use of actin to elucidate the phylogeny of marine top shells by employing primers specific for the gene that codes for a single isoform of the cytoplasmic actin and by showing agreement of the actin phylogeny with the 16S rRNA and COI phylogenies. How to address the issues of paralogous sequences in the actin gene is discussed further in Sections 2.9.12 and 2.9.13, pp. 89-91.

The primers listed in Table 2.2 amplified an approximately 900 bp fragment of the actin gene; this fragment was used for the snail phylogenetic analyses in Chapters 3 and 4. Nested PCR was carried out in which a primary PCR product was amplified using the primers ActF2 and ActR1; this fragment was then used as template for the secondary PCR using ActF1 and ActR. If amplification failed, several combinations of primers from the primary and secondary PCR were tried until a product was amplified.

Table 2.2: Summary of the actin primers.

Primers	Reference	Fragment Size (bp)
`ActF1 (sense):` `5′-TATGTTGGTGATGAGGCTCAG-3′`	Morgan *et al.* (2002)	~900

`ActF2 (sense):`
`5′-GGTATGGGTCAGAAGGACAGCTATG-3′`
`ActR1 (anti-sense):`
`5′-GAAGCATTTCCTGTGGTCAATG-3′`
`ActR (anti-sense):`
`5′-GATCCACATCTGTTGGAAGGT-3′`
	Designed by C. Hudelot	

2.2.1.1.1.3. Histone 3 gene

Histone 3 (H3) forms part of the histone core protein octamer that packs the eukaryotic chromatin into bead-like structures (Lewin, 2008). Histone core proteins are some of the most conserved proteins known, suggesting a function that is identical across eukaryotes (Lewin, 2008). Histone genes occur as a tandemly repeating unit comprising the different genes that code for the subunits of the core protein octamer. In *Drosophila*, the repeating unit consists of five genes in the following order, H1, H2A, H2B, H3 and H4; this repeating unit occurs 110 times (Lifton *et al.*, 1977). In bivalve molluscs, a different order was found in the genome of the bivalve mussel *Mytilus galloprovinialis*: H4, H2B, H2A, H3 and H1, with the copy number averaging more than 200 per haploid genome (Eirin-Lopez *et al*., 2004). Transcription of the H3 and H4 genes in the stylommatophorans occurs in opposite directions as in other protostomate animals (Armbruster *et al*., 2005) but not in the bivalve *Mytilus* (Eirin-Lopez *et al*., 2004). Among the gastropods, Colgan *et al*. (2000) noted a high codon usage bias for the H3 gene. As with the rRNA genes, H3 and H4 genes are subject to concerted evolution, thus leading to sequence homogeneity among copies of the genes within the species (Liao, 1999). The primers listed in Table 2.3 amplified a 331 bp fragment that was also used for the snail phylogenetic analyses in Chapters 3 and 4. Different primer combinations amplified roughly the same fragment.

Table 2.3: Summary of the histone 3 primers

Primers	**Reference**	**Fragment Size (bp)**
H3aF (sense): 5′-ATGGCTCGTACCAAGCAGACVGC-3′ H3aR (anti-sense): 5′-ATATCCTTRGGCATRATRAGTGAC-3′	Colgan *et al.* (1998)	328
H3Fm (sense): 5′-ATGGCTCGTACCAAGCAGAC-3′ H3Fm1 (sense): 5′-ATGGCTAGAACGAAGCAGAC-3′ H3Rm (anti-sense): 5′-TCCTTGGGCATGATGGTGAC-3′ H3Rm1 (anti-sense): 5′-CCAACTGAATATCTTTGGGCAT-3′	designed by C. Hudelot	331-340

2.2.1.1.2. Mitochondrial primers

2.2.1.1.2.1. Cytochrome c oxidase subunit I gene

Cytochrome c oxidase is an enzyme that transfers electrons from cytochrome c to O_2 during the electron transport chain in the mitochondrion (Zubay *et al*., 1995). A typical enzyme has three functional subunits in which subunits I and II contain the electron carriers (Alberts *et al.*, 2008). Although the amino acid sequence of the subunit I is conserved across the different animal phyla, the nucleotide sequence is subject to silent mutations (Palumbi, 1996), particularly in the 3rd codon positions. In fact, its variability that yields phylogenetic signal and its robust universal primers have made the COI a marker of choice for DNA barcoding in animals (Hebert *et al.*, 2003). Several primer pairs listed in Table 2.4 amplified a fragment that was used in Chapters 3 and 4. Different primer combinations amplified roughly the same fragment.

Table 2.4: Summary of the cytochrome c oxidase subunit I primers

Primers	**Reference**	**Fragment Size (bp)**
LCO 1490 (sense): 5′–GGTCAACAAATCATAAAGATATTGG–3′ HCO 2198 (anti-sense): 5′–TAAACTTCAGGGTGACCAAAAAATCA–3′	Folmer *et al.* (1994)	655
STY_LCOi (sense): 5′-TCAACGAATCATAAGGATATTGG-3′ STY_LCOii (sense): 5′–ACGAATCATAAGGATATTGGTAC–3′ STY_LCOiii (sense): STY_HCO: (anti-sense) 5′–GAATTAAAATATATACTTCTGGGTG-3′	designed by I. Fontanilla	628-667

2.2.1.1.2.2. 16S ribosomal (r) RNA gene

The 16S rRNA gene transcribes a ribosomal RNA that folds into a secondary structure following base pairing of the nucleotides within it, after which it is incorporated in the mitochondrial ribosome and is used for translation of proteins (Lewin, 2008). Among the Mollusca, 16S exhibits extreme variation in length, with those of the Stylommatophora being the shortest (Lydeard *et al.*, 2000). Two primer pairs are listed in Table 2.5. The first pair (STY_16Sarm and STY_16Sbrm) amplified a 420-450 bp fragment that was used for the snail phylogenies in Chapters 3 and 4. The second pair (16S1i and 16S_SSCP2i) amplified a 293 bp fragment that was used for the global population survey of *Achatina fulica* in Chapter 5.

Table 2.5: Summary of the 16S rRNA primers

Primers	**Reference**	**Fragment Size (bp)**
(for the phylogeny studies-chapters 3 & 4) STY_16Sarm (sense): 5′–CTTCTCGACTGTTTATCAAAAACA–3′ STY_16Sbrm (anti-sense): 5′–GCCGGTCTGAACTCAGATCAT–3′	Bonnaud *et al.* (1994)	420 – 500
(for the SSCP study-chapter 5) 16S1i: 5′–TGACTGTGCAAAGGTAGCATAA–3′ 16S_SSCP2i: 5′–CCTAGTCCAACATCGAGGTC–3′	designed by I. Fontanilla	293

2.2.1.2. Nematode PCR primers

The small subunit (SSU) rRNA, which is a part of the ribosomal gene family, has been used to elucidate the phylogeny of the Nematoda (Blaxter *et al.*, 1998; Meldal *et al.*, 2006). The 5' end of the SSU has also been employed as a marker to identify marine nematodes (Bhadury *et al.*, 2006). The primers listed in Table 2.6 amplified four overlapping fragments that included nearly the entire region of the small subunit (SSU) rRNA gene in nematodes (Blaxter *et al.*, 1998); this fragment was used to infer the phylogeny of the Angiostrongylidae relative to other metastrongylids as well as to determine the most suitable marker to identify *Angiostrongylus cantonensis* in Chapter 6. The relative locations of the binding sites for these primers are shown in Figure 2.2.

Table 2.6: The four overlapping primer pairs used to amplify nearly the entire region (approximately 1670 nucleotides) of the SSU rDNA gene.

	Primers	**Reference**	**Fragment size (bp)**

Set A	`SSU_F_07 (sense):`
	`5′-AAAGATTAAGCCATGCATG-3′`
	`SSU_R_09 (anti-sense):`
	`5′-AGCTGGAATTACCGCGGCTG-3′`
		Blaxter *et al.* (1998)	480

Set B	`SSU_F_11 (sense):`
	`5′-AAGTCTGGTGCCAGCAGCCGC-3′`
	`SSU_R_26 (anti-sense):`
	`5′-CATTCTTGGCAAATGCTTTCG-3′`
		Blaxter *et al.* (1998)	360

Set C	`SSU_F_24 (sense):`
	`5′-AGRGGTGAAATYCGTGGACC-3′`
	`SSU_R_23 (anti-sense):`
	`5′-TCTCGCTCGTTATCGGAAT-3′`
		Blaxter *et al.* (1998)	390

Set D	`SSU_F_02 (sense):`
	`5′-GGAAGGGCACCACCAGGAGTGG-3′`
	`SSU_R_81 (anti-sense):`
	`5′-TGATCCWKCYGCAGGTTCAC-3′`
		Blaxter *et al.* (1998)	600

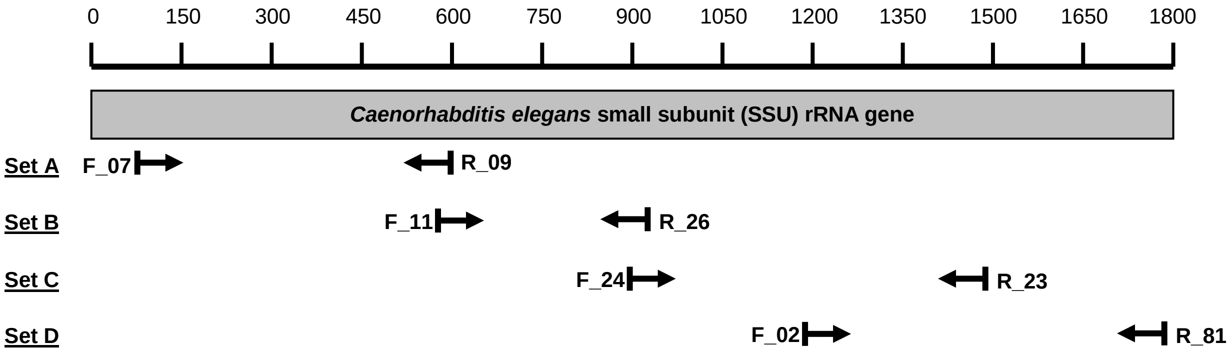

Figure 2.2: Schematic diagram of the SSU rRNA gene based on the complete sequence of *Caenorhabditis elegans* (GenBank X00133) and showing the position of the primers used in this study.

2.2.2. PCR components

Listed in Table 2.7 are the PCR components used and their concentrations. The optimal concentrations varied depending on the size of the gene and the number of copies available per cell. In particular, the concentration of $MgCl_2$ differed between the nuclear (1.5 mM) and the mitochondrial (2.5 mM) genes.

Table 2.7: PCR components used and their concentrations for the different genes

Components	Initial concentration	Final concentration		Volume (μl)	
Buffer	10X	1X		5.0	
dNTPs	1.25 mM	1^0 PCR for LSU: 300 μM	2^0 PCR for LSU/1^0 & 2^0 PCR for actin/ other genes: 200 μM	1^0 PCR for LSU: 12.0	2^0 PCR for LSU/1^0 & 2^0 PCR for actin/ other genes: 8.0
[a]MgCl$_2$	50 mM	LSU rRNA/ Actin/ Histone3: 1.5 mM	16S/ Cytochrome c oxidase I: 2.5 mM	LSU rRNA/ Actin/ Histone3: 1.5	16S/ Cytochrome c oxidase I: 2.5
Primer 1	10 mM	200 μM		1.0	
Primer 2	10 mM	200 μM		1.0	
[b]Q-solution	5X	1X		10	
Taq	1 unit/μl	0.01 unit/μl		0.5	
Sterile distilled H$_2$O	--	--		To make final volume of 50 μl	

[a] Some manufacturers provided PCR buffers that already contained MgCl$_2$ (e.g. QIAgen™ with 25 mM concentration), while other manufacturers separated the buffer and the MgCl$_2$ (e.g. Bioline™, which separately provided 50 mM MgCl$_2$). Care was taken in order to guarantee that the recommended final MgCl$_2$ concentration was followed.

[b] Provided by QIAgen™

2.2.3. PCR running conditions

Different reaction cycles were employed depending on the size of the expected PCR product. For the rRNA gene cluster, a very long extension step (5 minutes) was used in the 1^0 PCR reaction in order to ensure that the approximately 4000 bp fragment was amplified. For the rRNA 2^0 PCR reactions, which amplified the shorter internal rRNA fragments, a shorter extension step was used. For all other genes, reaction cycles followed those used for the rRNA 2^0 PCR reactions.

2.2.3.1. For rRNA 1^0 PCR

hot start at 96^0 C for 2 minutes

94^0 C for 30 sec
50^0 C for 30 sec
72^0 C for 5 minutes
$\}$ 35 cycles

2.2.3.2. For rRNA 2^0 PCR and all other genes:

hot start at 94^0 C for 2 minutes

94^0 C for 30 sec
${}^a45^0$ C for 30 sec
65^0 C for 60 sec
$\}$ 38 cycles

${}^a45^0$ C was the optimal annealing temperature for the mitochondrial primers; this temperature also worked well for the nuclear primers

2.3. Gel electrophoresis

Once the PCR products were amplified, they were then separated and visualized through gel electrophoresis. PCR products were loaded in wells in an agarose gel, after which an electric current was applied to move the DNA towards the positive electrode. Different-sized DNA fragments migrate at different rates with smaller fragments moving rapidly through the gel matrix and larger fragments moving more slowly. Different sized PCR products would therefore be found at different positions of the gel at the end of electrophoresis. The DNA molecules were visualized when the ethidium bromide in the agarose gel intercalated between the nitrogen bases of the DNA and fluoresced under UV light (Reece, 2004). Below is the general protocol for agarose gel electrophoresis.

1. For a 1.25% agarose gel, 1.25 g agarose was dissolved in 100 ml TBE buffer [54 g Tris, 27.5 g boric acid and 20 ml 0.5 EDTA dissolved in 1000 ml distilled water to make 5X TBE buffer, then diluted to 1X before use]. The agarose was melted in a microwave oven and the molten gel cast in a container. The combs were added to make the wells.
2. Once the gel had set, the combs were removed and the PCR products loaded on the wells, after which the gel was submerged in a tank containing 1X TBE.
3. A current (100-120 V) was applied through the gel using a portable power supply.
4. Once the PCR products had run their course through the gel, the gel was removed from the tank and placed on a UV transilluminator to visualize the bands.

2.4. Gel extraction

Since most of the PCR amplifications yielded more than one band, it was necessary to separate these bands by electrophoresis prior to purifying the band of the correct size from the agarose gel in preparation for sequencing. Each band in the gel represented a PCR product of a particular size, thus the nucleic acid purified from a particular band is assured of having no other PCR product or primer of a different size. For bands that were very close to each other, care was taken when cutting these bands.

The protocol follows the manufacturers' instructions for the Eppendorf Perfectprep™ Gel Extraction Kit.

1. The PCR product was excised from the agarose gel with a sterile, sharp scalpel and placed in a 1.5ml microfuge tube.

2. The gel slice was weighed. Three volumes of Binding Buffer were added to every volume of the excised gel (100 mg ~ 100 μl).
3. The gel slices were incubated at 50 ^{0}C for 10 minutes (or until the gel slice had completely dissolved). To help dissolve the gel, the tubes were inverted every 2-3 minutes during the incubation.
4. One gel volume of isopropanol was added and mixed to precipitate the PCR product.
5. A spin column with a membrane filter was placed in a 2 ml collection tube. To bind the PCR product, the sample was applied to the spin column provided and centrifuged at 13,000 rpm for 1 minute. The flow-through was discarded and the column was placed back into the same collection tube. (Maximum volume capacity of spin column was 800 μl. For sample volumes of more than 800 μl, the remaining samples were also loaded and the collection tube centrifuged again until all the samples were used up.)
6. 750 μl of the wash buffer were added to the column and centrifuged at 13,000 rpm for 1 minute. After discarding the flow-through the column was replaced in the collection tube and centrifuged at 13,000 rpm for another minute to completely remove traces of the Wash Buffer.
7. The spin column was placed into a clean 2 ml collection tube. 30 μl of the Elution Buffer (10 mM Tris-Cl, pH 8.5) was added to the center of the membrane filter and the collection tube centrifuged at 13,000 rpm for 1 minute to elute the PCR product.
8. The spin column was discarded, and the eluted product was stored at -20^0 C until further use.

2.5. DNA quantification

Eluted PCR products were quantified using a NanoDrop® ND-1000 spectrophotometer prior to DNA sequencing. For cycle sequencing using the ABI PRISM^{TM} Big Dye Version 3.1 Kit (see next section), approximately 1-3 ng concentration was recommended for every 100-200 bp of the PCR product to be sequenced.

2.6. Cycle sequencing

Cycle sequencing was employed to derive the sequence of the purified PCR products. This method uses the principle of dideoxy chain termination (also known as the Sanger method) in determining DNA sequences. In this procedure, a template DNA such as the double stranded PCR product was subjected to amplification of each strand in separate tubes using one primer each. A small amount of fluorescently labeled dideoxynucleotide triphosphates (ddNTPs) were included in the sequencing mix. These ddNTPs differed from the normal dNTPs in that they had an H group rather than an OH group on the 3rd carbon of the ribose sugar. When a ddNTP was incorporated instead of a dNTP in the growing chain, no other dNTP would bind to the 3rd carbon of the ribose sugar in the absence of the OH group, thereby prematurely terminating the sequence. This resulted in a mixture of different sized fragments all terminating in a fluorescently labeled ddNTP. After the sequencing reaction, these fragments were run on a gel in an automated DNA sequencer where the fragments separated according to size. As the samples passed through a certain point along the course of the gel, an argon ion laser fluoresced the dye attached to the samples. Each ddNTP (A, C, G and T) carried a dye that fluoresced at a particular wavelength, which were picked up and registered by a computer as a unique color. A sequence complementary to the template DNA was then generated as a series of differently colored peaks (Reece, 2004). The protocol below follows the manufacturers' instructions for the ABI PRISM™ Big Dye Version 3.1 Kit except that volumes were reduced by half for most components while less than 20% of the Big Dye was used.

2.6.1. Cycle sequencing components

Listed below are the components used for each sample sequenced. Sequencing of the forward and reverse strands was carried out in separate tubes.

1. 1.5 μl Big Dye Mix (for 500-1000 bp PCR product)
2. 1.6 μl primer (1 μM)
3. purified PCR product (approximately 1-3 ng/ 100-200 bp)
4. sterile distilled water to make a final volume of 10 μl.

2.6.2. Cycle sequencing running conditions

96^0 C for 5 minutes

$$\left.\begin{array}{l}96^0\text{ C for 10 sec}\\ 50^0\text{ C for 5 sec}\\ 60^0\text{ C for 4 minutes}\end{array}\right\}\text{ 25 cycles}$$

2.6.3. Precipitation of cycle sequencing samples

Once the cycle sequencing was complete, the samples were precipitated prior to being run in an automated sequencer such as the Applied Biosystems 3730 DNA sequencer. The instructions below follow those recommended by the manufacturers of the ABI PRISM™ Big Dye Version 3.1 Kit but with some modifications.

1. For each 1.5 ml microfuge tube, 2.0 μl 3M NaOAc (pH 4.6) and 50 μl 95% ethanol was added. The entire cycle sequencing mix was then added into the

NaOAc-ethanol mixture. The tubes were vortexed and set aside for at least 30 minutes. This step precipitated the different-sized PCR products in the tube.

2. The tubes were centrifuged for 20 minutes at 13,000 rpm. The supernatant was then carefully removed.
3. The pellet was rinsed with 190 μl 70% ethanol, then vortexed briefly.
4. The tubes were centrifuged for 5 minutes at 13,000 rpm, after which the supernatant was carefully removed.
5. The tubes were placed with the lid open in a heat block or thermal cycler at 90^0 C for one minute. The samples were then sent to the Department of Biochemistry of Oxford University or the DNA Sequencing Facility of the Natural History Museum for sequencing.

2.7. Cloning

There are instances in which PCR amplifies more than one copy of a particular gene fragment. This happens if an individual is either a heterozygote for a particular gene or actually possesses several genes. Once the PCR products are sequenced, variable sites among the different copies are manifested as ambiguous sites as PCR does not discriminate between copies as long as they have the same primer-binding sites. Such is the case for actin where several genes coding for actin are sometimes found within the same individual (Hernan, 1993). Where possible, all the different genes should be amplified, cloned and then sequenced in order to identify the presence of paralogous sequences. However, cloning was not possible for the snail phylogenetic analyses in Chapters 3 and 4 due to time and cost constraints, so direct-sequencing from PCR products was employed instead, with ambiguity codes assigned to positions of ambiguity in the direct sequences (see Section 2.9.3, pp. 72-73). These ambiguous sites were then utilized as ambiguities in the tree-building process. Sequences obtained via cloning from the different copies from a few selected taxa served as a reference in assigning codes for the ambiguous sites. One taxon that did not exhibit any ambiguous sites (i.e. *Leptinaria lamellata*, see Appendix 3.8C, p. 436) was also used for cloning in order to check if any ambiguity was missed in the direct sequence. It should be emphasized that, in the absence of sequencing all the actin clones for each taxon, using direct sequence with ambiguous sites implies using an “average” or consensus sequence for all the possible copies of the actin gene for that species. Caution must therefore be taken in interpreting trees involving taxa with potentially more than one actin gene.

Sequencing different copies of the actin gene separately was achieved by first cloning the PCR products in bacteria using a plasmid vector. A special plasmid used in cloning called the *pUC* plasmid included an ampicillin-resistant gene and a *lacZ* gene that coded for a subunit of the β-galactosidase enzyme that breaks down galactose. Foreign DNA can be inserted into this plasmid within the *lacZ* gene. Once the insert is incorporated in the plasmid, the plasmid was allowed to be taken in through chemical transformation by a *lacZ* mutant *E. coli* that could not produce a functional β-galactosidase enzyme. These bacteria were then allowed to grow in an agar plate containing ampicillin and galactose. Bacteria that took in the plasmid were able to grow on the medium because of the presence of the ampicillin-resistant gene in the plasmid. Bacteria that harbored plasmids with inserts would not exhibit β-galactosidase activity in the presence of galactose because the inserts were placed within the *lacZ* gene, thereby disrupting its transcription. Colonies of these bacteria appeared white when compared to bacteria with functional *lacZ* in the plasmid, which appeared as blue colonies. These white colonies were then picked from the agar and were subcultured in a liquid medium to allow them to grow, thereby producing a vast number of copies of the insert. The plasmids were then isolated from the bacteria and the inserts direct-sequenced using plasmid specific primers that bound to the flanking regions of the annealing site of the insert. As only one molecule of foreign DNA could be inserted into a plasmid, the inserts derived from a single colony represented a single copy of that insert (Reece, 2004). In this way individual copies of the actin gene were obtained for sequencing.

The protocol below follows the manufacturers' instructions for the Invitrogen™ TOPO Cloning Kit except that the volume of competent cells used was reduced by half.

2.7.1. Agar plate preparation

1. Around 15-20 ml LB agar was poured into a Petri dish and set aside at room temperature to solidify the agar. The agar plate was left slightly open in a drying cabinet for 30 minutes to remove condensation from the lid.
2. 17 μl of 50 mg/ml ampicillin was spread on top of the agar plate before replacing the lid.
3. The agar plate was then warmed at 37^0 C for 30 minutes.
4. 80 μl of 20 mg/ml X-gal was spread on the agar plate, after which it was incubated at 37^0 C until use.

2.7.2. Setting up the TOPO^{TM} Cloning Reaction

1. The following were mixed gently and incubated for five minutes at room temperature:

PCR product	1.0 µl	
Salt solution	0.5 µl	provided in the kit
water	1.0 µl	
TOPO	0.5 µl	

2. 1 µl of the TOPO cloning reaction from (1) was added to 25 µl of One-Shot^{TM} chemically competent cells and incubated on ice for 5 minutes.
3. The cells were heat-shocked for 30 seconds at 42^0 C without shaking. This allowed the cells to take in the plasmids. The tubes were immediately transferred in ice.
4. 125 µl of previously defrosted SOC medium from Box 2 was added, and the tube was then capped tightly and shaken horizontally (200 rpm) at 37 ^{0}C for one hour.
5. 50 µl from each transformation was spread on a pre-warmed (37^0 C) selective agar plate containing X-gal and incubated overnight at 37^0 C.
6. White colonies were picked and cultured overnight in 5-ml LB medium containing 50 ug/ml ampicillin.

2.7.3. Plasmid isolation

1. The culture was transferred into a microfuge, after which it was centrifuged for five minutes at 13,000 rpm to discard the supernatant.
2. The process was repeated until most of the culture was used up. [A small amount (~500 µl) was set aside in a separate tube where ~125 µl of 80% sterile

glycerol was added. The tubes were then stored at -80^0 C so that the culture could be re-grown in the near future should the need arise.]

3. 1.0 ml of cold TE buffer was added, after which the tube was vortexed. The tube was then centrifuged for 5 minutes at 13,000 rpm to discard the supernatant.
4. 100 μl of cold TE buffer was added and the tube was then vortexed. Incubation on ice for a minimum of 15 minutes followed.
5. 200 μl of 0.2 N freshly prepared NaOH / 1% SDS solution was added. This mix lysed the bacterial cells.
6. 150 μl of 3M KOAc, pH 4.8 was added followed by gentle mixing. The tube was mixed gently and left in ice for 5 minutes. This stage precipitated the proteins and neutralized the alkaline pH.
7. The tube was centrifuged for 5 minutes at 13,000 rpm. The supernatant was moved to a separate tube while the pellet was discarded.
8. 10 μl of 2 mg/ml RNAse was added, and the tube was then incubated at 37^0 C for 30 minutes. This degraded RNA.
9. An equal volume (~450 μl) of phenol-chloroform was added, after which the tube was inverted several times. It was then centrifuged for 5 minutes at 13,000 rpm. The aqueous phase was transferred to a new tube.
10. An equal volume (~400 μl) of chloroform was added, after which the tube was inverted several times. It was then centrifuged for five minutes at 13,000 rpm. The aqueous phase was transferred to a new tube.
11. 2.5 volumes (~1 ml) of ice-cold 95% ethanol were added. The tube was placed in -80^0 C for at least 20 minutes or in -20^0 C for at least 2 hours and 30 minutes.

It was then centrifuged for 10 minutes at 13,000 rpm. The aqueous phase was discarded.

12. 1.0 ml of 70% ice-cold ethanol was added, and the tube was then centrifuged for 5 minutes at 13,000 rpm before the aqueous phase was discarded.
13. The pellets were dried at 45^0 C for 15 minutes. These were then eluted in 20 µl sterile distilled water and stored at -20^0 C until use.

2.7.4. Sequencing of the insert

The protocols for sequencing of the insert were the same as those in Section 2.6 (see pp. 59-61) except that the M13 forward primer (5' – GTAAAACGAC GGCCAGTGAA – 3') and the M13 reverse primer (5' – CAGGAAACAG CTATGACCATGA – 3') were used. These primers bound to sites that flank the annealing site of the insert in the plasmid. This ensured that the sequence, which included some segments of the plasmid DNA, was derived from the insert.

2.8. Single strand conformational polymorphism analysis

Determining variation at the DNA level among populations need not require sequencing every sample. One method of detecting variation is single strand conformational polymorphism analysis (SSCP), which was used to evaluate the variation in global populations of *Achatina fulica* (Chapter 5). Amplified PCR products from a marker gene such as the 16S rRNA was compared for nucleotide variation by denaturing them into single strands and then allowing them to migrate slowly over a long period in a polyacrylamide gel. Single stranded DNA underwent conformational changes that depended on their nucleotide composition. Therefore, similar sized fragments that varied even in just a single nucleotide assumed different conformations and hence exhibited different migration rates. The DNA was visualized by silver staining in which silver nitrate bound to the DNA. The pattern generated by the two single stranded DNA's on a polyacrylamide gel represented the haplotype of the individual for the amplified genetic marker (Orita *et al.*, 1989). The SSCP technique, however, only works for fragments that are 400 bp or shorter (Sunnucks *et al.*, 2000); in this study, the amplified PCR products derived from the 16S primers were 293 bp long. The subsequent protocol follows that of Orita *et al.* (1989) with some modifications.

2.8.1. Native polyacrylamide gel preparation:

1. The following were mixed in a beaker:

2X MDE™ gel solution (Cambrex Bio Science®)	7.5 ml
1X TBE buffer	18 ml
sterile distilled water	4.0 ml
TEMED	40 µl
ammonium persulfate	400 µl

   Note: The ammonium persulfate was added last as this catalyzed the polymerization of the gel.

2. Once the reagents were mixed, the solution was immediately poured into two glass plates stacked on top of each other and separated by 0.4 mm spacers. The gel set–up was then tapped at the bottom to ensure that no bubbles formed. The combs were subsequently added on top of the gel set-up.
3. The gel was allowed to set for at least 40 minutes, after which the combs were gently removed and the wells washed with water.
4. The gel plates were secured to the rig, which was filled with 2.0 L of 0.6X TBE.

2.8.2. Preparation of PCR products for SSCP analysis

1. An equal volume of isopropanol was added to each PCR product. The tubes were then inverted several times, then placed in ice for at least 30 minutes to precipitate the DNA.
2. The tubes were centrifuged for 15 minutes at 13,000 rpm, after which the supernatant was discarded. The pellets were dried at 45-55^0 C for 15 minutes.
3. The pellets were resuspended in formamide-heavy loading buffer. [Loading buffer: 0.2 g bromophenol blue, 0.2 g CFF, 20 ml 0.5 M EDTA; one part loading buffer diluted in nine parts formamide]
4. The tubes were incubated at 95^0 C for 10 minutes to denature the DNA into single strands, then the tubes were placed in ice to prevent gradual reannealing.

2.8.3. Loading of samples in the polyacrylamide gel

1. 15 μl of formamide-heavy loading buffer was loaded in each well. The gel was allowed to run at 180 volts for at least one hour to ensure that the gel was both consistent and equilibrated.
2. Once the gel was equilibrated, the samples were then loaded directly from ice into the wells.
3. The samples were allowed to migrate along the gel for 24 hours at 180 V.

2.8.4. Silver staining of SSCP gels

1. The following solutions were prepared:

Fix-stop solution

10% acetic acid	200 ml
Distilled water	1800 ml

Silver nitrate solution

Silver nitrate	2.0 g
Distilled water	1997 ml
Formaldehyde	3.0 ml

Developer

Sodium carbonate	60 ml
Distilled water	1997 ml
Formaldehyde	3.0 ml

2. After the run was complete, the gel was transferred into a staining tray containing 200 ml of fix-stop solution. Under the fume hood, the gel was agitated for 45 minutes to ensure complete fixation of the bands, after which the fix-stop solution was removed.
3. The gel was washed with distilled water three times for 20 minutes or until it attained a smooth appearance, indicating that it was already free of fix-stop solution. The excess water was removed.
4. 200 ml of silver nitrate solution was carefully added on the side of the tray and not directly onto the gel itself to prevent it from blackening. The gel was agitated for 40 minutes to give adequate time for the silver nitrate to bind with the DNA. The silver nitrate solution was removed afterwards into a suitable waste jar containing NaOH pellets to neutralize the solution.

5. The gel was washed with distilled water to remove excess sliver nitrate, then the water was discarded into the silver nitrate waste jar.
6. 200 ml of developer was added and the gel agitated until bands were clearly visible.
7. The reaction was stopped by pouring 200 ml of fix-stop solution onto the gel, which was then agitated for an additional 5 minutes to release all the CO_2.
8. The gel was repeatedly washed with 200 ml distilled water until the smell of the acetic acid was no longer detected, after which the excess water was removed.
9. The gel was transferred onto a clean filter paper and covered with cling film. The gel was allowed to dry in a gel dryer for approximately 3 hours at 70 ^{0}C.

2.9. DNA sequence analyses

DNA sequences were assembled using the STADEN package version 1.5.3 (Staden, 2000) and aligned manually within the Genetic Data Environment (GDE) Version 2.2 (Smith *et al.*, 1994). The sequences were then checked for ambiguous nucleotide sites, saturation, and phylogenetic signal before being subjected to phylogenetic estimation. To this end, the optimal model that best fits the dataset was first identified, then a range of tree construction methods were employed.

2.9.1. Aligning sequences

Sequences were brought into the Genetic Data Environment (GDE) Version 2.2 (Smith *et al.*, 1994) where they were aligned manually. Positions were identified as unambiguously aligned when there was absolutely no question over their positional homology. All other positions for which homology could not be ascertained were excluded from subsequent analyses. For the nuclear rRNA cluster and the mitochondrial 16S rRNA, the sequences were aligned according to their secondary structure. Initial secondary structure-based alignments for the nuclear rRNA and mitochondrial 16S rRNA for the Stylommatophora were obtained by C. Hudelot with all other sequences brought and aligned into these initial alignments. The initial alignment of the SSU for the Nematoda was provided by M. Blaxter. This alignment was updated to include all nematode SSU sequences available in GenBank (GB Release Numbers 157-158) as well as the new sequences obtained in this study.

2.9.2. Checking for contamination

Every precaution was taken to avoid contamination, which could have occurred either during DNA extraction, PCR amplification of the gene fragment of interest, or through cycle sequencing. These precautions included maintaining a clean work bench, regularly cleaning pipettes with 0.1 N HCl to destroy any contaminant DNA present, and using sterile pipette tips, scalpel blades and reagents. However, sequences obtained were still checked for contamination. A cursory inspection of the alignment was conducted to see if a sequence varied greatly or was more difficult to align than the rest. A BLAST check through NCBI was also carried out to verify if indeed the sequence originated from a contaminant (i.e. the sequence had a closest identity to a non-mollusc such as a human gene or a cross-contaminant with another mollusc). Sequences obtained in this study were also crosschecked against each other to determine whether sequences from different taxa (or even segments of sequences as in the case of the rRNA cluster) exhibited identical sequences; this might indicate cross contamination (though it should be noted that among closely related taxa, relatively conserved regions might reasonably be expected to be identical). In cases of contamination, the entire process from PCR amplification to cycle sequencing was repeated. Where the same result was obtained, the process was again repeated, this time starting from the DNA extraction.

2.9.3. Assigning ambiguous sites

Sequence positions were scored as ambiguous either because the sequence could not be read reliably (due to poor quality sequence reads), or because there were several copies of the gene (as in the case of actin for which several copies were identified in some achatinoid species; see Chapters 3 and 4). For the actin gene, the identification of ambiguous sites (positions where different copies of the actin gene differed in sequence) was facilitated by using as guides the sequences obtained through cloning from representative taxa. For perfectly clear forward and reverse sequences, an ambiguous site was assigned to a position where two overlapping peaks were seen for that position in both strands. In cases where one strand was clear and the other strand had background noise, then the clear strand was used as the basis for deciding whether the site was ambiguous or not. If both strands exhibited background noise and yet both had the same clear overlapping peaks for a site, then that site was also assigned as ambiguous. Table 2.8 lists the codes for ambiguous nucleotides.

Table 2.8: Codes for ambiguous positions in DNA sequences (Cornish-Bowden, 1985)

Base ambiguity	Code
A or C	M
A or G	R
A or T	W
C or G	S
C or T	Y
G or T	K
A or C or G (not T)	V
A or C or T (not G)	H
A or G or T (not C)	D
C or G or T (not A)	B
A or C or G or T	N

2.9.4. Estimating the average base frequencies and the number of variable and parsimony-informative sites

Sequences for DNA very rarely exhibit identical frequencies for each base due to nucleotide bias. An extreme example of this is exhibited at the 3rd codon position of insects and crustaceans where 95% of the bases are either A or T (Palumbi, 1996). For all sequences under consideration, base frequencies were estimated using the basefreq command in the PAUP* (version 4.0b10) package (Swofford, 2002). The numbers of variable and parsimony-informative sites were calculated using the randtrees command in PAUP*.

2.9.5. Identifying the optimal model for DNA sequence evolution

Multiple 'hits', where pre-existing mutations are masked by more recent mutations that occur at the same site, will lead to an underestimate of the actual number of changes that have taken place at a particular site, thus obscuring the phylogenetic relationship of the taxa being compared. It is therefore necessary to apply a model of sequence evolution in order to 'correct' for such multiple 'hits' (Graur & Li, 2000). Models require certain assumptions as to how variations in DNA sequences evolve. All possible assumptions for a given situation that are taken into account form a 'conceptual model' in which phylogenetic estimation is made. As more assumptions or parameters are incorporated in the model, the more complex it becomes. Several models can be used to account for DNA sequence evolution; these include the JC69 (Jukes & Cantor, 1969), F81 (Felsenstein, 1981), K2P (Kimura, 1980), HKY85 (Hasegawa, *et al*. 1985), TN93 (Tamura & Nei, 1993) and general time-reversible (GTR) models (Rodriguez *et al*., 1990). The JC69 is the simplest model and assumes that all types of change (all substitutions) are equally likely, base frequencies are equal, all sites are equally likely to change and change independently of each other, and base composition is at equilibrium among all the sequences under consideration (Jukes & Cantor, 1969). The K2P is an extension of the JC69 model but allows transitions and transversions to have different substitution rates (Kimura, 1980). Likewise, the F81 model is an extension of the JC69 but allows for unequal base frequencies (Felsenstein, 1981). The HKY85 model allows for different rates of substitution for transitions and transversions as well as allowing for unequal base frequencies (Hasegawa *et al.*, 1985). The TN93 model is an extension of the HKY model but distinguishes between transition rates of purines and pyrimidines (Tamura & Nei, 1993). Finally, the GTR model allows all six pairs of substitution to have different substitution rates as well as allowing for unequal base frequencies (Rodriguez *et al.*, 1990). Rate heterogeneity between sites can also be accounted for by incorporating gamma distributed rates (Γ) into the models (Yang, 1993). Gu *et al.* (1995) proposed to take into account the proportion of invariant sites (I) in the gamma distributed rates, hence the 'Γ+I' model. Yang (2006) describes this model as "pathological" as gamma distribution with an α shape parameter less than 1 already accounts for the invariant sites. Depending on the model under consideration, the base frequencies, rate matrix and shape parameter (α) of the gamma distribution using 16 rate categories were estimated using likelihood by iteration from an initial neighbor-joining (NJ) tree. The parameters derived from the initial tree were then used to build a new neighbor-joining tree and the parameters re-estimated, repeating the process until no noticeable improvement is seen in the likelihood.

Models are generally selected based on their fit to the sequence data as measured by likelihood values (Kelchner & Thomas, 2007). Normally, addition of parameters in a model increases the likelihood score; this, however, increases complexity and thus the data are spread more thinly, so if there is no significant improvement in likelihood score then there is no justification for using the more complex model. One way to identify which model to use is through a likelihood ratio test (LRT). The LRT is a statistical test that determines the goodness of fit of any two models being compared with a particular dataset. This can be applied to models that are nested since twice the difference in the likelihood scores between two nested models is approximately Chi squared distributed. The formula for this test is given as: LR = 2*(lnL1-lnL2); where lnL1-lnL2 is the difference in the log likelihood scores between any two nested models being compared. The LRT can then be used to determine if there is a significant difference between the log likelihood scores of the two models by identifying the degrees of freedom and checking for the *P* value in a Chi square table. The number of degrees of freedom is the difference between the number of parameters used by the two models being compared. For example, the GTR and the GTR+Γ models differ by one parameter (addition of the gamma distribution in the latter); therefore, the number of degrees of freedom for comparing these two models is 1 (Huelsenbeck & Crandall, 1997). Table 2.9 summarizes the number of parameters for a given model of DNA substitution. The model with the best likelihood score was selected but only if it was significantly better than a less complex model; otherwise, the simpler model was used.

Table 2.9: Summary of the number of parameters of the different models of DNA substitution (taken from Morrison, 2006)

Model	**Number or Parameters**
JC69	0
JC69+Γ	1
K2P	1
K2P+Γ	2
F81	3
F81+Γ	4
HKY85	4
HKY85+Γ	5
TN93	5
TN93+Γ	6
GTR	8
GTR+Γ	9

Twelve different models were evaluated; these were: (1) JC69, (2) JC69+Γ, (3) K2P, (4) K2P+Γ, (5) F81, (6) F81+Γ, (7) HKY85, (8) HKY85+Γ, (9) TN93, (10) TN93+Γ, (11) GTR, (12), and GTR+Γ. Since the F81 and K2P models are not nested, they could not be compared with each other. F81 and K2P could, however, be compared with any other model. Although it was tempting to restrict the model search to the parameter-rich HKY85, TN93 and GTR models as they were determined to be the optimal models by the ModelTest program in 80% of 208 published datasets in 2004 alone (Kelchner & Thomas, 2007), it was more prudent to check the less parameter-rich models to confidently rule them out if the more complex models had significantly higher likelihood scores. The likelihood scores for these models were computed in PAUP*, with the command lines summarized in Appendix 2.1, pp. 360-366.

The application of the LRT described here is similar to that which is applied in the Modeltest program by Posada and Crandall (1998) except that the LRT used in this study allows for a comprehensive comparison of all models under consideration (apart from non-nested models) whereas Modeltest ‘traverses’ a model space through a series of pairwise comparisons of the different models. For instance, if Modeltest compares the likelihood scores of JC69 and F81 and found the latter to be significantly better, then F81 is selected and compared with HKY85. If HKY85 is better than F81, then HKY85 is selected and compared with GTR. If GTR is better than HKY, then GTR is compared with GTR+Γ. Otherwise, HKY and TN93 will instead be compared. The problem with this approach is that it does not allow for a comprehensive comparison of all the different models being considered. In the above example, the GTR and TN93 models were not compared, and there is the possibility that TN93 is not significantly better than GTR.

2.9.6. Evaluating the sequences for evidence of saturation

Sequence data could suffer from extreme substitution saturation to such a degree that an optimal model of DNA sequence evolution could no longer correct for multiple hits (Xia *et al.*, 2003). The effect of this phenomenon of substitution saturation in phylogenetic analyses is twofold. First, it underestimates the amount of evolutionary change that took place. Second, homoplasy could occur where descendant sequences appear similar even if the similarity is not brought about by descent from a common ancestor (Graur & Li, 2000). For protein-coding genes, the third codon position has been found to be the most variable, with the 1st and 2nd codon positions more conserved. This is because substitution in either the 1st or 2nd codon position is more likely to lead to amino acid replacement that could affect the function of the protein being coded by the gene; hence, substitution tends to occur at a higher frequency at the 3rd codon position where substitution is mostly synonymous (Graur & Li, 2000). Including the 3rd codon position in phylogenetic analyses is beneficial when close relationships are examined as it is the most variable position and therefore contains much of the phylogenetic information; removing it, on the other hand, would leave only a few variable sites in the 1st and 2nd codon positions to work with. In the presence of substitution saturation, however, using the 3rd codon position could be more disadvantageous since 3rd codon positions would saturate first (Xia *et al.*, 2003).

Constructing different types of plots based on substitutions have been the standard procedure to check for evidence of saturation in sequence datasets (Morisson, 2006; Xia *et al.*, 2009), and their use abounds in the literature. Three types of plots were constructed. Plotting pairwise uncorrected distances against pairwise corrected distances based on an optimal model (Plot 1), for instance, would normally result in a curve. When distances are small there would be little difference between the uncorrected and corrected distances. As more divergent sequences are compared, however, multiple hits would lead to an underestimate of the actual amount of change in the uncorrected distances relative to the corrected distances where a correction is made to account for these unseen changes. At some point, the sequences being compared would become too divergent to allow correction for multiple hits to be made reliably leading to substitution saturation; when this happens, a plateau is observed, and the actual amount of change taking place would be underestimated (Strimmer & von Haeseler, 2003). Morisson (2006) used this type of plot on the actin and HSP70 genes of *Cryptosporidium*. If both transitions and transversions are plotted against total distance (Plot 2), on the other hand, both would be expected to increase linearly. However, as more divergent sequences are compared, transitions (which generally occur more frequently than transversions, Brown *et al.*, 1982) would be expected to saturate prior to transversions, leading to the transition line curving and eventually reaching a plateau. Transversions (which generally occur less frequently than transitions, Brown *et* *al.*, 1982) would continue to increase linearly for longer but eventually as sequences become even more divergent even the transversion substitutions would saturate, eventually leading to a curved transversion line and ultimately a plateau. This type of plot was used by Jorgensen *et al.* (2008) on the 16S rRNA and COI genes of apple snails. Plotting transitions against transversions (Plot 3) would result in a linear relationship when sequences are unsaturated. As divergence increases and the transitions saturate, the relationship between transitions and transversions would be non-linear, resulting in a curve in the plot. Tsigenopolous *et al.* (2002) employed this type of plot on the cytochrome b of southern African barbs. It was noted that interpretation of the plots could be somewhat subjective, particularly in determining when a plot has plateaued; it was imperative that all three types of plots were considered alongside one another in evaluating the level of saturation of each dataset.

The command lines in PAUP* for computing the uncorrected and corrected distances as well as the transition and transversion values are listed in Appendix 2.2, p. 367.

In addition to the plots mentioned above, there are other ways to detect the presence of full substitution saturation in a given dataset. One method is the randomization or permutation test in which a set of tree lengths are generated from randomized set of characters derived from the same dataset. If the dataset is saturated, then the tree lengths will not be significantly different from one another (Archie, 1989). Another method is the tree-independent relative apparent synapomorphy analsysis (RASA) where synapomorhpies or shared characteristics between any two given taxa are statistically evaluated (as expressed by the sum total of all shared character states between two taxa at the exclusion of third taxon) to determine if they result from shared evolutionary history or from convergence (Lyons-Weiler *et al.*, 1996). Both methods, however, can incorrectly conclude that there is no saturation taking place if there are two very closely related taxa in the dataset even if the other taxa have reached full substitution saturation (Xia, 2009). A third method is the frequency-dependent significance test based on parsimony (see discussion on parsimony in Section 2.9.8, p. 84) in which the distribution of phylogenetically informative sites is statistically tested against the hypothesis that the sequence variation is random, as in the case of full substitution variation (Steel *et al*., 1993, 1995). This method, however, is affected by long branch attraction, a typical problem of parsimony, where highly divergent taxa tend to group together by chance not because of shared homology but precisely because of homoplasy (Xia, 2009). A fourth method makes use of the index of saturation based on the concept of entropy in information theory where entropy is defined as the measure of uncertainty pertaining to a random variable, in this case the frequency of a nucleotide for a nucleotide site (Xia & Xie, 2001, Xia *et al.*, 2003). The index of substitution saturation (Iss) is the ratio of the observed mean entropy of all the sites in a gene of specific length over the expected entropy of the sequence at full saturation. Once the Iss has reached a critical value (or is not statistically significantly different from this critical value) in which the sequences could no longer be expected to recover the true tree, then the dataset is said to be saturated. However, applying this method becomes problematic if more than 32 taxa are used (Xia, 2009). It is also limited to determining if saturation has taken place for a perfectly symmetrical and completely asymmetrical tree but not anything in between. For all the reasons mentioned, these four methods were therefore not used for testing for evidence of saturation.

2.9.7. Testing for phylogenetic signal

If the tree lengths of all tree topologies generated through maximum parsimony (discussed in Section 2.9.8, p. 84-85) follow a normal distribution, then the differences in tree lengths are due to chance rather than homology; otherwise, the distribution is skewed enough that very few alternative solutions exist near the shortest tree, thus indicating the presence of a phylogenetic signal. A g1 test can measure how skewed a dataset is when applied to a set of tree lengths based on parsimony. Critical values for the g1 measure of skewness for such datasets (Table 2.10) were derived by Hillis and Huelsenbeck (1992). If g1 test scores obtained are smaller (or more negative) than the critical values, then the tree length distributions are said to be skewed and therefore exhibit phylogenetic signal. It should be noted that the critical values change little beyond 15 taxa being investigated so the values derived for 25 taxa can be used to test datasets with more than 25 taxa (Hillis & Huelsenbeck, 1992). Where the number of parsimony-informative sites or the number of taxa being investigated is not available in the table, then the next lower number should be used as a basis for deriving the critical value. Increasing the number of parsimony-informative sites or the number of taxa will increase the critical value (make it less negative), so if a g1 score for a particular number of parsimony-informative sites and taxa is less than the critical value for a lower number of parsimony-informative sites or lower number of taxa, then there is phylogenetic signal for the dataset.

Table 2.10: Critical values for g1 measure of skewness at $P=0.05$.

No. of parsimony-informative sites	No. of Taxa							
	5	6	7	8	9	10	15	25
10	-0.95	-0.70	-0.59	-0.51	-0.44	-0.34	-0.23	-0.16
50	-0.78	-0.58	-0.45	-0.37	-0.25	-0.28	-0.19	-0.12
100	-0.66	-0.56	-0.40	-0.31	-0.25	-0.30	-0.20	-0.10
250	-0.81	-0.43	-0.39	-0.26	-0.22	-0.20	-0.16	-0.08

Caution was taken, however, when interpreting strong skewness as this could be misleading. The presence of duplicated taxa or even very closely related taxa (i.e. those with very similar sequences) in a group of random taxa could lead to a very strong left skew as the tree that would show monophyly of these taxa would be considerably shorter than the other trees generated (Swofford *et al.*, 1996).

The g1 test statistic was performed in PAUP* and applied to all the gene datasets using the randtrees command with 10,000 replicates in PAUP*.

2.9.8. Tree Construction

Phylogenetic trees are graphical representations of the evolutionary relationships among taxa derived from morphological or molecular datasets. For molecular datasets, tree-construction methods either convert aligned sequences into a matrix of pairwise distances among the taxa (distance methods), or they use the positions in the sequences directly (character-state methods). Tree construction methods can use an algorithm to search for the single best tree estimate (algorithmic methods) or they define a criterion by which several alternative trees are compared and scored in order to identify the best tree (optimality criterion methods) (Graur & Li, 2000).

The maximum likelihood (ML) method (Cavalli-Sforza & Edwards, 1967; Felsenstein, 1981) is a character-state method that finds the best tree with the highest probability of fit with the data (measured as the likelihood score) using a specific model of DNA sequence evolution (Graur & Li, 2000). The objective of maximum likelihood is to find the tree with the best or largest likelihood score. However, phylogenetic analyses involving many taxa would entail evaluating a large number of trees (e.g. there are more than 34 million possible rooted trees for only 10 taxa) so that conducting an exhaustive search is impractical. Instead, a heuristic search is done in which an initial start tree (obtained by stepwise addition, with a random sequence input order and 10 replicates) is successively improved by swapping branches until the most likely tree with the best likelihood score is obtained. Unlike an exhaustive search, a heuristic search only evaluates a subset of all the possible trees and provides the best guess of the optimal tree (Hall, 2008). ML was undertaken in PHYML Version 2.4.4 (Guindon *et al.*, 2005). The command lines in PHYML are listed in Appendix 2.3.1, pp. 368-369.

Bayesian inference (BI) is similar to maximum likelihood in that it also utilises likelihood values. Unlike maximum likelihood, Bayesian inference determines the best hypothesis that maximises the posterior probability, which is proportional to the likelihood value multiplied by the prior probability of the hypothesis. A prior probability is based on what is initially known about the dataset (Holder & Lewis, 2004). Computer programs that conduct Bayesian inference such as MrBayes make use of the Markov Chain Monte Carlo algorithm to approximate posterior probability values of randomly generated trees through a number of generations until the chain attains a stable likelihood value (Ronquist & Huelsenbeck, 2003; Hall, 2008). Four chains of a Markov Chain Monte Carlo algorithm in BI were used to compute the posterior probability values with an optimized number of generations and heating temperature (Temp). The number of generations was optimized when the values of the posterior probabilities across the four chains converged or did not vary significantly from each other. The heating temperature was optimized when the acceptance rates of the Metropolis-Hastings mcmc sampler ranged between 0.1 and 0.7. (See also Appendix 2.3.2, pp. 369-370.) Bayesian inference was conducted in MrBayes Version 3.1.2 package (Ronquist & Huelsenbeck, 2003), and the command lines for this package are listed in Appendix 2.3.2., pp. 369-370.

The neighbor-joining (NJ) method (Saitou & Nei, 1987) is an algorithmic distance method that uses a modified distance matrix that adjusts the separation of each pair of sequences based on the pair's average divergence from all the other sequences. This method identifies the shortest tree by sequentially finding neighbors that minimize the total length of the tree (Graur & Li, 2000). NJ trees were built in PAUP*, with the command lines summarized in Appendix 2.3.3, p. 371.

The maximum parsimony (MP) method is a non-model based method that identifies a topology that requires the least number of possible changes (Eck & Dayhoff, 1966; Fitch, 1977). As with ML, a heuristic search for the most parsimonious tree or a set of equally most parsimonious trees is conducted by starting with an initial tree (obtained by stepwise addition, with a random sequence input order and 10 replicates) and swapping branches until the optimal tree is obtained. MP analysis was undertaken in PAUP* with a heuristic search using the tree bisection and reconnection (TBR) swapping routine and 10 random input orders. The command lines are listed in Appendix 2.3.4, pp. 371-372.

Advantages and disadvantages of the four tree methods are summarized in Table 2.11.

Table 2.11: Comparison of methods (table taken from Holder & Lewis, 2004)

Tree method	Advantages	Disadvantages
Neighbor-joining	Fast	Information is lost in compressing sequences into distances; reliable estimates of pairwise distances can be hard to obtain for divergent sequences
Maximum likelihood	The likelihood fully captures what the data tell us about the phylogeny under a given model	Can be prohibitively slow
Bayesian inference	Has a strong connection to the maximum likelihood method; might be a faster way to assess support for trees rather than the	The prior distributions must be specified; it can be difficult to determine whether the Markov chain Monte Carlo (MCMC)

	maximum likelihood bootstrapping	approximation has run for long enough
Maximum parsimony	Fast enough for the analysis of hundreds of sequences; robust if branches are short (closely related sequences or dense sampling)	Can perform poorly if there is substantial variation in branch length

2.9.9. Estimating reliabilities of clades in phylogenetic trees

A phylogenetic tree represents the best estimate of the true tree based on the sequences available and the method of tree construction. Reliability of the tree estimates, which can be measured by how many times the members of a particular clade are recovered as members of that clade, can be done through the bootstrap method in the maximum likelihood, neighbor-joining and maximum parsimony methods and through measuring posterior probabilities in the Bayesian inference method (Hall, 2008). The bootstrap method is a resampling technique used to estimate the confidence level of hypotheses in phylogenetic estimation. A measure of support for the branches in the tree is provided by bootstrap values, which are based on the percentage of the number of times a particular branch is generated in the bootstrap datasets (generated by random sampling from the dataset with replacement) (Graur & Li, 2000). For instance, a particular dataset is resampled 1000 times with replacement to produce 1000 resampled datasets, with each dataset used to generate a tree. Out of the 1000 trees, the percentage of the trees in which a particular branch appears becomes its measure of support. Bootstrap resampling with 1000 replicates was undertaken in PHYML for ML (see Appendix 2.3.1, pp. 368-369) and in PAUP* for NJ and MP (see Appendix 2.3.3, p. 371 for NJ and 2.3.4, pp. 371-372 for MP). In Bayesian inference analysis, the fraction of times a clade occurred among the last 1000 trees surveyed as part of the MCMC process was directly computed as posterior probabilities. Unlike the bootstrap method, the underlying data are not resampled (Hall, 2008). The posterior probabilities were computed in MrBayes (see Appendix 2.3.2, pp. 369-370).

2.9.10. Combining datasets

As well as undertaking phylogenetic analyses for each gene independently, where possible the individual gene datasets were combined in order to get a better estimate of the phylogeny. It has been recognized that a phylogeny based only on a single gene, known as a gene tree, cannot truly represent a species tree (Cummings *et al.*, 1995; Graur & Li, 2000) as organisms that participate in the evolutionary process are a collection of genes, each with its own evolutionary history, that interact with each other and with the environment (Morrison, 2006). Combining data from different genes tends to increase phylogenetic signal and disperse noise while at the same time uncovering the underlying signal found in the different data partitions (Baldauf *et al.*, 2000). Using genes in concert that have different evolutionary rates and modes of inheritance (i.e. the relatively slower evolving nuclear genes and the faster evolving, maternally inherited mitochondrial genes) can also provide information at different levels of phylogeny (Graybeal, 1994). Combining datasets are also known to reduce the phenomenon of long-branch attraction in parsimony analysis (Gontcharov *et al.*, 2004) in which long branches in a tree tend to cluster together (Graur & Li, 2000).

Concatenation is the combination of all datasets into a single data matrix for the purpose of phylogenetic analysis (Morrison, 2006). However, simply concatenating the datasets under consideration and analyzing them using only one evolutionary model could produce a phylogeny with the wrong groupings if the different datasets represent very divergent evolutionary histories (Cunningham, 1997). The partition homogeneity test (also known as the incongruence length test) based on maximum parsimony in

PAUP* was used in this study to distinguish between separate datasets that could be combined to give an improved phylogenetic accuracy (with *P* normally greater than 0.01) and individual datasets that give poorer accuracy when combined (with $P<0.001$) due to their very divergent evolutionary histories (Cunningham, 1997). The command lines for the partition homogeneity test in PAUP* are shown in Appendix 2.4, p. 373. As the test makes use of maximum parsimony to determine if datasets can be combined, its utility is hampered if at least one of the genes being considered exhibit polytomies as this considerably slows down PAUP*. For such a scenario, the decision to combine would rely on whether or not the single gene phylogenies exhibited concordance with each other.

Two sets of concatenated sequence alignments were prepared for the combined gene analyses. The first included only taxa with complete sequences across all genes evaluated. In order not to lose any taxon, a second set of concatenated sequences was also prepared in which taxa with missing datasets were also included. Though including taxa with incomplete datasets could be potentially problematic in phylogenetic analyses, Wiens (2006) found that these taxa could still be included and their phylogenetic position accurately determined so long as enough characters have been surveyed; their inclusion could also remove misleading long branches and potentially increase the accuracy of the combined phylogeny. The trees generated from the second set of concatenated sequences were compared for any similarity with the individual gene phylogenies as well as those derived from the first set of concatenated sequences.

An alternative to combining datasets by concatenating sequences is to construct from multiple trees a consensus tree derived from several genes with the same set of taxa or a supertree if the taxa sampled are not identical but there are taxa overlapping between trees (Morrison, 2006). Two strategies employed to construct consensus trees and supertrees are strict consensus (tree generated contains all the groups that occur on all trees considered) and majority consensus (tree generated includes groups that occur in at least 50% of all the trees considered) (Felsenstein, 2004). However, the effectiveness of consensus methods is limited by the following: 1) their tendency to produce spurious groups that do not appear in any of the trees; 2) the non-avoidance of pseudoreplication as a result of using overlapping data in some of the trees that increases the weight of these data; 3) the inappropriateness of using branch support methods such as bootstrapping (Morrison, 2006); and 4) their treatment of each tree, no matter how bad, as equally good (Wade, pers. comm.). The consensus methods were therefore not used.

2.9.11. Hypothesis testing

An optimal tree may not necessarily produce the expected topologies, as in the case where a supposedly monophyletic group based on taxonomy turned out not to be monophyletic in the optimal tree. A tree can be constrained to reflect the expected topology, and this tree can be compared for significant difference with the optimal tree. If the optimal tree turns out to be not significantly better than the constrained tree, then the hypothesis being put forward by the optimal tree is not a strong hypothesis. The Shimodaira-Hasegawa test (Shimodaira & Hasegawa, 1999; Goldman *et al.*, 2000) was applied on the datasets found in Chapters 3 and 4 to compare for significant difference between constrained and optimal NJ trees using likelihood. The command lines for the Shimodaira-Hasegawa test, which was carried out in PAUP*, are listed in Appendix 2.5, p. 374.

2.9.12. Inferring the presence of paralogous sequences in the dataset

The presence of paralogous sequences due to gene duplication could yield misleading trees. All genes were therefore evaluated for the presence of paralogs. Of the genes used in this study, actin is most susceptible to the problem of paralogy since several copies of the actin gene, which arose from gene duplication events, abound. Although the primers used to amplify the actin gene were known to be specific for the cytoplasmic actin (see Section 2.2.1.1.1.2, pp. 48 – 50), this was no guarantee that only orthologous sequences were amplified as duplication events could also have taken place within the cytoplasmic actin. To infer the presence of paralogous sequences, the PCR-direct sequences were checked for the presence of ambiguous sites; the presence of ambiguous sites (where more than one peak is obtained at the same position in a DNA sequence) implies that more than one copy of the gene is present in that individual. All sequences obtained in this study were evaluated for the presence of ambiguities. Where evidence of multiple copies is found, cloning the PCR products prior to sequencing enables each copy of the gene to be examined individually. Cloning of the actin gene (Chapters 3 and 4) was undertaken for a limited number of clones from three taxa (time and cost constraints precluded a more detailed analysis).

2.9.13. Assessing the utility of the actin gene for phylogenetic analyses

The inherent problem of actin in relation to the presence of paralogous sequences could limit its utility in phylogenetic analyses. However, the potential of actin to provide some phylogenetic signal should not be underestimated. Several steps were undertaken to evaluate the utility of the actin dataset. First, the clones derived from representative taxa were checked for monophyly; if all clones derived from a taxon fall as a monophyletic group within the actin tree, then they will not mislead organismal phylogeny. Second, the number of ambiguous sites within a taxon was compared with the total number of nucleotide differences between the taxon and its closest relative based on the closest sequence identity of the actin sequence (i.e. the least number of nucleotide differences between any two taxa). In principle, the time of divergence between two taxa should be earlier than the evolution of the different actin genes within these taxa, such that the number of ambiguous sites should not exceed the number of differences between the two taxa being compared. However, it is possible for two taxa to have a higher number of ambiguous sites than nucleotide differences if these ambiguous sites are due to a large number of multiple copies, in which each contains only a small number of variable sites (when this variation is added together it may exceed the number of nucleotide differences). These sequences will still cluster together in a tree and will not mislead phylogeny. Third, a partition homogeneity test (see

Section 2.9.10, pp. 86-88) was undertaken to determine whether or not the sequences from the actin gene exhibited a significant difference in terms of phylogenetic signal with the other genes being evaluated. If no significant difference was observed, this would suggest that the actin gene could be utilized alongside the other genes in phylogenetic analyses and that the presence of multiple copies of the actin gene was not having a significant effect on phylogenetic estimation. Lastly, the phylogenetic tree obtained from the actin dataset was checked for concordance with the other gene phylogenies. Concordance would suggest that the presence of multiple copies of the actin gene was not misleading phylogeny. Phylogenetic analyses involving the actin gene were therefore approached with caution, with reference to the limitations of using this gene.

2.10. Literature cited

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CHAPTER 3 – Phylogeny of the Achatinoidea

3.1. Introduction

The Giant African Land Snail, *Achatina fulica*, and other members of the superfamily Achatinoidea belong to the suborder Stylommatophora, whose members possess a vascularised mantle cavity that serves as a lung and two pairs of caudal tentacles, the upper pair of which bears the eyes at their tips (Ruppert *et al*., 2004; Barker, 2001). Using the Pilsbry-Baker system of classification, the Stylommatophora can be divided into four infraorders based on the structure of the excretory system (Pilsbry, 1900; Baker, 1955). *Achatina fulica* and other members of the Achatinoidea belong to the infraorder Sigmurethra, in which the excretory system does not have a distal ureteric pouch or orthureter but possesses a ureter that runs along the anterior portion of the nephridium and connects to the pallial cavity before terminating at the pneumostome. Recent molecular phylogenetic studies (Wade *et al*., 2001, 2006) based on the nuclear ribosomal (r) RNA gene cluster (including part of the 5.8S and LSU genes) revealed a principal division of the Stylommatophora into two major clades. The 'achatinoid' clade comprises the superfamilies Streptaxoidea, represented by the single family Streptaxidae, and the Achatinoidea, represented by the families Achatinidae, Coeliaxidae, Ferussaciidae, Glessulidae, Subulinidae and Thyrophorellidae. All other stylommatophoran families fall within the 'non-achatinoid' clade.

3.1.1. The Achatinoidea

The composition of the Achatinoidea varies according to author (Solem, 1978; Abbott, 1989; Tillier, 1989; Vaught, 1989; Schileyko, 1999; Bouchet & Rocroi, 2005; Table 1.1). Solem (1978) included the Achatinidae, Ferussaciidae, Megaspiridae, Spiraxidae and Subulinidae (including the coeliaxids and glessulids as the subfamilies Coeliaxinae and Glessulinae, respectively), while Abbott (1989) regarded the Coeliaxidae as a family in its own right and additionally included the monotypic Thyrophorellidae. Tillier (1989) classified land snails under the superfamily Achatinoidea based on certain morphological features such as a closed ureter in the excretory system and possession of symmetrical cerebro-pedal connectives, short commissure and contiguous left parietal and visceral ganglia in the nervous system. His Achatinoidea comprised the Achatinidae, Ferussaciidae, Subulinidae (including the subfamilies Coeliaxinae and Glessulinae), Thryphorellidae as well as the Streptaxidae, Succineidae and the Oleacinidae (Spiraxidae and Testacellidae). Vaught (1989) did not include the Streptaxidae, Succineidae, Spiraxidae or Testacellidae in her Achatinoidea but instead included the Thyrophorellidae and the Coeliaxidae (elevated from a subfamily of subulinids) in addition to the Achatinidae, Ferussaciidae and Subulinidae. Schileyko (1999) placed only the Achatinidae in the Achatinoidea, whereas Bouchet & Rocroi (2005) included the Achatinidae, Ferussaciidae, Subulinidae (which also incorporated the coeliaxids and glessulids as the subfamilies Coeliaxinae and Glessulinae) and Micractaeonidae. Wade *et al.*'s (2001, 2006) molecular phylogenies based on a part of the rRNA gene cluster lend support to Vaught's Achatinoidea. In this study, I utilise an Achatinoidea that largely resembles Vaught's and comprising the Achatinidae, Coeliaxidae, Ferussaciidae, Glessulidae (a subfamily of the Subulinidae in Vaught's classification), Subulinidae and Thyrophorellidae.

The family Achatinidae, which includes the Giant African Land Snail, *Achatina fulica*, has shells that are mostly dextral, are generally higher than wide and range in size from medium to very large (Schileyko, 1999). The reproductive structures of the achatinids are highly variable (Mead, 1991), but all members possess a penis sheath

(Schileyko, 1999). With the exception of *Achatina fulica*, which has been introduced by Man into new areas (Mead, 1979; Raut & Barker, 2002), all other achatinids are restricted to Africa and nearby islands (Schileyko, 1999).

The monotypic family Thyrophorellidae is represented by *Thyrophorella thomensis* from São Thomé. The shell is sinistral and is made up of three nearly flat whorls so that it appears low conic on top and bulging at the bottom (Schileyko, 2001). *Thyrophorella thomensis* is one of the few stylommatophorans that have secondarily acquired a structure similar in function to the prosobranch gastropod operculum; in the case of *T. thomensis*, a lobe-shaped outgrowth of the parietal wall of the shell's aperture is hinged on a flexible periostracal layer to serve as a covering of the aperture (Barker, 2001). Bouchet and Rocroi (2005) included the Thyrophorellidae in the superfamily Punctoidea, although recent molecular data from the LSU rRNA gene (Wade *et al*., 2006) clearly places this family within the Achatinoidea.

Members of the Ferussaciidae have very small dextral shells that are elongate-ovate to nearly cylindrical and appear translucent or transparent (Schileyko, 1999). Ferussaciids are unique among the 'achatinoids' because they superficially resemble the 'non-achatinoid' Succineidae in possessing a short but transversely elongate kidney (Tillier, 1989) with a complete ureter (Schileyko, 1999). The ferussaciids are largely found in the Mediterranean, with several in tropical Africa, the Indian subcontinent and Indian Ocean islands, the Philippines, Hawaii, Mexico, the Caribbean, Brazil (Schileyko, 1999), Hawaii (introduced, Cowie, pers. comm.), New Caledonia (introduced, Schileyko, 1999) and Northwest Europe (Kerney & Cameron, 1979).

The family Subulinidae is a large group with a pantropical distribution (Tillier, 1989). With very few exceptions, its members have characteristic slender and turreted shells and are generally dextral. The internal anatomy of members of the group is not well studied, and most taxa within the family are grouped together based largely on the similarity of their shells and their geographic distribution. Such an approach is exemplified by Zilch (1959). In revising the Subulinidae, Schileyko (1999) attempted to restructure their classification by including characters of the reproductive tract, primarily those proximal to the genital orifice. As the only comprehensive review of the group since Pilsbry (1906-1907; 1908-1910), it seems logical to use Shileyko (1999) as the primary source when reviewing the group as was done by Bouchet & Rocroi (2005). According to Schileyko (1999), eight subfamily groups can be recognized. These are the Subulininae (dextral shell with the last whorl lacking internal sculpture and with a reproductive tract that has a reduced or absent epiphallus, a muscular organ responsible for the formation of the spermatphores, and a short or absent flagellum, an extension of the epiphallus; distributed in tropical and subtropical regions of the world), Petriolinae (dextral or sinistral shell similar to Subulininae but with a prominent epiphallus; found in Africa and St. Helena), Rishetiinae (dextral shell with a simple columella and a reproductive organ with a long flagellum; found in the Hindustan Peninsula, Ceylon, and Southeast Asia), Rumininae (dextral shell decollated or entire and with a reproductive organ lacking an epiphallus and a flagellum; found in South Africa and the Mediterranean), Opeatinae (with dextral shell and an enlarged penis; found in subtropical regions of the Old and New World), Obeliscinae (dextral shell slender turreted to subfusiform and with a reproductive organ lacking an epiphallus and a flagellum; found in South America, the Caribbean and Southeast Asia), Tristaniinae (sinistral shell; found in Tristan da Cunha Islands), and Perrieriinae (shell sinistral and subcylindrical or pillar-shaped; found in New Guinea) (Schileyko, 1999). Other subulinid groups have been accorded by some authors with full taxonomic family status such as the Coeliaxidae (Abbott, 1989; Vaught, 1989) and the Glessulidae (Schileyko, 1999). The coeliaxids have slender dextral or sinistral shells and are distributed in South Africa (only one species), the Gulf Island of São Thomé in West Africa, the Caribbean, Colombia and Peru (Schileyko, 1999). The glessulids generally have glossy, oblong-conic dextral shells and are restricted to the Indian subcontinent and Sri Lanka (Schileyko, 1999).

However, closer examination of Schileyko's results raises doubts regarding his conclusions, and the taxonomy of the Subulinidae therefore warrants further scrutiny. For instance, rather than representing a subulinid subfamily, *Tristania* is a junior synonym of *Balea*, which is a member of the Clausiliidae (Preece & Gittenberger, 2003). *Rishetia* is anatomically close to *Glessula* (both have a shell with truncated columella and penis with epiphallus), and both are restricted to South Asia; therefore, there seems to be no basis for Schileyko's erection of the subfamily Rishetiinae. Shileyko's acceptance of Thiele's (1933) genus *Striosubulina* is supposedly justified by the reproductive anatomy described and figured by Shileyko. However, in describing the penis, Shileyko seems to have mistaken that part of the penis surrounded by the penial sheath for the complete penis, and most of what he describes as the penial retractor muscle is in fact the long thin penis almost identical to that of *Subulina octona*, the type species of *Subulina* (Naggs, pers. comm.). Thus, the arrangement of the Subulinidae into eight subfamilies by Shileyko (1999), subsequently accepted by Bouchet & Rocroi (2005), is unreliable and will need to be reassessed. Furthermore, some pieces of information on distributions of the subulinids based on published records were not included by Shileyko (1999). For example, in giving the range of *Glessula* as 'Hindustan peninsula and Ceylon (1999, page 541), Shileyko fails to mention that several species of *Glessula* occur in Myanmar, Yunnan (China), Thailand and east as far as Vietnam and southeast into the Indonesian peninsula (Pilsbry, 1908-

1910; Van Benthem Jutting, 1952, 1959; Hemmen & Hemmen, 2001; Vermeulen & Maassen, 2003). With the Ruminiinae, the geographical range for the group alters drastically if *Zootecus* is excluded (see Table 3.1) or included, when the range extends from circum-Mediterranean, Arabian and West African to encompass a large longitudinal range from the Cape Verde islands through Central and Northern India to Myanmar (Gude, 1914). It should be noted that Schileyko (1999) placed *Zootecus* under the Subulininae.

Table 3.1: Comparison of the composition and distribution of the Ruminiinae according to Zilch (1959) and Schileyko (1999).

	Ruminiinae sensu Zilch (1959)	Ruminiinae sensu Shileyko (1999)	Distribution according to Shileyko	Distribution according to Zilch
Namibiella	x	X	SW Africa	SW Africa
Xerocerastus	x	X	SW Africa	SW Africa
Lubricetta	x	X	SW Africa	SW Africa
Krapfiella		X	E. Africa	
Riebeckia		X	Sokotra	
Balfouria		X	Sokotra	
Rumina	x	X	Mediterranean	Europe and N. Africa
Obeliscella	x			Arabia
Zootecus	x			Cape Verde Islands, N Africa, N & C. India

3.1.2. Some questions about the Achatinoidea

Although the Achatinoidea is strongly supported in Wade *et al's* (2006) rRNA phylogeny with 93% NJ bootstraps (see Figure 3.1), their phylogeny was based on only 823 nucleotide sites from the rRNA gene cluster and incorporated only 15 achatinoid taxa. Clearly, the clade could be further refined by obtaining new sequence data (both longer sequences of the rRNA as well as sequences from other new genes) as well as the inclusion of additional taxa.

For instance, the achatinids are a compact group based on the presence of a penis sheath (Schileyko, 1999) and their restricted geographic distribution to sub-Saharan Africa (Mead, 1979; Raut & Barker, 2002). Wade *et al.* (2006) used four taxa to represent the Achatinidae, but support for the monophyly of the group was equivocal (38% NJ bootstraps and *P*=0.94 BI) based on the small segment of the rRNA gene cluster used in their analyses.

The ferussaciid *Ferussacia folliculus* forms a distinct basal lineage in the Achatinoidea (Wade *et al.*, 2006). Whether this topology persists if other ferussaciids are surveyed remains to be seen.

The monophyly of the Subulinidae and its subfamilies also needs to be verified as, anatomically, this group is poorly studied (Schileyko, 1999), and both the coeliaxids (Abbott, 1989; Vaught, 1989) and the glessulids (Abbott, 1989; Schileyko, 1999) have been regarded as separate families. In particular, the placement of *Zootecus* in the Subulininae according to Schileyko (1999) must be validated. The subulinids, coeliaxids and glessulids were represented by nine taxa in the Wade *et al.* (2006) study, which formed several groups together with the thyrophorellid *Thyrophorella thomensis* but with no support apart from the *Riebeckia-Coeliaxis* group (92% NJ bootstraps and *P*=1.0 BI) and the *Pyrgina-Thyrophorella* group (100% NJ bootstraps and *P*=1.0 BI).

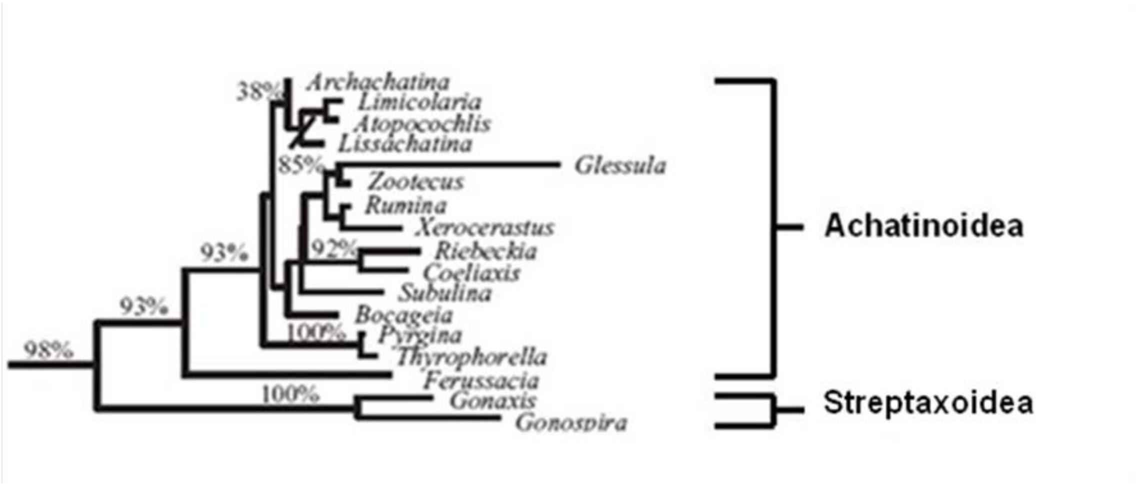


Figure 3.1: Phylogeny of the Achatinoidea based on 823 unambiguously aligned nucleotide sites of the rRNA gene cluster. (Taken from the stylommatophoran phylogeny of Wade *et al.*, 2006.)

3.1.3. Use of molecular markers to determine phylogeny

Various molecular markers are available for determining evolutionary relationships. These include the nuclear ribosomal RNA gene family (see Section 2.2.1.1.1.1 of Chapter 2, pp. 45-48). Already described is Wade *et al.*'s (2001, 2006) use of the nuclear ribosomal RNA gene cluster to infer phylogenetic relationships within the Stylommatophora. However, their results were derived from only a partial segment of the rRNA cluster. Wade *et al* (2001, 2006) amplified an approximately 1460 nucleotide region of the rRNA (comprising approximately 80 nucleotides of the 5.8S gene, the complete internal transcribed spacer (ITS) 2 region and approximately 840 nucleotides of the LSU gene) of which 843 (2001 study) and 823 (2006 study) nucleotide sites could be aligned across all taxa and were therefore used in phylogeny reconstruction. Expanding the Wade *et al.* fragment to cover the entire LSU gene (approximately 4000 nucleotides) could provide better resolution of the Achatinoidea. The small subunit (SSU) rRNA gene has also been employed to elucidate evolutionary relationships among different gastropod groups. For example, Winnepenninckx *et al.*

(1998) applied the full-length SSU rRNA gene (approximately 1800 nucleotides), to reassess the groupings within the Gastropoda, demonstrating the basal position of the archaeogastropods. However, their results could not resolve whether the pulmonates or even the stylommatophorans were monophyletic.

In addition to the ribosomal genes, the nuclear actin and histone 3 genes have also been used to estimate phylogeny within the Mollusca. The actin gene encodes a protein that is involved in various functions such as muscle contraction, cell division and differentiation (Hernan, 1993, see also Section 2.2.1.1.1.2 of Chapter 2, pp. 48-50). However, several actin genes may exist in animals as a result of gene duplication and divergence (Hightower & Meagher, 1986); these genes code for protein isoforms that are broadly classified as either the muscle (α) type or the cytoplasmic (β) type (Vandekerckhove & Weber, 1984; Adema, 2002). Great care must therefore be taken to ensure that paralogous copies of the gene do not mislead the phylogenetic analysis. A 784 bp fragment of the actin gene has been successfully employed to show the monophyly of several groups within the coleoid cephalopods such as the Octopodiformes, the Decapodiformes, the Octopoda and the Incirrata (Carlini *et al*, 2000). The actin gene was also used together with the mitochondrial 16S and cytochrome c oxidase subunit I (COI) genes to resolve the phylogeny within the ancestral archaeogastropod monodontine topshells (family Trochidae) from the southern hemisphere, with three species of *Austrocochlea* being transferred to the genus *Chlorodiloma* (Donald *et al.*, 2005). The actin fragment (764 bp) used in this study was amplified using primers designed for the cytoplasmic actin fragment of the planorbid snail *Biomphalaria glabrata* previously sequenced by Adema (2002). To date, the cytoplasmic type actin gene has not been used in the Achatinoidea, and the utility of this gene for phylogenetic analysis of the group is worth investigating, though the potential presence of paralogous sequences could limit its utility.

The histone 3 (H3) gene codes for two subunits of the histone core protein octamer that packs the eukaryotic chromatin into bead-like structures (Lewin, 2008) (see Section 2.2.1.1.1.3 of Chapter 2, pp. 50-51). Histone 3 was used, in conjunction with the nuclear SSU and LSU rRNA genes and the mitochondrial COI gene, to resolve the incongruence between molecular and morphological data for the gastropod phylogeny (Colgan *et al.*, 2003). The results demonstrated the monophyly of the Euthyneura, which include the stylommatophoran pulmonates. The H3 fragment (331 bp) used in this study corresponds to the 3' end of the gene in the bivalve *Spisula solidissima*. Like the actin gene, the histone 3 gene has not been used in the Achatinoidea; thus, its usefulness is worth investigating.

Using mitochondrial genes in concert with nuclear genes is desirable for constructing phylogenetic trees as they tend to improve phylogenetic accuracy (Lake & Moore, 1998; Steinke *et al.*, 2004). Nuclear and mitochondrial genes evolve at different rates and are not inherited in the same way; as such, they provide information at different levels of phylogeny (Graybeal, 1994). Mitochondrial genes generally evolve faster than nuclear genes; they are also maternally inherited and are therefore not subject to recombination (Brown, 1985; Avise, 1994). Two mitochondrial genes commonly used for phylogenetic analyses are the cytochrome c oxidase subunit I (COI) gene, which codes for an enzyme that accepts electrons from cytochrome c during the electron transport chain in the mitochondrion (Zubay *et al.*, 1995; see also Section 2.2.1.1.2.1 of Chapter 2, pp. 51-52), and the 16S rRNA gene, which transcribes a ribosomal rRNA that is incorporated in the mitochondrial ribosome (Lewin, 2008; see also Section 2.2.1.1.2.2 of Chapter 2, pp. 52-53). Steinke *et al.* (2004) used a combined data set of nuclear rRNA genes (18S and ITS-1) and mitochondrial genes (16S rRNA and COI) to separate the Western Palaearctic helicoid stylommatophorans into two families: Helicidae and Hygromiidae. They reasoned that the faster evolving mitochondrial genes were able to resolve the terminal taxa while the more conserved nuclear rRNA genes separated the basal groups. The 16S rRNA fragment (approximately 400 bp) was amplified using Palumbi *et al.*'s (1991) universal primers while the COI fragment (approximately 500 bp) was amplified using Folmer *et al*.'s (1994) universal primers. As mentioned previously, these same fragments were also used by Carlini *et al.* (2000) alongside the actin gene for the coleoid cephalopod phylogeny. Furthermore, both 16S (Thollesson, 1999) and COI (Remigio & Hebert, 2003) were employed with some degree of success to evaluate higher level phylogenies within the Gastropoda even though both genes are susceptible to significant levels of saturation. Neither Palumbi *et al*.'s (1991) universal 16S primers nor Folmer *et al*.'s (1994) universal COI primers have been applied previously to phylogenetic analyses of the Achatinoidea.

Aside from the COI and the 16S rRNA genes, several other mitochondrial genes have also been used for inferring deep level phylogenies within the gastropods. Grande *et al*. (2004) employed several mitochondrial genes, in addition to the 16S and COI, such as the tRNA-valine, tRNA-argenine, tRNA-proline and the NADH dehydrogenase subunits 5 and 6 genes in the study of the Euthyneura (opisthobranchs and pulmonates) in which their molecular data rejected the monophyly of the pulmonates.

At present, no study has attempted to use nuclear and mitochondrial genes in concert to address the issues regarding the relationships within the Achatinoidea. Using several genes together approximates the species tree that traces the evolutionary relationships of the species under consideration, which is more desirable than representing their relationships based on the history of individual genes, as shown by a gene tree (Grauer & Li, 2000). Combining these genes could also resolve the phylogeny of the Achatinoidea at all levels, with the faster evolving mitochondrial genes (COI and 16S) resolving the shallower nodes and the slower evolving nuclear genes (rRNA, actin and possibly histone 3) resolving the deeper nodes (Graybeal, 1994; Johnson & Clayton, 2000). Combining genes could also increase phylogenetic signal and disperse noise (Baldauf *et al*. 2000; Gontcharov *et al.*, 2004).

3.1.4. Objectives of this study

This study had the following objectives: (1) to identify the primary divisions within the superfamily Achatinoidea and to elucidate the relationship of the different families; (2) to establish if the Achatinidae are monophyletic and to identify their position relative to the other families within the Achatinoidea; (3) to determine whether the Ferussaciidae is monophyletic and to establish its phylogenetic position; (4) to settle the taxonomic designation of the Subulinidae, Coeliaxidae and Glessulidae; and (5) to validate the different subfamilies of the Subulinidae. To address these objectives, the phylogeny of the Achatinoidea was inferred by examining representative taxa from all major groupings across the superfamily using molecular data from three nuclear genes (rRNA cluster, actin, and histone 3) and two mitochondrial genes (16S rRNA and COI). The genes were analyzed separately and in combination.

3.2. Materials and methods

3.2.1. Taxa used

Twenty-four taxa from six achatinoid families (Achatinidae, Coeliaxidae, Ferussaciidae, Glessulidae, Subulinidae and Thyrophoprellidae) and three streptaxid outgroup taxa, two of which were used by Wade *et al*. (2006) and were found to fall at the base of the ‘achatinoid clade,’ were used to evaluate the phylogeny of the Achatinoidea (see Table 3.2). Four subulinid subfamilies following Schileyko’s (1999) classification (Petriolinae, Rishetiinae, Rumininae and Subulininae) were also represented in this study. Thirteen taxa were entirely new to this study while the remaining 14 taxa were used by Wade *et al*. (2006) in their phylogeny of the land snails based on a partial fragment of the rRNA cluster.

Table 3.2: Taxa used for the phylogenetic study of the Achatinoidea. Taxa marked with (*) are new to this study and were solicited through email by myself, C. Hudelot, F. Naggs and C. Wade from the collectors shown in the table. The DNA for the remaining taxa was provided by C. Wade from the collections obtained for Wade *et al.* (2001, 2006).

Family		**Species**	**Collection/Location**	**Collector/Provider**
Achatinidae	*	*Achatina achatina* (Linneaus, 1758)	Unknown (Zool. Soc. Lond. Colln.)	NHM**
		Achatina fulica Bowdich, 1822	Captive bred, unknown origin	NHM**
	*	*Achatina stuhlmanni* von Martens, 1892	Semuliki National Park, Uganda	B. Rowson
	*	*Cochlitoma ustulata* (Lamarck, 1822)	Western Cape Prov., South Africa	A. Moussalli & D. Stuart-Fox
Coeliaxidae		*Coeliaxis blandii* (Pfeiffer, 1852)	New Bradford, South Africa	N. Smith
		Pyrgina umbilicata Greeff, 1882	São Thomé	A. Gascoigne
Ferussaciidae	*	*Cecilioides gokweanus* (Boettger, 1870)	Cape Vida, Bhangazi Hill, Zululand, South Africa	D. Herbert
		Ferussacia folliculus (Gmelin, 1791)	Los Alcornales, Prov Cadiz, Spain	M. Seddon
Glessulidae		*Glessula ceylanica* (Pfeiffer, 1845)	Colombo, Sri Lanka	P. Karunaratne
Subulinidae				
S.f. Petriolinae		*Bocageia* sp.	São Thomé	A. Gascoigne
	*	*Subulona* sp.	Ossen Forest, Tupen Hills, Kenya	M. Pickford
S.f. Rishetiinae	*	*Eutomopeas layardi* (Benson, 1863)	Koralegama, Sri Lanka	?
	*	*Tortaxis erectus* (Pilsbry, 1906)	Guilin, Guangxi Prov., China	R. Anderson
S.f. Rumininae		*Riebeckia* sp.	Samha, Sokotra Archipelago	E. Neubert
		Rumina decollata (Linneaus, 1758)	Sicily	A. Davison
		Xerocerastus sp.	Otjiwarongo, Namibia	W. Sirgel
S.f. Subulininae	*	*Allopeas clavulinum* (Potiez & Michaud, 1838)	University of Sao Paulo, Brazil	F. Florens & C. Baider
	*	*Leptinaria lamellata* (Potiez & Michaud, 1838)	Botanical Garden, Rio de Janeiro, Brazil	F. Florens & C. Baider
	*	*Paropeas achatinaceum* (L. Pfeiffer, 1846)	Agra Gajaba's Garden Sri Lanka	D. Raheem
	*	*Subulina octona* (Bruguiere, 1789)	Island of Pulo Anna, Sonsorol, Southwest Islands, Republic of Palau	R. Rundell & A.M. Gawel
		Subulina striatella (Rang, 1831)	Kew Gardens (introduced)	F. Naggs
	*	*Subulina vitrea* (Mousson, 1887)	Gauss, Namibia	?
		Zootecus insularis (Ehrenberg, 1831)	Dubai, United Arab Emirates	S. Green
Thyrophorellidae		*Thyrophorella thomensis* Greeff, 1882	Zampala, São Thomé, West Africa	A. Gascoigne
Streptaxidae (outgroups)	*	*Gibbulinella dewinteri* Bank, Groh & Ripken, 2002	Puntas Coloradas, La Gomera Island	M. Ibañez
		Gonaxis quadrilateralis Preston, 1910	Reunion	O. Griffiths
		Gonospira sp.	Mauritius	O. Griffiths

** NHM-Natural History Museum

3.2.2. DNA extraction, PCR amplification and sequencing

For all new specimens, tissue slices (approximately eight mm^3) from the foot muscle of the snail were obtained and the DNA was extracted using the standard CTAB method of DNA extraction (Section 2.1.1 of Chapter 2, pp. 37-39). The DNA was provided by C. M. Wade for those specimens utilized in the Wade *et al.* (2001, 2006) studies.

Amplification by PCR, gel migration and purification of PCR products from agarose gels were carried out as described in Sections 2.2-2.4 of Chapter 2, pp. 42-59. Nearly the entire fragment of the nuclear LSU rRNA gene, the internal transcribed spacer 2 (ITS2) and 80 bp of the 5.8S rRNA gene (for a total of approximately 4000 bp) were amplified using six overlapping primer pairs listed in Table 2.1 of Chapter 2, p. 47. Sequences of the Morgan (2002) nuclear cytoplasmic actin gene fragment (approximately 900 bp), the Colgan *et al.* (2003) nuclear histone 3 fragment (328 bp), the Folmer *et al*. (1994) mitochondrial COI fragment (approximately 650 bp) and the Palumbi *et al.* (1991) mitochondrial 16S fragment (420-500 bp) were amplified using the primers listed in Tables 2.2-2.5 of Chapter 2, pp. 50-53. For all fragments, both sense and anti-sense strands were sequenced directly using an Applied Biosystems 3730 DNA sequencer and BigDye version 3.1 termination cycle sequencing chemistry (see Section 2.6 of Chapter 2, pp. 59-61 for details).

3.2.3. Sequence analysis

Sequences were assembled using the STADEN package version 1.5.3 (Staden *et al*., 2000) and aligned manually within the Genetic Data Environment (GDE) Version 2.2 (Smith *et al.*, 1994). The rRNA and 16S rRNA sequences were aligned following alignments generated by C. Hudelot for the Stylommatophora based on the secondary structure of these genes. Ambiguous sites due to sequencing errors (for all genes) or the presence of multiple copies (for the actin gene) were assigned as described in Section 2.9.3 of Chapter 2, pp. 72-73. Cloned sequences of actin gene copies from three representative taxa of the Achatinoidea were used as a guide to assign ambiguous sites in the actin gene (see Section 2.7 of Chapter 2, pp. 61-66).

For each gene fragment, the average base frequencies as well as the numbers of variable and parsimony-informative sites were determined in PAUP* Version 4.0b10 package (Swofford, 2002) (Section 2.9.4 of Chapter 2, p. 73). Corrected distances were computed after determination of the optimal model for DNA sequence evolution. This was carried out using likelihood by estimating the log likelihood scores in the PAUP* for the JC69 (Jukes & Cantor, 1969), F81 (Felsenstein, 1981), K2P (Kimura, 1980), HKY85 (Hasegawa *et al.*, 1985), TN93 (Tamura & Nei, 1993) and the GTR (Rodriguez *et al.*, 1990) models as well as their variant that incorporated gamma distributed rates (Γ) (Yang, 1993), after which the scores were compared for significant differences using the Likelihood Ratio Test (LRT) (see Section 2.9.5 of Chapter 2, pp. 73-77 for details of the LRT).

In order to examine the sequences for evidence of saturation, the following plots were generated: pairwise corrected versus pairwise uncorrected distances (Plot 1); pairwise uncorrected transition and transversion distances versus pairwise uncorrected total distances (Plot 2); and pairwise uncorrected transition distances versus pairwise uncorrected transversion distances (Plot 3) (see Section 2.9.6 of Chapter 2, pp. 77-81). Gene datasets that demonstrated saturation were excluded from subsequent phylogenetic analyses. To test for the presence of phylogenetic signal, tree length distribution using parsimony was also determined for a g1 measure of skewness for 10,000 tree length replicates (see Section 2.9.7 of Chapter 2, pp. 81-82). Due to the potential problems posed by the presence of paralogous sequences the actin gene was assessed for its utility in phylogenetic analyses using the procedures outlined in Section 2.9.13, pp. 90-91.

Phylogenetic trees were generated from the aligned datasets using the model based maximum likelihood (ML), Bayesian inference (BI) and neighbor-joining (NJ) methods and the non-model based maximum parsimony (MP) method (Section 2.9.8 of Chapter 2, pp. 82-85). The trees for NJ and MP were generated in PAUP* while that of ML was generated using PHYML Version 2.4.4 (Guindon *et al.*, 2005). Bootstrap resampling (Felsenstein, 1985) with 1000 replicates for MP and NJ (using PAUP*) and 1000 replicates for ML (using PHYML) were also carried out. Bayesian inference (BI) was performed using the MrBayes (Version 3.1.2) package (Ronquist & Huelsenbeck, 2003) using four chains of a Markov Chain Monte Carlo algorithm. The number of generations to explore the tree space and the heating temperature used for each gene were optimised as described in the BI segment of Section 2.9.8 of Chapter 2, pp. 83-84 and on Appendix 2.3.2, pp. 369-370. A consensus tree for each gene (where unsaturated) was constructed using the last 1000 trees.

To determine if the sequences from the genes that did not exhibit saturation could be combined and analyzed as a single dataset of concatenated sequences, a partition-homogeneity test (Swofford, 2002) was carried out within PAUP* (Section 2.9.10 of Chapter 2, p. 86-88). Two sets of concatenated sequences were prepared. The first one included only those taxa with complete sequences for all the gene fragments under consideration while the second set included all taxa. Studies show that taxa with incomplete datasets could still be used and their phylogenetic positions accurately determined provided that a lot of characters were surveyed from the other sequences (Wiens, 2006). Inclusion of such taxa could also benefit the combined gene analyses by removing misleading long branches and potentially increase the accuracy of the phylogeny (Wiens, 2006).

Where taxonomic groups expected to be monophyletic based on taxonomy did not cluster together in the optimal trees, their monophyly was tested using the Shimodaira-Hasegawa (1999) test in PAUP* (Section 2.9.11 of Chapter 2, p. 89).

3.3. Results

3.3.1. Molecular data

Twenty four achatinoid and three streptaxid outgroup taxa (*Gibbulinella dewinteri*, *Gonaxis quadrilateralis* and *Gonospira* sp.) were examined. Sequences were obtained for the nuclear rRNA cluster, actin and histone 3 genes as well as the mitochondrial 16S and cytochrome c oxidase I genes. Sequence alignments are presented in Appendices 3.1-3.5 on pp. 375-432. All sequences were scanned for the presence of ambiguous positions in the direct sequences that might be indicative of the presence of multiple gene copies. Ambiguities indicative of multiple gene copies were detected only for the actin gene (see Section 3.3.2.2, p. 155-156 for details). A summary of the molecular data for all the sequences is shown in Table 3.2. For the protein-coding genes (actin, histone 3 and COI), summary information was obtained separately for the entire gene (all codon positions), the combined 1st and 2nd codon positions and the 3rd codon position only. Uncorrected and corrected pairwise distances and their optimal models were determined for all five genes and are summarized in Table 3.3. The GTR+Γ model was found to be the optimal model by LRT for the nuclear rRNA cluster, the mitochondrial 16S RNA and for both the full (all codon positions) and 3rd codon position datasets for the actin, histone 3 and COI genes. For the combined 1st + 2nd codon position datasets, TNR93+Γ was determined to be the optimal model for the actin, TN93 for the histone 3, and GTR+Γ for COI. (See Appendix 3.6, p. 433 for the summary of the LRT results).

Nearly the entire fragment of the LSU rRNA gene, the internal transcribed spacer 2 (ITS 2) and 80 nucleotides of the 5.8S rRNA gene was sequenced (approximately 4000 nucleotides) for the rRNA gene cluster, of which 3435 nucleotides could be aligned unambiguously. The ITS 2 region was too variable to align across all taxa and was therefore excluded from the analysis. A total of 260 (7.6%) variable sites were found, of which 151 were parsimony-informative. Pairwise distances across all taxa ranged from 0.001 to 0.034 (uncorrected) and 0.001 to 0.062 (corrected). The highest base frequency was obtained for G (0.318) followed by C (0.260), then by A (0.229) and finally by T (0.193). For the actin gene, 861 nucleotide positions were sequenced, of which all sites could be aligned unambiguously; of these, 288 (33.5%) were variable and 240 were parsimony-informative. Pairwise distances ranged from 0.009 to 0.173 (uncorrected) and 0.009 to 0.469 (corrected). Highest average base frequency was for A (0.274) followed by C (0.255) then T (0.250) and finally G (0.220). The majority of the variable sites (237) and parsimony-informative sites (210) were found at the 3rd codon position, while the combined 1st and 2nd codon positions only had 51 variable sites and 30 parsimony-informative sites. For the histone 3 gene, 328 nucleotides were sequenced and aligned unambiguously, with 103 (31.4%) variable positions and 71 parsimony-informative sites. Pairwise distances ranged from 0 to 0.183 (uncorrected) and 0 to 0.605 (corrected). Average base frequencies, in decreasing order, were as follows: C (0.321); G (0.271); A (0.242) and T (0.166). As with the actin gene, the 3rd codon position exhibited the most number of variable sites (93) as well as parsimony-informative sites (70) in comparison to the combined 1st and 2nd codon positions with only 10 and 1, respectively. Amplification of the histone 3 gene fragment for *Cecilioides gokweanus* (Ferussaciidae), *Paropeas achatinaceum*, *Riebeckia* sp., and *Subulina vitrea* (Mousson) (Subulinidae) proved unsuccessful. Only a single streptaxid outgroup sequence (*Gibbulinella dewinteri*) was obtained for the histone 3 gene. For the COI gene, approximately 650 nucleotides were sequenced, with the length varying depending on the primers used. A total of 607 unambiguously aligned nucleotides were used; of which 279 (46.0%) were variable and 250 were parsimony-informative. Pairwise distances ranged from 0.160 to 0.265 (uncorrected) and 7.215 to 57.369 (corrected). Average base frequencies, in decreasing order, were as follows: T (0.395); A (0.249); G (0.194) and C (0.163), indicating a strong bias for T; this was heightened in the 3rd codon position where average frequency of T rose to 0.462. The 3rd codon position had 201 variable sites and 188 parsimony-informative sites, whereas the combined 1st and 2nd codon positions only had 78 and 62, respectively. Amplification of the COI gene for *Cecilioides gokweanus* was also unsuccessful. As with the histone 3 gene, only a single streptaxid outgroup sequence (*Gibbulinella dewinteri*) was obtained for the COI gene. The 16S rRNA gene product ranged from 420-500 nucleotides, with 294 that were unambiguously aligned, 139 (47.3%) that were variable, and 120 that were parsimony-informative. Pairwise distances ranged from 0.078 to 0.279 (uncorrected) and 0.107 and 1.082 (corrected). Base frequencies were as follows: T (0.306); A (0.296); G (0.217) and C (0.181), showing bias for A and T. Sequencing of the 16S rRNA gene fragment for *Eutomopeas layardi* and *Subulona* sp. (Subulinidae) was unsuccessful.

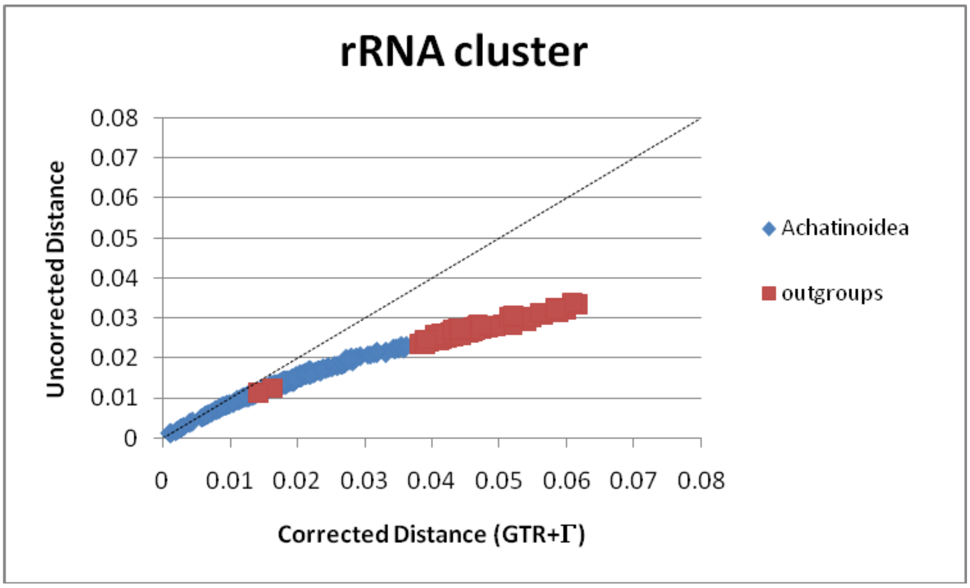
Table 3.3: Summary of molecular data across all genes used for the Achatinoidea and three streptaxid outgroup taxa (rRNA gene cluster, actin and 16S) and one streptaxid outgroup taxon (histone 3 and COI). A=Achatinoidea only; A+O=Achatinoidea and outgroup.

	Length (bp)	# of variable sites (%)		Range of distances (Uncorrected)		Optimal Model (α value for Γ distribution)	Range of distances (Corrected)		Average base frequencies								# of parsimony-informative sites	
									A		C		G		T			
		A	A+O	A	A+O		A	A+O	A	A+O	A	A+O	A	A+O	A	A+O	A	A+O
rRNA cluster	3435	212 (6.2)	260 (7.6)	0.001-0.029	0.001-0.034	GTR+Γ (0.049)	0.001-0.048	0.001-0.062	0.229	0.229	0.260	0.260	0.319	0.318	0.192	0.193	113	151
Actin combined	861	283 (32.9)	288 (33.5)	0.009-0.173	0.009-0.173	GTR+Γ (0.190)	0.009-0.469	0.009-0.469	0.276	0.274	0.254	0.255	0.219	0.220	0.251	0.250	230	240
Actin 1st and 2nd codon positions	574	50 (8.7)	51 (8.9)	0-0.046	0-0.046	TN93+Γ (0 .059)	0-0.105	0-0.105	0.316	0.316	0.228	0.228	0.228	0.228	0.229	0.229	29	30
Actin 3rd codon position	287	233 (81.2)	237 (82.6)	0.025-0.444	0.025-0.444	GTR+Γ (1.339)	0.023-1.056	0.023-1.056	0.192	0.189	0.307	0.312	0.203	0.206	0.298	0.294	201	210
Histone3 combined	328	97 (29.6)	103 (31.4)	0-0.156	0-0.183	GTR+Γ (0.164)	0-0.491	0-0.605	0.241	0.242	0.322	0.321	0.272	0.271	0.165	0.166	66	71
Histone 3 1st and 2nd codon positions	218	8 (3.7)	10 (4.6)	0-0.023	0-0.028	TN93 (N/A)	0-0.024	0-0.029	0.287	0.287	0.285	0.285	0.261	0.261	0.167	0.167	1	1
Histone 3 3rd codon positions	110	89 (80.9)	93 (84.5)	0-0.449	0-0.520	GTR+Γ (1.811)	0-1.289	0-1.452	0.145	0.147	0.397	0.395	0.297	0.295	0.161	0.163	65	70
COI combined	607	276 (45.5)	279 (46.0)	0.160-0.265	0.160-0.265	GTR+Γ (0.077)	7.215-57.369	7.215-57.369	0.249	0.249	0.163	0.163	0.194	0.194	0.394	0.395	250	250
COI 1st and 2nd codon positions	404	75 (18.6)	78 (19.3)	0.032-0.119	0.032-0.119	GTR+Γ (0.086)	0.046-0.459	0.046-0.459	0.205	0.205	0.199	0.199	0.235	0.235	0.361	0.361	62	62
COI 3rd codon positions	203	201 (99.0)	201 (99.0)	0.365-0.631	0.365-0.631	GTR+Γ (0.386)	299.377-5420.470	299.377-5420.470	0.335	0.336	0.091	0.090	0.114	0.113	0.459	0.462	188	188
16S rRNA	294	137 (46.6)	139 (47.3)	0.078-0.279	0.078-0.279	GTR+Γ (0.233)	0.107-1.082	0.107-1.082	0.292	0.296	0.184	0.181	0.220	0.217	0.304	0.306	113	120

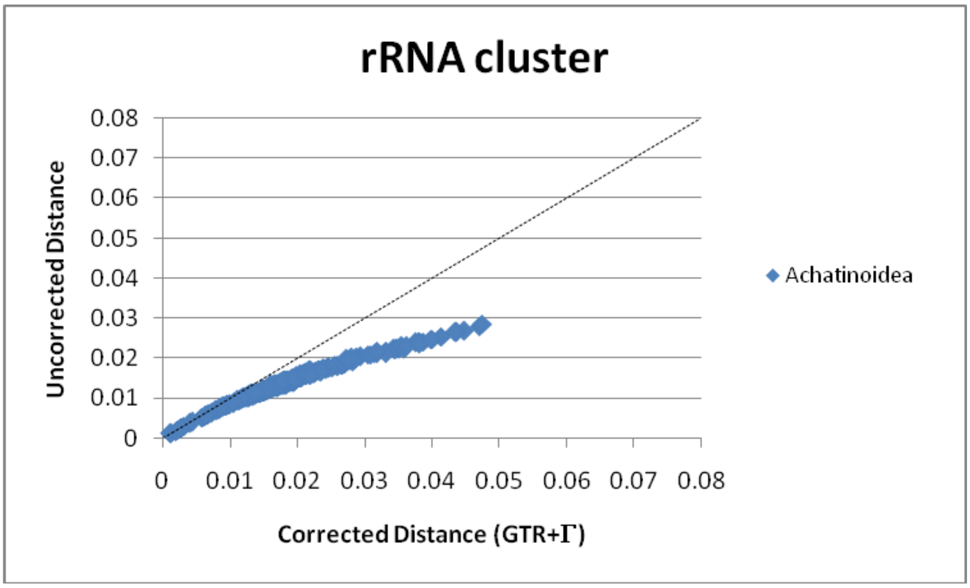
3.3.2. Sequence analyses

3.3.2.1. Evaluating for saturation and phylogenetic signal

For the rRNA cluster, the uncorrected versus corrected distances plots (Plot 1, Figure 3.2) demonstrated that the corrected distance based on the optimal GTR+Γ model deviated from linearity starting at an uncorrected (*p*) distance of approximately 0.01 but no plateau was reached for the plots of either the Achatinoidea or the Achatinoidea plus outgroups. This suggested that the dataset for the rRNA cluster was far from being saturated and that the GTR+Γ model was adequate at correcting the distances for multiple hits.



(A)



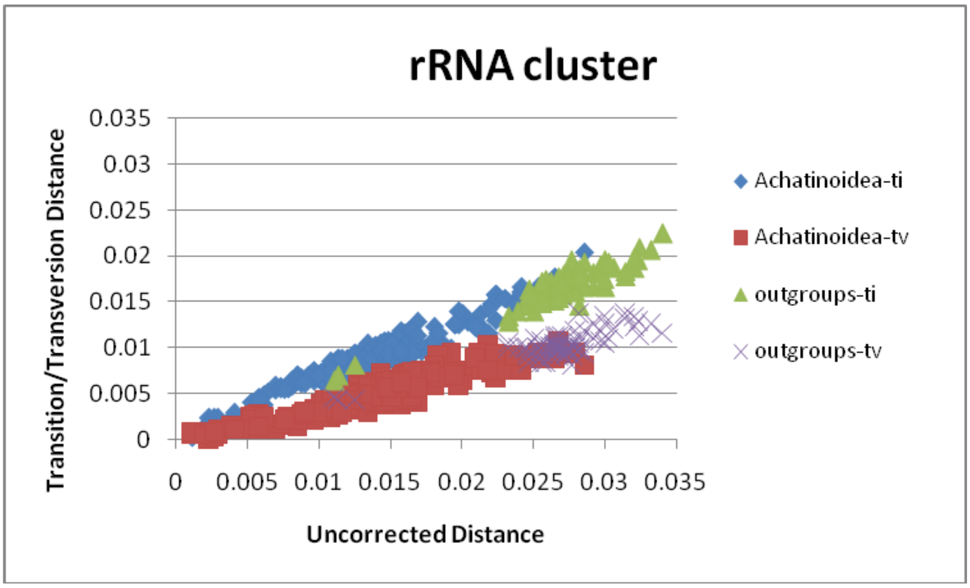
(B)

Figure 3.2: Plots of pairwise uncorrected distance against corrected (GTR+Γ) distance for the rRNA cluster in **(A)** the Achatinoidea and the streptaxid outgroup taxa and **(B)** the Achatinoidea only.

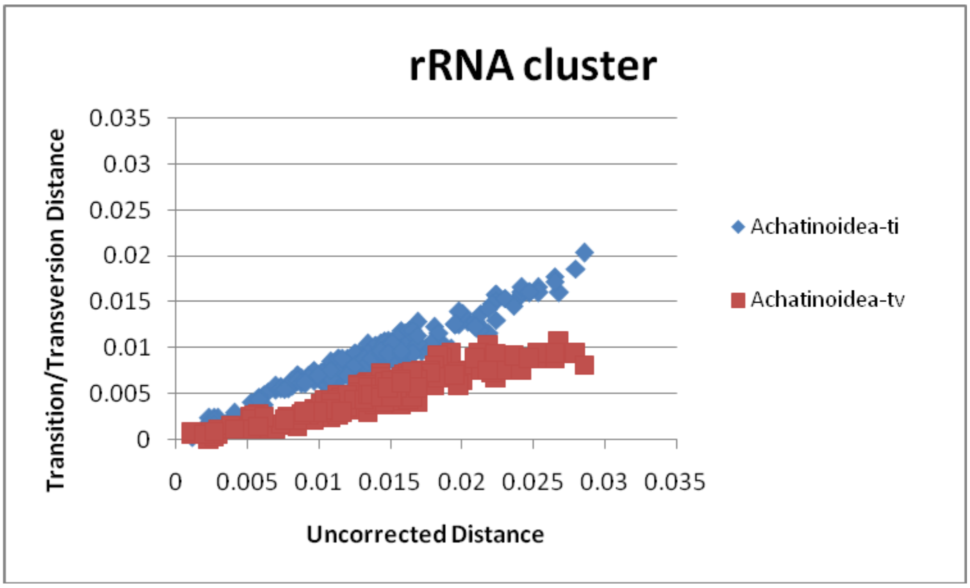
Plots for the transition and transversion rates versus uncorrected distances both with and without the outgroup taxa (Plot 2, Figure 3.3) showed transition distances that were higher than the tranversion distances, with both types of substitutions increasing linearly. Plots for transitions against transversions both with and without the outgroup taxa (Plot 3, Figure 3.4) demonstrated that all transitions were higher than transversions. These suggested that neither transition nor transversion distances were saturated for the rRNA cluster.

A g1 value of -1.200 was obtained for the rRNA cluster with 10,000 replicates based on 27 taxa and 151 parsimony-informative characters. This value differed significantly from the critical g1 value of -0.1 at P=0.05 level of significance for 25 taxa and 100 parsimony-informative characters (Hillis & Huelsenbeck, 1992). This result was indicative of a strong phylogenetic signal.

The lack of substitution saturation and the presence of a strong phylogenetic signal suggested that the rRNA cluster was suitable for phylogenetic analyses of the Achatinoidea and outgroups.

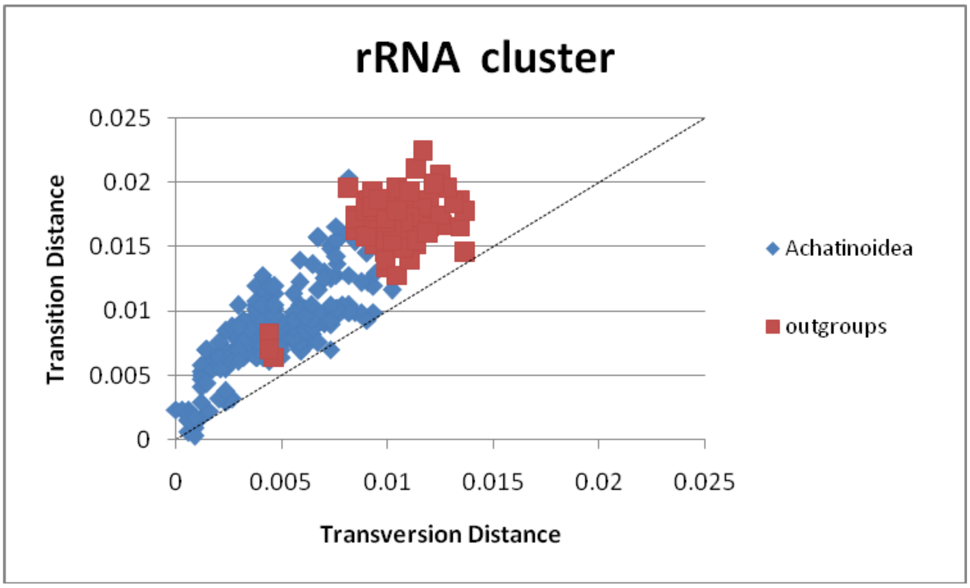


(A)

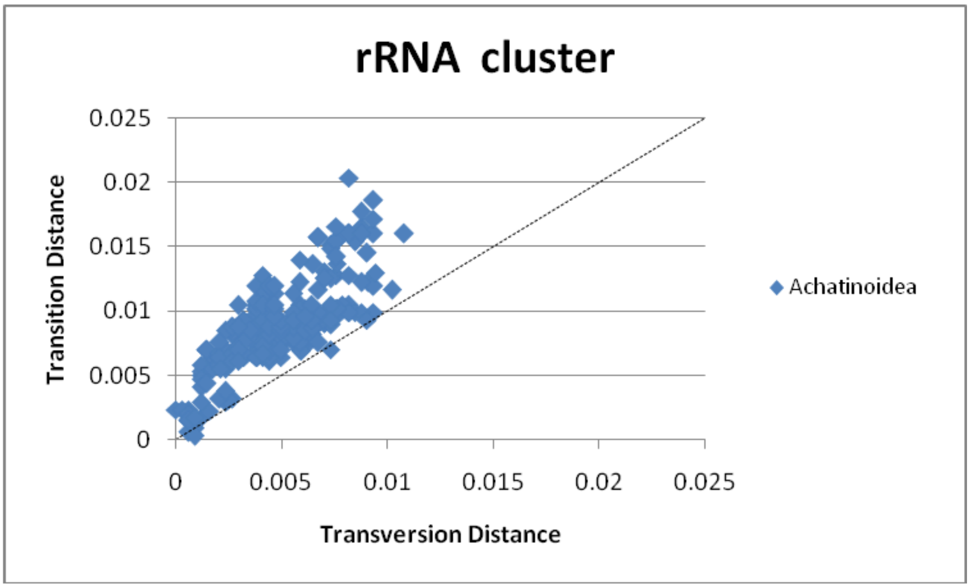


(B)

Figure 3.3: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the rRNA cluster in **(A)** the Achatinoidea and outgroup taxa and **(B)** the Achatinoidea only.



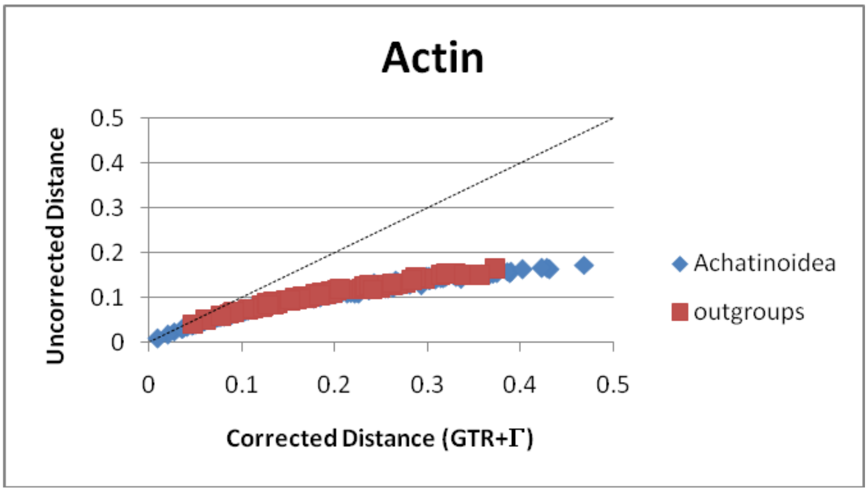
(A)



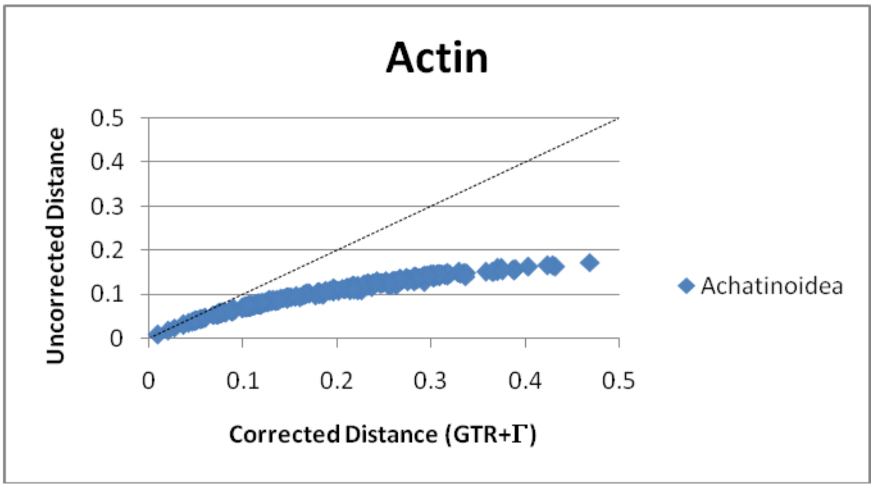
(B)

Figure 3.4: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances for the rRNA cluster in **(A)** the Achatinoidea and the streptaxid outgroup taxa and **(B)** the Achatinoidea only.

For the actin gene, Plot 1 (Figure 3.5) showed that the corrected distance, based on the optimal GTR+Γ model, deviated from linearity starting at an uncorrected (*p*) distance of approximately 0.04 for both the Achatinoidea only and the Achatinoidea plus outgroup taxa. The plots were still increasing and had not reached a plateau, suggesting adequate correction of the optimal GTR+Γ model and no saturation in the dataset.



(A)



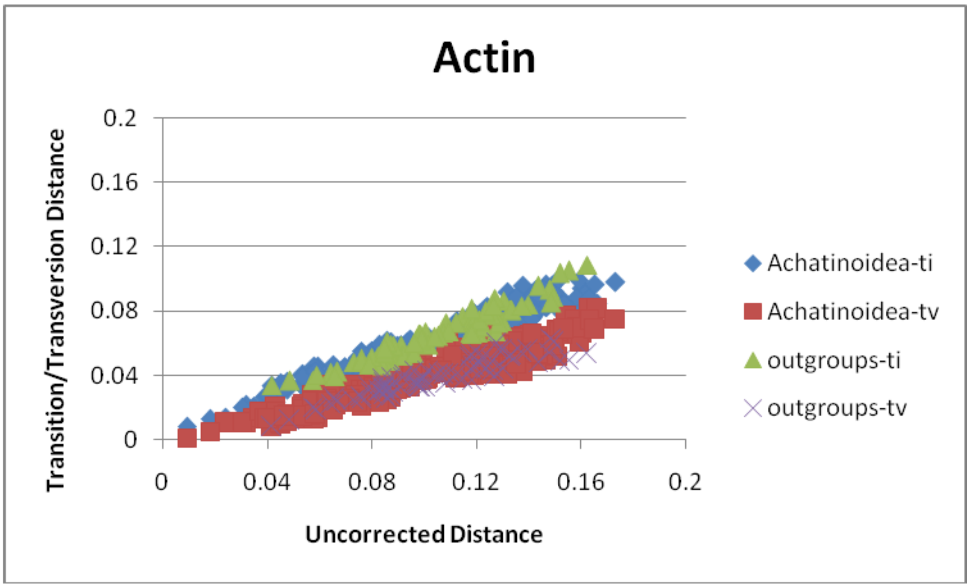
(B)

Figure 3.5: Plots of pairwise uncorrected distance against corrected distance for the actin gene in **(A)** the Achatinoidea and the streptaxid outgroup taxa and **(B)** the Achatinoidea only.

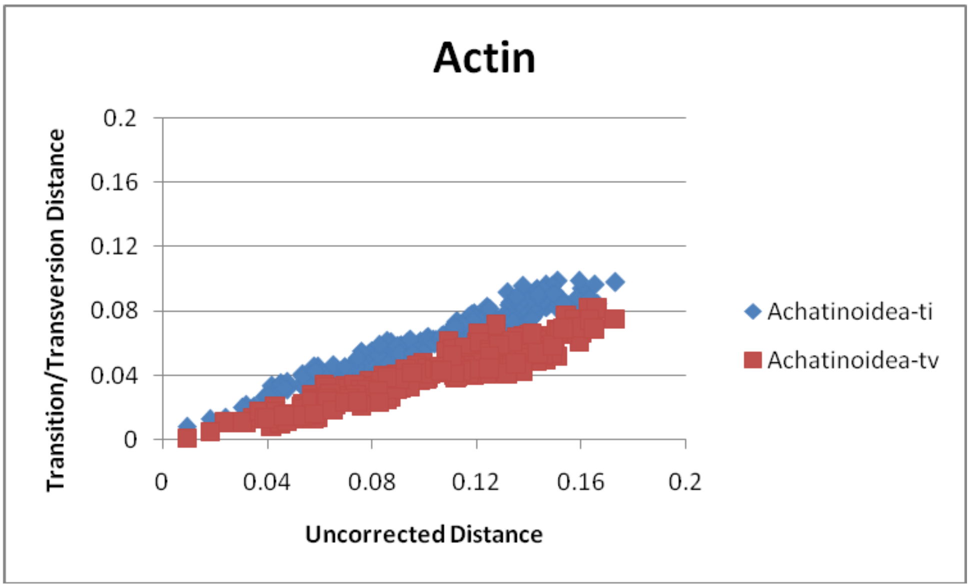
Plot 2 (Figure 3.6) for the actin gene, whether with or without outgroup taxa, exhibited a linear increase for both transitions and transversions. Plot 3 (Figure 3.7) showed that except for four points, all transitions were higher than tranversions. These suggest that neither transition nor transversion distances were saturated for the actin gene.

A g1 value of -0.767 was computed for the actin gene based on 27 taxa and 245 parsimony-informative sites, much lower than the critical value of -0.1 at p=0.05 level of significance for 25 taxa and 100 parsimony-informative characters (Hillis & Huelsenbeck, 1992). The actin gene therefore exhibited strong phylogenetic signal.

The absence of substitution saturation and the presence of phylogenetic signal suggested that the actin gene was suitable for phylogenetic analyses of the Achatinoidea and outgroups.

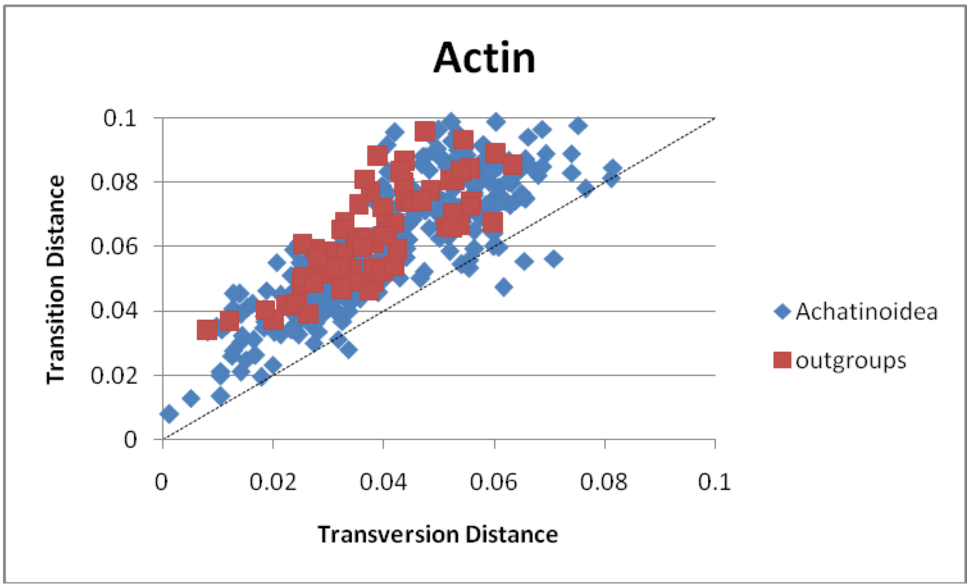


(A)

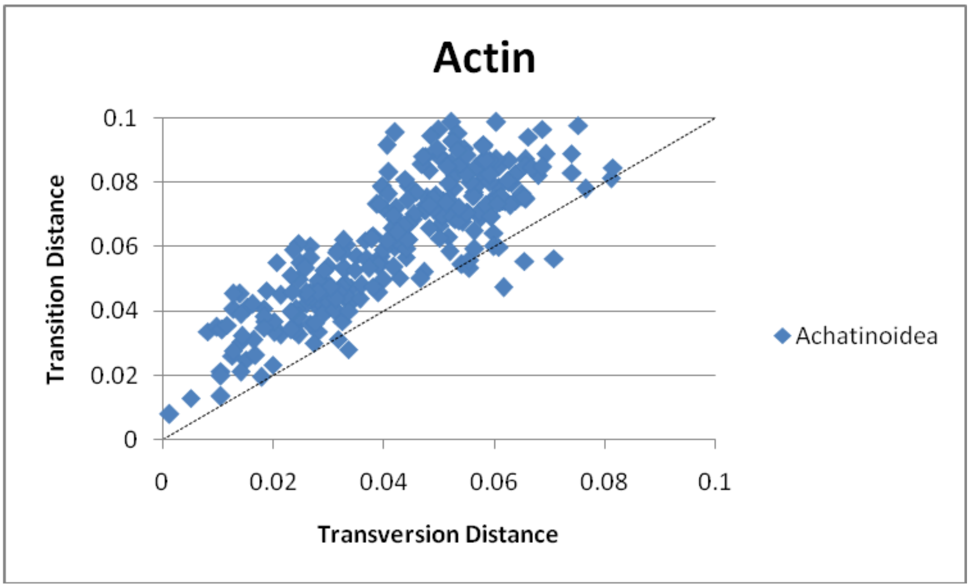


(B)

Figure 3.6: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the actin in **(A)** the Achatinoidea and the streptaxid outgroup taxa and **(B)** the Achatinoidea only.



(A)

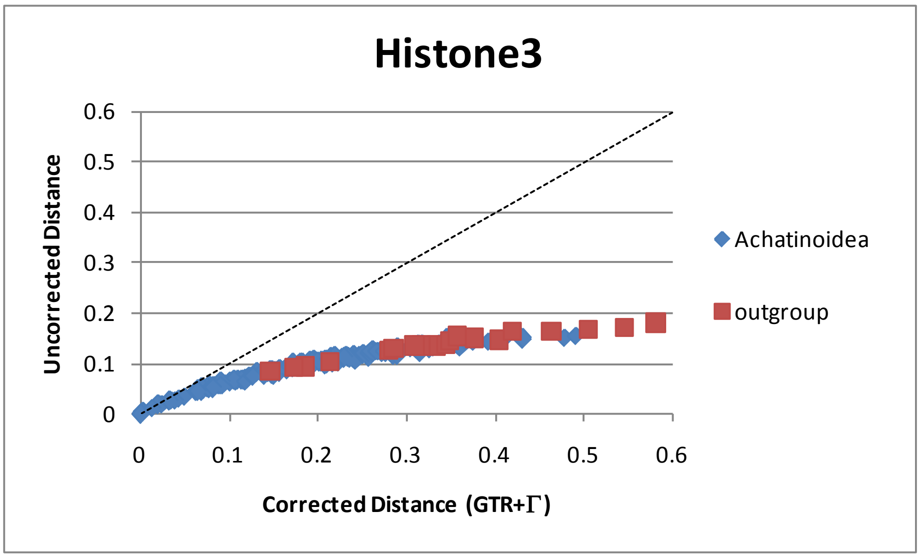


(B)

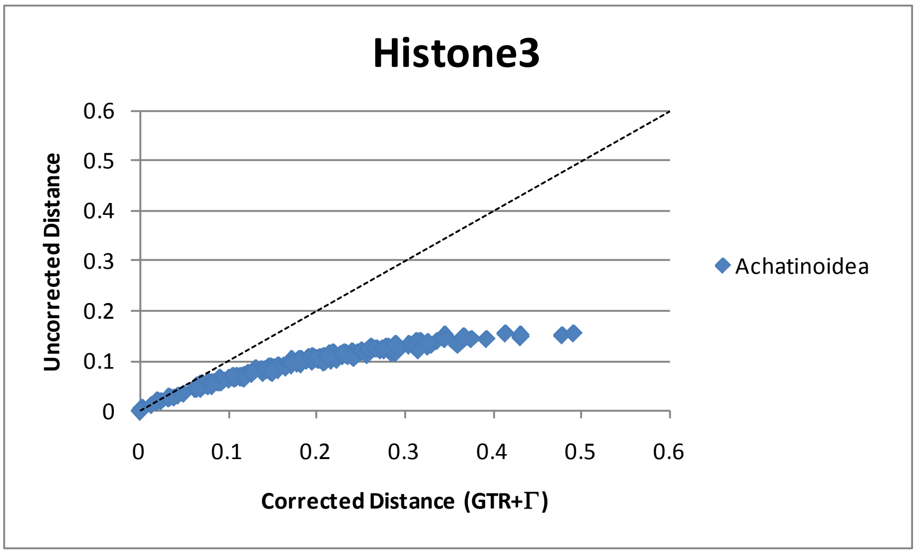
Figure 3.7: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances for the actin gene in **(A)** the Achatinoidea and the streptaxid outgroup taxa and **(B)** the Achatinoidea only.

For the histone 3 gene, Plot 1 (Figure 3.8) revealed a curve for the corrected distances using the optimal GTR+Γ model, with the deviation from a linear increase beginning at an uncorrected (*p*) distance of approximately 0.02 for both the

Achatinoidea only and including the streptaxid outgroup taxon *Gibbulinella dewinteri*. The plots were still increasing and had not reached a plateau, implying that the histone 3 gene had not reached saturation.



(A)

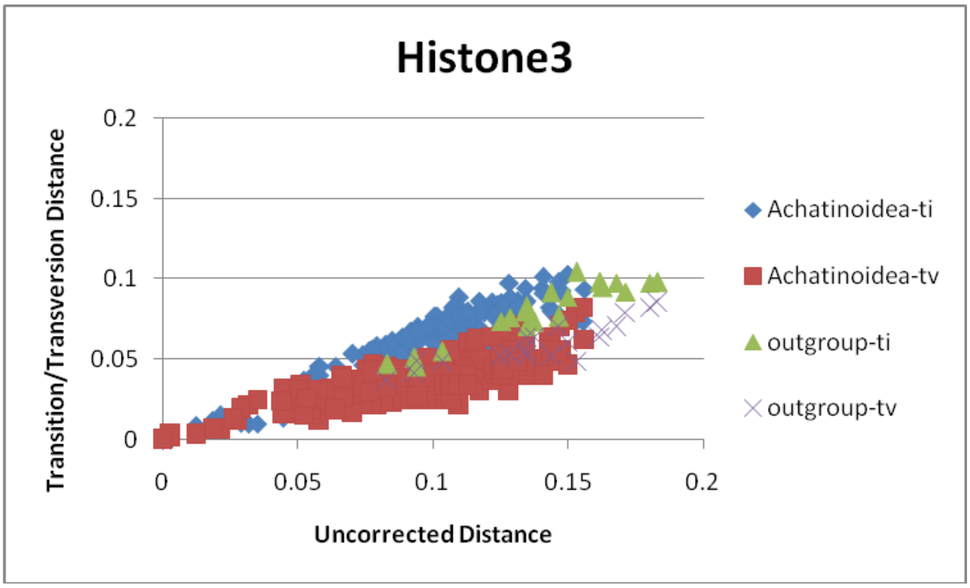


(B)

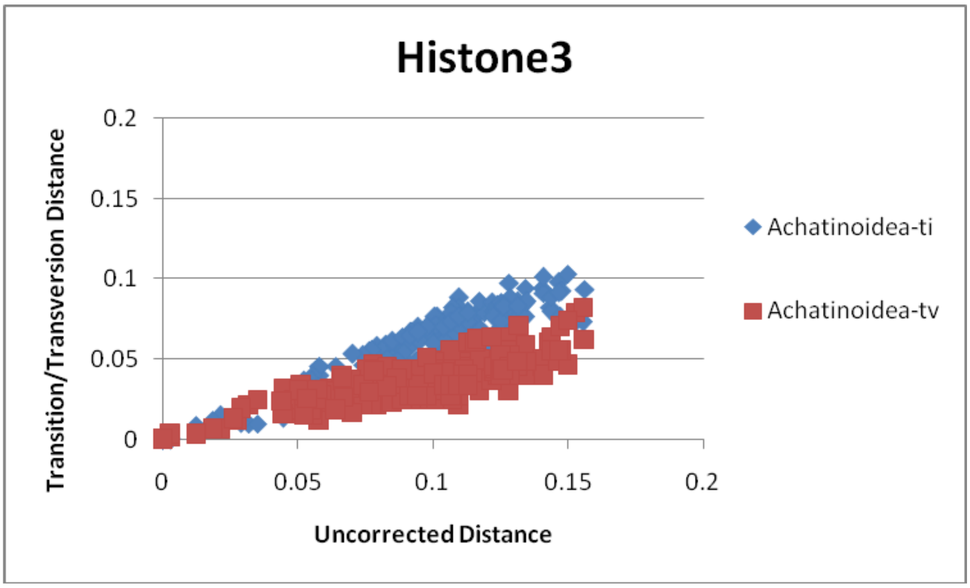
Figure 3.8: Plots of pairwise uncorrected distance versus corrected (GTR+Γ) distance for the histone 3 gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only.

Plot 2 (Figure 3.9) for histone 3 revealed a linear increase of both transitions and transversions for the Achatinoidea, but the transition line appeared to be beginning to curve when the outgroup was included. Although transitions were generally higher than transversions, some overlap was seen. Plot 3 (Figure 3.10) showed that the majority of transitions were higher than transversions. This suggested that the histone 3 dataset was just beginning to saturate, particularly if the outgroup taxon was included.

The g1 value for histone 3 based on 21 taxa and 71 parsimony-informative sites was -0.539, which was significantly smaller than the critical value of -0.16 based on 15 taxa and 50 parsimony-informative sites. The histone 3 gene therefore exhibited phylogenetic signal.

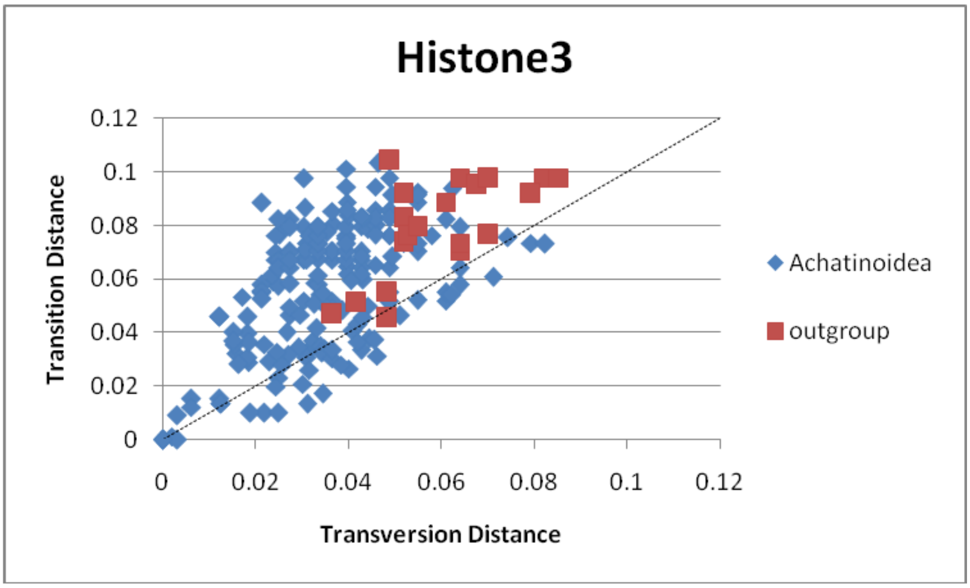


(A)

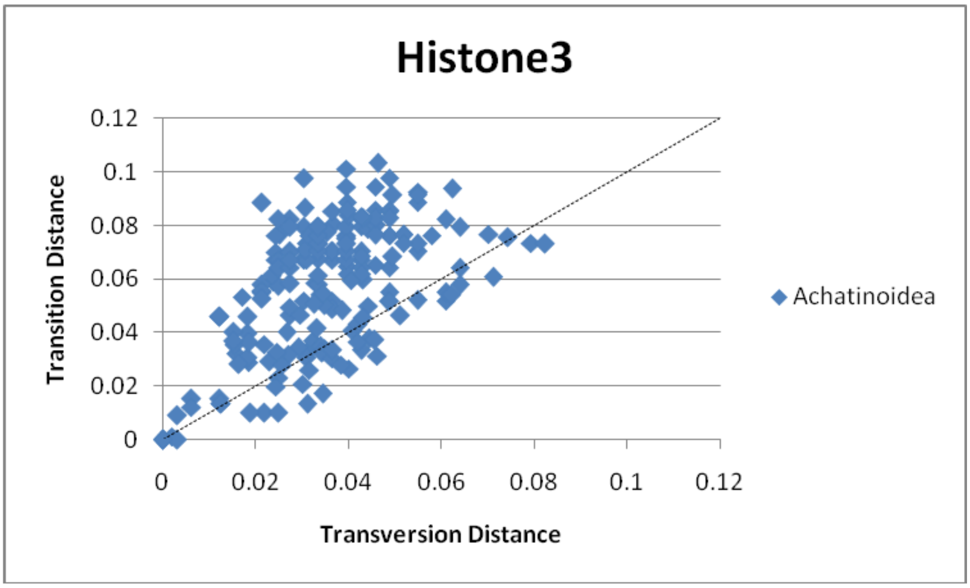


(B)

Figure 3.9: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the histone 3 gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only.



(A)

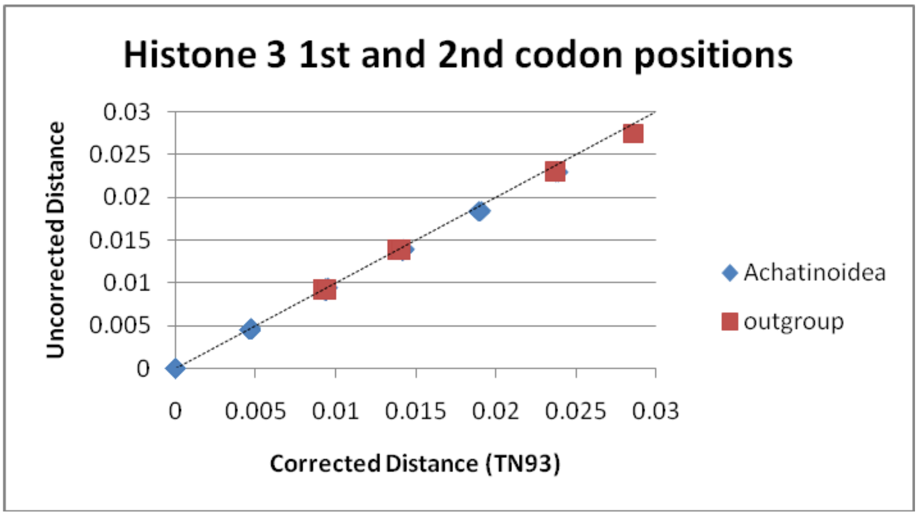


(B)

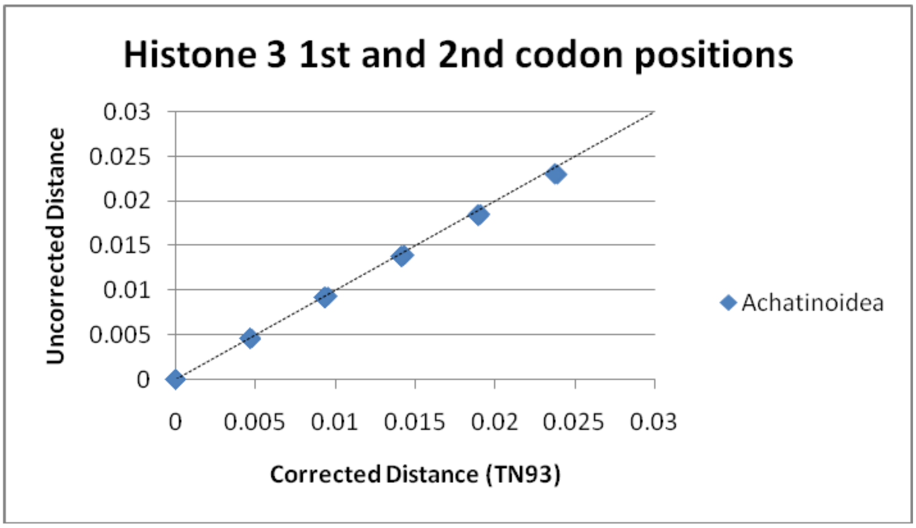
Figure 3.10: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances for the histone 3 gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only.

The analyses of the histone 3 gene as a whole (all codon positions) demonstrated that the dataset began to saturate when the outgroup taxon was included. The combined 1st and 2nd codon positions and the 3rd codon positions were therefore evaluated separately.

For the 1st and 2nd codon positions of the histone 3 gene, only a handful of sites varied (10 of 218 sites in the dataset that included the Achatinoidea and outgroup taxon). Plot 1 (Figure 3.11) showed a direct relationship between the corrected (based on the optimal TN93 model) and uncorrected distances, indicative of a highly conserved dataset with no saturation.



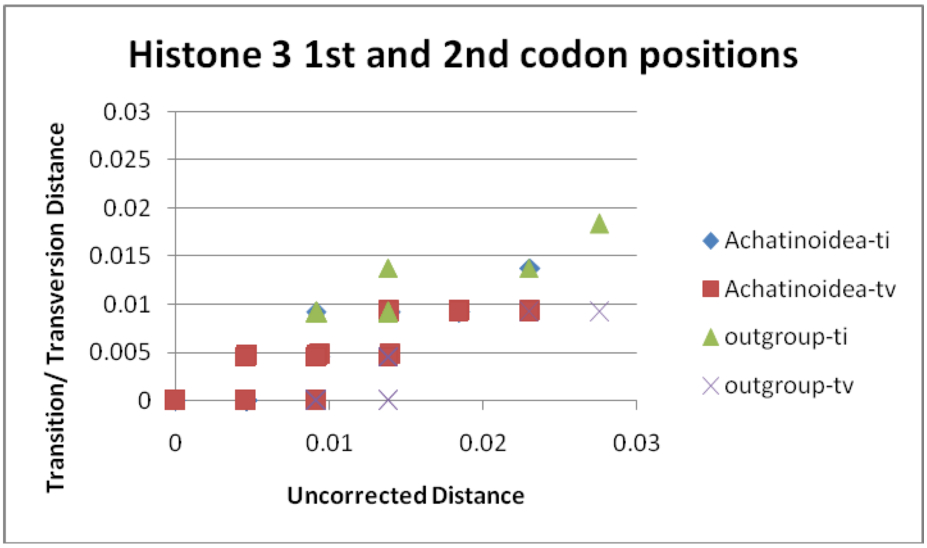
(A)



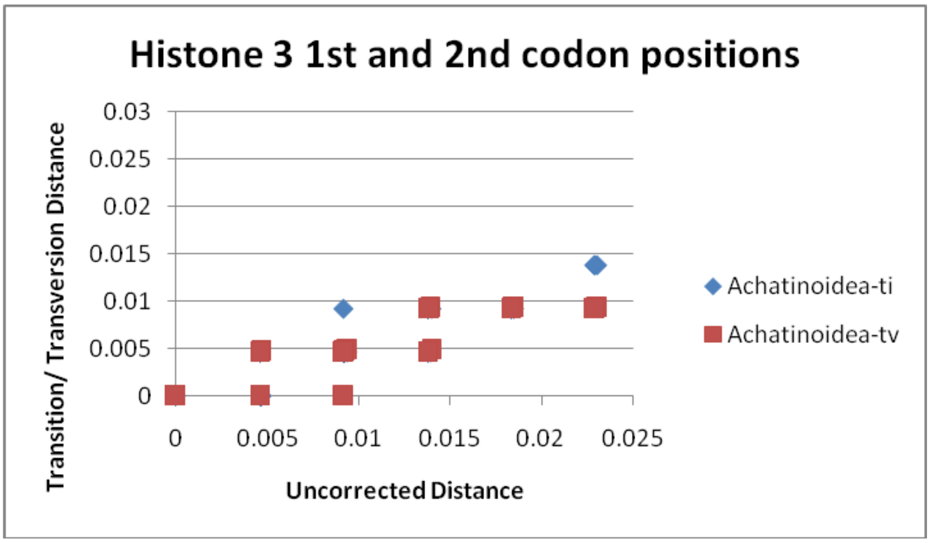
(B)

Figure 3.11: Plots of pairwise uncorrected distance versus corrected (TN93) distance for the 1st and 2nd codon positions of the histone 3 gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only.

Plots 2 (Figure 3.12) and 3 (Figure 3.13) showed overlap between transitions and transversions, but curving due to saturation could not be assessed due to the small number of variable sites (10) evaluated.

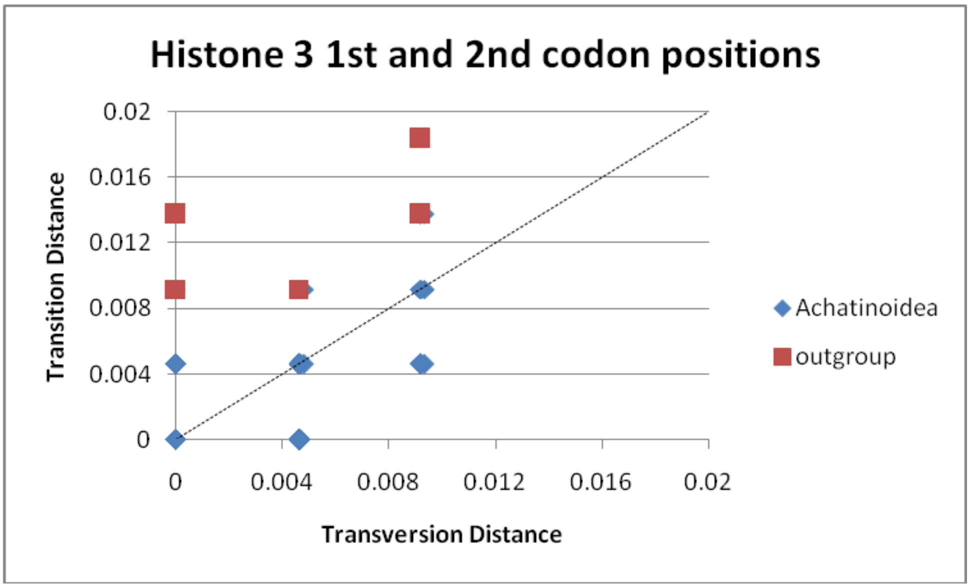


(A)

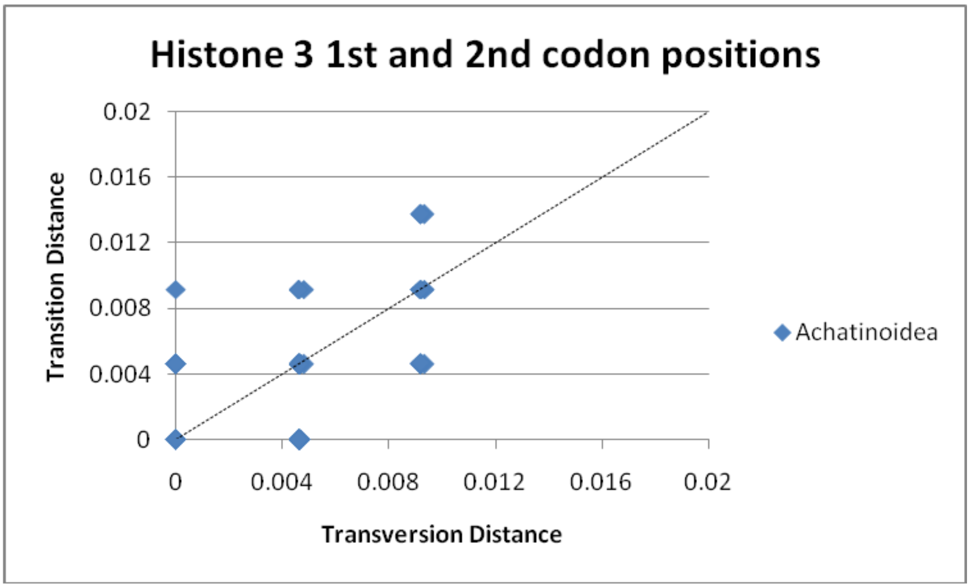


(B)

Figure 3.12: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the 1st and 2nd codon positions of the histone 3 gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only. Some transitions overlapped with transversions and were therefore not evident in the plots.



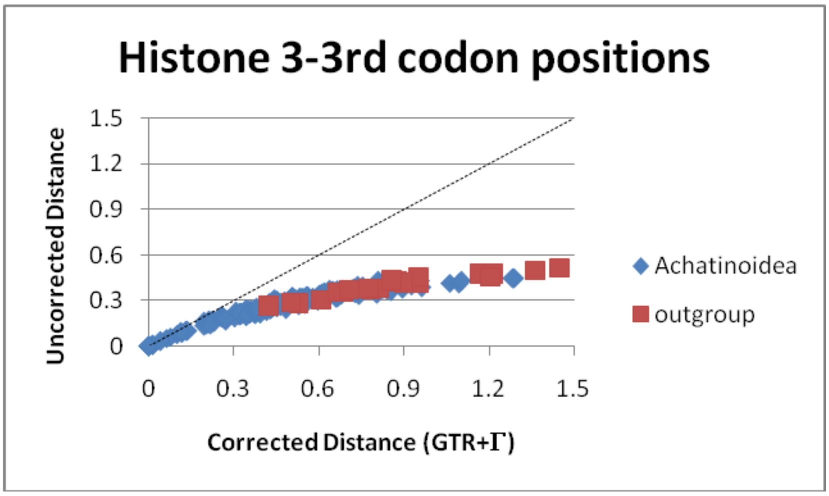
(A)



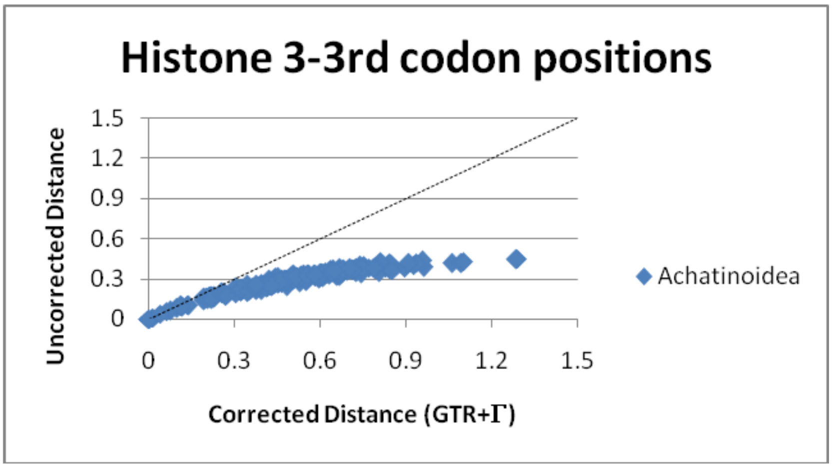
(B)

Figure 3.13: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances for the 1st and 2nd codon positions of the histone 3 gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only.

For the 3rd codon position, Plot 1 (Figure 3.14) revealed a curve for the corrected distances based on the optimal GTR+Γ model that deviated from linearity at an uncorrected (*p*) distance of approximately 0.1. The corrected distances were still increasing and had not reached a plateau, implying that the dataset had not reached saturation.



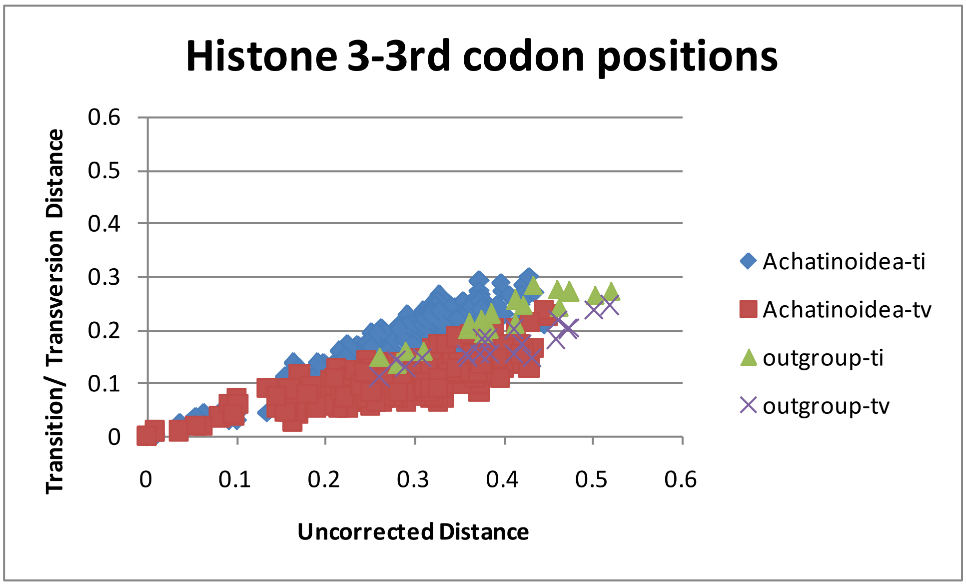
(A)



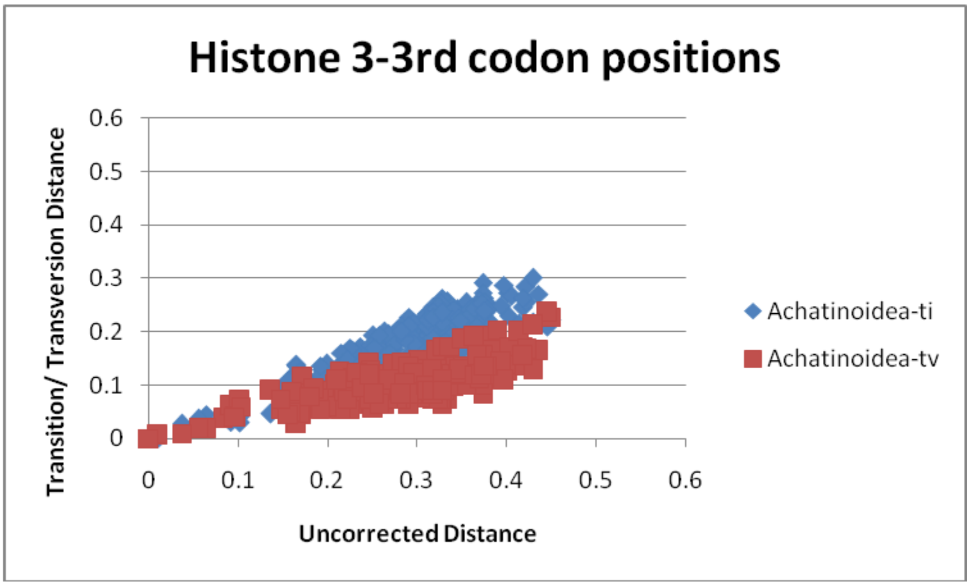
(B)

Figure 3.14: Plots of pairwise uncorrected distance versus corrected (GTR+Γ) distance for the 3rd codon position of the histone 3 gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only.

Plot 2 (Figure 3.15) revealed a linear increase of both transitions and transversions, but the transition line appeared to be beginning to curve when the outgroup was included. Although transitions were generally higher than transversions, some overlap was seen. Plot 3 (Figure 3.16) demonstrated that majority of transitions were still higher than transversions. These results suggested that the 3rd codon positions of the histone 3 gene were just beginning to saturate, particularly as the outgroup taxon was included.

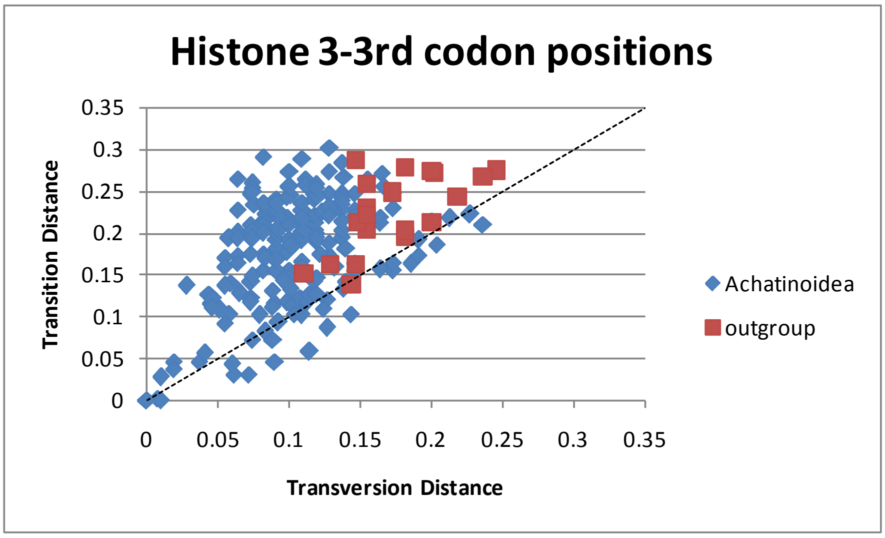


(A)

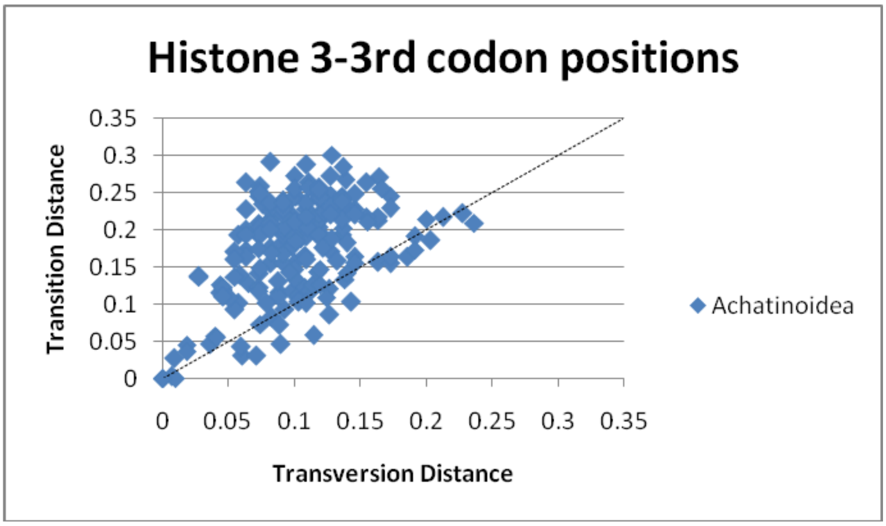


(B)

Figure 3.15: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the 3rd codon position of the histone 3 gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only.



(A)

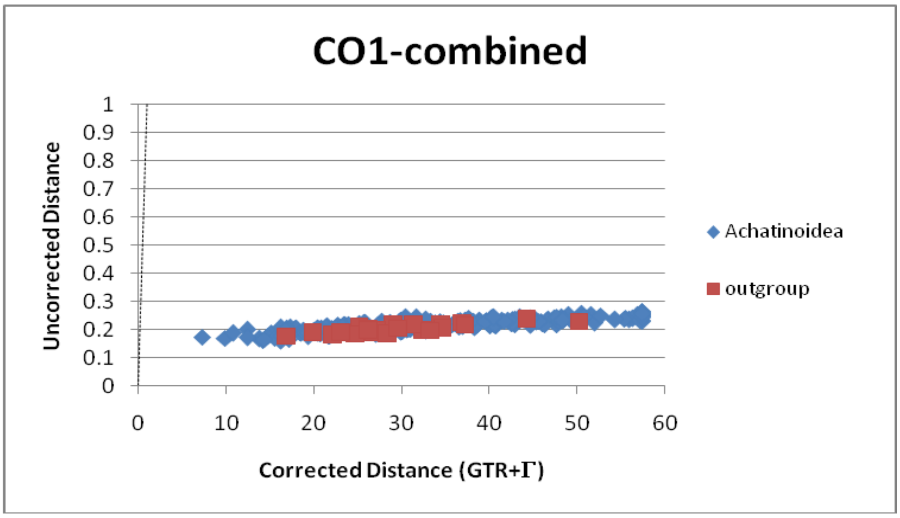


(B)

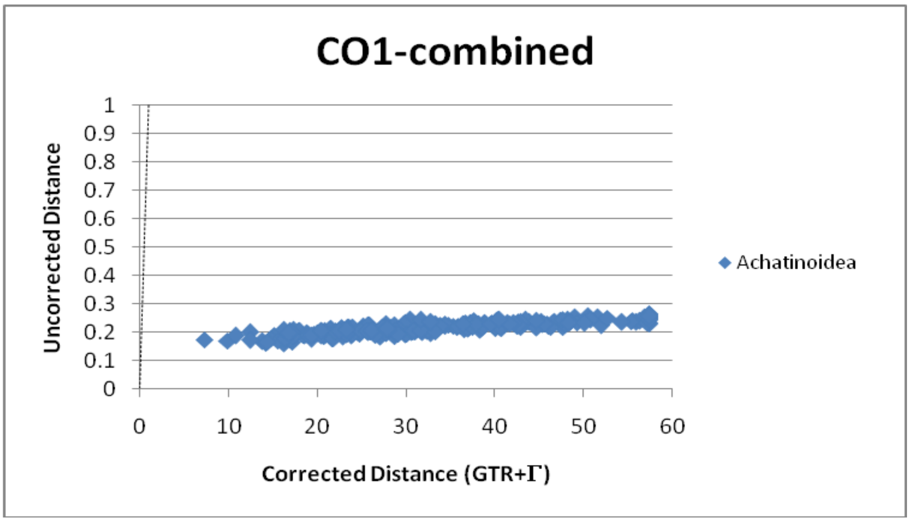
Figure 3.16: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances for the 3rd codon position of the histone 3 gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only.

The findings suggested that the histone 3 dataset could be employed in its entirety in phylogenetic analyses of the Achatinoidea though with caution, particularly when the outgroup taxon was included. Moreover, particular care should be taken over the interpretation of the findings of the non-model based maximum parsimony method.

For the COI gene, Plot 1 (Figure 3.17) yielded an almost horizontal trend for all taxa and for the Achatinoidea only. This, along with corrected distances in excess of 50, indicated severe saturation for the COI gene and the optimal GTR+Γ model was unable to correct the dataset for multiple hits.



(A)

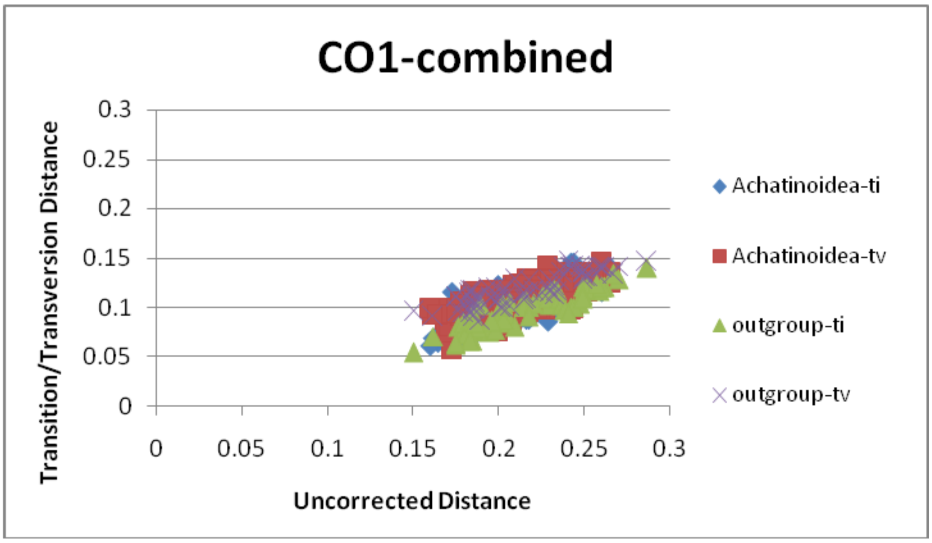


(B)

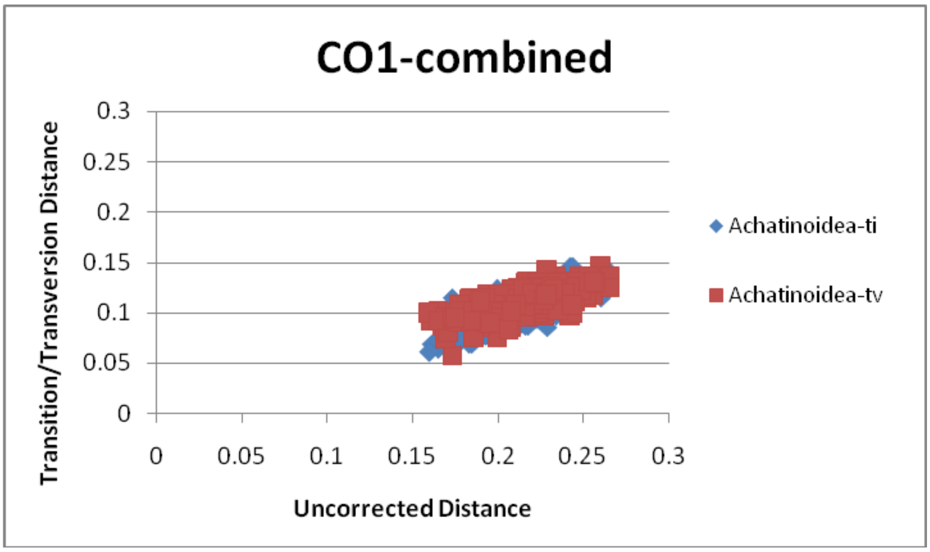
Figure 3.17: Plots of pairwise uncorrected distance against corrected distance for the COI gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only.

Plot 2 (Figure 3.18) revealed transversions overlapping with transitions in both the Achatinoidea only and the Achatinoidea plus outgroup datasets, while Plot 3 (Figure 3.19) revealed that the majority of the pairwise comparisons had higher rates of transversions than transitions.

The g1 test score for the COI gene based on 24 taxa and 250 parsimony-informative sites was -0.142, still significantly larger than the critical value of -0.16 for 15 taxa and 250 parsimony-informative sites. The g1 test therefore suggested that no phylogenetic information could be generated from the dataset.

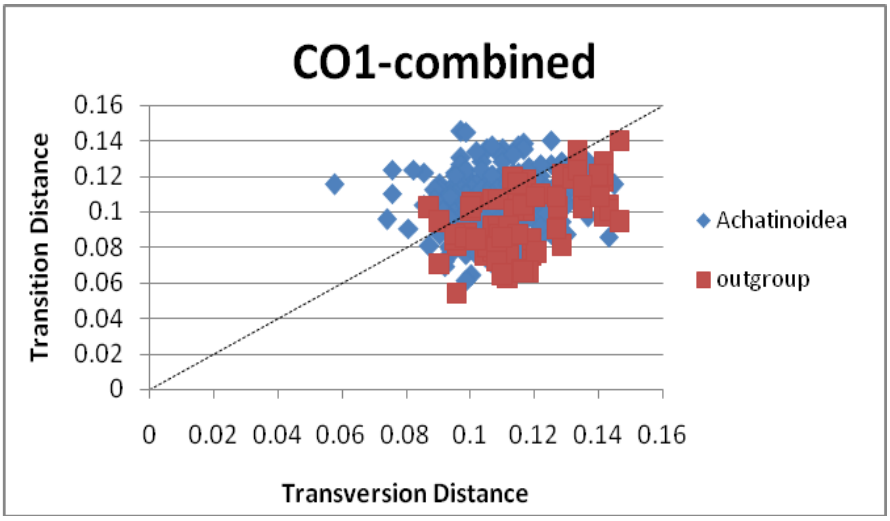


(A)

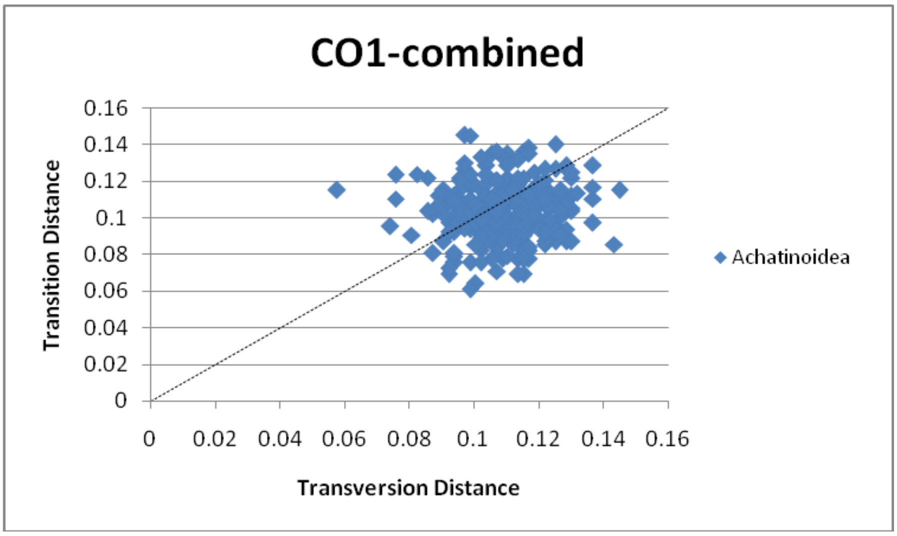


(B)

Figure 3.18: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the COI gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only.



(A)

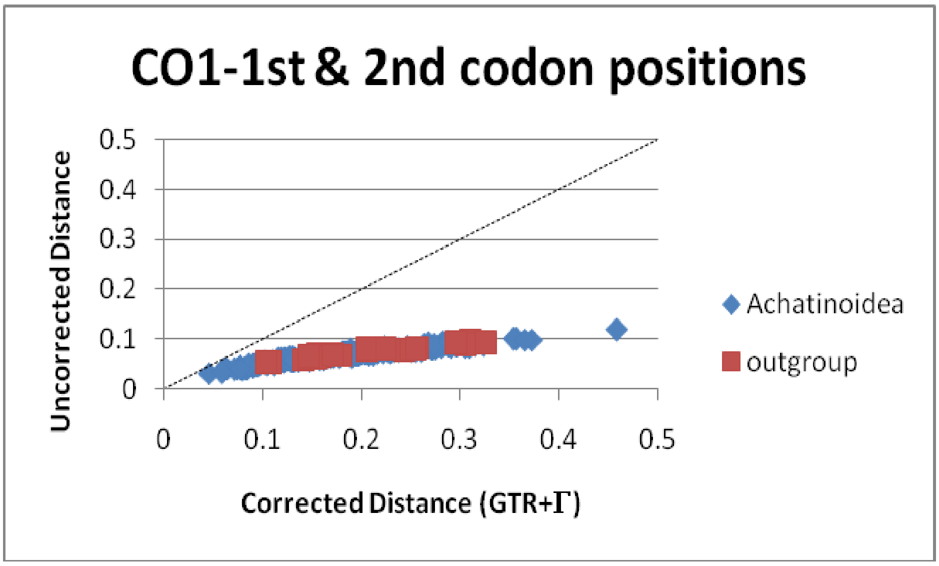


(B)

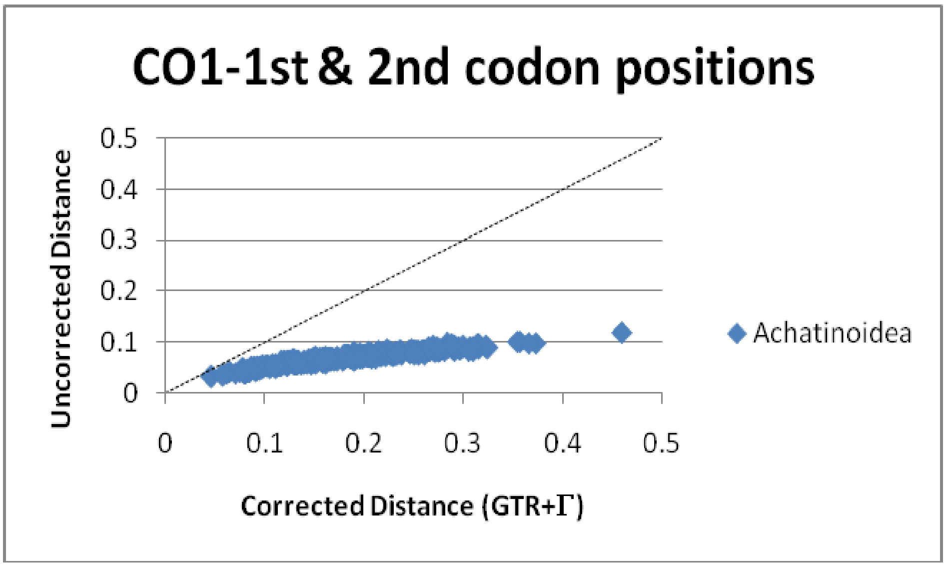
Figure 3.19: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances for the COI gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only.

The analyses of the COI gene as a whole (all codon positions) clearly demonstrated the existence of extensive saturation in the dataset, especially as shown by Plot 1. Its utility was further compromised by the absence of phylogenetic signal based on the g1 test. In order to evaluate whether this saturation was restricted to the 3rd codon position and whether some phylogenetic signal could be recovered from the 1st and 2nd codon positions, the combined 1st and 2nd codon positions and the 3rd codon position were evaluated separately.

For the 1st and 2nd codon positions of the COI gene, Plot 1 (Figure 3.20) revealed a curve for the corrected distances using the optimal GTR+Γ model, with the deviation from linearity beginning at an uncorrected (*p*) distance of approximately 0.03 for both the Achatinoidea only and including the outgroup taxon. The plots were still increasing slightly and had not reached a plateau, implying that the 1st and 2nd codon positions of COI had not yet reached saturation.



(A)

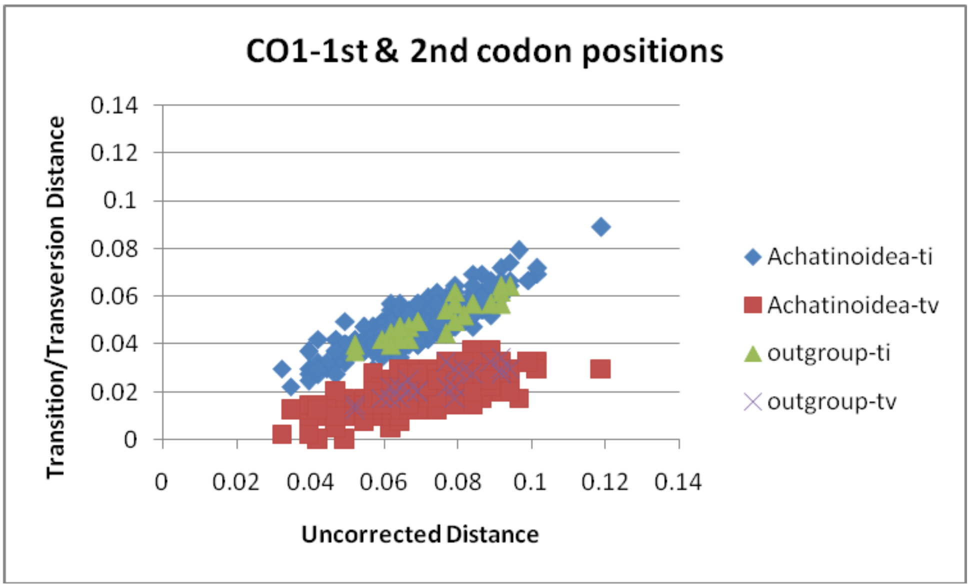


(B)

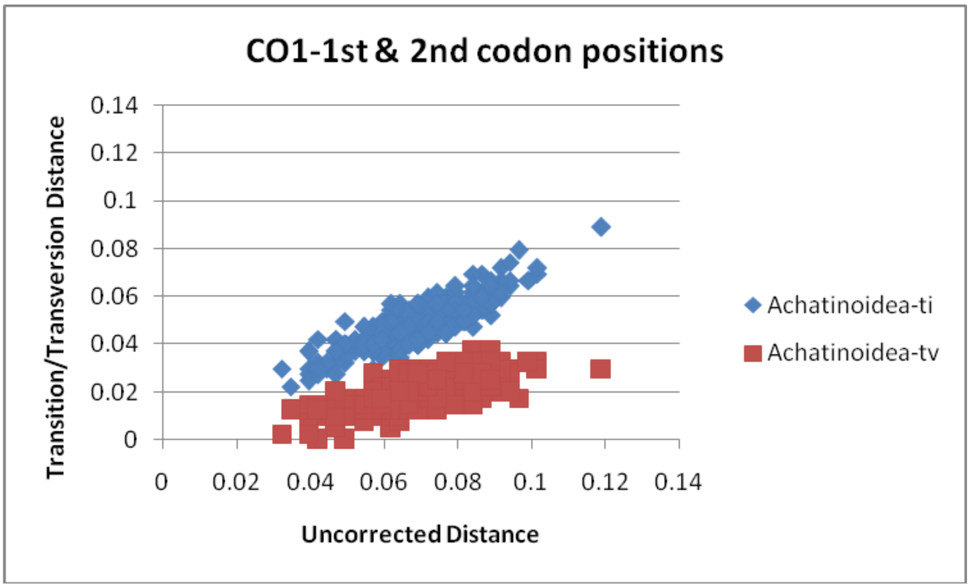
Figure 3.20: Plots of pairwise uncorrected distance versus corrected (GTR+Γ) distance for the 1st and 2nd codon positions of the COI gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only.

Plot 2 (Figure 3.21) for the 1st and 2nd codon positions of the COI gene showed a linear increase of both transitions and transversions for the Achatinoidea and when the outgroup taxon was included, with the transitions being higher than the transversions. Plot 3 (Figure 3.22) also demonstrated the same conclusions as Plot 2. These findings suggested that the 1st and 2nd codon positions were not saturated.

The g1 value based on 24 taxa and 62 parsimony-informative sites was -0.283, which was significantly smaller than the critical value of -0.16 based on 15 taxa and 50 parsimony-informative sites. The 1st and 2nd codon positions of the COI gene therefore exhibited phylogenetic signal.

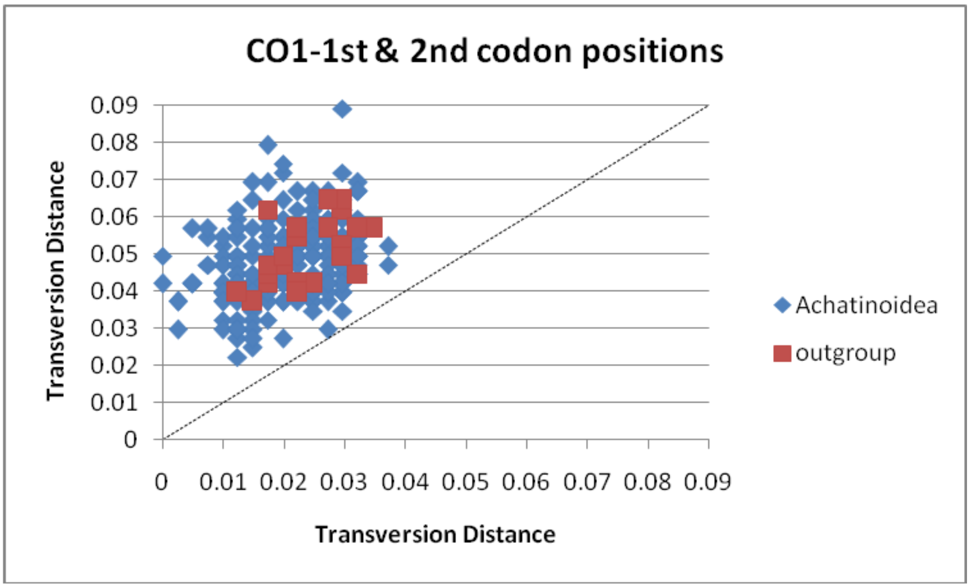


(A)

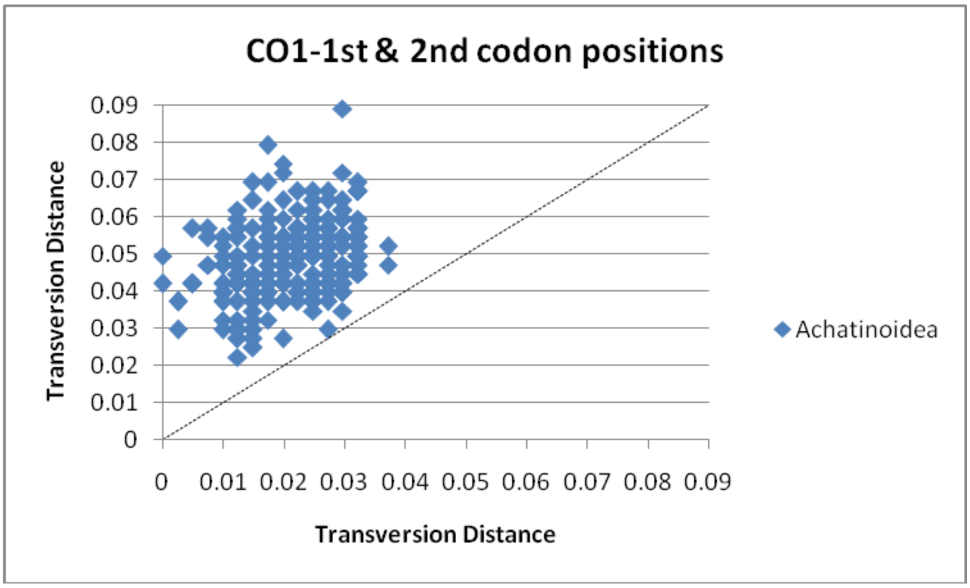


(B)

Figure 3.21: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the 1st and 2nd codon positions of the COI gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only.



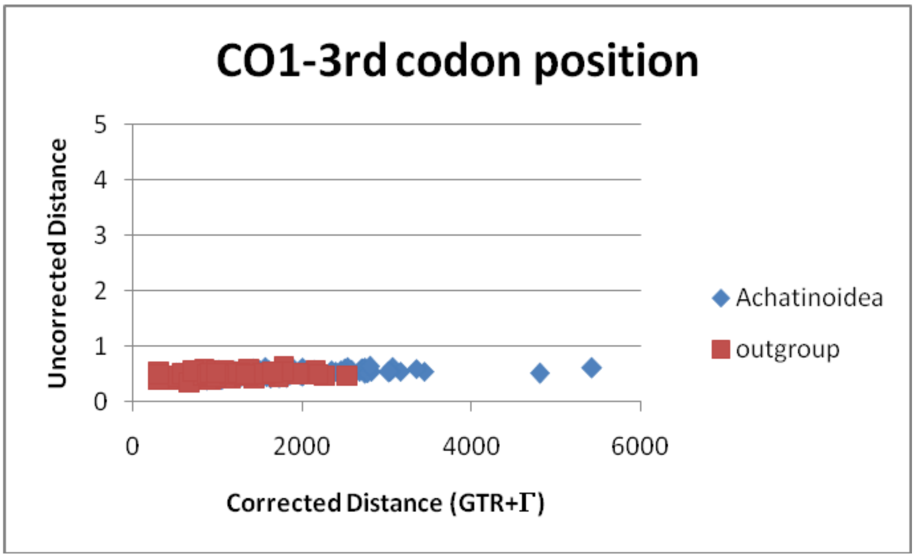
(A)



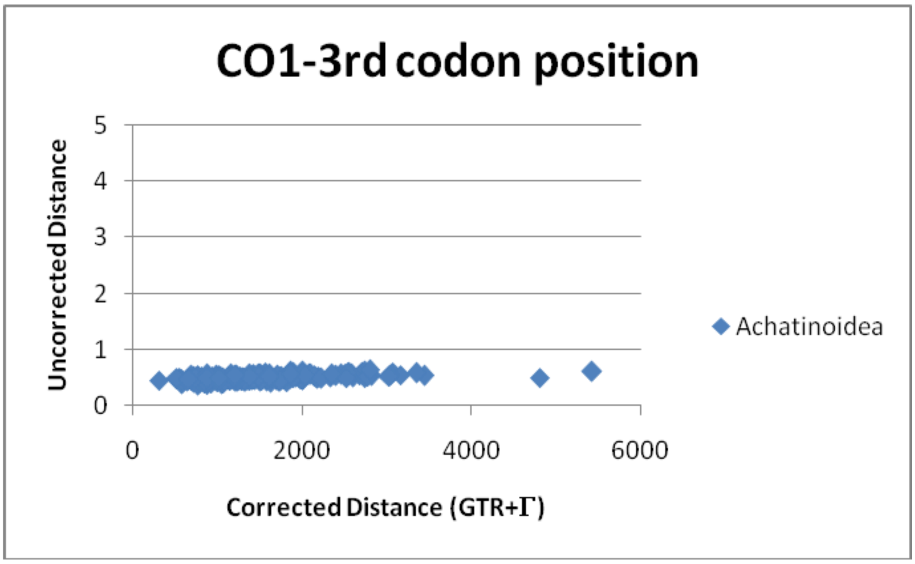
(B)

Figure 3.22: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances for the 1st and 2nd codon positions of the COI gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only.

For the 3rd codon position of the COI gene, Plot 1 (Figure 3.23) revealed that the optimal GTR+Γ model was unable to correct the dataset for multiple hits as demonstrated by the nearly horizontal trend for both plots. The uncorrected distances also ranged from 0.365 to 0.631 while corrected distances ranged from 299.377 to 5420.470 (see also Table 3.3). This indicated severe saturation for the 3rd codon position.



(A)

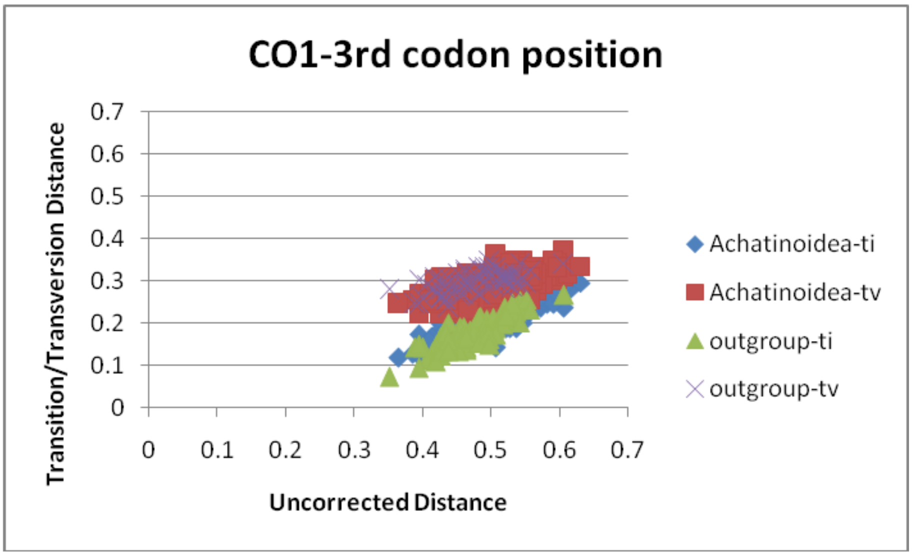


(B)

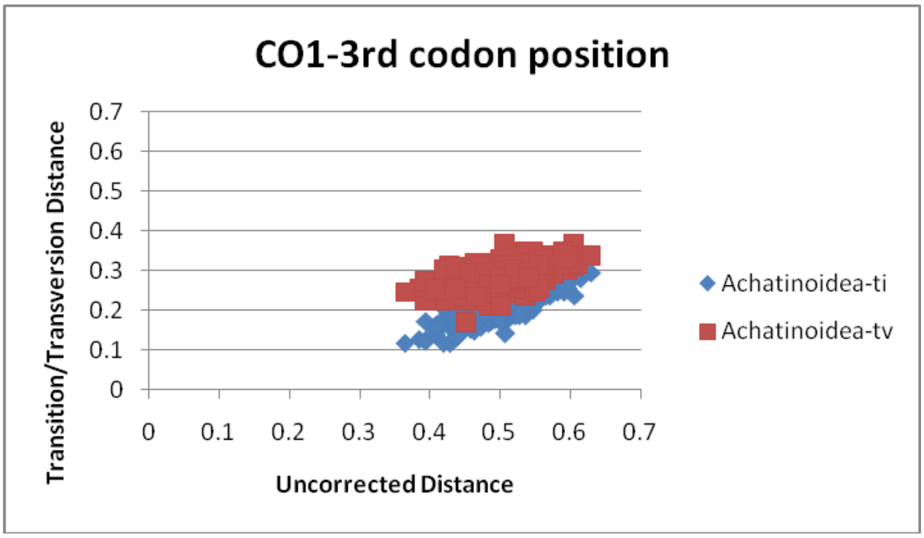
Figure 3.23: Plots of pairwise uncorrected distance against corrected distance for the 3rd codon position of the COI gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only.

Plot 2 (Figure 3.24) for all taxa as well as for the Achatinoidea only showed transversions overlapping with transitions, with the transversions generally higher than the transitions. Plot 3 (Figure 3.25) demonstrated that most of the pairwise comparisons had higher rates of transversions than transitions.

The g1 test score for the 3rd codon position of the COI gene based on 24 taxa and 188 parsimony-informative sites was -0.050, which was significantly larger than the critical value of -0.16 for 15 taxa and 100 parsimony-informative sites. The 3rd codon position therefore did not exhibit any phylogenetic signal.

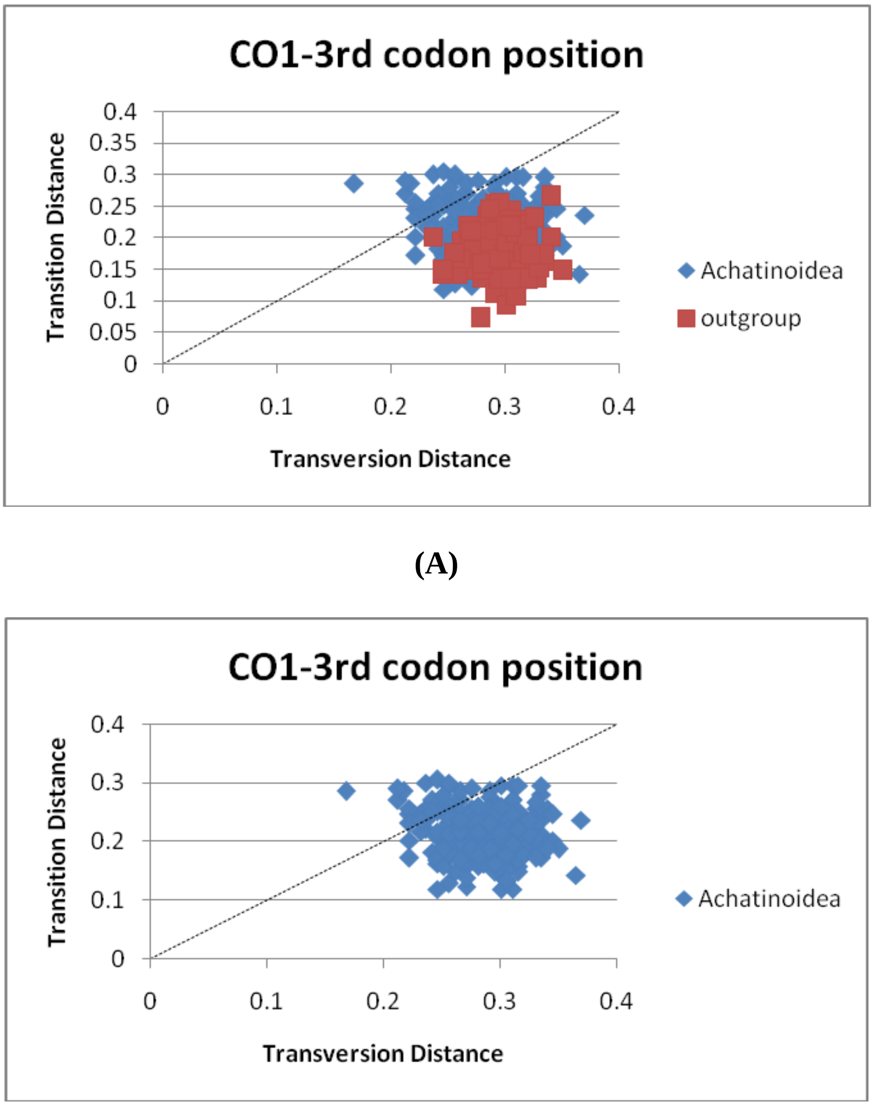


(A)



(B)

Figure 3.24: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the 3rd codon position of the COI gene in (A) the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and (B) the Achatinoidea only.



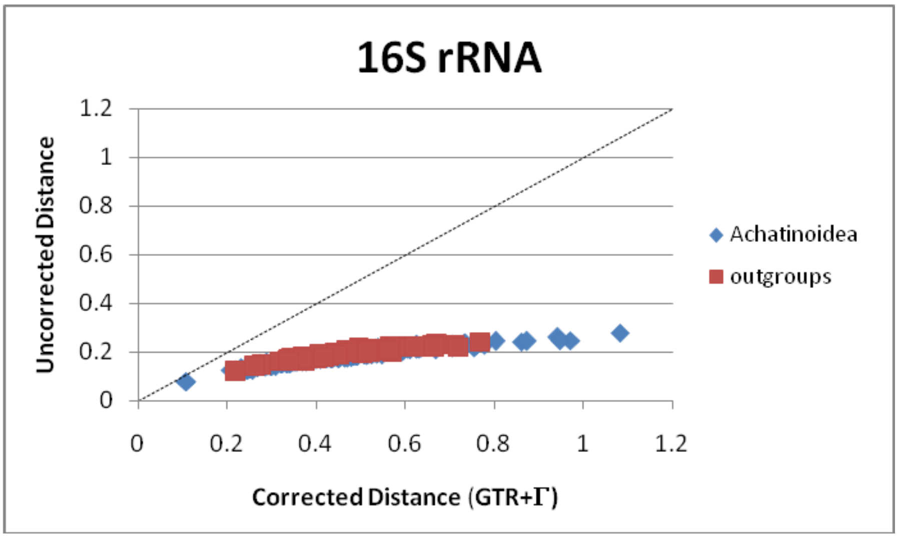
(A)

(B)

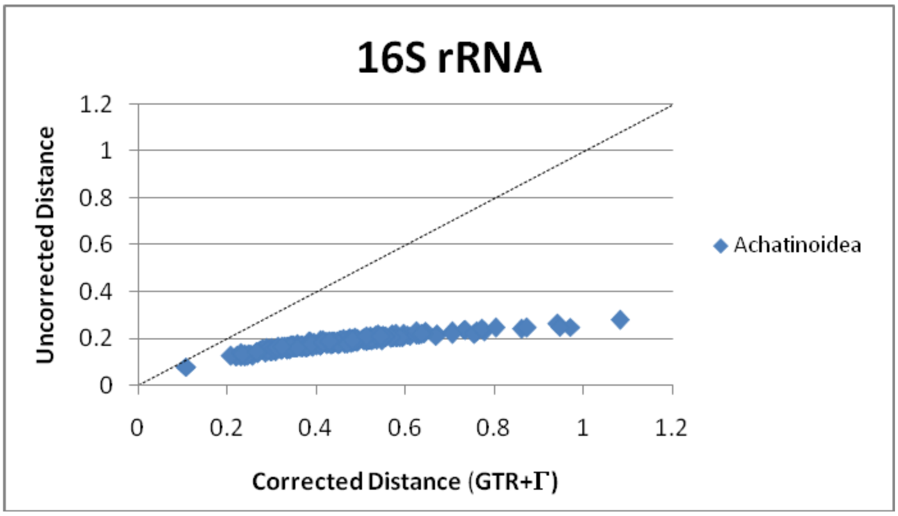
Figure 3.25: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances for the 3rd codon position of the COI gene in **(A)** the Achatinoidea and the streptaxid outgroup taxon *Gibbulinella dewinteri* and **(B)** the Achatinoidea only.

The lack of phylogenetic signal (as indicated by the g1 test) and the strong evidence for saturation of the entire COI gene suggested that the gene should not be used in its entirety for phylogenetic analyses. Further analysis revealed that the saturation is entirely due to the 3rd codon position. Phylogenetic analyses for the COI gene were therefore limited to the 1st and 2nd codon positions only.

For the 16S rRNA gene, Plot 1 (Figure 3.26) produced corrected distances based on the optimal GTR+Γ model that curved from linearity at an uncorrected (*p*) distance of 0.08 or below and approached a plateau at an uncorrected distance of approximately 0.3. One corrected distance even exceeded the value of 1. These findings suggest the possibility of saturation in the 16S dataset.



(A)



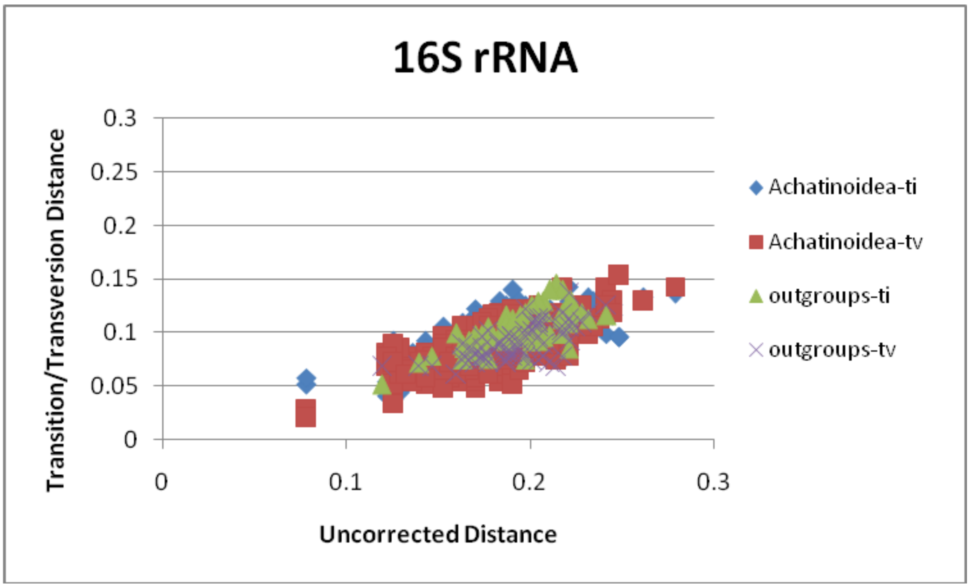
(B)

Figure 3.26: Plots of pairwise uncorrected distance against corrected (GTR+Γ) distance for the 16S rRNA gene in **(A)** the Achatinoidea and the streptaxid outgroup taxa and **(B)** the Achatinoidea only.

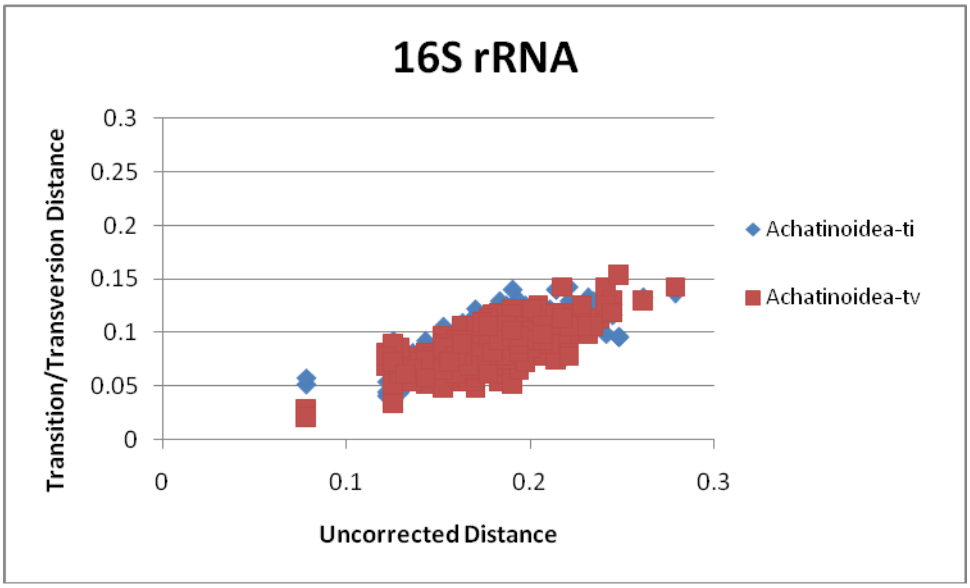
Plot 2 (Figure 3.27) yielded a transition line that began to curve at higher distances where it was overtaken by the transversion line that continued to increase, thus indicative of saturation. An unmistakable overlap was also seen between transitions and transversions. Plot 3 (Figure 3.28) revealed that approximately half of all pairwise comparisons had higher rates of transversions than transitions.

The g1 value based on 25 taxa and 120 parsimony-informative sites was -0.437, which was significantly smaller than the critical value of -0.1 at p=0.05 for 25 taxa and 100 parsimony-informative sites. Phylogenetic signal was therefore evident in the 16S rRNA gene.

Similarly to the COI gene, there was evidence of saturation in the 16S rRNA dataset. This suggested that the gene should not be used for phylogenetic analyses, despite apparently exhibiting some phylogenetic signal based on the g1 test.

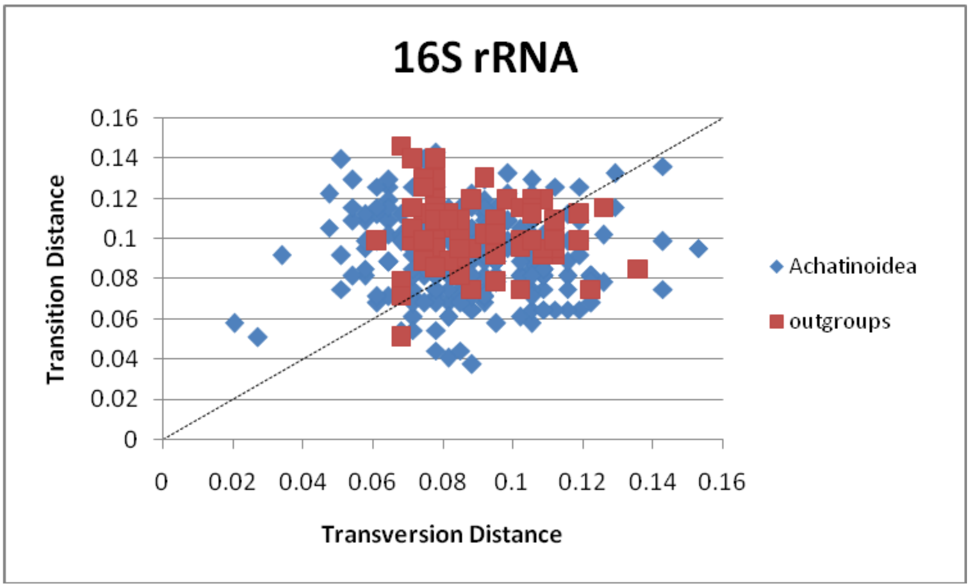


(A)

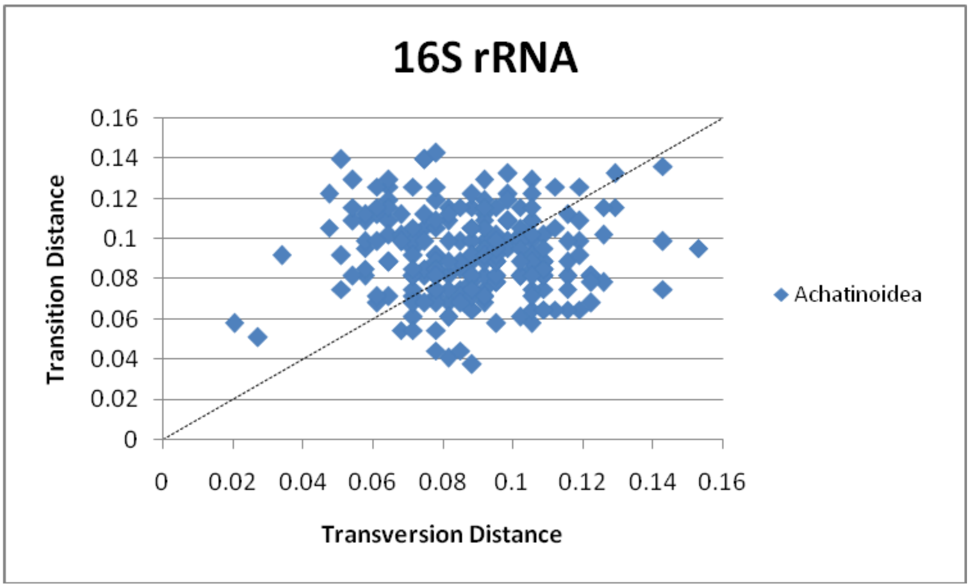


(B)

Figure 3.27: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the 16S rRNA gene in **(A)** the Achatinoidea and the streptaxid outgroup taxa and **(B)** the Achatinoidea only.



(A)



(B)

Figure 3.28: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances **(A)** the Achatinoidea and the streptaxid outgroup taxa and **(B)** the Achatinoidea only.

3.3.2.2. Inferring the presence of paralogous sequences in the actin dataset and assessing its utility for phylogenetic analysis

To infer the presence of paralogous sequences, the actin sequences (obtained by direct sequencing of PCR products) were examined for the presence of ambiguous sites. Ambiguous sites were detected in 17 out of 24 achatinoid taxa and all three streptaxid outgroups (Appendix 3.7, p. 434), indicating the presence of more than one copy of the actin gene in the Achatinoidea and the Streptaxoidea.

Clones derived from three representative taxa, which had varied numbers of ambiguous sites in their direct sequences (*Coeliaxis blandii,* 21 ambiguities; *Cochlitoma granulata,* 9 ambiguities; *Leptinaria lamellata,* 0 ambiguities), were examined to assess the ability of the PCR-direct sequences to detect variation among actin copies as ambiguities in the direct sequence. (See details of actin clones in Appendix 3.8, pp. 435-437). The three taxa were selected to represent those with many, few and no ambiguous sites, respectively and were chosen from a batch of actin sequences processed early on, with their cloned sequences used as guides to assign ambiguities in direct sequences. Other actin sequences obtained later yielded considerably more ambiguous sites after subsequent processing, as in the case of *Bocageia* sp. with 101 ambiguous sites. Although the sequences of the clones would be subject to Taq error, a reasonably close correlation would be expected between the amount of variation detected among clones and the amount of ambiguity detected in the direct sequences. However, for *C. blandii*, a total of 163 variable sites were detected among the 4 clones obtained, as opposed to only 21 ambiguities in the direct sequence (Appendix 3.8A, p. 435). Of these variable sites, 132 were attributed to a single clone (Clone 3) that was clearly not picked up in the direct sequence (see Appendix 3.8B-1, p. 436). Likewise for *C. granulata*, 72 variable sites were detected among the 7 clones obtained as opposed to only 9 ambiguities in the direct sequence (Appendix 3.8A). The majority of these variable sites (55) were attributed to Clones 3 and 6 that were not picked up in the direct sequence (see Appendix 3.8B-2, p. 437). For *L. lamellata*, six clones were obtained, with three clones (Clones 1, 3 and 5) bearing sequences identical to the direct sequence (Appendix 3.8A). Clones 2 and 4 had one variable site each while Clone 6 had two; none of the four variable sites were picked up in the direct sequence (see Appendix 3.8B-3, p. 437). The very small number of variable sites in the *L. lamellata* clones and their absence in the direct sequence would suggest that these variable sites were probably due to Taq sequencing error. The cloned sequences therefore confirmed the presence of multiple actin genes in at least some achatinoid taxa, with some clones exhibiting highly divergent sequences when compared to other clones derived from the same taxon. Moreover, not all of the variation observed in the clones was detected in the PCR-direct sequences. The reason for the failure of the direct sequences to identify all of the variation among the clones is not clear. One explanation may lie in the fact that the PCR-direct sequence is effectively a consensus of the different actin copies within an individual in which rare copies of the gene might reasonably be expected to be averaged out.

To assess the utility of the actin gene for phylogenetic analysis of the Achatinoidea, four approaches were undertaken to determine whether the observed paralogy in actin was likely to mislead phylogeny. First, a neighbor-joining tree was constructed for all actin sequences for the Achatinoidea as well as all clones obtained for *C. blandii* (4 clones), *C. granulata* (7 clones) and *L. lamellata* (6 clones) in order to determine whether the clones for each species were monophyletic. Monophyly would suggest that the gene duplication event that led to the actin paralogs detected was recent relative to the date of species divergence. Moreover, if all copies of the gene were monophyletic, the organismal phylogeny would not be misled. However, monophyly was not observed for the clones of either *C. blandii* or *C. granulata*, with the most divergent clones (Clone 3 for *C. blandii* and Clones 3 and 6 for *C. granulata*) falling separately from both the PCR direct sequence and the other clones from the species (see Appendix 3.9, p. 438). This suggested a high probability that the organismal phylogeny may be misled. Nevertheless, the most divergent sequences for *C. blandii* and *C. granulata* (that fell separately from the other *C. blandii* and *C. granulata* sequences in the neighbor-joining tree) were not represented as ambiguities in the PCR-direct sequences and would therefore not affect the phylogenetic signal of the direct sequences.

Second, the number of ambiguous sites within a taxon was compared with the total number of nucleotide differences between the taxon and its closest relative (based on actin sequence identity). The number of ambiguous sites within a taxon should not exceed the number of differences between this taxon and its closest relative if the time of divergence between the two taxa were to be earlier than the evolution of the different actin genes within these taxa. With the exception of *Pyrgina umbilicata* and *Thyrophorella thomensis*, a lower number of ambiguous sites was observed within each taxon when compared to the number of nucleotide differences between the taxon and its closest relative. Thus, based on the number of ambiguous sites observed from the direct sequences, in most cases the divergence among taxa was deeper than the divergence among the different copies of the actin gene, suggesting that some phylogenetic signal could be derived from actin at and above the genus level (see Table 3.4). However, the presence of divergent actin gene sequences falling deeper than the divergence among taxa should not be ruled out, as some divergent sequences, which were not picked up as ambiguities in the direct sequences, were detected by cloning; these sequences did not cluster with the other clones or the direct sequence from that species (i.e. *Coeliaxis blandii* and *Cochlitoma granulata*). It should also be noted that since the closest relative was identified based on actin sequence identity, such a relationship was not always found to be associative. For instance, *Achatina achatina* is most similar to *A. fulica* with 65 nucleotide differences, and yet the latter is most similar to *C. ustulata* with only 46 differences.

Third, a partition homogeneity test (see Section 2.9.10, p. 86-88) was undertaken to determine whether or not the sequences from the actin gene exhibited a significant difference in terms of phylogenetic signal compared to the other genes being evaluated (see results in Section 3.3.2.3, p. 161-165). The test revealed that the actin dataset was not too divergent in terms of its evolutionary history relative to the other datasets and that the presence of multiple copies of the actin gene was not having a significant effect on phylogeny.

Lastly, the phylogenetic tree obtained from the actin dataset was checked for concordance with the phylogeny obtained from the rRNA cluster. The actin phylogeny showed concordance with the rRNA phylogeny with respect to many well-supported groups (see results in Section 3.3.3, pp. 162-163 and 169-171), suggesting that the presence of multiple copies of the actin gene was not having a significant effect on phylogeny.

Thus, despite serious reservations over the utility of the actin gene in phylogenetic anaysis of the Achatinoidea, it seems that some useful phylogenetic signal could be gleaned from the gene. Actin was therefore utilised in phylogenetic analyses of the Achatinoidea though its shortcomings suggest that its findings should be interpreted with extreme caution.

Table 3.4. Comparison of the actin ambiguous sites and nucleotide differences for each achatinoid and its closest relative. The closest relative for each taxon is determined based on the actin sequence identity (least number of nucleotide differences). Note that in scoring for the total differences, comparison between an ambiguous site and an unambiguous site is counted as different even if one of the possible nucleotides for the ambiguous site is the same as that found in the unambiguous site being compared (e.g. A vs. R, which is either A or G). See also Table 2.8 of p. 73 for assignment of ambiguous positions.

Species (total ambiguous sites)	Closest relative (total ambiguous sites)	Total number of nucleotide differences between each species and its closest relative
ACHATINIDAE		
Achatina achatina (45)	*Achatina fulica* (18)	65
Achatina fulica (18)	*Cochlitoma ustulata* (0)	46
Achatina stuhlmanni (2)	*Cochlitoma ustulata* (0)	28
Cochlitoma ustulata (0)	*Achatina stuhlmanni* (2)	28
SUBULINIDAE		
Allopeas clavulinum (0)	*Eutomopeas layardi* (0)	36
Bocageia sp. (101)	*Rumina decollata* (29)	126
Eutomopeas layardi (0)	*Allopeas clavulinum* (0)	36
Leptimnaria lamellata (0)	*Allopeas clavulinum* (0)	104
Paropeas clavulinum (1)	*Allopeas clavulinum* (0)	46
Riebeckia sp. (76)	*Coeliaxis blandii* (21)	107
Rumina decollata (29)	*Zootecus insularis* (20)	55
Subulina octona (0)	*Subulina striatella* (26)	63
Subulina striatella (26)	*Subulina octona* (0)	63
Subulina vitrea (37)	*Coeliaxis blandii* (21)	87
Subulona sp. (0)	*Achatina stuhlmanni* (2) *Cochlitoma ustulata* (0)	117
Tortaxis erectus (32)	*Rumina decollate* (29) *Zootecus insularis* (20)	110
Xerocerastus sp. (0)	*Zootecus insularis* (20)	60
Zootecus insularis (20)	*Rumina decollata* (29)	55
COELIAXIDAE		
Coeliaxis blandii (21)	*Zootecus insularis* (20)	82
Pyrgina umbilicata (88)	*Thyrophorella thomensis* (62)	77
THYROPHORELLIDAE		
Thyrophorella tomensis (62)	*Pyrgina umbilicata* (88)	77
GLESSULIDAE		
Glessula ceylanica (53)	*Cochlitoma ustulata* (0)	149
FERUSSACIIDAE		
Cecilioides gokweanus (4)	*Xerocerastus* sp. (0)	81
Ferussacia folliculus (4)	*Xerocerastus* sp. (0)	99
STREPTAXIDAE (OUTGROUP)		
Gibbulinella dewinteri (6)	*Gonaxis quadrilateralis* (55)	94
Gonaxis quadrilateralis (55)	*Gibbulinella dewinteri* (6)	94
Gonospira sp. (77)	*Gonaxis quadrilateralis* (55)	117

3.3.2.3. Partition homogeneity test for combining datasets

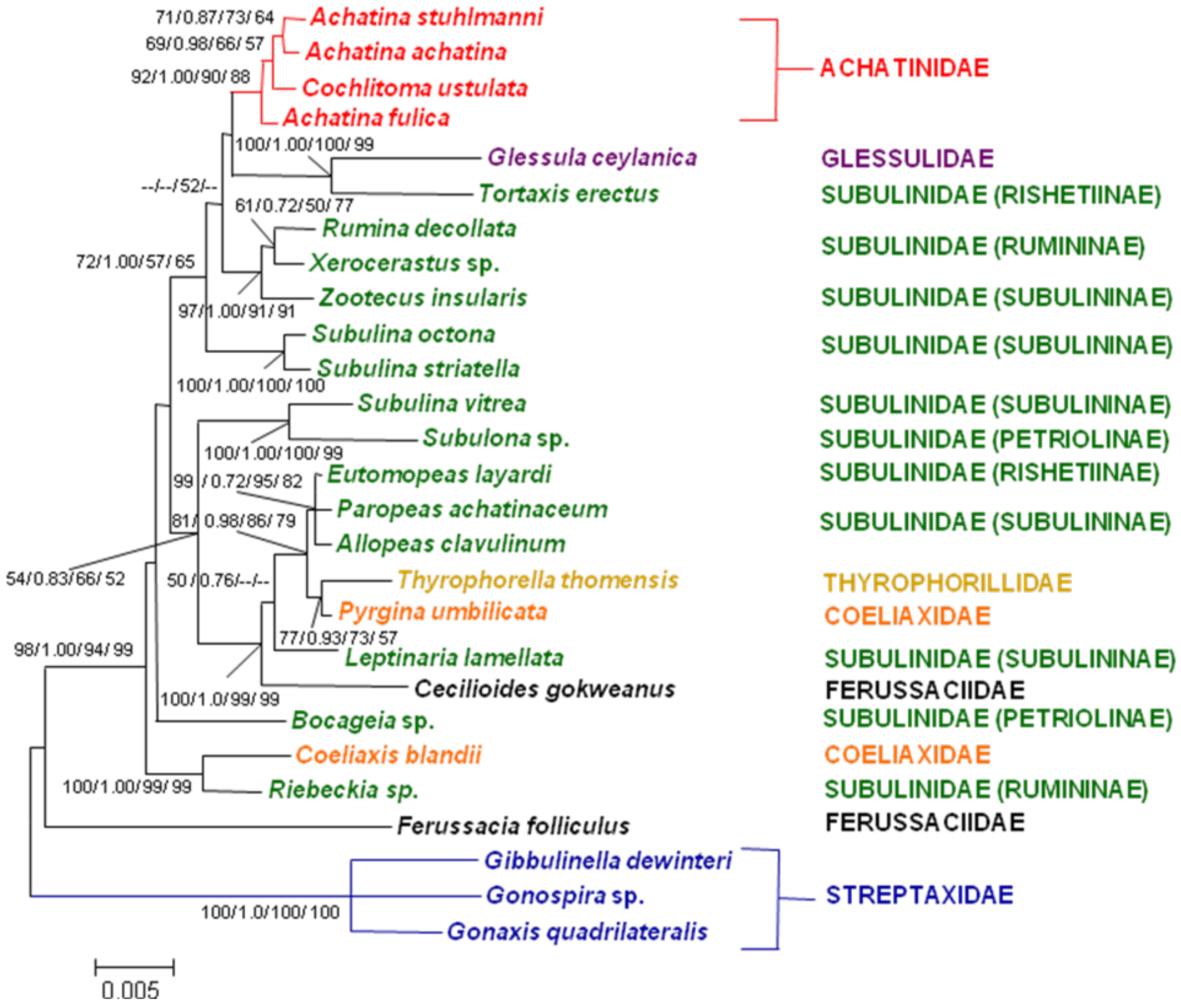
A partition homogeneity test of the rRNA cluster, actin and histone 3 datasets and the 1st and 2nd codon positions of the COI gene (5028 nucleotides total) for all taxa with complete DNA sequences yielded a *P* value of 0.01 (note that the 16S rRNA gene and the 3rd codon position of the COI gene were excluded due to saturation (see Section 3.3.2.1, pp. 138-154). This would indicate that the genes under consideration, including the actin, exhibited similar evolutionary histories (Cunningham, 1997). The datasets from the four genes could therefore be combined as a single dataset.

3.3.3. Molecular phylogeny

The maximum likelihood (ML) phylogenies for the rRNA cluster, actin, H3 and COI (1st and 2nd codon positions only) are shown in Figure 3.29 and those of the concatenated sequences from the four genes in Figure 3.30. Note that for the concatenated sequences, two sets of phylogenetic analyses were carried out. In the first, only taxa with sequences from all four genes were used in the phylogeny; thus, the achatinoids *Celilioides gokweanus, Paropeas achatinaceum, Riebeckia* sp. and *Subulina vitrea* and the streptaxids *Gonaxis quadrilateralis* and *Gonospira* sp. were excluded (Figure 3.30A). In the second, all taxa were included in the analyses (Figure 3.30B), with missing data assigned in the analyses for taxa with incomplete datasets. Also shown in the phylogenies are the bootstrap support values for ML, neighbor-joining (NJ) and maximum parsimony (MP) analyses and the posterior probabilities for Bayesian inference (BI) analysis. The BI, NJ and MP phylogenies for the genes and the concatenated sequences are shown in Appendices 3.10-3.15, pp. 439-450.

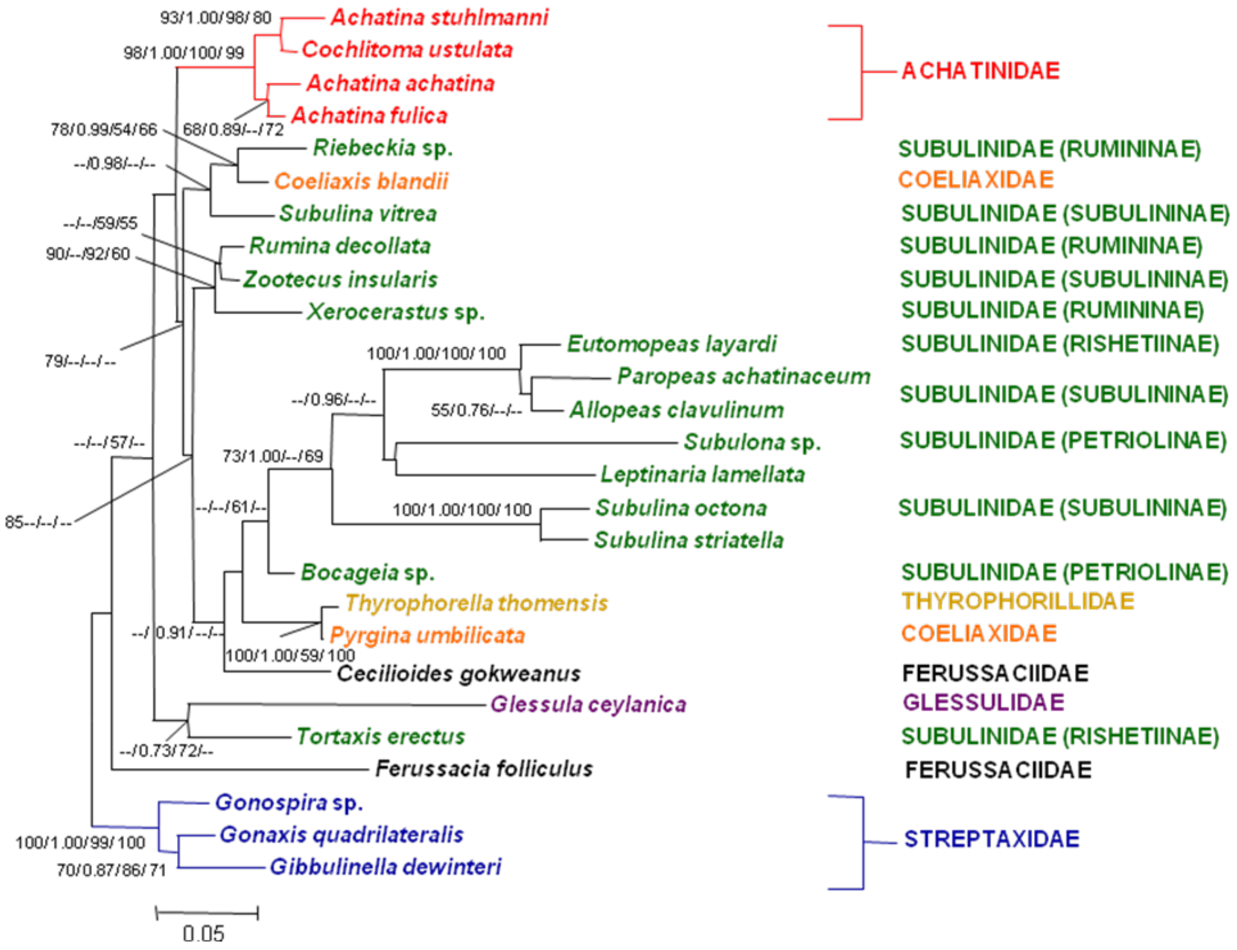
Figure 3.29: (See next four pages). Maximum likelihood phylogenetic trees of the Achatinoidea based on (**A**) the rRNA cluster (3435 nucleotides); (**B**) the actin gene (861 nucleotides); (**C**) the histone 3 gene (328 nucleotides) and (**D**) the 1st and 2nd codon positions of the COI gene (404 nucleotides). The phylogenies were rooted on the streptaxids *Gibbulinella dewinteri*, *Gonaxis quadrilateralis* and *Gonospira* sp for the rRNA and actin datasets and *Gibulinella dewinteri* for the histone 3 and COI datasets. Values on the nodes represent bootstrap support (1000 replicates) for ML, posterior probabilities (based on the last 1000 trees) for BI, and bootstrap support (1000 replicates) for NJ and MP, respectively. Bootstrap support less than 50% and posterior probabilities less than 0.7 are not shown. For BI, the optimized number of generations to explore the tree space was 2,000,000 for all the genes; the optimized heating temperatures for each gene were as follows: rRNA cluster-0.1; actin-0.1; histone 3-0.1; 1st and 2nd codon positions of COI-0.075. The scale bar for (**A**) represents 5 substitutional changes per 1000 nucleotide positions; those of (**B**), (**C**) and (**D**) represent 5 substitutional changes per 100 nucleotide positions.

Figure 3.29 (contd.)



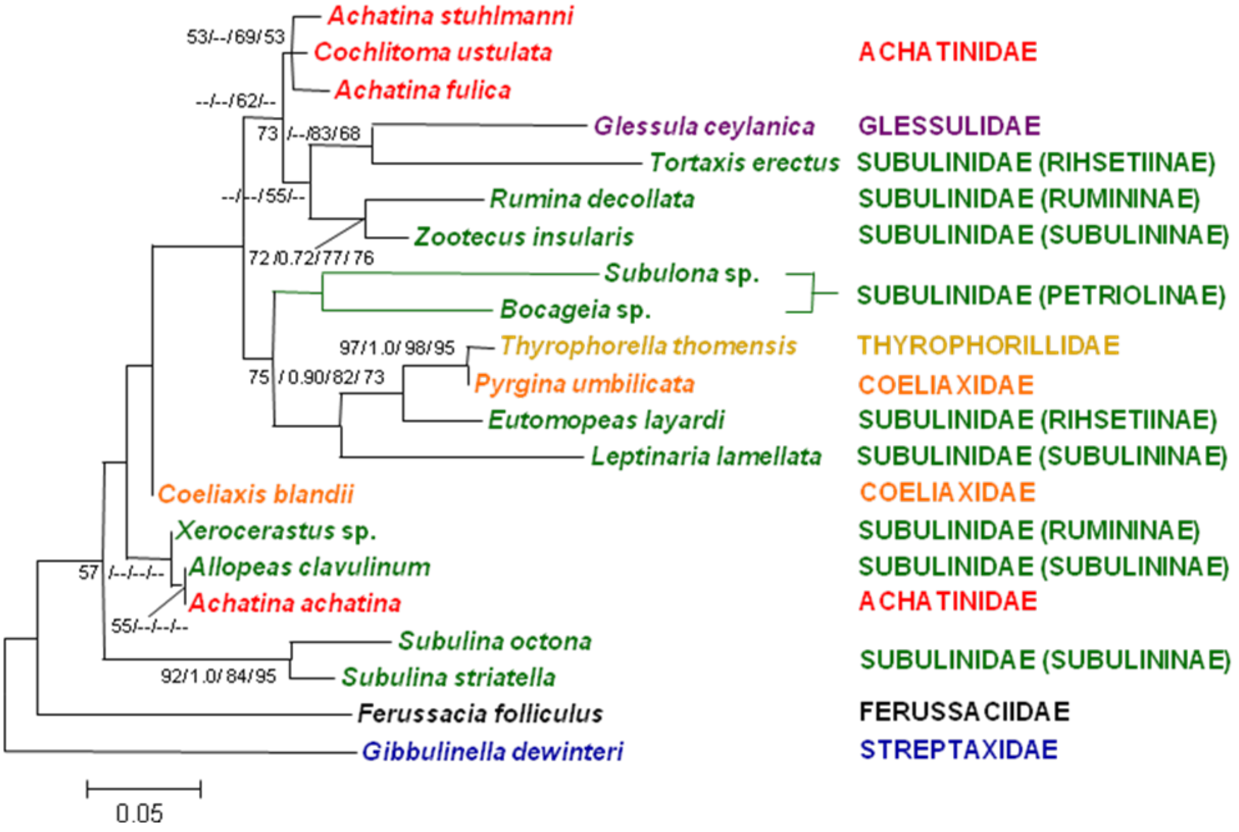
(A) – rRNA cluster

Figure 3.29 (contd.)



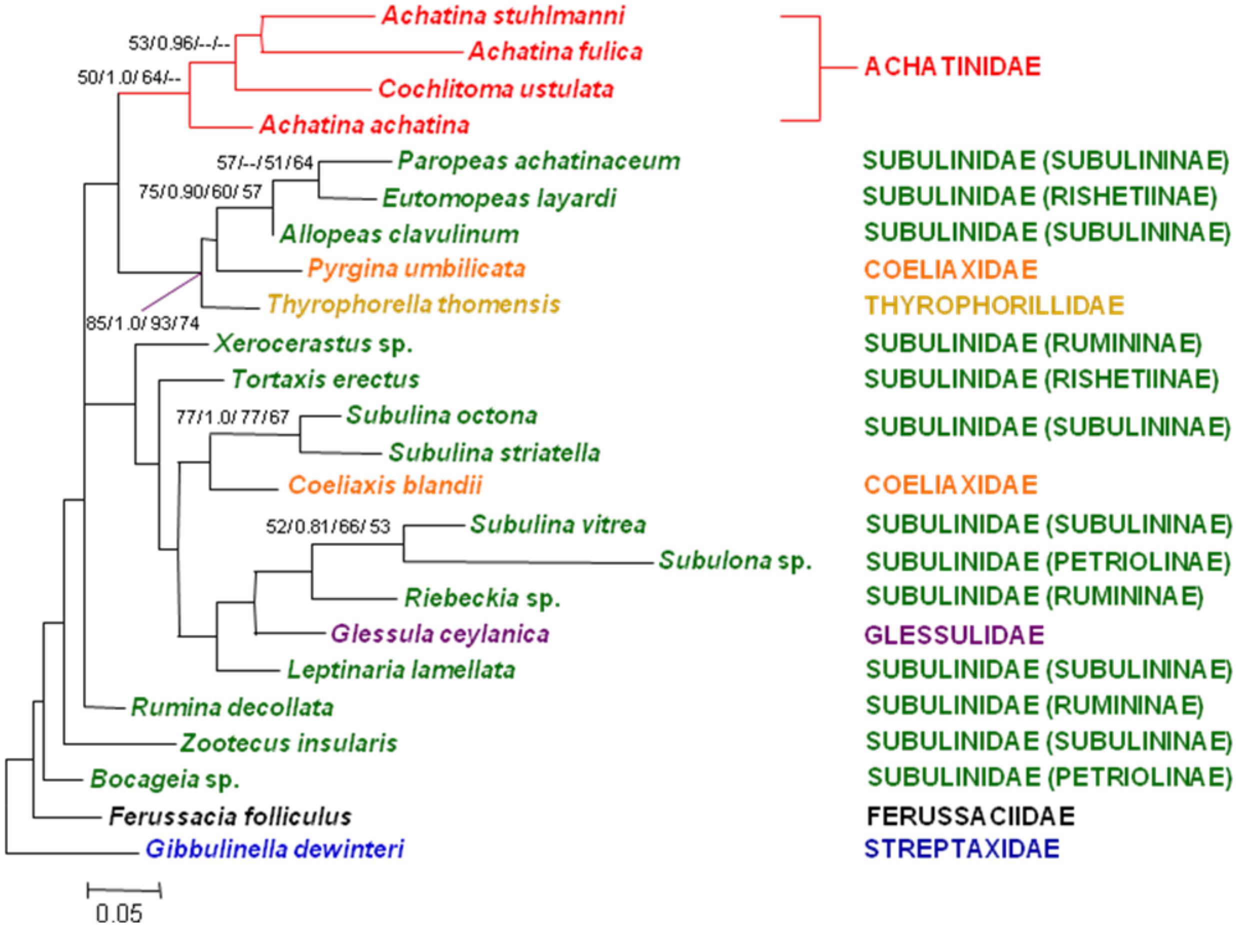
(B) – Actin

Figure 3.29 (contd.)



(C) – H3

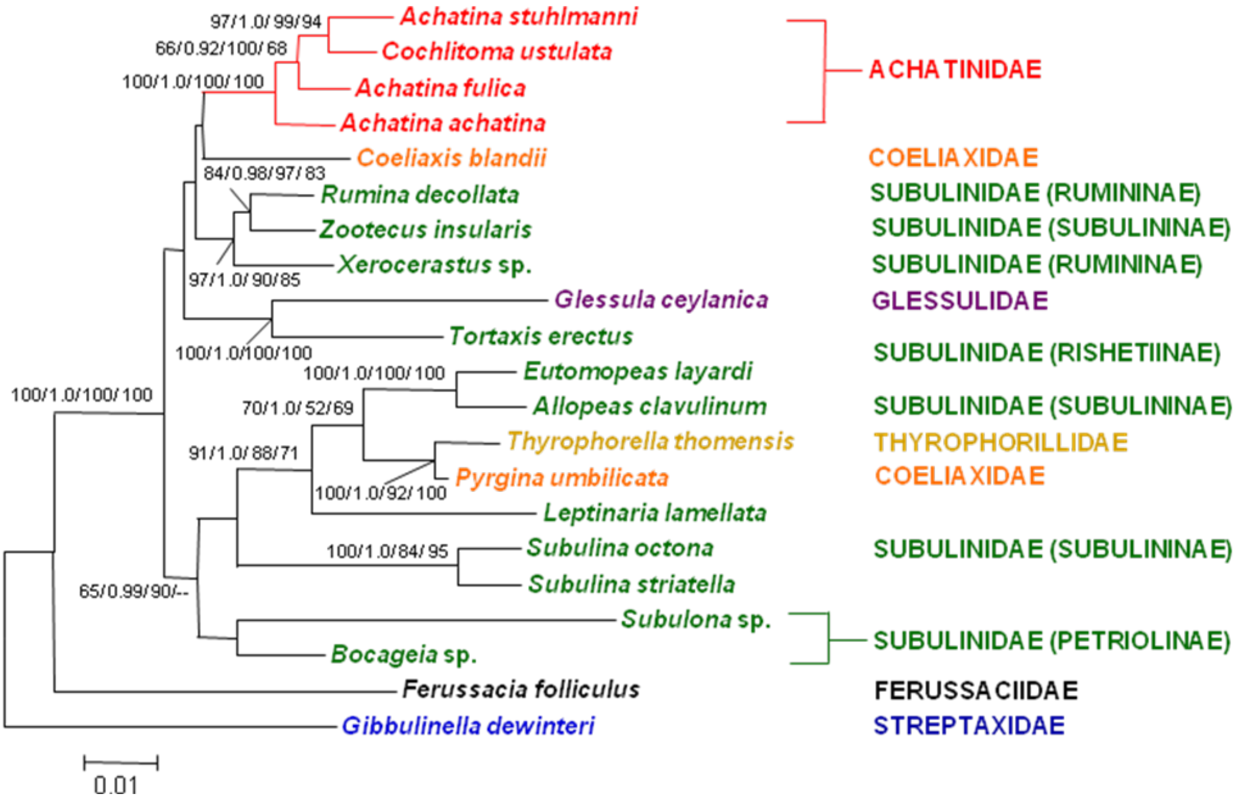
Figure 3.29 (contd.)



(D) – COI-1st and 2nd codon positions

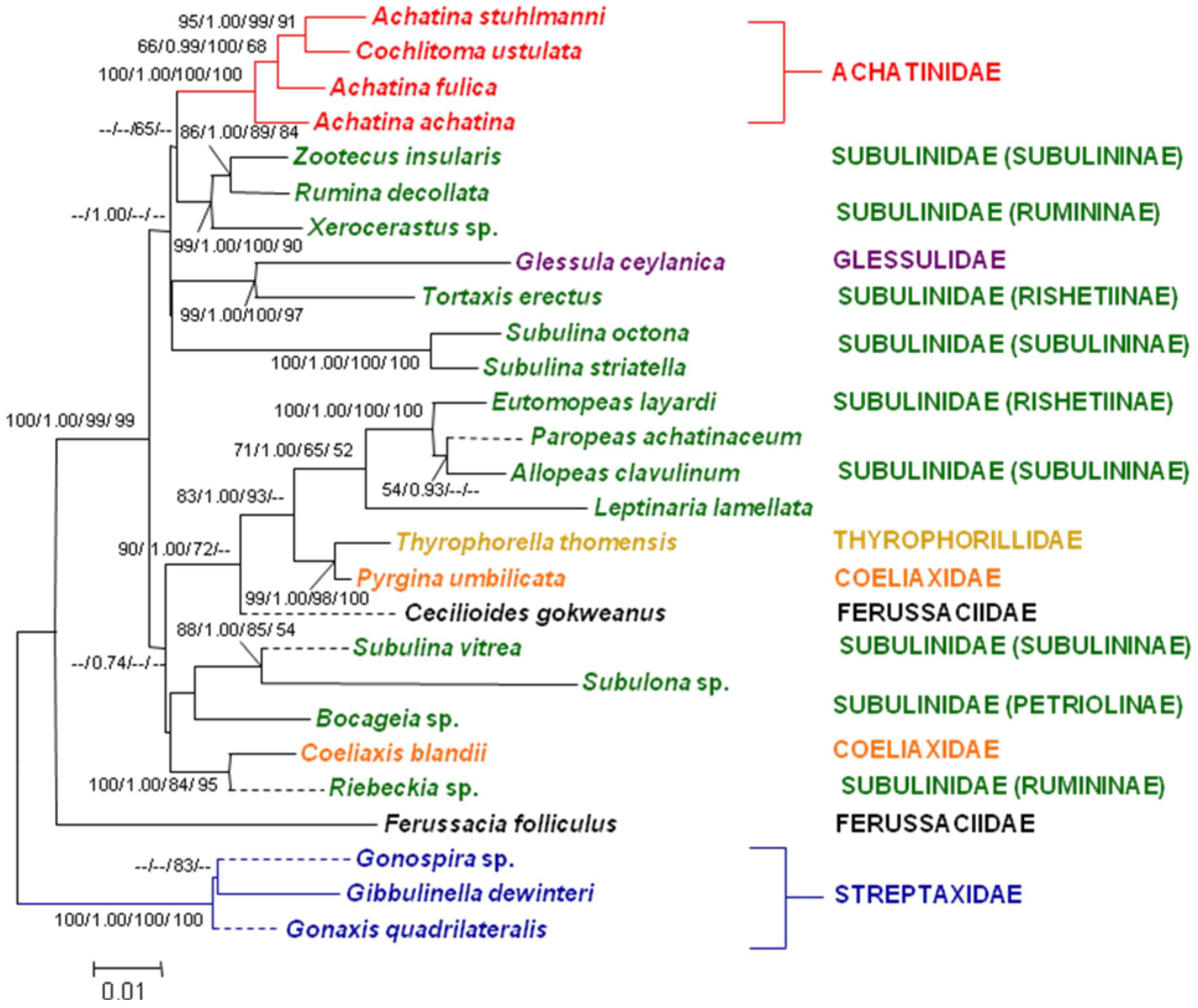
Figure 3.30: (See next two pages.) Maximum likelihood phylogenetic trees of the Achatinoidea based on a concatenated sequence of 5028 nucleotides derived from the combined dataset of the rRNA cluster, actin and H3 genes as well as the 1st and 2nd codon positions of the COI gene. The phylogeny in (**A**) includes only those taxa which have complete sequence data for all sequence regions while that in (**B**) includes all taxa including some with missing data. The following taxa had missing DNA sequence data: *Cecilioides gokweanus* (Histone 3 and COI), *Paropeas achatinaceum* (Histone 3), *Riebeckia* sp. (Histone 3), *Subulina vitrea* (Histone 3), *Gonaxis quadrilateralis* (Histone 3 and COI) and *Gonospira* sp. (Histone 3 and COI). The phylogeny in (A) is rooted on the streptaxid *Gibbulinella dewinteri* while that in (B) is rooted on the streptaxids *Gibbulinella dewinteri, Gonaxis quadrileteralis* and *Gonospira* sp. Values on the nodes represent bootstrap support (1000 replicates) for ML, posterior probabilities (based on the last 1000 trees) for BI, and bootstrap support (1000 replicates) for NJ and MP, respectively. Bootstrap support less than 50% and posterior probabilities less than 0.7 are not shown. For BI, the optimized number of generations to explore the tree space was 2,000,000 while the optimized heating temperature was 0.125 for both trees. The scale bars represent 1 substitutional change per 100 nucleotides. Branches for taxa with missing data are marked with dashes.

Figure 3.30 (contd.)



(A) – taxa with complete DNA sequence data

Figure 3.30 (contd.)



(B) - all taxa

3.3.3.1. Individual gene phylogenies

The phylogenies based on the four genes yielded several consistent groups. Even with the incorporation of new taxa and the addition of an extra 2612 nucleotide sites, the topology of the Achatinoidea based on the nuclear rRNA cluster (Figure 3.29A) remained similar to that obtained by Wade *et al*. (2006) based on a partial 823 bp fragment of the rRNA cluster. Several well-supported groups were recovered in the rRNA phylogeny. The Achatinidae, which included *Achatina fulica*, was recovered as monophyletic, with strong support with all tree methods (92% ML bootstraps, *P*=1.0 BI, 90% NJ bootstraps and 88% MP bootstraps). The other achatinoid families were not recovered in the tree as expected, but six groupings with strong support were resolved. The first group incorporated the coeliaxid *Coeliaxis blandii* and the subulinid *Riebeckia* sp. (100 ML bootstraps, *P*=1.00, 99% NJ bootstraps and 99% MP bootstraps). The second group included the thyrophorellid *Thyrophorella thomensis*, the coeliaxid *Pyrgina umbilicata*, the subulinids *Leptinaria lamellata*, *Eutomopeas layardi*, *Paropeas achatinaceum* and *Allopeas clavulinun* and the ferussaciid *Cecilioides gokweanus* (100% ML bootstraps, *P*=1.0 BI, 99% NJ bootstraps and 99% MP bootstraps). Within this group, the two São Thomé taxa, the ‘operculate’ *T. thomensis* and the coeliaxid *P. umbilicata*, clustered together (77% ML bootstraps, *P*=0.93 BI, 73% NJ bootstraps and 57% MP bootstraps) while *E. layardi*, *P. achatinaceum* and *A. clavulinum* formed another cluster (99% ML bootstraps, *P*=0.72, 95% NJ bootstraps and 82% MP bootstraps). The third group included the subulinids *Subulina vitrea* and *Subulona* sp. (100% ML bootstraps, *P*=1.0, 100% NJ bootstraps and 99% MP bootstraps). The fourth group consisted of another pair of subulinids, *Subulina octona* and *Subulina striatella* (100% ML bootstraps, *P*=1.0 BI, 100% NJ bootstraps and 100% MP bootstraps). The fifth group incorporated the subulinids *Xerocerastus* sp., *Rumina decollata* and

Zootecus insularis (97% ML bootstraps, *P*=1.0 BI, 91% NJ bootstraps and 91% MP bootstraps). The sixth group clustered together the subulinid *Tortaxis erectus* and the glessulid *Glessula ceylanica* (100 ML bootstraps, *P*=1.0 BI, 100% NJ bootstraps and 99% MP bootstraps). Finally, the ferussacid *Ferrusaccia foliculus* fell at the base of the Achatinoidea and was separated from the other ferusaccid in the study, *Cecilioides gokweanus.*

Despite the limitations of the nuclear actin gene for phylogenetic analysis due to the presence of multiple copies of the gene within an individual, the actin phylogeny was very similar to the rRNA tree, with many strongly supported groups in the actin tree also recovered in the rRNA tree. This suggests that the presence of multiple copies of the actin gene had a minimal effect on the achatinoid phylogeny. There was, however, less structure in the actin tree when compared to the rRNA tree as shown by the lower or equivocal support in many of the internal branches (Figure 3.29B). *Ferussacia folliculus* again fell at the base of the tree; however, this was only moderately supported by NJ (57% bootstraps). Other groups that were consistent with the rRNA cluster phylogeny included the Achatinidae, which again formed a monophyletic group (98% ML bootstraps, *P*=1.0 BI, 100% NJ bootstraps and 99% MP bootstraps); the *C. blandii* and *Riebeckia* sp. group (78% ML bootstraps, *P*=0.99 BI, 54% NJ bootstraps and 66% bootstraps); the São Thomé taxa *T. thomensis* and *P. umbilicata* (100 ML bootstraps, *P*=1.0 BI, 59% NJ bootstraps and 100% MP bootstraps); the *E. layardi*, *P. achatinaceum* and *A. clavulinum* group (100 ML bootstraps, *P*=1.0 BI, 100% NJ bootstraps and 100% MP bootstraps); the *S. octona* and *S. striatella* group (100 ML bootstraps, *P*=1.0 BI, 100% NJ bootstraps and 100% MP bootstraps); the *Xerocerastus* sp., *R. decollata* and *Z. insularis* group (90% ML bootstraps, *P*<0.7 BI, 92% NJ bootstraps and 60% MP bootstraps); and the *T. erectus* and *G. ceylanica* group (with only *P*=0.73 BI and 72% NJ bootstraps as support).

The phylogeny based on the nuclear histone 3 gene (Figure 3.29C), which excluded the achatinoids *Cecilioides gokweanus*, *Paropeas achatinaceum*, *Riebeckia* sp. and *Subulina vitrea* and the streptaxids *Gonaxis quadrilaterlis* and *Gonospira* sp., revealed some groupings that were consistent with the rRNA phylogeny but showed less structure and a general reduction of support for most groups when compared to either the rRNA or the actin gene phylogenies (as shown in Figure 3.30C). For instance, *Achatina achatina* did not cluster with the rest of the Achatinidae and instead grouped with the subulinids *Xerocerastus* sp. and *A. clavulinum,* although it only received 57% ML bootstrap support. Some groups were recovered, however, such as *T. thomensis* and *P. umbilicata* (97% ML bootstraps, *P*=1.0 BI, 98% NJ bootstraps and 95% MP bootstraps), *S. octona* and *S. striatella* (92% ML bootstraps, *P*=1.0 BI, 84% NJ bootstraps and 95% MP bootstraps), and *T. erectus* and *G. ceylanica* (73% ML bootstraps, 83% NJ bootstraps and 68% MP bootstraps).

The mitochondrial COI gene phylogeny for codon positions 1 and 2 (Figure 3.29D) likewise revealed some groups that were consistent with the rRNA phylogeny but showed less structure and support (see Figure 3.30D). These were the Achatinidae (50% ML boostraps, *P*=1.0 BI and 64% NJ bootstraps), *S. vitrea* and *Subulona* sp. (52% ML bootstraps, *P*=0.81 BI, 66% NJ bootstraps and 53% MP bootstraps), *S. octona* and *S. striatella* (77% ML bootstraps, *P*=1.0 BI, 77% NJ bootstraps and 67% MP bootstraps), and *E. layardi, P. achatinaceum* and *A. clavulinum* (75% ML bootstraps, *P*=0.90 BI, 60% NJ bootstraps and 57% MP bootstraps). It should be noted that *T. thomensis* and *P. umbilicata* also clustered with these three taxa with strong support

(85% ML bootstraps, *P*=1.0 BI, 93% NJ bootstraps and 74% MP bootstraps) as with the rRNA phylogeny.

3.3.3.2. Combined gene phylogenies

Combining datasets from genes with different evolutionary rates and mechanisms of inheritance provides information at different levels of phylogeny and therefore provides signals both for the internal branches and the terminal branches (Graybeal, 1994). The combined analysis for the rRNA cluster, actin, H3, and the 1st and 2nd codon positions of COI, but excluding the four taxa that did not yield either or both H3 and COI sequences, recovered most groups identified in the rRNA phylogeny and exhibited longer internal branches with similar or better support (Figure 3.30A). *Ferussacia folliculus* still fell at the base of the Achatinoidea while the other achatinoids clustered together but with improved support when compared to the rRNA tree (100% ML bootstraps, *P*=1.0 BI, 100% NJ bootstraps and 100% MP bootstraps). The monophyly of the Achatinidae was also recovered again with better support (100% ML bootstraps, *P*=1.0 BI, 100% NJ bootstraps and 100% MP bootstraps). Consistent with the rRNA tree was the group that consisted of *L. lamellata*, *T. thomensis*, *P. umbilicata*, *E. layardi* and *A. clavulinum* (91% ML bootstraps, *P*=1.0 BI, 88% NJ bootstraps and 71% MP bootstraps), with the São Thomé taxa *T. thomensis* and *P. umbilicata* again forming one pair and with increased support (100% ML bootstraps, *P*=1.0 BI, 92% NJ bootstraps and 100% MP bootstraps) and *E. layardi* and *A. clavulinum* forming a second pair likewise with increased support (100% ML bootstraps, *P*=1.0 BI, 100% NJ bootstraps and 100% MP bootstraps). Still other groups from the rRNA tree that were also recovered included *S. octona* and *S. striatella* (100% ML bootstraps, *P*=1.0 BI, 84% NJ bootstraps and 95% MP bootstraps), *Xerocerastus* sp., *R. decollata* and *Z.*

insularis (97% ML bootstraps, *P*=1.0 BI, 90% NJ bootstraps and 85% MP bootstraps) and *T. erectus* and *G. ceylanica* (100% ML bootstraps, *P*=1.0 BI, 100% NJ bootstraps and 100% MP bootstraps).

When all taxa were included in the combined analysis (including those taxa for which there was missing data), all groups found in the rRNA phylogeny were recovered and in general received higher support (Figure 3.30B). *Ferussacia folliculus* fell at the base of the Achatinoidea while the remaining Achatinoidea formed a separate clade with increased support (100% ML bootstraps, *P*=1.0 BI, 99% NJ bootstraps and 99% MP bootstraps). Within this clade and consistent with the rRNA tree were the monophyletic Achatinidae with increased support (100% ML bootstraps, *P*=1.0 BI, 100% NJ bootstraps and 100% MP bootstraps); *C. blandii* and *Riebeckia* sp. (100% ML bootstraps, *P*=1.0 BI, 84% NJ bootstraps and 95% MP bootstraps); *Subulina vitrea* and *Subulona* sp. (88% ML bootstraps, *P*=1.0 BI, 85% NJ bootstraps and 54% MP bootstraps); *S. octona* and *S. striatella* (100% ML bootstraps, *P*=1.0 BI, 100% NJ bootstraps and 100% MP bootstraps); *G. ceylanica* and *T. erectus* (99% ML bootstraps, *P*=1.0 BI, 100% NJ bootstraps and 97% MP bootstraps); *Xeroxerastus* sp., *Rumina decollata* and *Zootecus insularis* with increased support (99% ML bootstraps, *P*=1.0 BI, 100% NJ bootstraps and 90% MP bootstraps); and *C. gokweanus*, *P. umbilicata*, *T. thomensis*, *L. lamellata*, *A. clavulinum*, *P. achatinaceum*, and *E. layardi* (90% ML: bootstraps, *P*=1.0 BI and 72% NJ bootstraps). Within the last group, *A. clavulinum*, *P. achatinaceum* and *E. layardi* clustered together with increased support (100% ML bootstraps, *P*=1.0 BI, 100% NJ bootstraps and 100% MP bootstraps), and in turn clustered with *L. lamellata* (71% ML bootstraps, *P*=1.0 BI, 65% NJ bootstraps and 52% MP bootstraps) while the São Thomé group *T. thomensis* and *P. umbilicata* clustered together with increased support (99% ML bootstraps, *P*=1.0 BI, 98% NJ bootstraps and 100% MP bootstraps).

3.3.3.3. Hypothesis testing of groups expected to be monophyletic based on taxonomy

Seven expected monophyletic groups (based on taxonomy) that were not recovered in either the single gene or combined gene phylogenies were subjected to hypothesis testing using the Shimodaira-Hasegawa (1999) test. These groups were the Coeliaxidae, Ferussaciidae, and the Subulinidae; within the Subulinidae were the subfamilies Petriolinae, Rishetiinae, Rumininae and the Subulininae. The placement of *Zootecus insularis* in the Subulininae (according to Schileyko, 1999), in contrast to its placement in the Rumininae (according to Zilch, 1959), was also subjected to the SH test. A summary of the Shimodaira-Hasegawa tests are shown in Table 3.5. Constraining the NJ trees for the four single gene and combined gene phylogenies to show monophyly of the Coeliaxidae produced likelihood scores that were significantly worse (*P*<0.01) than those of the optimal trees (see Table 3.5 for details). This confirmed the non-monophyly of the Coeliaxidae. The monophyly of the Ferussaciidae was evaluated only for the rRNA cluster and actin gene phylogenies, for which both *Ferussacia folliculus* and *Cecilioides gokweanus* were successfully sequenced, as well as the combined gene phylogeny that included taxa with missing data. The constrained trees showing monophyly of the Ferussaciidae for the rRNA cluster and the combined genes that included all taxa were significantly worse than the optimal tree (*P*<0.01, Table 3.5), indicating that the family is not monophyletic. This was not the case for the actin gene where no significant difference was noted (*P*=0.293, Table 3.5). The monophyly of the Subulinidae was also rejected in the SH tests (*P*<0.01, Table 3.5) as was the monophyly of two of its subfamilies, the Rishetiinae ($P<0.03$, Table 3.5) and the Subulininae (with *Z. insularis*-$P<0.01$; without *Z. insularis*-$P<0.04$, Table 3.5). For the Petriolinae, the expected topology (Petriolinae monophyletic) was present in the actin NJ tree (see Appendix 3.10B, p. 440) while no significant difference was shown between the likelihood scores for the constrained trees in which the Petriolinae were monophyletic and the optimal NJ trees in the rRNA cluster ($P=0.093$), histone 3 ($P=0.184$), 1st and 2nd codon positions of COI ($P=0.083$), combined genes but excluding taxa with missing data ($P=0.433$) and combined genes with all taxa ($P=0.150$). Support for the monophyly of the Petriolinae based on the molecular data is therefore equivocal. The constrained trees showing monophyly of the Rumininae yielded significantly worse likelihood scores than those of the optimal trees ($P\leq0.001$ for both with and without *Z. insularis* for the rRNA cluster, actin and combined genes with all taxa, Table 3.5). *Riebeckia* sp. was not included in the datasets for histone 3, COI (1st and 2nd codon positions) and the combined genes that excluded taxa with missing data. Significant difference between the optimal tree and the constrained tree was observed in histone 3 ($P\leq0.01$ for both with and without *Z. insularis*) but not in the 1st and 2nd codon positions of the COI ($P\leq0.3$ for both with and without *Z. insularis*) and the combined genes but excluding taxa with missing data ($P=0.370$ for without *Z. insularis* while expected NJ topology was generated when *Z. insularis* was included) (see Table 3.5). On the basis of the taxa examined, neither Shileyko's (1999) nor Zilch's (1959) Rumininae is monophyletic.

Table 3.5: Hypothesis testing for the monophyly of selected taxa of the Achatinoidea using the Shimodaira-Hasegawa test.

Gene	**Likelihood Score**		***P* for SH[a] Test (Conclusion[b])**
	Optimal NJ tree	**Constrained NJ tree**	
COELIAXIDAE			
rRNA cluster	7951.71731	8036.16984	<0.001 (Significant)
Actin	5881.25298	5972.47679	<0.001 (Significant)
Histone 3	1815.79561	1864.59737	<0.001 (Significant)
COI (1st and 2nd codons)	1885.86879	1924.07354	0.006 (Significant)
Combined	16679.19409	16826.68130	<0.001 (Significant)
Combined-all taxa	18474.64048	18683.79407	<0.001 (Significant)
FERUSSACIIDAE			
rRNA cluster	7951.71731	7982.47034	0.010 (Significant)
Actin	5881.25298	5877.42426	0.293 (Not significant)
Histone 3	Not applicable; *Cecilioides gokweanus* not included		
COI (1st and 2nd codons)	Not applicable; *Cecilioides gokweanus* not included		
Combined	Not applicable; *Cecilioides gokweanus* not included		
Combined-all taxa	18474.64048	18518.72376	0.010 (Significant)
SUBULINIDAE			
rRNA cluster	7951.71731	8098.27402	<0.001 (Significant)
Actin	5881.25298	5922.88073	0.001 (Significant)
Histone 3	1815.79561	1874.36463	0.008 (Significant)
COI (1st and 2nd codons)	1885.86879	1933.58362	0.005 (Significant)
Combined	16679.19409	16974.41302	0.005 (Significant)
Combined-all taxa	18474.64048	18638.18916	<0.001 (Significant)
PETRIOLINAE (SUBULINIDAE)			
rRNA cluster	7951.71731	7967.95035	0.093 (Not significant)
Actin	Not applicable; expected topology exists in optimal NJ tree		
Histone 3	1815.79561	1813.07222	0.184 (Not significant)
COI (1st and 2nd codons)	1885.86879	1911.13362	0.083 (Not significant)
Combined	16679.19409	16680.26472	0.433 (Not significant)
Combined-all taxa	18474.64048	18486.19798	0.150 (Not significant)
RISHETIINAE (SUBULINIDAE)			
rRNA cluster	7951.71731	8084.95708	<0.001 (Significant)
Actin	5881.25298	6059.01720	<0.001 (Significant)
Histone 3	1815.79561	1838.11663	0.026 (Significant)
COI (1st and 2nd codons)	1885.86879	1924.68912	<0.001 (Significant)
Combined	16679.19409	16914.16222	<0.001 (Significant)
Combined-all taxa	18474.64048	18758.90087	<0.001 (Significant)
RUMININAE sensu Schileyko-without *Zootecus insularis* (SUBULINIDAE)			
rRNA cluster	7951.71731	8019.95480	<0.001 (Significant)
Actin	5881.25298	5911.57548	0.001 (Significant)
Histone 3	1815.79561	1837.83013	0.01 (Significant)
COI (1st and 2nd codons)	1885.86879	1896.97810	0.226 (Not significant)
Combined	16679.19409	16681.37066	0.370 (Not significant)
Combined-all taxa	18474.64048	18578.49191	<0.001 (Significant)
RUMININAE sensu Zilch-with *Zootecus insularis* (SUBULINIDAE)			
rRNA cluster	7951.71731	8000.77016	0.001 (Significant)
Actin	5881.25298	6042.92852	<0.001 (Significant)
Histone 3	1815.79561	1835.88838	0.009 (Significant)
COI (1st and 2nd codons)	1885.86879	1894.94276	0.244 (Not significant)
Combined	Not applicable; expected topology exists in optimal NJ tree		
Combined-all taxa	18474.64048	18542.21668	<0.001 (Significant)

SUBULININAE sensu Schileyko-with *Zootecus insularis* (SUBULINIDAE)			
rRNA cluster	7951.71731	8106.81200	<0.001 (Significant)
Actin	5881.25298	6067.38758	<0.001 (Significant)
Histone 3	1815.79561	1865.98883	0.002 (Significant)
COI (1st and 2nd codons)	1885.86879	1940.19417	<0.003 (Significant)
Combined	16679.19409	16965.35856	<0.001 (Significant)
Combined-all taxa	18474.64048	18805.02183	<0.001 (Significant)
SUBULININAE sensu Zilch-without *Zootecus insularis* (SUBULINIDAE)			
rRNA cluster	7951.71731	8051.96505	<0.001 (Significant)
Actin	5881.25298	5898.27655	<0.028 (Significant)
Histone 3	1815.79561	1841.74798	0.034 (Significant)
COI (1st and 2nd codons)	1885.86879	1933.96199	<0.001 (Significant)
Combined	16679.19409	16825.89704	<0.001 (Significant)
Combined-all taxa	18474.64048	18706.81385	<0.001 (Significant)

[a] SH test – Shimodaira-Hasegawa Test

[b] Significant at $P<0.05$

3.4. Discussion

This phylogenetic study provides the first systematic coverage of the Achatinoidea with over 24 species from 20 genera and 6 families (Achatinidae, Coeliaxidae, Ferussaciidae, Glessulidae, Subulinidae and Thyrophorellidae), including 4 subfamilies from the Subulinidae (Petriolinae, Rishetiinae, Rumininae and Subulininae).

3.4.1. Single versus combined gene phylogenies

Three nuclear genes and two mitochondrial genes were used for this study. Among these genes, the nuclear rRNA showed the least saturation, and its phylogeny provided the most resolved structure. Many of the basal nodes were well supported, most notably the splitting of the Achatinoidea into *Ferussacia folliculus* and the rest of the achatinoids. Many terminal nodes likewise received support. Expanding the coverage of the rRNA cluster to include nearly the entire LSU when compared to Wade *et al.*'s (2001, 2006) studies led to an increase in support for the Achatinoidea (99% NJ bootstraps and P=1.0 BI for this study versus 93% NJ bootstraps and P=0.98 BI in Wade *et al.*'s (2006) study). Support for the Achatinidae increased significantly from

38% NJ bootstraps and *P*=0.94 BI to 90% NJ bootstraps and *P*=1.0 BI, although a different set of achatinid taxa (apart from *A. fulica*) were used when compared to the Wade *et al.* (2006) study. There was also a slight increase in support for the *Coeliaxis blandii* and *Riebeckia* sp. grouping (99% NJ bootstraps and *P*=1.0 BI for this study versus 92% NJ bootstraps and *P*=1.0 BI in Wade *et al.*'s (2006) study). However, a rather surprising decrease in support was noted for the *Pyrgina umbilicata* and *Thyrophorella thomensis* group (73% NJ bootstraps and *P*=0.93 BI for this study versus 100% NJ bootstraps and *P*=1.0 BI in Wade *et al.*'s (2006) study). The actin gene also recovered many strongly-supported groupings found in the rRNA cluster despite the presence of several copies of the actin gene within many taxa leading to ambiguous sites in the sequences. While many basal groups received less than 50% bootstrap support (ML, NJ and MP) and less than 0.7 posterior probabilities (BI), the splitting of the Achatinoidea into *F. thomensis* and the other achatinoids was still strongly supported with 100% bootstrap support (ML, NJ, MP) and a posterior probability of 1.0 (BI). Two terminal groups also received higher support in actin than in the rRNA cluster. For instance, the Achatinidae obtained 98% NJ bootstraps, *P*=1.0 BI, 100% NJ boostraps and 99% MP bootstraps. The second group, comprising *Pyrgina umbilicata* and *Thryphorella thomensis,* received 100% ML boostraps, *P*=1.0 BI, 59% NJ bootstraps and 100% MP bootstraps; however, *Pyrgina* exhibited more ambiguous sites (88) than the total number of nucleotide differences (77) between it and *Thyrohorella thomensis*. It is highly probable that the actin copies in *P. umbilicata* and *T. thomensis* diverged earlier than the two taxa, and interpretation of this grouping should be treated with caution. On the other hand, the histone 3 and COI (1st and 2nd codon position) gene phylogenies generally had less structure with little support for basal nodes in the tree. This could be attributed to the relatively smaller number of sites used, particularly in the

COI where the 3rd codon positions were excluded, as well as the possibility that both datasets were approaching saturation. In the COI, for example, the high levels of saturation of the 3rd codon position would imply the fast rate of evolution for this gene. Nevertheless, several groups in common with the rRNA and actin phylogenies were also recovered from the histone 3 and COI data. The 16S rRNA gene was excluded because it was found to be saturated and therefore not suitable for phylogenetic analyses at the level of the Achatinoidea.

The groups recovered in the rRNA tree also emerged in the phylogenies based on the concatenated sequence after the partition homogeneity test revealed that the individual datasets could be combined. The resolution within the internal branches and the statistical support for groupings in the tree clearly improved when the datasets were combined and analyzed under a single model (GTR+Γ) for both the phylogeny that excluded taxa with missing datasets and for the phylogeny with all taxa. The combined phylogenies were dominated by the signal from the rRNA cluster as all groups from the rRNA phylogeny that did not appear in the other single gene phylogenies were recovered in the combined phylogenies.

3.4.2. Phylogenetic relationships within the Achatinoidea

3.4.2.1. The monophyly and phylogenetic position of the Achatinidae

The limited natural range of the Achatinidae to sub-Saharan Africa (Tillier, 1989, Raut & Barker, 2002) and the existence of fossils no earlier than the Pleistocene (0.01-1.8 MYA) (Zilch, 1959-1960; Solem, 1979) suggest that the achatinids are a relatively recent group (Tillier, 1989), although Raut & Barker (2002) believed them to be much older than the fossil record. The first molecular evidence for the monophyly of the Achatinidae was provided by Wade *et al*. (2001) based on the analysis of a partial fragment of the rRNA cluster. Further molecular evidence for achatinid monophyly is provided in this study based on the analysis of an expanded rRNA dataset as well as the analysis of data from three other genes; actin, histone 3 and the 1^{st} and 2^{nd} codon positions of COI. High support for the monophyly of the family was also obtained when the genes were combined. The relative position of the Achatinidae within the Achatinoidea was not resolved.

3.4.2.2. The monophyly and phylogenetic position of the Ferussaciidae

This study included two representatives from the Ferussaciidae, *Ferussacia folliculus* and *Cecilioides gokweanus*, although the H3 and COI gene fragments failed to amplify in the latter. In the rRNA phylogeny, the two taxa did not cluster together as expected, and the early divergence of *F. folliculus* from the rest of the Achatinoidea, including *C. gokweanus*, was strongly supported (98% ML bootstraps, *P*=1.00 BI, 94% NJ bootstraps and 99% MP bootstraps). Furthermore, the Shimodaira-Hasegawa test conclusively rejected the monophyly of the Ferussaciidae. The actin gene also did not recover the Ferussaciidae as a monophyletic unit, though both bootstrap support/Bayesian posterior probabilities and the Shimodaira-Hasegawa test were equivocal. *Cecilioides gokweanus* has only been described conchologically; its internal anatomy has not been described, although that of *Cecilioides acicula* is already available. *Cecilioides acicula*, like *Ferussacia folliculus*, exhibits characteristics unique to Ferussaciidae such as the short but transversely elongated kidney (Watson, 1928; Tillier, 1989). However, the kidney of *C. acicula* is broader and curves gradually forward as it approaches the rectum whereas the kidney of *F. folliculus* bents abruptly where it meets the rectum. Furthermore, *C acicula* has a simpler penis structure than *F.*

folliculus, as the former possesses an indistinct penis papilla (Watson, 1928). There is therefore no compelling evidence from morphological data to show that the Ferussaciidae are monophyletic, and the molecular data from this study confirm their polyphyly.

3.4.2.3. Evaluation of the taxonomic designation of the Subulinidae, Coeliaxidae, Glessulidae and Thyrophorellidae

The single and combined phylogenies clearly showed that the Subulinidae (represented by eleven taxa in this study), are a polyphyletic group, with members of the Coeliaxidae (two representatives), Glessulidae (one representative) and Thyrophorellidae (one representative) falling among the subulinids. Subulinid monophyly was also significantly rejected by the SH test. The phylogenies also revealed that the Coeliaxidae, which are regarded as a subfamily, Coeliaxinae, under the Subulinidae by Schileyko (1999), are likewise not monophyletic, as *Coeliaxis blandii* and *Pyrgina umbilicata* did not cluster together. Coeliaxidae monophyly was also significantly rejected by the SH test.

The polyphyly of the subulinids is not surprising considering several taxa have not been described anatomically and are grouped together based only on their shell morphology and geographic distribution (Schileyko, 1999). However, some fascinating groupings have emerged. For instance, *Xerocerastus* sp. from southwest Africa (Schileyko, 1999), *Rumina decollata* from the Mediterrenean (Schileyko, 1999) and *Zootecus insularis* from the Sahara, Arabia, India and Burma (Schileyko, 1999) formed one group despite having distinct geographic distributions. Most descriptions of *Xerocerastus* species are limited to the shell (Van Bruggen, 1970; Schileyko, 1999), but both *R. decollata* and *Z. insularis* have a very short to nearly absent oviduct (Schileyko, 1999). *Xerocerastus* should be evaluated anatomically to determine if it shares any morphological features with *R. decollata* and *Z. insularis*.

Two of the three *Subulina* species clustered together: *S. octona* from central and tropical South America (Schileyko, 1999) and *S. striatella* from tropical Africa (Jurickova, 2006). The third species, *S. vitrea*, which has a geographic distribution limited to within southwest Africa (Van Bruggen, 1970), clustered with the tropical African *Subulona* sp. The internal structures of *S. striatella* and *S. vitrea* have not been described, but *S. octona* and the type species of *Subulona*, *S. badia* (Martens), are distinct morphologically in that the former has a penis sheath while the latter does not (Schileyko, 1999). The reproductive tracts of *S. striatella* and *S. vitrea* are therefore worth investigating to determine if they are also distinct.

The subulinid *Allopeas clavulinum* (Subulininae), which has a New World distribution, clustered with another subulinid, *Eutomopeas layardi* (Rishetiinae), which is restricted to Sri Lanka and neighboring islands (Schileyko, 1999). Like most subulinid genera, which are classified according to their shell characteristics, both taxa can be distinguished from one another conchologically based on the shape of the apex, color pattern and the presence or absence of the umbilicus (Schileyko, 1999). However, *Allopeas* and *Eutomopeas* also share other shell characteristics, including shape, size and translucence (Schileyko, 1999). Cain (1977) observed that distinct taxa, such as the high spired *Cochlicella acuta* and *Cionella* (=*Cochlicopa*) *lubrica*, which live in separate but very similar environments and possibly exhibit similar feeding habits, may manifest strikingly similar shell morphology as a result of convergent evolution. Mead (1994) found the same observations for two species of the Achatinidae. This could also be the case for *A. clavulinum* and *E. layardi*. Only the internal anatomy of *A. clavulinum* has been described, so it is therefore worthwhile to note if the internal structures of these taxa are also congruent with molecular data. If that is the case, then the shell characteristics used to distinguish the two taxa into separate subfamilies and even genera may not be valid.

The coeliaxid *Coeliaxis blandii* from South Africa (Schileyko, 1999) grouped with the subulinid *Riebeckia* sp. found in Sokotra near the tip of Somalia (Schileyko, 1999). Only *C. blandii* has been described morphologically. Comparison of the two taxa based on internal structures is therefore not possible.

The other coeliaxid, *Pyrgina umbillicata*, forms a group with the thyrophorellid *T. thomensis* that is consistent in all the single gene and combined gene phylogenies. This grouping is highly controversial in that, in contrast to *A. clavulinum* and *E. layardi*, these two taxa are very distinct from each other conchologically. Whereas *P. umbilicata* is dextral and turricate with 13 narrow whorls (Schileyko, 1999), *T. thomensis* is sinistral and low conic above and bulging below (Schileyko, 2001). Furthermore, the thyrophorellid bears a unique operculum-like structure (Schileyko, 2001). It is speculated that differences in shell morphology often reflect the differences of the feeding behaviour of the taxa being compared (Cain, 1977) and not necessarily their phylogenetic relationship. The only similarity exhibited by *P. umbilicata* and *T. thomensis* at present is their geographic distribution; both are restricted to São Thomé (Schileyko, 1999, 2001). It is not uncommon to have distinct morphological variation that arises between closely related taxa within a small geographic area as a result of adaptive radiation. A classic example of this is Darwin’s finches in the Galapagos Islands, where different environmental conditions could have given rise to different feeding niches for these birds that could have led to the evolution of different beak forms (Whittaker & Fernandez-Palacios, 2007). Further examination of the internal structures of *P. umbilicata* is imperative so that it can be compared with *T. thomensis*, which is already anatomically described (Schileyko, 2001).

Tortaxis erectus from Indochina and southern China (Schileyko, 1999) and the glessulid *Glessula ceylanica* from the Indian subcontinent and Sri Lanka (Schileyko, 1999) formed another group. Conchologically, the two species are somewhat similar in having glossy shells, although *T. erectus* has a turreted, cylindrical-turrited or subulate-turrited shell with 6-13 convex whorls while *Glessula* has an elongated-ovate to ovate-conic shell with 5-8 convex whorls (Schileyko, 1999). The anatomy of *T. erectus* is likewise unknown, so comparison of the two taxa based on internal structures is not possible. In addition to *G. ceylanica*, there are various other *Glessula* species that need to be characterized at the molecular level as they are very similar to each other conchologically (Beddome, 1906).

Based, therefore, on molecular data presented in this study, and in light of the fact that numerous subulinids are not described anatomically, revision of the Subulinidae is clearly needed as this no longer appears to be a valid group. The Coeliaxidae must also be revised as its representatives in this study grouped with either another subulinid or a thyrophorellid. The designation of the monotypic Thyrophorellidae requires re-examination based on *Thyrophorella thomensis*' close association with the coeliaxid *Pyrgina umbilicata*. Finally, the association of *Tortaxis erectus* with *Glessula ceylanica* raises the question as to whether the Glessulidae are really restricted to the Indian subcontinent.

3.4.2.4. Evaluation of the monophyly of the different subulinid subfamilies

Of the four subulinid subfamilies represented in this study, only the Petriolinae (represented by *Bocageia* sp. and *Riebeckia* sp.) were recovered in any of the gene phylogenies, in this case the NJ tree based on the actin gene though bootstrap support was less than 50% (see Appendix 3.11B, p. 442). For the rRNA, H3, COI and combined gene phylogenies, the Shimodaira-Hasegawa test did not find any significant difference in the likelihood scores between the optimal NJ tree (in which the Petriolinae were not monophyletic) and the constrained tree showing monophyly of the Petriolinae. There is therefore no compelling evidence to rule out the monophyly of the Petriolinae but neither is there any convincing evidence in support of the subfamily. The Petriolinae is distinct from all the other subfamilies based on the presence of a well-developed epiphallus and a very large and fleshy stimulator in the penis. *Bocageia* sp. and *Subulona* sp. have not yet been described based on their reproductive structure and were only included in the subfamily based on their shell morphology (Schileyko, 1999). The monophyly of the other subulinid subfamilies, particularly Rumininae sensu Schileyko (without *Zootecus*) and Rumininae sensu Zilch (with *Zootecus*), were strongly rejected by the Shimodaira-Hasegawa Test, and a re-examination of their taxonomic position is warranted. As discussed in the previous section, many of these taxa that have been included in the subfamilies have not been described anatomically, particularly with regards to the reproductive structures. In fact, this situation applies to many subulinids in general, which leaves their taxonomic position questionable (Schileyko, 1999).

3.4.3. The next step

The monophyly of the Achatinidae using molecular data is based only on very limited taxa sampled to date. A comprehensive survey of taxa within the family will determine the extent of their monophyly and at the same time give a glimpse of the inter-relationships of the various groups in the family on the basis of molecular data. Mead (1991, 1995) has already described various groups within the Achatinidae using the reproductive tract as a criterion, and it would be interesting to know if these groupings are supported by molecular data. The molecular data have revealed that the Ferusaciidae are not monophyletic; the inclusion of additional taxa from the family is therefore necessary in order to re-evaluate the relationships within the group. The Subulinidae are also determined to be non-monophyletic based on molecular data; this necessitates a re-examination of the different surprising groupings of these subulinids in the light of their association with the Coeliaxidae (also non-monophyletic), Glessulidae and Thyrophorellidae by expanding the taxon coverage to include other members of the families mentioned. There is also a need to investigate the morphological features of many of the anatomically undescribed species to correlate the molecular data with morphological data. Within the Subulinidae, only the Petriolinae had equivocal support for its monophyly. Including other taxa from the Petriolinae could shed more light on its status as a valid group. Other subfamilies that were not represented in this study (Obeliscinae, Opeatinae, Perrieriinae and Tristaniinae) should likewise be surveyed to determine their validity in the light of the rejection of the monophyly of the Rishetiinae, Rumininae and Subulininae.

3.5. Summary

The study provides a phylogenetic analsyis of the Achatinoidea based on 24 taxa representing six families using the nuclear rRNA, actin and histone 3 genes and the 1st and 2nd codon positions of the mitochondrial cytochrome c oxidase subunit I gene. The 16S rRNA gene and the 3rd codon position of the COI gene were severely saturated and were excluded from the phylogenetic analyses. Combined gene phylogenies recovered most of the groupings in the rRNA phylogeny with longer internal branches and similar or slightly better statistical support. The study provided further strong molecular support

for the monophyly of the Achatinidae. The Ferussaciidae did not form a monophyletic group within the molecular trees, with *Ferussacia folliculus* falling separately from *Cecilioides gokweanus* at the base of the Achatinoidea, thus warranting a re-evaluation of the Ferussaciidae as a valid taxonomic group. The Coeliaxidae was not supported, with the two representatives sequenced to date falling separately in the molecular trees, thereby prompting a re-evaluation of the validity of the family. Finally, the Subulinidae were not supported in the molecular trees with members of the Coeliaxidae, Glessulidae and Thyrophorellidae falling among the subulinids. As with the Ferussaciidae and the Coeliaxidae, the molecular data prompt a re-evaluation of the Subulinidae as a valid taxonomic group.

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CHAPTER 4 - Phylogeny of the Achatinidae

4.1. Introduction

4.1.1. The Achatinidae

Other than as exotic alien species, the Achatinidae are confined to sub-Saharan Africa and the Atlantic Islands in the Gulf of Guinea, West Africa. *Achatina* (*Lissachatina*) *immaculata* Lamarck is considered to have been introduced into Madagascar (Raut & Barker, 2002), but the most notable colonizing achatinid is *Achatina* (*Lissachatina*) *fulica* Bowdich, which has been introduced by Man throughout much of the tropics where it is a major pest species (Mead, 1979a; Raut & Barker, 2002). Achatinids include some of the largest known terrestrial molluscs (Bequaert, 1950) and have been aptly called Giant African Land Snails. There are 13 genera and approximately 200 species (Raut & Barker, 2002) distributed across 3 subfamilies within the Achatinidae (Schileyko, 1999). With the exception of the sinistral *Columna columna* (Müller) and *Archachatina bicarinata* (Bruguière), the shells of the Achatinidae are dextral. In general, achatinid shells are higher than wide and are fusiform, ovoid or pillar-shaped (Schileyko, 1999). Although achatinids do not possess the wide range of anatomical accessory structures that are found in many other stylommatophoran groups, the morphology of the genital structures in achatinids is highly variable (Mead, 1991); all members of the Achatinidae possess a well-developed penis sheath (Schileyko, 1999).

4.1.2. Distribution and habitat of the Achatinidae

The Achatinidae are widely distributed in sub-Saharan Africa. They are present from Senegal to Guinea in the west, the Zaire Basin, the Lake District and Southern Sudan in the centre, Somalia and southern Ethiopia in the northeast, Kenya, Tanzania and Mozambique in the east, and to Zambia, Botswana, Zimbabwe, South Africa, Namibia and Angola in the south and southwest (Mead, 1991; Raut & Barker, 2002). The Atlantic Islands in the Gulf of Guinea, including São Thomé and Principe, also harbor certain achatinids such as *Columna columna* (Schileyko, 1999) and the monotypic *Atopocochlis exarata* (Müller) (Mead, 1991; Raut & Barker, 2002). Van Bruggen (1986) noted an unequal distribution of diversity of the Achatinidae within sub-Saharan Africa, with Western Africa exhibiting a high concentration of endemic species. Habitat preferences of the achatinids are also diverse. Members of the genus *Achatina* in Central Africa thrive in humid, tropical forest areas. Some achatinids such as *Achatina* (*Lissachatina*) *fulica* in Eastern Africa flourish in modified tropical forests and forest margins and even in highly disturbed areas such as gardens, intensively farmed crops and plantations. Others such as the lowland *Cochlitoma zebra* (Bruguière) and the montane *Cochlitoma omissa* (van Bruggen) live in temperate regions in Southern Africa. Still others can be found in less humid areas, for example *Achatina* (*Lissachatina*) *immaculata* Lamarck in savannah and *Achatina* (*Achatina*) *damarensis* (Pfeiffer) in deserts of south and southwest Africa (Raut & Barker, 2002).

4.1.3. The search for the phylogeny of the Achatinidae using morphological characters

Several studies have attempted to elucidate the phylogeny of the Achatinidae using morphological characters (Bequaert, 1950; Mead, 1950, 1979b, 1991, 1995).

Classification within the family is based mostly on shell form and structure as well as the anatomy of the genitalia. However, different forces of selection act to different extents on the two systems. Shell form is subjected to selection pressures associated with particular habitats and homoplasy in shell form is common (Cain, 1977; Mead, 1994); modifications to the genitalia are more likely to reflect evolutionary processes (Mead, 1994) partly in response to sexual selection and selection pressures associated with the need for compatibility of form within species and incompatibility of form acting as reproductive isolation mechanisms between species. It is therefore not unusual to have cases where there is no correspondence between shell structures and the genitalia (Mead, 1979b, 1991) where distinct taxa living in separate but very similar environments may undergo convergent evolution and manifest strikingly similar shell morphology (Mead, 1994). For instance, the western species *Achatina* (*Achatina*) *achatina* Linneaus and the southern species *Cochlitoma zebra* (Bruguière) are very similar conchologically and were placed in the same genus, *Achatina*, by Bequaert (1950) when clearly they belong to different genera based on the differences in their reproductive organs (Mead, 1991).

A typical achatinid reproductive system based on *Archachatina* (*Calachatina*) *marginata* Swainson is shown in Figure 4.1. Achatinids, like all stylommatophorans, are hermaphroditic. Both the sperm and egg are produced in the ovotestis, though not at the same time, and pass through the hermaphrodite duct. During copulation, the sperm proceeds to the male portion of the common hermaphrodite duct and then to the vas deferens and the penis. The penis then protrudes through the genital atrium and the genital pore and inserts into the reproductive tract of the partner until it reaches the vagina where it injects the sperm into the spermolytic sac through the spermolytic duct. The penis then retracts through the penial retractor muscle. Most of the sperm injected into the spermolytic sac is digested by proteolytic enzymes. Sperm that survive go through the spermolytic duct and pass through the oviduct into the female hermaphrodite duct (=uterus) before they are stored in the seminal receptacle (=carrefour). Fertilization also takes place in the seminal receptacle, after which the fertilized eggs or zygotes receive yolk from the albumin gland. The zygotes then pass through the female hermaphrodite duct where the yellow egg shells are added before the eggs are released through the genital pore (Segun, 1975; Egonmwan, 2007).

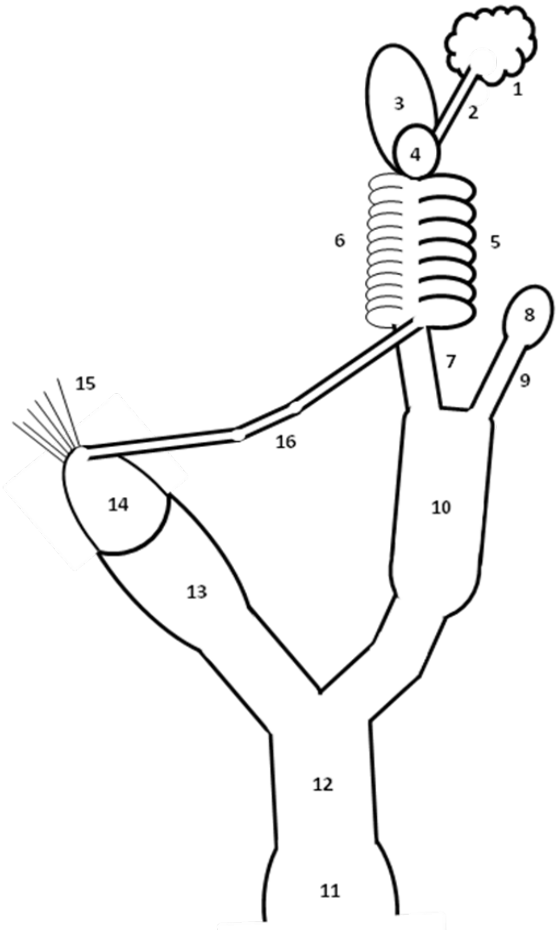


Figure 4.1: Generalized reproductive structure of achatinids. 1 – ovotestis; 2 – hermaphroditic duct; 3 – albumin gland; 4 – seminal receptacle; 5 - male part of common hermaphrodite duct; 6 – female part of common hermaphrodite duct (=uterus); 7 oviduct; 8 – spermolytic sac (=spermatheca); 9 – spermolytic duct; 10 – vagina; 11 – genital pore; 12 – genital atrium; 13 – penis sheath; 14 – penis; 15 – penial retractor muscle; 16 – vas deferens (Segun, 1975; Gomez, 2001; Egonmwan, 2007).

Morphological features of achatinid reproductive systems show a strong correlation with geographic distribution. For example, Mead (1991, 1994) hypothesized that members of the subfamily Callistoplepinae, which are found in Lower Guinea (Cameroon, Equatorial Guinea, Gabon and adjacent islands) in West Africa and include the genera *Callistoplepa* and *Leptocala*, probably gave rise to the other achatinids because they have the most ‘primitive’ genitalia in which the penis sheath does not enclose the vas deferens (Figure 4.2A). For the rest of the achatinids, the developing penis sheath envelopes the apical vas deferens to divide it into the apical and basal portions. Among these achatinids, the penis sheath either encloses the basal vas deferens but not the entire penis (microphallate type, Figure 4.2B) or it encloses both the basal part of the vas deferens as well as the entire penis (macrophallate type, Figure 4.2C). These two types can be found across different geographic regions of the Sub-Saharan Africa over several genera; for instance, the microphallate type is present in the West African *Achatina* (*Achatina*) *achatina*, *Archachatina marginata* and *Pseudachatina downesii* Sowerby and the Southern African *Metachatina kraussi* L. Pfieffer while the macrophallate type is evident in the East African *Achatina* (*Lissachatina*) *fulica,* the Southern African *Cochlitoma* species and the East and West African *Limicolaria* species (Mead, 1979b; 1991). Apart from the penis sheath, other features also reflect groupings within the Achatinidae that have been thought to mirror their routes of dispersal. In the subfamily Limicolariinae, members are restricted to tropical regions of Africa and possess penial retractor muscles that originate from the diaphragm and are not enclosed by the penis sheath; a verge or penis papilla is also present at the base of the penis in this subfamily (Schileyko, 1999). Greater variation in the reproductive structure is exhibited in the subfamily Achatininae, members of which are distributed all over Sub-Saharan Africa (Schileyko, 1999), with some genera possessing reproductive features that reflect their geographic distributions. For instance, extroversion muscles at the base of the penis sheath are very prominent in East African *Achatina* in the subgenus *Lissachatina* (Mead, 1979b, 1991), which include *A.* (*L.*) *fulica*, *A.* (*L.*) *immaculata*, *A.* (*L.*) *reticulata* Pfeiffer and *A.* (*L.*) *zanibarica* Bourguignat. In Southern Africa, several species of *Archachatina* and *Achatina* exhibit a distinct folding of the penis, which prompted Mead (2004) to resurrect *Cochlitoma* Pilsbry. Based on these morphological features, it was proposed that the Achatinidae originated in Lower Guinea and dispersed through much of Sub-Saharan Africa (south of the Sahel) where they adapted to specific environmental conditions, from humid to arid, and tropical to temperate (Mead, 1991; Raut & Barker, 2002).

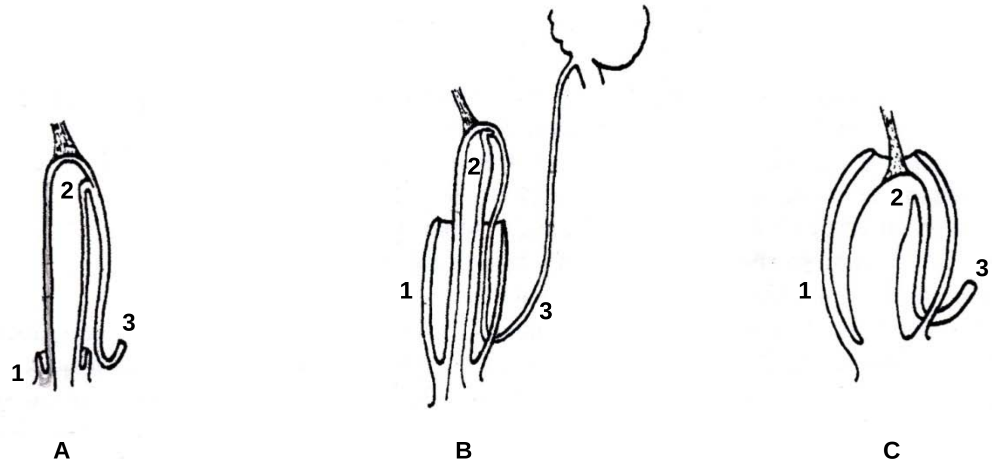


Figure 4.2: Schematic diagrams of how the penis sheath envelops certain parts of achatinid genitalia. 1 – penis sheath; 2 – penis; 3 – vas deferens. **A** – the penis sheath does not envelop the vas deferens, as in *Callistoplepa*. **B** – the penis sheath envelopes the vas deferens and divides into the apical and basal portions, as in the West African *Archachatina*. **C** – the penis sheath envelopes both the entire penis and the basal segment of the vas deferens, as in *Achatina* (*Lissachatina*). (From Mead, 1991).

4.1.4. Taxonomic revision of the genus *Achatina* based on morphological characteristics

Bequaert (1950) used the appearance of the nepionic whorls of the shell to distinguish two subgenera of the genus *Achatina*, namely: (1) *Achatina* found in West and Central Africa; and (2) *Lissachatina* found in East Africa. He noted that the nepionic whorls in *Achatina* (*Achatina*) are sculptured whereas those of *Achatina* (*Lissachatina*) are either smooth or with faint vertical wrinkles. Mead (1995) further added that *Achatina* (*Achatina*) normally has a plateaued apex while *Achatina* (*Lissachatina*) exhibits a lopsided or half-dome apex. However, distinguishing these two subgenera using taxonomic characters based on the shell can be unreliable in the case of specimens with worn or weathered shells (Mead, 1995). The morphology of the reproductive organs is considered to provide more reliable characters for recognizing natural groups (Mead, 1991). For example, *Achatina* (*Achatina*) has a short spermolytic duct (=spermathecal duct *sensu* Mead), which causes the spermolytic sac (=spermatheca) to be located below the junction of the apical vas deferens and the uterine portion of the common hermaphrodite duct (=spermoviduct). In contrast, *Achatina* (*Lissachatina*) has a very long spermolytic duct, thus pushing the spermolytic sac way above the junction of the apical vas deferens and the uterine portion of the common hermaphrodite duct. Furthermore, *Achatina* (*Lissachatina*) tends to have a muscular, bulboid enlargement at the basal vagina (Fig. 4.3) in addition to the presence of extroversion muscles at the base of the penis sheath (Mead 1991; 1995).

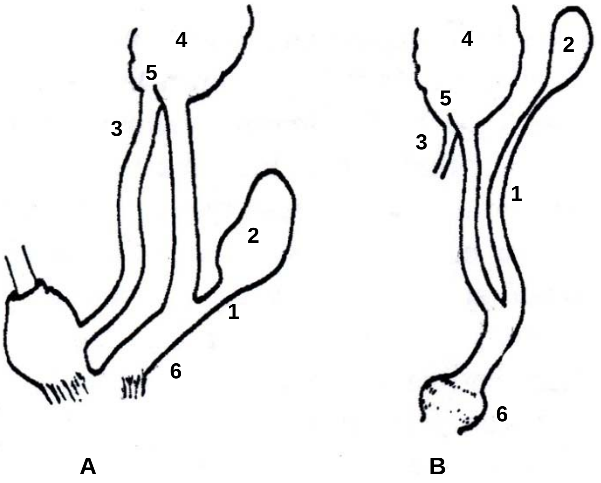


Figure 4.3: Schematic illustrations of the reproductive organs of the West and Central African *Achatina* (*Achatina*) (A) and the East African *Achatina* (*Lissachatina*) (B). 1 – spermolytic duct; 2 – spermolytic sac; 3 – apical vas deferens; 4 – uterine portion of the common hermaphrodite duct; 5 – junction of 3 and 4; 6 – basal vagina. Note that the spermolytic duct is longer in *Achatina* (*Lissachatina*), pushing the spermolytic sac above the junction of the vas deferens and the uterine portion of the common hermaphroditic duct. *Lissachatina* also tends to have a bulbous basal vagina. (From Mead, 1991)

4.1.5. Objective of the study

Results from Chapter 3 confirm the monophyly of the Achatinidae as represented by four taxa. However, no molecular based phylogenetic analyses have been carried out to determine the relationships within the Achatinidae. The current investigation aimed to address this issue by obtaining molecular data for the nuclear ribosomal rRNA cluster, actin and histone 3 genes as well as the mitochondrial cytochrome c oxidase subunit 1 and 16S rRNA genes to elucidate the phylogeny of the Achatinidae. The validity of the taxonomic designation of the East African *Lissachatina* and the West African *Achatina* was also evaluated using the molecular data.

4.2. Materials and methods

4.2.1. Taxa used

Twenty-nine taxa from the family Achatinidae were used to evaluate the phylogeny of the Achatinidae (see Table 4.1). Except for five taxa used by Wade *et al*. (2006), namely *Achatina* (*Lissachatina*) *fulica*, *Archachatina marginata*, *Atopocochlis exarata*, *Limicolaria kambeul* and the subulinid outgroup taxon *Rumina decollata*, all other taxa have not been evaluated in previous studies. *Rumina decollata* was chosen as the outgroup because it fell immediately outside of the Achatinidae in the phylogenetic studies found in Chapter 3, and it was the taxon that allowed incorporation of the greatest number of unambiguously aligned nucleotide sites across the Achatinidae for the ITS 2 region. Three subgenera of *Achatina* were represented in this study, namely *Achatina* (represented by *A. achatina*, *A. bisculpta*, *A. damarensis* and *A. stuhlmanni*), *Euaethiopina* (*A. loveridgei*) and *Lissachatina* (*A. fulica*, *A. immaculata*, *A. reticulata* and *A. zanzibarica*).

Table 4.1: Taxa used for the phylogenetic study of the Achatinidae. With the exception of *Achatina* (*Lissachatina*) *fulica*, *Archachatina marginata*, *Atopocochlis exarata*, *Limicolaria kambeul* and *Rumina decollata* from Wade *et al*. (2006), all other taxa were not used in previous studies and were solicited through email by myself, C. Hudelot, F. Naggs and C. Wade from the collectors shown in the table. The DNA for the five taxa used by Wade *et al.* (2006) was provided by C. Wade.

Family	Species	Collection/Location	Collector/Provider
Achatinidae	*Achatina* (*Achatina*) *achatina* (Linneaus, 1758)	Unknown (Zool. Soc. Lond. Colln.)	NHM*
	Achatina (*Achatina*) *biscultpa* Smith, 1878	Gauteng Prov., South Africa	K. du Preez
	Achatina (*Achatina*) *damarensis* (Pfeiffer, 1870)	Damaraland, Namibia	D. Herbert
	Achatina (*Achatina*) *stuhlmanni* von Martens, 1892	Semuliki National Park, Uganda	B. Rowson
	Achatina (*Lissachatina*) *fulica* Bowdich, 1822	Captive bred, unknown origin	NHM
	Achatina (*Lissachatina*) *immaculata* Lamarck, 1822	Cato Ridge, South Africa	D. Herbert
	Achatina (*Lissachatina*) *reticuata* Pfeiffer, 1845	Mkungwe Forest reserve, Uluguru Mts, Tanzania	B. Rowson
	Achatina (*Lissachatina*) *zanzibarica* Bourguignat, 1879	Lulanda Forest Reserve, Udzungwa Scarp, Tanzania	B. Rowson
	Achatina (*Euaethiopina*) *loveridgei* (Clench & Archer, 1930)	Uluguru Forest Reserve, Tanzania	B. Rowson
	Archachatina marginata (Swainson, 1821)	Purchased in Lagos Market, Nigeria	NHM
	Atopocochlis exarata (Müller, 1774)	Nr. Belem, São Thomé	A. Gascoigne
	Cochlitoma churchilliana (Melvill & Ponsonby, 1895)	KwaZulu-Natal, South Africa	D. Herbert
	Cochlitoma dimidiata (Smith, 1878)	Mpumalanga, South Africa	A. Moussalli & D. Stuart-Fox
	Cochlitoma granulata (Krauss, 1848)	KwaZulu-Natal, South Africa	A. Moussalli & D. Stuart-Fox
	Cochlitoma kilburni Mead, 2004	Eastern Cape Prov., South Africa	L. Davis & M. Bursey
	Cochlitoma marinae (Sirgel, 1989)	Mossel Bay, Eastern Cape Prov., South Africa	K. Tolly
	Cochlitoma montistempli (van Bruggen, 1965)	Cathedral Peak area, Fern Forest, South Africa	D. Herbert
	Cochlitoma omissa (van Bruggen, 1965)	Monks Cowl area, South Africa	D. Herbert
	Cochlitoma semidecussata (Pfeiffer, 1846)	Durban, Pigeon Valley Park, South Africa	A. Moussalli & D. Stuart-Fox
	Cochlitoma simplex (Smith 1878)	Colenso area, Emaweni Game Ranch, near Brakfontein, South Africa	V. Albers
	Cochlitoma sp. cf *vestita* (Pfeiffer, 1861)	KwaZulu-Natal, South Africa	D. Herbert
	Cochlitoma ustulata (Lamarck, 1822)	Western Cape Prov., South Africa	A. Moussalli & D. Stuart-Fox
	Cochlitoma varicosa (Pfeiffer, 1861)	Transkei, South Africa	J. Marais
	Cochlitoma zebra (Bruguière, 1789)	W. Cape, Witsand, South Africa	A. Moussalli & D. Stuart-Fox
	Limicolaria kambeul (Bruguiere, 1792)	Somalia (NHM collection)	M. Leng
	Limicolaria martenssii (Smith, 1880)	Bulyanbulu, Tanzania	A. Moussalli
	Limicolariopsis ruwenzoriensis Pilsbry, 1919	Rwenzori Mts, National Park, Uganda	B. Rowson
	Limicolariopsis sp.	Saimoforest, Tupen Hills, Kenya	M. Pickford
	Metachatina kraussi Pilsbry, 1904	Zululand, South Africa	D. Herbert
Subulinidae (outgroup)	*Rumina decollata* (Linneaus, 1758)	Sicily	A. Davison

*NHM-Natural History Museum

4.2.2. DNA extraction, PCR amplification and sequencing

The CTAB method of DNA extraction (Section 2.1.1 of Chapter 2, pp. 37 – 39) was used on tissue slices (approximately 8 mm^3) derived from the foot muscle of each snail. The DNA for *Achatina* (*Lissachatina*) *fulica*, *Archachatina marginata, Atopocochlis exarata, Limicolaria kambeul* and *Rumina decollata* was provided by C.M. Wade.

Amplification by PCR, gel migration and purification of PCR products from agarose gels were carried out as described in Sections 2.2 – 2.4 of Chapter 2, pp. 42 – 59. Approximately 4000 bp of the nuclear rRNA cluster (80 bp of the 5.8S rRNA, the full ITS2 and nearly the entire fragment of the LSU rRNA), 900 bp of the nuclear cytoplasmic actin gene, 328 bp of the nuclear histone 3 gene, 650 bp of the Folmer *et al.* (1994) mitochondrial COI fragment and 420-500 bp of the Palumbi *et al.* (1991) mitochondrial 16S (420-500 bp) fragment were amplified using the primers listed in Tables 2.1 – 2.5 of Chapter 2, pp. 47 – 53. Both sense and anti-sense strands were sequenced directly using an Applied Biosystems 3730 DNA sequencer and BigDye version 3.1 terminator cycle sequencing chemistry (see Section 2.6 of Chapter 2, pp. 59 – 61 for details).

4.2.3. Sequence analysis

Sequences were assembled using the STADEN package version 1.5.3 (Staden *et al*., 2000) and aligned manually within the Genetic Data Environment (GDE) Version 2.2 (Smith *et al.*, 1994). Ambiguous sites due to sequencing errors (for all genes) or the presence of multiple copies (for the actin gene) were assigned as described in Section 2.9.3 of Chapter 2, pp. 72-73 and using as a guide the three cloned sequences from representative taxa of the Achatinoidea in Chapter 3.

The average base frequencies and the numbers of variable and parsimony-informative sites for each gene fragment were determined (Section 2.9.4 of Chapter 2, p. 73). Corrected distances were computed after determination of the optimal model for DNA sequence evolution. Models evaluated by the Likelihood Ratio Test (LRT) were the JC69 (Jukes & Cantor, 1969), F81 (Felsenstein, 1981), K2P (Kimura, 1980), HKY85 (Hasegawa *et al.*, 1985), TN93 (Tamura & Nei, 1993) and the GTR (Rodriguez *et al.*, 1990) models as well as their variant that incorporated gamma distributed rates (Γ) (Yang, 1993) (Section 2.9.5 of Chapter 2, pp. 73-77). The sequences were also examined for evidence of saturation by plotting the pairwise corrected versus pairwise uncorrected distances (Plot 1), pairwise uncorrected transition and transversion distances versus pairwise uncorrected total distances (Plot 2), and pairwise uncorrected transition distances versus pairwise uncorrected transversion distances (Plot 3) (Section 2.9.6 of Chapter 2, pp. 77-81). Gene datasets that demonstrated saturation were excluded from subsequent phylogenetic analyses. The sequences were also subjected to the g1 measure of skewness test based on 10,000 tree length replicates to determine if there is phylogenetic signal (Section 2.9.7 of Chapter 2, p. 81-82). The presence of paralogous sequences in actin that could affect phylogenetic analyses was detected (Section 2.9.12 of Chapter 2, pp. 89-90) and the utility for of the actin gene for phylogenetic studies assessed (Section 2.9.13 of Chapter 2, pp. 90-91).

Phylogenetic trees were generated from the aligned datasets using the model based maximum likelihood (ML), Bayesian inference (BI) and neighbor-joining (NJ) methods and the non-model based maximum parsimony (MP) method (Section 2.9.8 of Chapter 2, pp. 82-85). Bootstrap resampling (Felsenstein, 1985) with 1000 replicates for ML, MP and NJ were also carried out. Bayesian inference (BI) was performed using four chains of a Markov Chain Monte Carlo algorithm. The number of generations to explore the tree space and the heating temperature used for each gene were optimised as described in the BI segment of Section 2.9.8 of Chapter 2, p. 83-84 and in Appendix 2.3.2, pp. 369-370. A consensus tree for each gene (where unsaturated) was constructed using the last 1000 trees.

A partition-homogeneity test (Swofford, 2002) was carried out to determine if the sequences from the different genes could be combined into one dataset (Section 2.9.10 of Chapter 2, pp. 86-88). Two sets of concatenated sequences were prepared; one set included only those taxa with complete sequences for all gene fragments while the other set included all taxa.

The Shimodaira-Hasegawa (1999) test was used to test the monophyly of taxonomic groups that were expected to be monophyletic based on taxonomy but did not cluster together in the optimal trees (Section 2.9.11 of Chapter 2, p. 89).

4.3. Results

4.3.1. Molecular data

Twenty nine achatinids and the subulinid *Rumina decollata* were examined for the nuclear rRNA cluster, actin and histone 3 genes as well as the mitochondrial 16S and cytochrome c oxidase I genes. Sequence alignments are presented in Appendices 4.1 – 4.5 on pp. 451-507. All sequences were checked for the presence of ambiguous positions in the direct sequences that might indicate the presence of multiple gene copies. (Ambiguities due to multiple gene copies were detected only in the actin gene; see Section 4.3.2.2, pp. 247-249 for details). A summary of the molecular data for all the sequences is shown in Table 4.1. For the protein-coding genes (actin, histone 3 and COI), information was obtained separately for the entire gene (all codon positions), the combined 1st and 2nd codon positions and the 3rd codon position only. Uncorrected and corrected pairwise distances and their optimal models were determined for all five genes and are likewise summarized in Table 4.2. The following models were found to be the optimal models for the different datasets: GTR+Γ for the 16S rRNA gene and the full (all codon positions) of the actin and COI genes as well as the 1st + 2nd codon position and the 3rd codon position datasets of COI and the 3rd codon position dataset of actin; TN93+Γ for the actin 1st and 2nd codon positions; TN93 for the nuclear rRNA cluster; HKY for the histone 1st and 2nd codon positions; and HKY+Γ for the histone 3 full and 3rd codon position datasets. (See Appendix 4.6, p. 508 for the summary of the LRT results).

Nearly the entire fragment of the LSU rRNA gene, the internal transcribed spacer 2 (ITS 2) and 80 nucleotides of the 5.8S rRNA gene were sequenced (approximately 4000 nucleotides) for the rRNA gene cluster, of which 3648 nucleotides (including 194 nucleotides of the ITS2) could be aligned unambiguously. A total of 105 (2.9%) variable sites was found, of which 40 were parsimony-informative. Pairwise distances across all taxa ranged from 0 to 0.014 (uncorrected) and 0 to 0.139 (corrected). *Cochlitoma montistempli* and *C. omissa* yielded identical sequences based on the 3648 unambiguously aligned sites, although variations were exhibited between these two taxa in the excluded nucleotides, particularly in the ITS2 region. The highest base frequency for the rRNA gene cluster dataset was obtained for G (0.320) followed by C (0.266), then by A (0.224) and finally by T (0.190). For the actin gene, 873 nucleotide positions were sequenced, of which all sites could be aligned unambiguously; of these, 185 (21.2%) were variable and 84 were parsimony-informative. Pairwise distances ranged from 0 to 0.147 (uncorrected) and 0 to 0.372 (corrected). Highest average base frequency for actin was computed for A (0.268) followed by T (0.257) then by C (0.254) and finally by G (0.221). Looking at the different codon positions, the majority of the variable sites (161) and parsimony-informative sites (72) were at the 3rd codon position, while the combined 1st and 2nd codon positions only had 24 variable sites and 12 parsimony-informative sites. Amplification of the actin gene for *Limicolariopsis ruwenzoriensis* was unsuccessful. For the histone 3 gene, 328 nucleotides were sequenced and aligned unambiguously, with 61 (18.6%) variable positions and 27 parsimony-informative sites. Pairwise distances ranged from 0 to 0.090 (uncorrected) and 0 to 0.148 (corrected). Five sets of identical sequences were observed for the histone 3 gene; the first set included *Achatina* (*Lissachatina*) *fulica*, *A.* (*L.*) *reticulata* and *A.* (*L.*) *zanzibarica*; the second included *Achatina* (*Achatina*) *bisculpta*, *A.* (*A.*) *damarensis* and *A.* (*A.*) *stuhlmanni*; the third included *Limicolaria kambeul* and *Limicolaria martenssii*; the fourth included *Cochlitoma dimidiata*, *C. montistempli*, *C. omissa*, *C. semidecussata*, *C. simplex* and *C. varicosa*; and the fifth included *C. kilburni* and *C.* sp. cf. *vestita*. The presence of these sets of identical sequences and the low uncorrected distances demonstrate the conserved nature of the histone 3 gene fragment at the level of the Achatinidae. Average base frequencies for histone 3, in decreasing order, were as follows: C (0.320); G (0.275); A (0.243) and T (0.162). As with the actin gene, the 3rd codon position exhibited the most number of variable sites (57) as well as parsimony-informative sites (26) in comparison to the combined 1st and 2nd codon positions with only 4 and 1, respectively. Amplification of the histone 3 gene fragment for *Achatina* (*Euaethiopina*) *loveridgei* and *Limicolariopsis ruwenzoriensis* was unsuccessful. For the mitochondrial COI gene, approximately 650 nucleotides were sequenced, with the length varying depending on the primers used. A total of 641 unambiguously aligned nucleotides were used, of which 293 (45.7%) were variable and 276 were parsimony-informative. Pairwise distances ranged from 0.067 to 0.264 (uncorrected) and 0.211 to 11.856 (corrected), making the COI gene fragment more variable than the nuclear genes above. No two sequences were found alike, and the smallest uncorrected distance is 0.067, way above the 0.03 sequence divergence threshold for any two species set by Hebert *et al.* (2003) for the COI.

Average base frequencies, in decreasing order, were as follows: T (0.376); A (0.239); G (0.204) and C (0.180), indicating a strong bias for T; this was heightened in the 3rd codon position where average frequency of T rose to 0.404. The 3rd codon position had 214 variable sites and 212 parsimony-informative sites, whereas the combined 1st and 2nd codon positions only had 79 and 64, respectively. Note that sequencing was unsuccessful for *A.* (*E.*) *loveridgei* and *Limicolariopsis ruwenzoriensis.* The mitochondrial 16S rRNA gene product ranged from 420-500 nucleotides, with 310 that were unambiguously aligned, 147 (47.4%) that were variable, and 110 that were parsimony-informative. Pairwise distances ranged from 0.019 to 0.242 (uncorrected) and 0.021 and 0.837 (corrected); thus, the gene is likewise more variable than the nuclear genes. As with the COI, no two sequences were found alike. Base frequencies were as follows: T (0.285); A (0.277); G (0.247) and C (0.191), showing bias for A and T. Sequencing of the 16S rRNA gene fragment for *L. ruwenzoriensis* was unsuccessful.

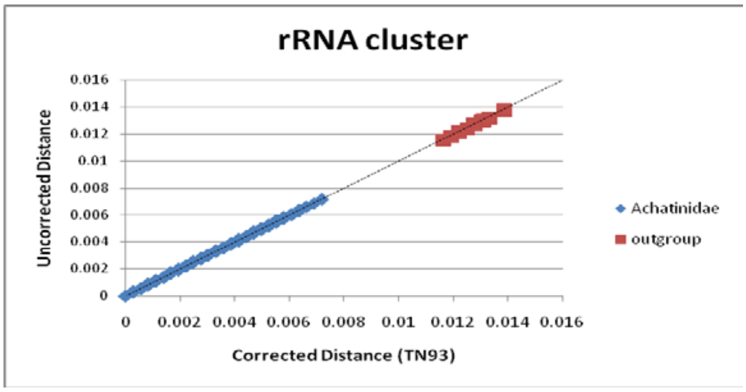
Table 4.2: Summary of molecular data across all genes used (rRNA gene cluster, actin, histone 3, COI and 16S) for the Achatinidae and the subulinid outgroup *Rumina decollata*. A=Achatinidae only; A+O=Achatinidae and outgroup.

	Length (bp)	# of variable sites (%)		Range of distances (Uncorrected)		Optimal Model (α value for Γ distribution)	Range of distances (Corrected)		Average base frequencies								# of parsimony-informative sites	
									A		C		G		T			
		A	A+O	A	A+O		A	A+O	A	A+O	A	A+O	A	A+O	A	A+O	A	A+O
rRNA cluster	3648	77 (2.1)	105 (2.9)	0-0.007	0-0.014	TN93 (N/A)	0-0.007	0-0.139	0.224	0.224	0.266	0.266	0.320	0.320	0.190	0.190	37	40
Actin combined	873	176 (20.2)	185 (21.2)	0-0.147	0-0.147	GTR+Γ (0.175)	0-0.372	0-0.372	0.268	0.268	0.254	0.254	0.221	0.221	0.257	0.257	71	84
Actin 1st and 2nd codon positions	582	23 (4.0)	24 (4.1)	0-0.031	0-0.031	TN93+Γ (0.043)	0-0.053	0-0.053	0.311	0.311	0.229	0.229	0.227	0.227	0.233	0.233	11	12
Actin 3rd codon position	291	153 (52.6)	161 (55.3)	0-0.628	0-0.384	GTR+Γ (0.686)	0-0.628	0-0.628	0.180	0.179	0.303	0.304	0.211	0.211	0.306	0.306	60	72
Histone3 combined	328	53 (16.2)	61 (18.6)	0-0.090	0-0.090	HKY85+Γ (0.256)	0-0.148	0-0.148	0.243	0.243	0.320	0.320	0.275	0.275	0.162	0.162	22	27
Histone 3 1st and 2nd codon positions	218	4 (1.8)	4 (1.8)	0-0.019	0-0.019	HKY85 (N/A)	0-0.019	0-0.019	0.288	0.288	0.285	0.285	0.261	0.261	0.166	0.166	1	1
Histone 3 3rd codon positions	110	49 (44.5)	57 (51.8)	0-0.280	0-0.280	HKY85+Γ (2.967)	0-0.460	0-0.460	0.150	0.151	0.392	0.391	0.305	0.305	0.154	0.154	21	26
COI combined	641	292 (40.9)	293 (45.7)	0.067-0.264	0.067-0.264	GTR+Γ (0.106)	0.211- 11.856	0.211-11.856	0.239	0.239	0.181	0.180	0.205	0.204	0.376	0.376	275	276
COI 1st and 2nd codon positions	427	78 (18.3)	79 (18.5)	0.007-0.098	0.007-0.098	GTR+Γ (0.072)	0.008- 0.389	0.008- 0.389	0.197	0.197	0.204	0.204	0.236	0.236	0.362	0.362	63	64
COI 3rd codon positions	214	214 (100)	214 (100)	0.164-0.625	0.164-0.625	GTR+Γ (0.659)	1.304-120.141	1.304-120.141	0.321	0.323	0.134	0.133	0.142	0.140	0.403	0.404	212	212
16S rRNA	310	145 (46.8)	147 (47.4)	0.019-0.242	0.019-0.242	GTR+Γ (0.250)	0.021- 0.837	0.021- 0.837	0.277	0.277	0.191	0.191	0.247	0.247	0.285	0.285	107	110

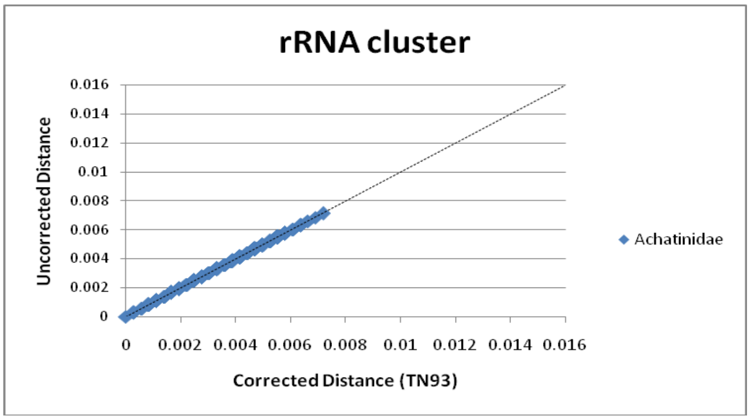
4.3.2. Sequence analyses

4.3.2.1. Evaluating for saturation and phylogenetic signal

For the rRNA cluster, the uncorrected versus corrected distances plots (Plot 1, Figure 4.4) demonstrated a linear relationship between the corrected distance (based on the optimal TN93 model) and the uncorrected (*p*) distance. This suggested that the dataset for the rRNA cluster was not saturated and that the TN93 model was adequate for correcting the distances for multiple hits.



(A)



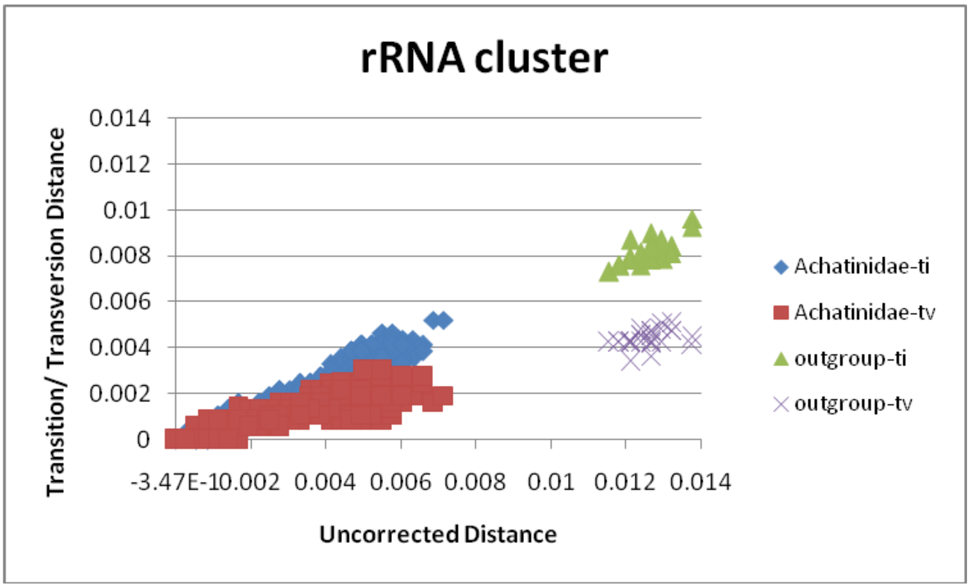
(B)

Figure 4.4: Plots of pairwise uncorrected distance against corrected (TN93) distance for the rRNA cluster in (A) the Achatinidae and the subulinid outgroup *Rumina decollata* and (B) the Achatinidae only.

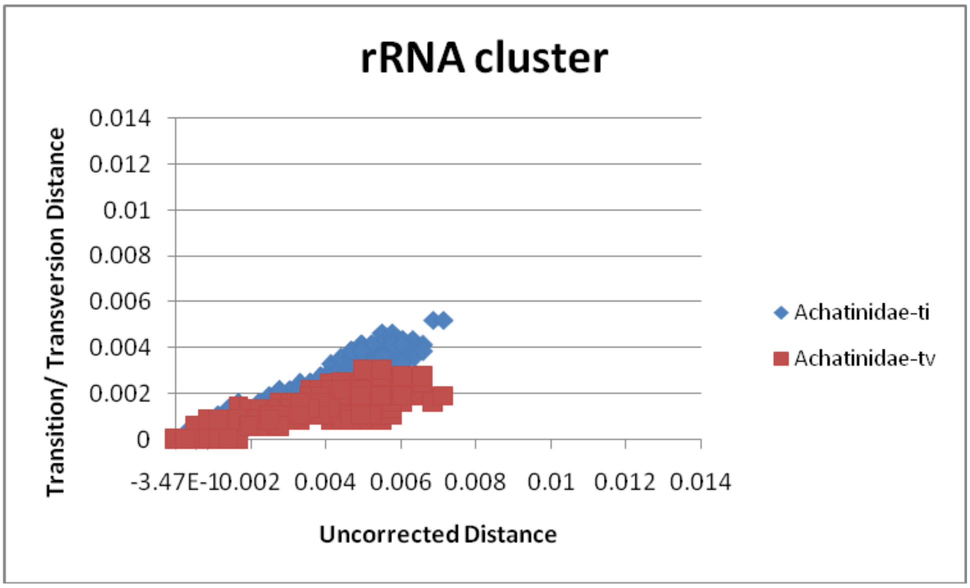
Plots for the transition and transversion rates versus uncorrected distances both with and without the outgroup taxon (Plot 2, Figure 4.5) showed that both transition and transversion substitutions were increasing linearly with transition distances higher than transversion distances. Plots for transitions against transversions both with and without the outgroup taxon (Plot 3, Figure 4.6) confirmed the results of Plot 2 where transition rates were higher than transversion rates. The results suggested that the rRNA cluster dataset was not saturated.

A g1 value of -0.596 was obtained for the rRNA cluster with 10,000 replicates based on 30 taxa and 40 parsimony-informative characters. This value differed significantly from the critical g1 value of -0.16 at $P=0.05$ level of significance for 25 taxa and 10 parsimony-informative characters (Hillis & Huelsenbeck, 1992). This result was indicative of a strong phylogenetic signal.

The absence of saturation and the presence of phylogenetic signal implied that the rRNA cluster was suitable for phylogenetic analyses of the Achatinidae.

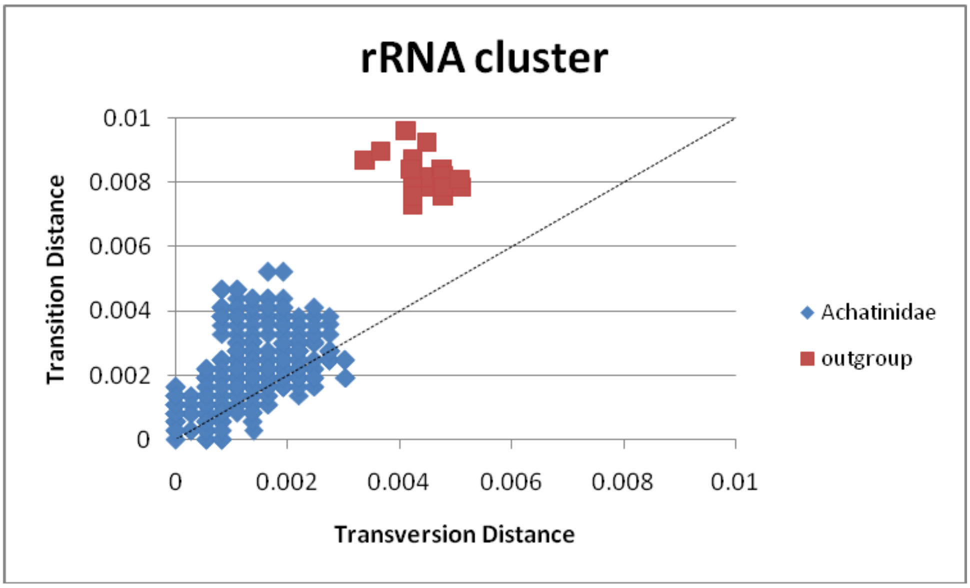


(A)

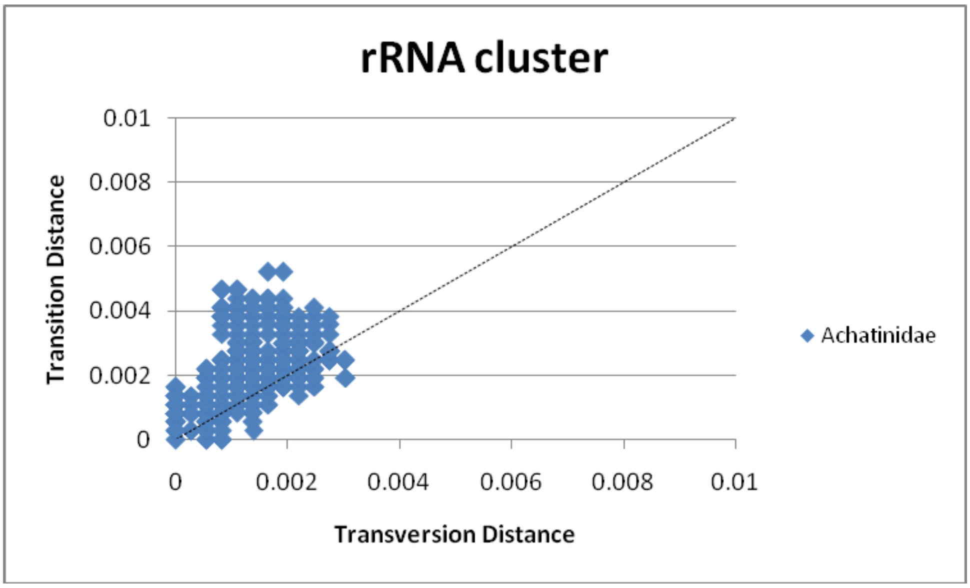


(B)

Figure 4.5: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the rRNA cluster in (A) the Achatinidae and the subulinid outgroup *Rumina decollata* and (B) the Achatinidae only.



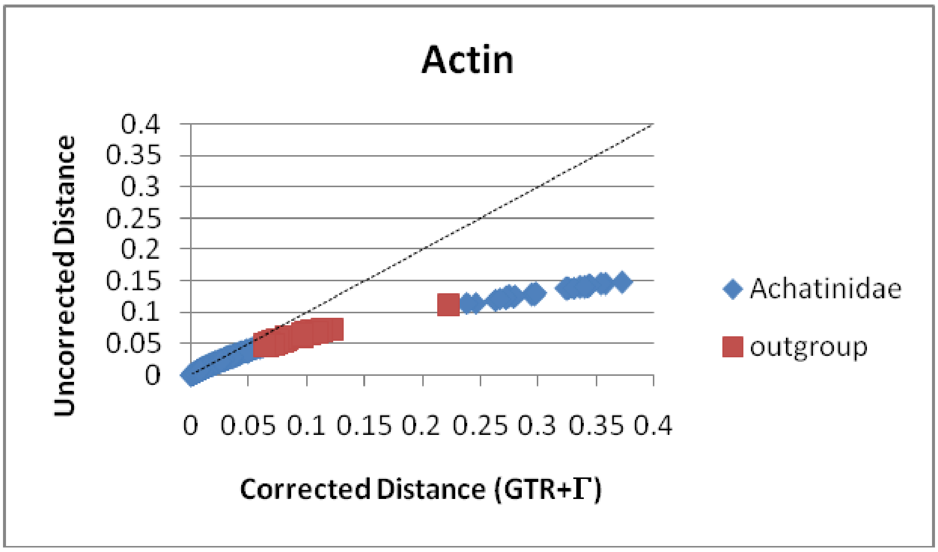
(A)



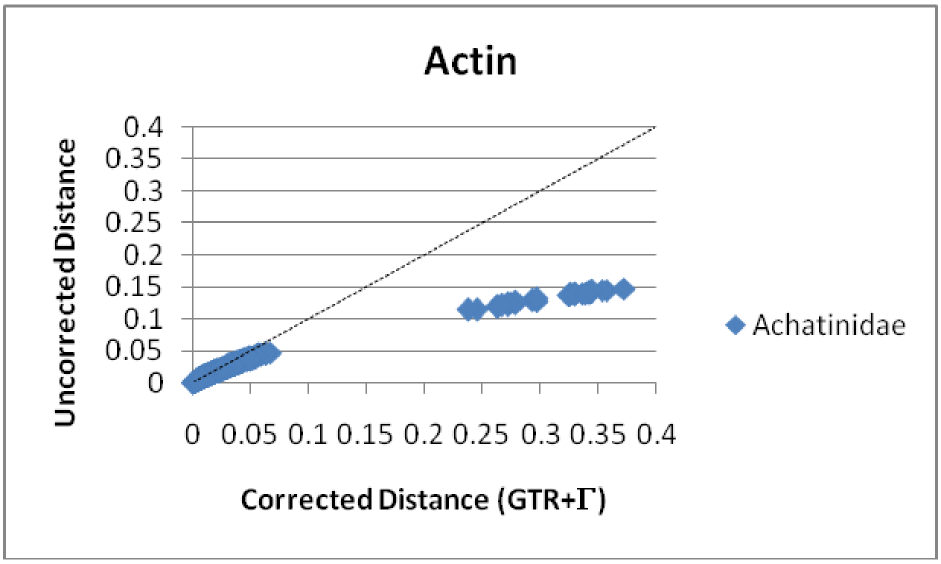
(B)

Figure 4.6: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances for the rRNA cluster in (A) the Achatinidae and the subulinid outgroup *Rumina decollata* and (B) the Achatinidae only.

For the actin gene, Plot 1 (Figure 4.7) demonstrated that the corrected distance, based on the optimal GTR+Γ model, deviated from linearity starting at an uncorrected (*p*) distance of approximately 0.05 for both the Achatinidae only and the Achatinidae plus outgroup taxon. A big gap was also shown in both plots; the points that came after the gap were attributed to the distance between the actin copy of *Cochlitoma marinae* and those of the other taxa. The presence of this highly divergent actin copy and its implications in the phylogenetic analysis of the Achatinidae using actin is discussed further in Section 4.3.2.2, pp. 247-249. Both plots were still increasing and had not reached a plateau, suggesting adequate correction of the optimal GTR+Γ model and no saturation in the dataset.



(**A**)



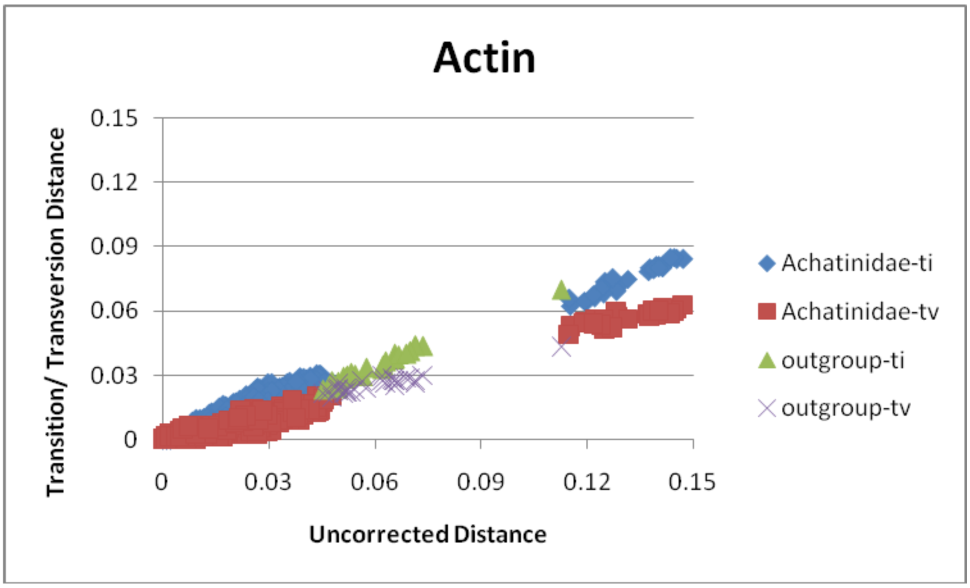
(**B**)

Figure 4.7: Plots of pairwise uncorrected distance against corrected distance for the actin gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only. Points after the gap were attributed to the divergent actin sequence of *Cochlitoma marinae*.

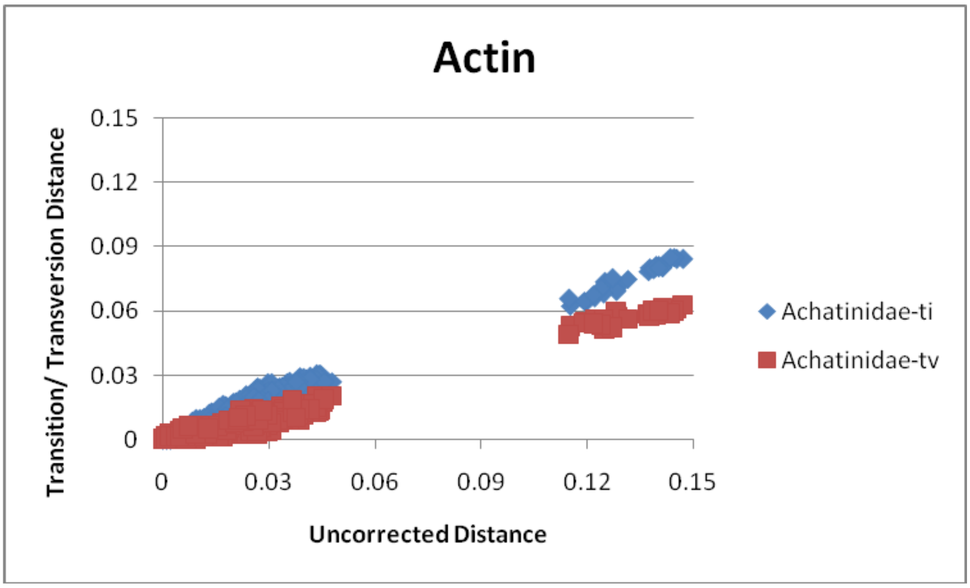
Plot 2 (Figure 4.8) for the actin gene, whether with or without outgroup taxa, exhibited a linear increase for both transitions and transversions, with transition distances higher than transversion distances. Plot 3 (Figure 4.9) confirmed the higher transition rates over the transversion rates. These results suggested that the actin gene was not saturated. Once again, a gap was observed in both plots due to the highly divergent *Cochlitoma marinae*.

A g1 value of -0.475 was computed for the actin gene based on 29 taxa and 84 parsimony-informative sites, much lower than the critical value of -0.12 at p=0.05 level of significance for 25 taxa and 50 parsimony-informative characters (Hillis & Huelsenbeck, 1992). The actin gene therefore exhibited strong phylogenetic signal.

Lack of saturation and the presence of phylogenetic signal implied that the actin gene was suitable for phylogenetic analyses of the Achatinidae and the outgroup taxon. However, the observed gap in the plots due to the highly divergent sequence of *Cochlitoma marinae* suggested caution must be exercised in using this gene in phylogenetic analyses. These issues are discussed in section 4.3.2.2, pp. 247-249.

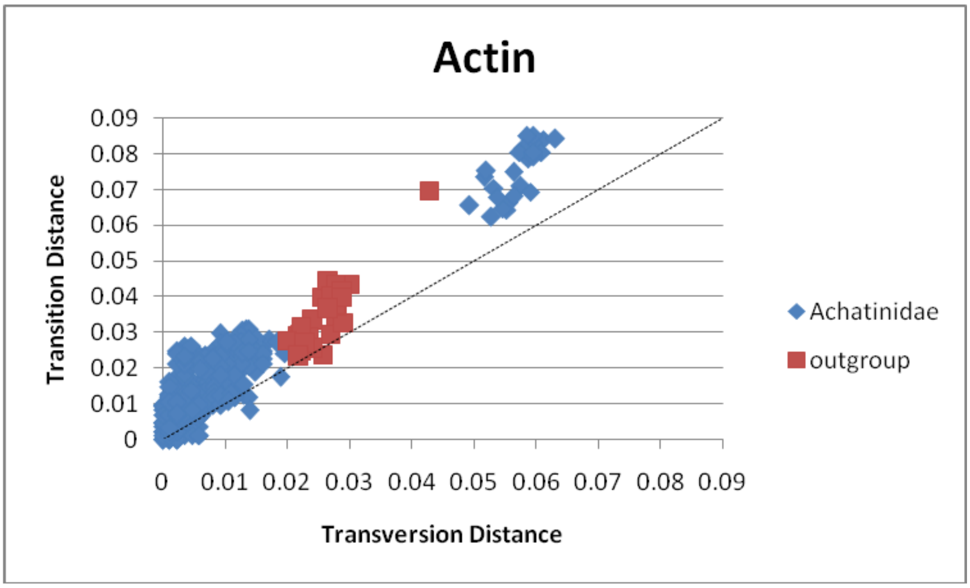


(**A**)

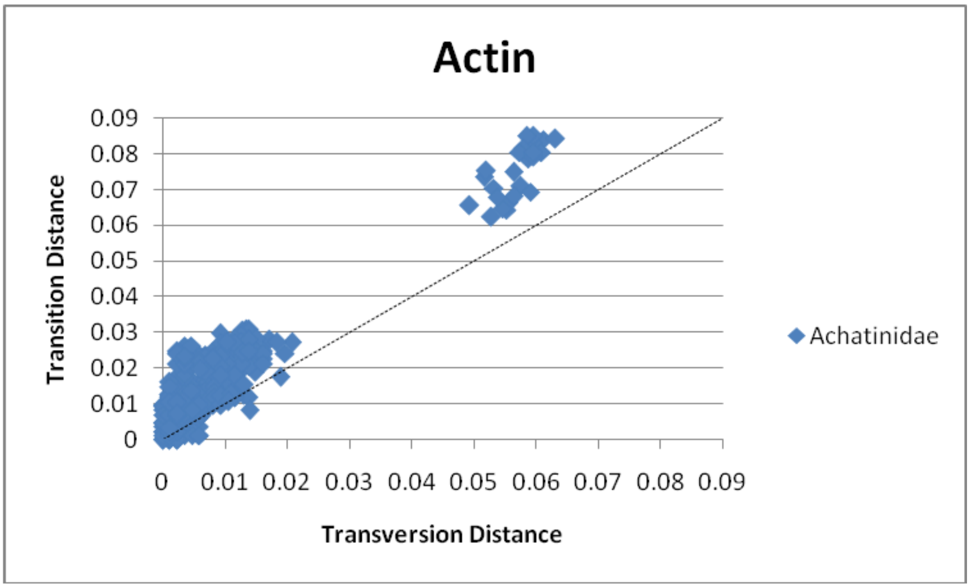


(**B**)

Figure 4.8: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the actin in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only. Points after the gap were attributed to the divergent actin sequence of *Cochlitoma marinae*.



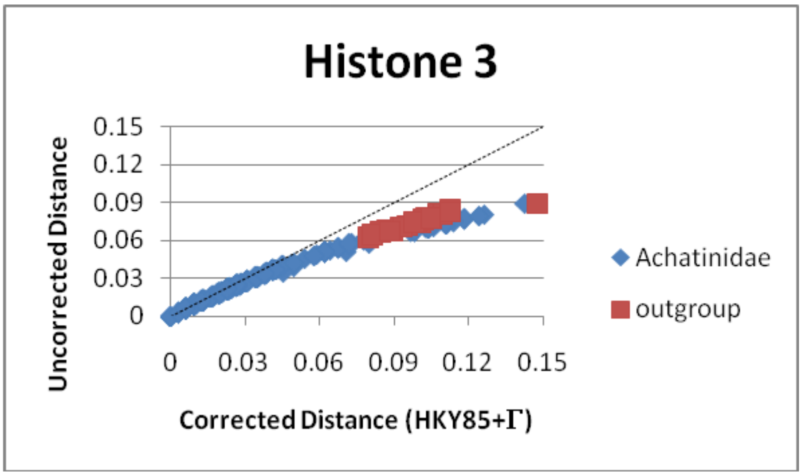
(**A**)



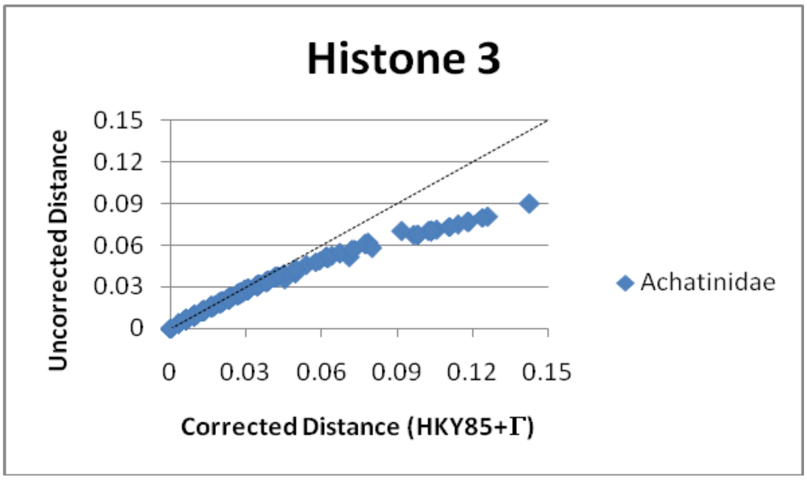
(**B**)

Figure 4.9: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances for the actin gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only. Points after the gap were attributed to the divergent actin sequence of *Cochlitoma marinae*.

For the histone 3 gene, Plot 1 (Figure 4.10) revealed a curve for the corrected distances using the optimal GTR+Γ model, with the deviation from a linear increase beginning at an uncorrected (*p*) distance of approximately 0.03 for both the Achatinidae only and including the subulinid outgroup taxon. Both plots were still increasing and had not reached a plateau, implying that the histone 3 had not reached saturation.



(**A**)

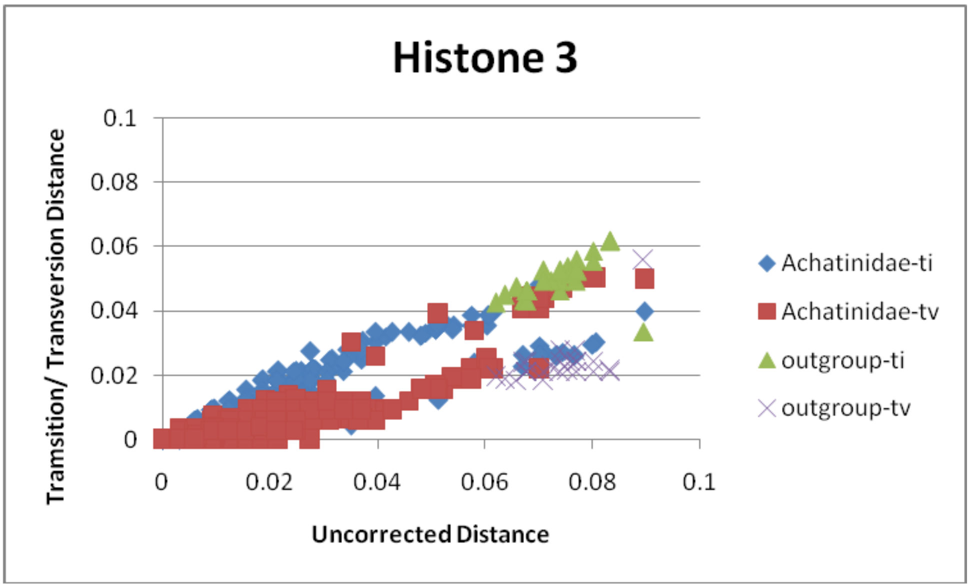


(**B**)

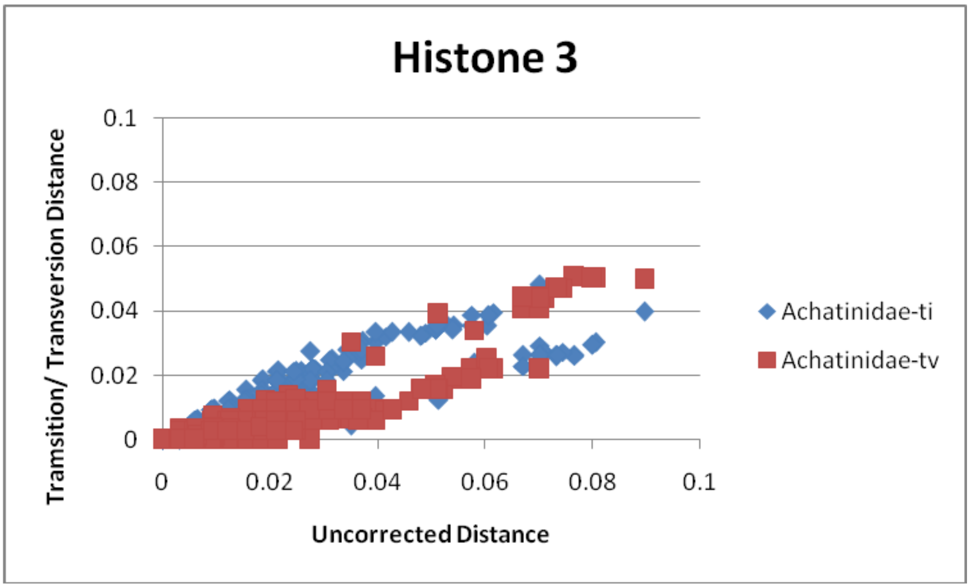
Figure 4.10: Plots of pairwise uncorrected distance versus corrected (GTR+Γ) distance for the histone 3 gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only.

For plot 2, transitions and transversions were increasing and did not curve for both the Achatinidae only and including the outgroup taxon. Transitions were also generally higher than transversions. However, both the transition and transversion lines appeared to each form two separate lines beginning at approximately 0.035 uncorrected distance in both plots (Figure 4.11). Plot 3 (Figure 4.12) supported the observations from Plot 2, with several pairwise comparisons exhibiting higher transversions than transitions.

The g1 value for the histone 3 gene based on 28 taxa and 27 parsimony-informative sites was -0.900, significantly smaller than the critical value of -0.16 based on 25 taxa and 10 parsimony-informative sites. The histone 3 gene therefore exhibited phylogenetic signal.

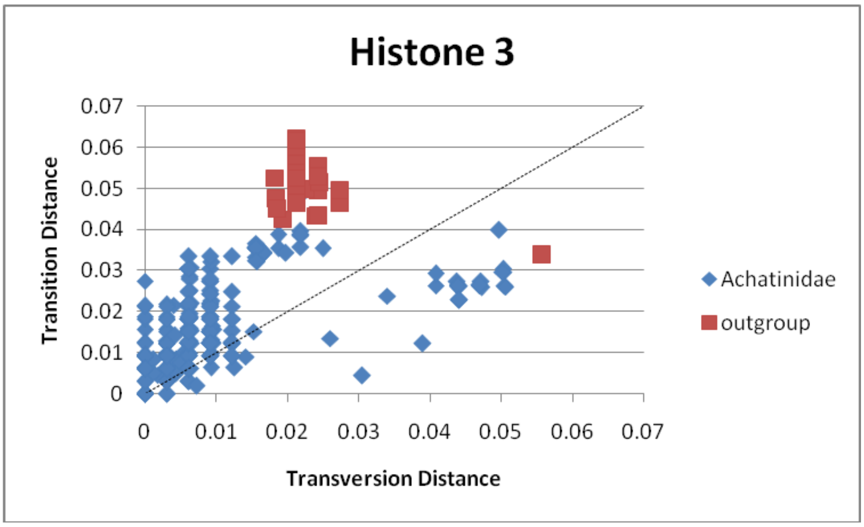


(**A**)

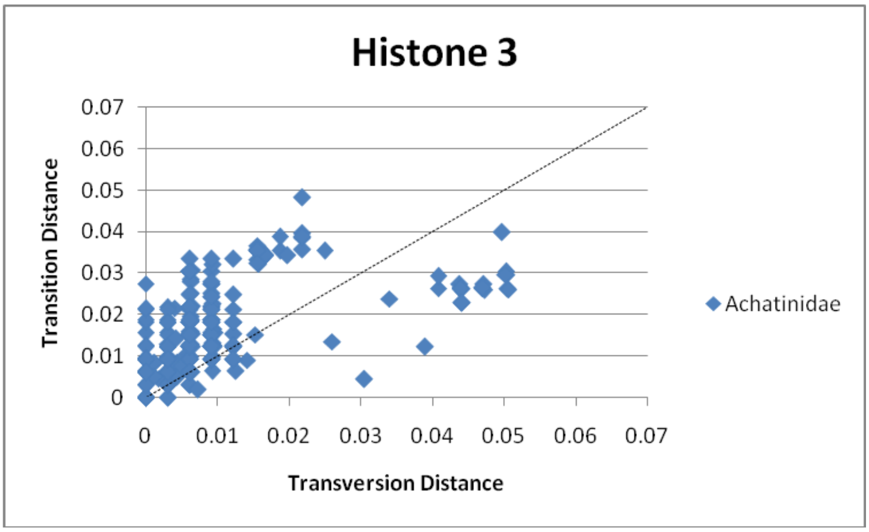


(**B**)

Figure 4.11: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the histone 3 gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only.



(A)

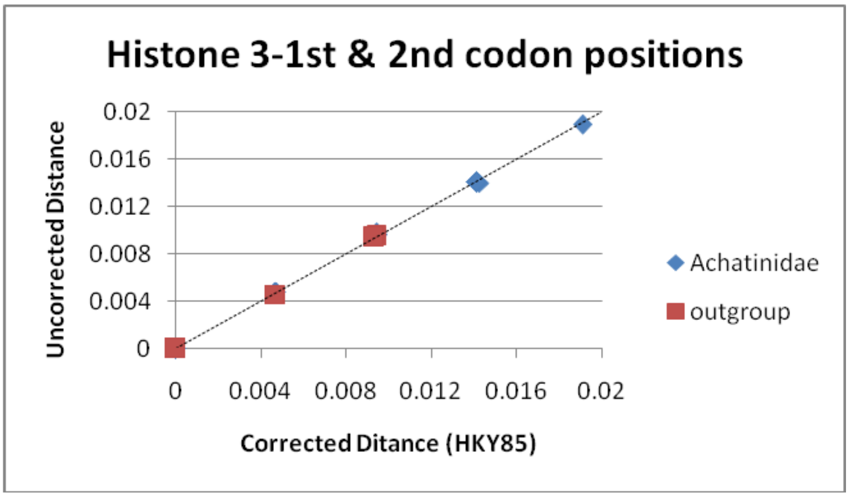


(B)

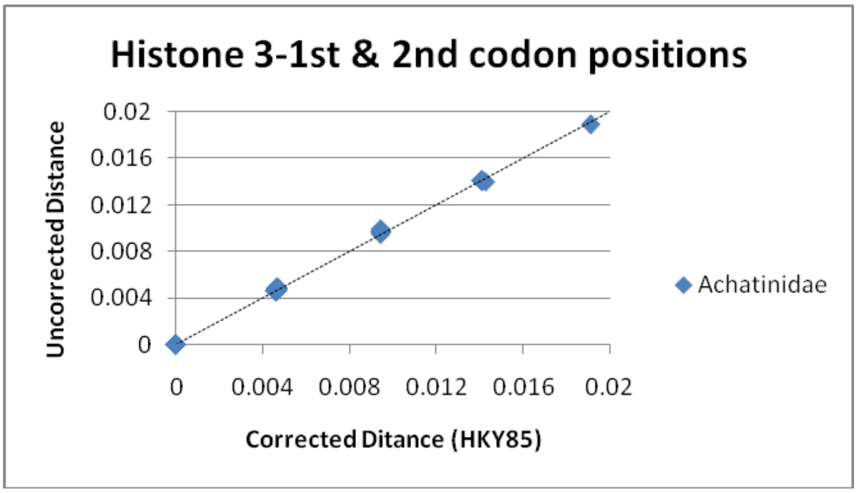
Figure 4.12: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances for the histone 3 gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only.

To account for the distinct lines that separated from the main transition and transversion lines observed in Figure 4.9, to determine if these observations were restricted to the 3rd codon positions, and whether such observations could be associated with saturation, separate plots were made for the combined 1st and 2nd codon positions as well as the 3rd codon positions.

For the 1st and 2nd codon positions, Plot 1 (Figure 4.13) showed a direct relationship between the corrected distances based on the optimal HKY85 model and the uncorrected distances, signifying adequate correction of the model and the absence of saturation. Note, however, that the distances were computed based only on four variable sites.



(A)

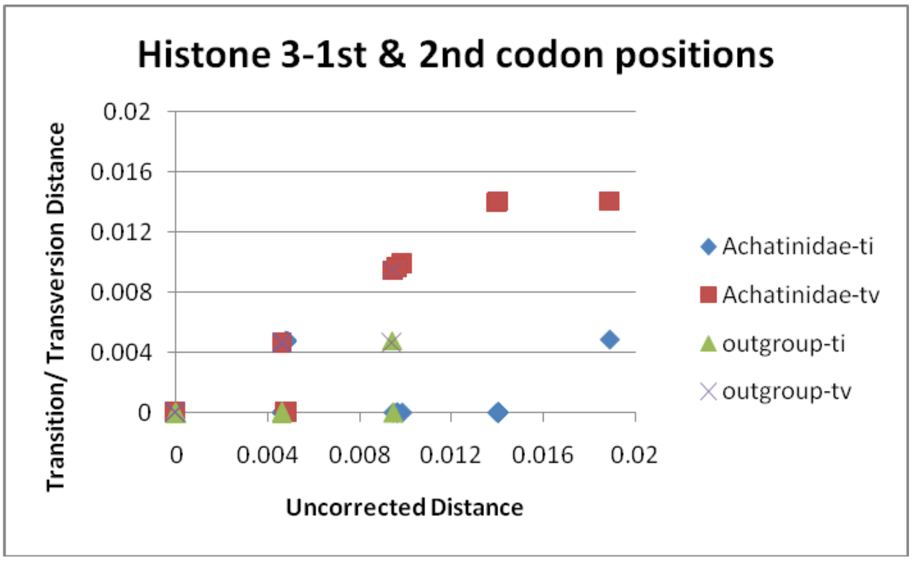


(B)

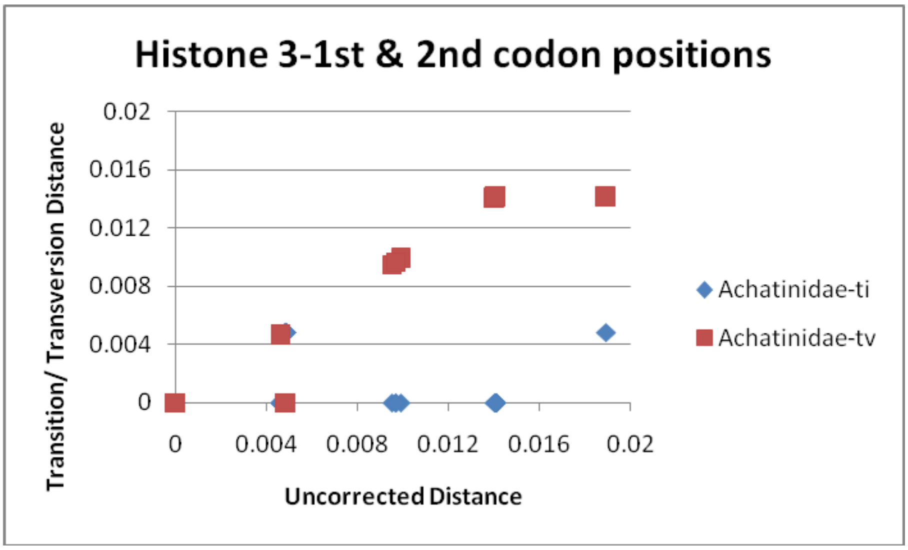
Figure 4.13: Plots of pairwise uncorrected distance versus corrected (HKY85) distance for the 1st and 2nd codon positions of the histone 3 gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only.

For Plot 2 (Figure 4.14), transversion distances overtook the transition distances, and this was also evident in Plot 3 (Figure 4.15) where there were more transversions than transitions. However, the limited number of variable sites in the 1st and 2nd codon positions made it difficult to assess the presence of saturation through the curving of the plots.

The g1 value for the 1st and 2nd codon positions of histone 3 gene based on 28 taxa and one parsimony-informative site was -0.204. No critical value was available for 25 taxa and at least 2 parsimony-informative sites. The presence of phylogenetic signal could not be assessed based on one parsimony-informative site.

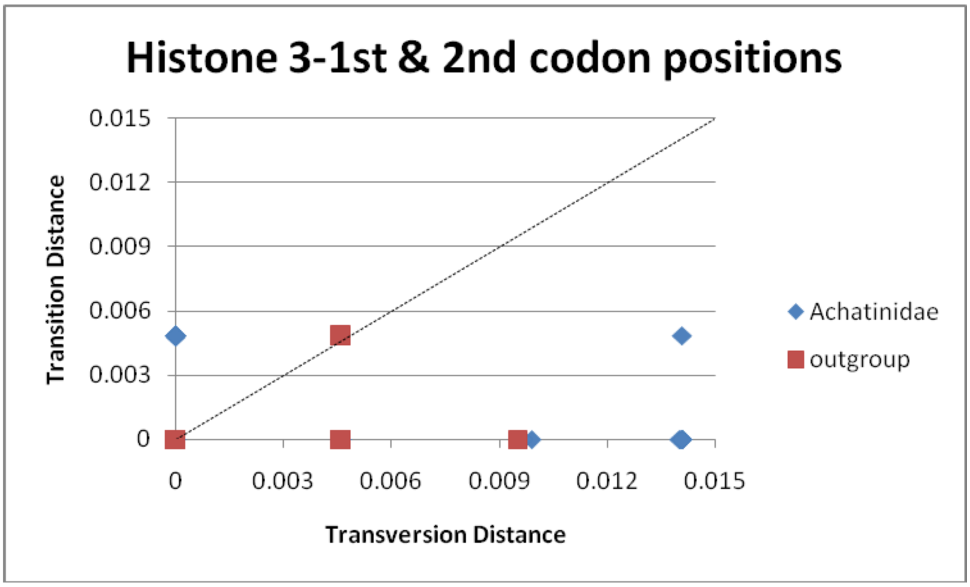


(A)

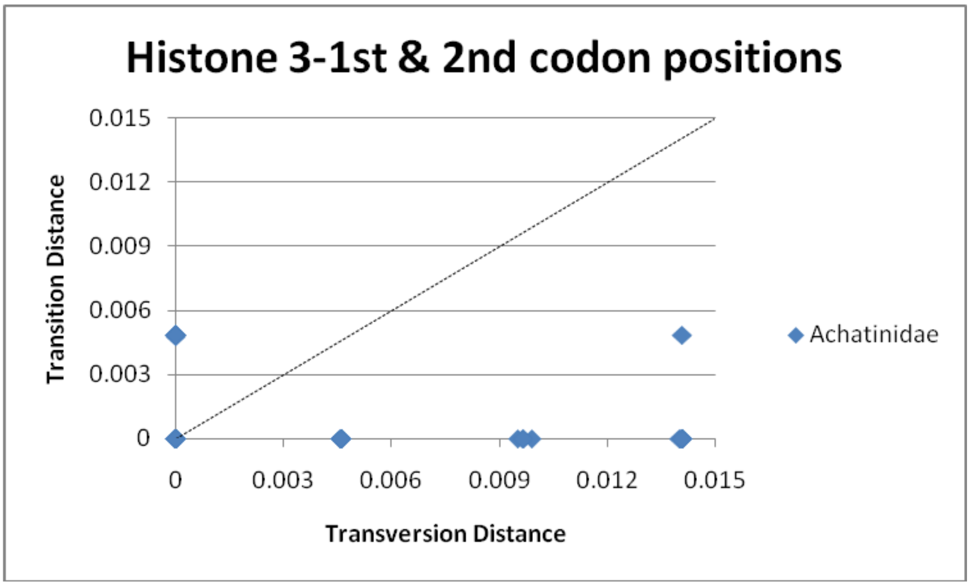


(B)

Figure 4.14: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the 1st and 2nd codon positions of the histone 3 gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only.



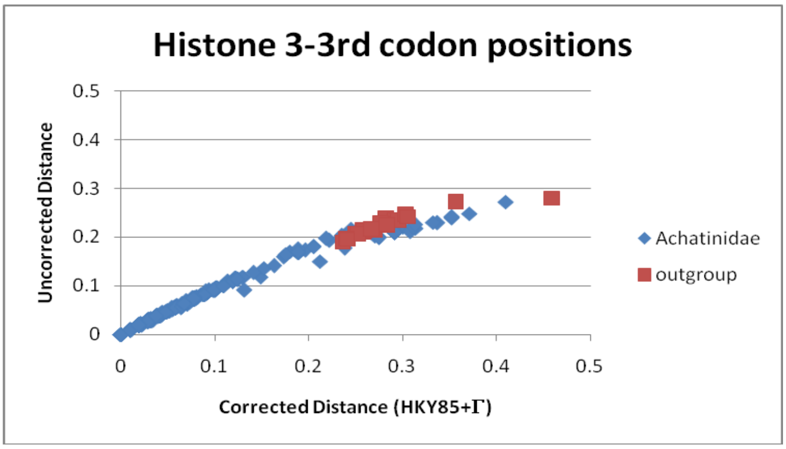
(A)



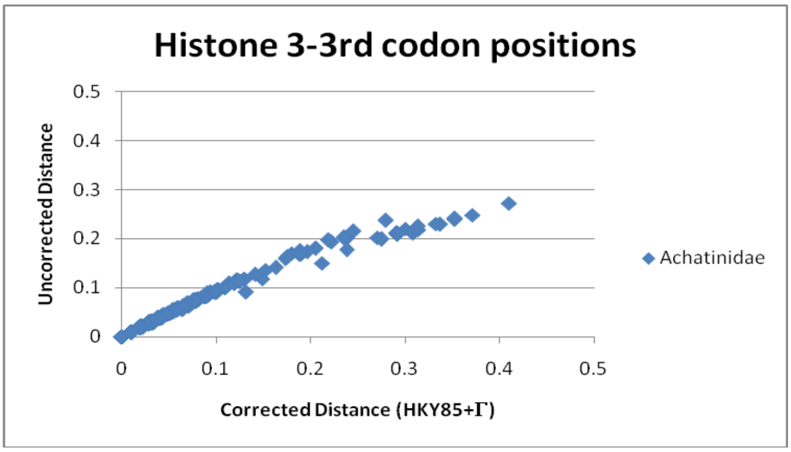
(B)

Figure 4.15: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances for the 1st and 2nd codon positions of the histone 3 gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only.

For the 3rd codon position of the histone 3 gene, Plot 1 (Figure 4.16) showed the corrected distances based on the optimal model HKY85+Γ to be increasing but deviating from linearity at an uncorrected (*p*) distance of approximately 0.14. However, both plots showed an umistakable second line starting at 0.13 corrected distance. This second line was attributed to the divergent sequence exhibited by *Archachatina marginata* as supported by the fact that the second line disappeared when *A. marginata* was removed from the plots (see Figure 4.16C). Nevertheless, no plateau was observed, suggesting that adequate correction was made by the optimal model and that the 3rd codon position was not saturated.



(A)



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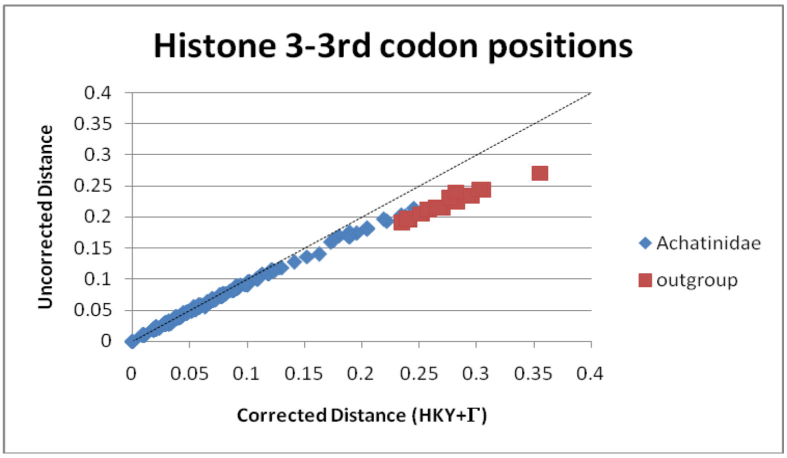
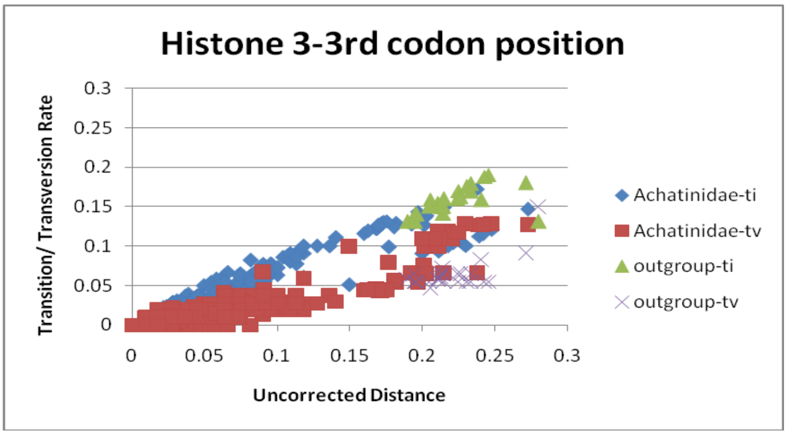


(C)

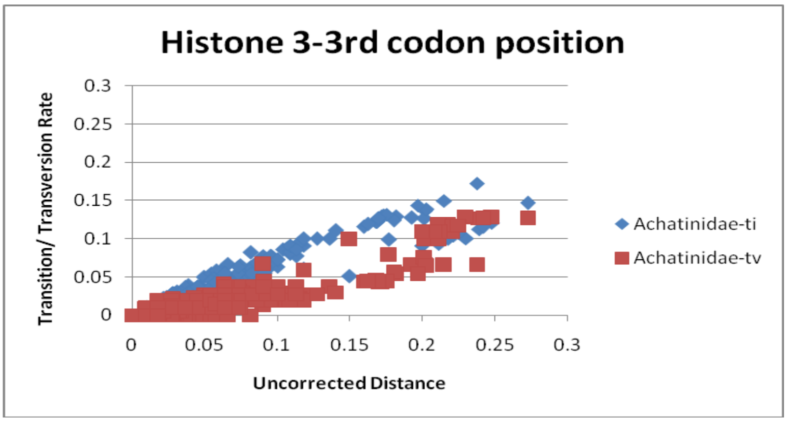
Figure 4.16: Plots of pairwise uncorrected distance versus corrected (HKY85+Γ) distance for the 3rd codon position of the histone 3 gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata*; (**B**) the Achatinidae only; and (**C**) Achatinidae and subulinid outgroup *Rumina decollata* but without *Archachatina marginata*.

For Plot 2 (Figure 4.17), the same observations were seen as in Figure 4.11 where both the transition and transversion lines each formed a distinct line beginning at approximately 0.09 uncorrected distance and resulting in a separate transversion line that was higher than the separate transition line in both the Achatinidae only and with the outgroup taxon. These separate lines were attributed to the divergent sequence of *Archachatina marginata*. When this sequence was excluded from the plots (see Figure 4.17C), it became clear that both the transition and transversion lines were increasing with no curving evident. Plot 3 (Figure 4.18) also showed majority of the pairwise comparisons with higher transitions than transversions. Those points with higher transversions than transitions involved *A. marginata* as these points dissappeared when *A. marginata* was excluded from the plot (see Figure 4.18C). These results indicated that the 3rd codon position was not saturated.

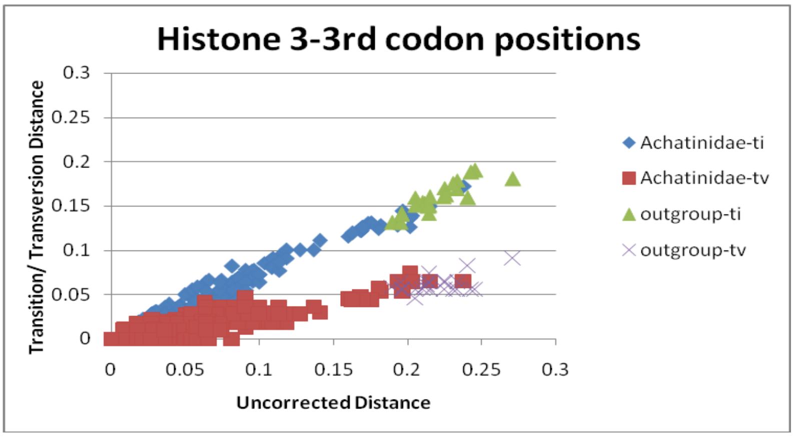
The g1 value for the 3rd codon position of the histone 3 gene based on 28 taxa and 26 parsimony-informative sites was -0.886, which was significantly smaller than the critical value of -0.16 based on 25 taxa and 10 parsimony-informative sites. The 3rd codon position of the histone 3 gene therefore exhibited phylogenetic signal.



(A)

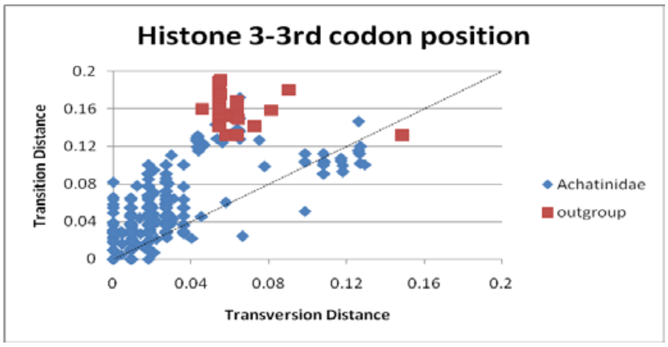


(B)

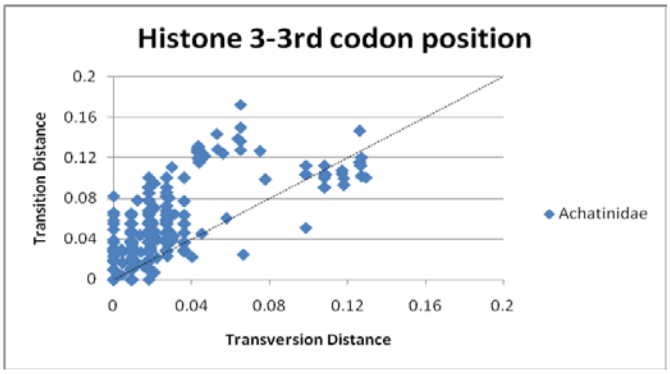


(C)

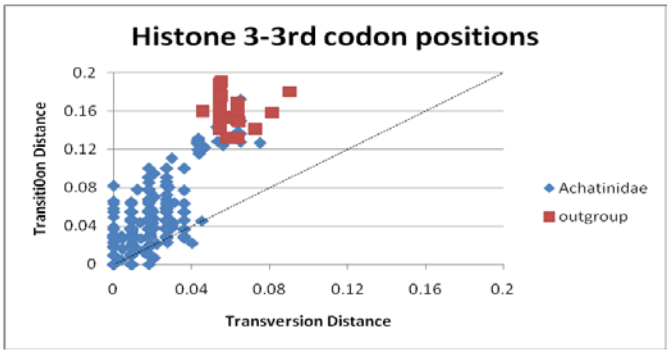
Figure 4.17: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the 3rd codon position of the histone 3 gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata*; (**B**) the Achatinidae only; and (**C**) the Achatinidae and the subulinid outgroup *Rumina decollata* but excluding *Archachatina marginata*.



(A)



(B)

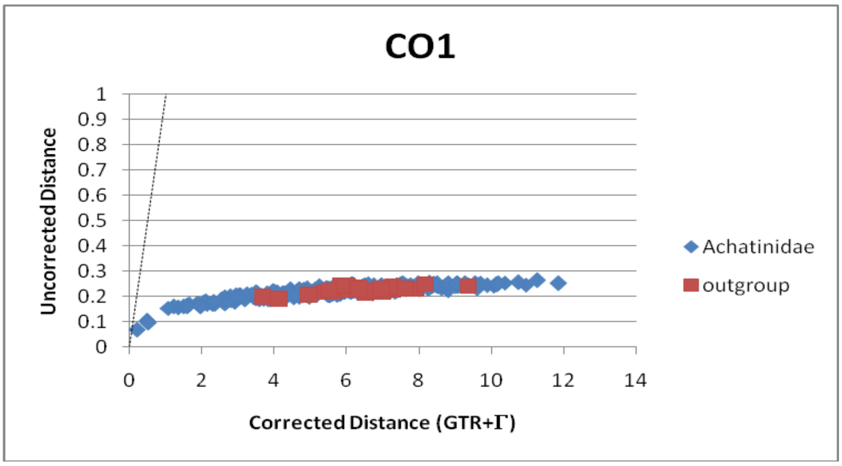


(C)

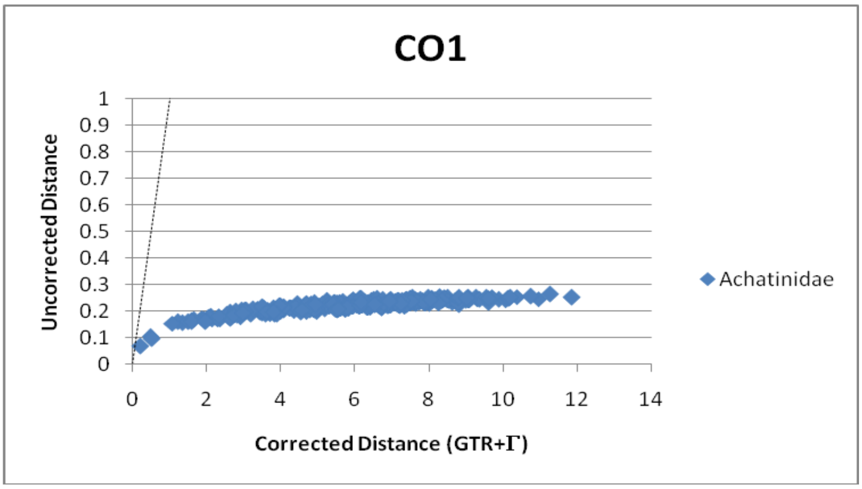
Figure 4.18: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances for the 3rd codon position of the histone 3 gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata*; (**B**) the Achatinidae only; and (**C**) the Achatinidae and the subulinid outgroup *Rumina decollata* but excluding *Archachatina marginata*.

The findings suggested that the entire histone 3 dataset could be employed for the phylogenetic analyses of the Achatinidae, although the divergent sequence of *Archachatina marginata* should be taken into account when interpreting the trees.

For the COI gene, Plot 1 (Figure 4.19) yielded an almost horizontal trend for all taxa and for the Achatinidae only. This, along with corrected distances of up to 12, indicated severe saturation for the COI gene and the optimal GTR+Γ model was unable to correct the dataset for multiple hits.



(A)

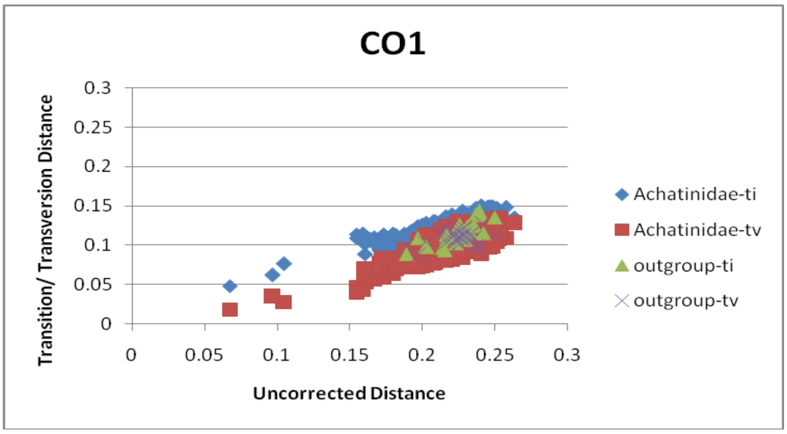


(B)

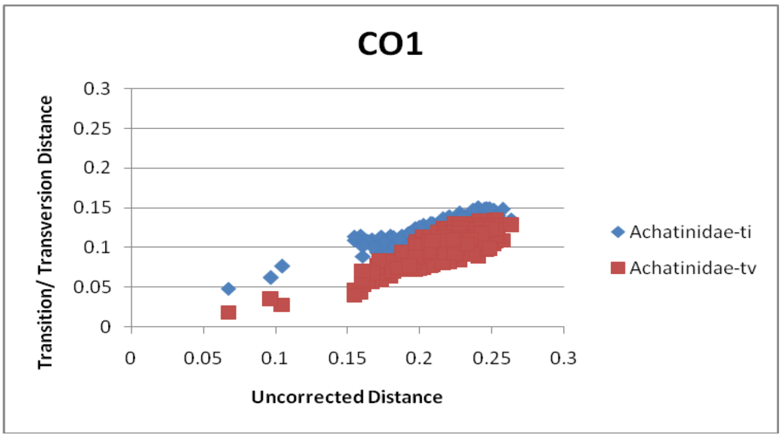
Figure 4.19: Plots of pairwise uncorrected distance against corrected distance for the COI gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only.

Plot 2 (Figure 4.20) for all taxa as well as the Achatinidae only revealed transversions overlapping with transitions. Plot 3 (Figure 4.21) showed approximately a quarter of all pairwise distances showing transversions that were higher than transitions.

The g1 test score for the COI gene based on 28 taxa and 276 parsimony-informative sites was -0.507, significantly smaller than the critical value of -0.08 for 25 taxa and 250 parsimony-informative sites. The g1 test suggested some phylogenetic information could be generated from the dataset.

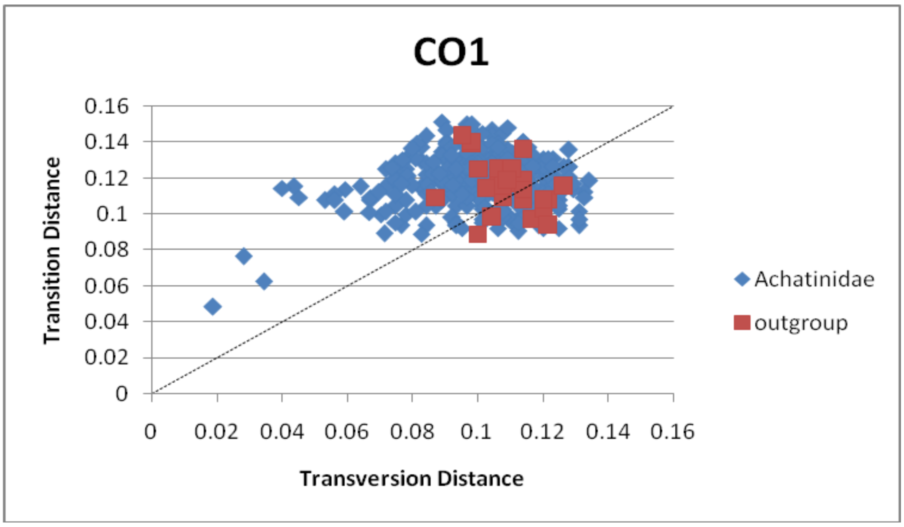


(**A**)

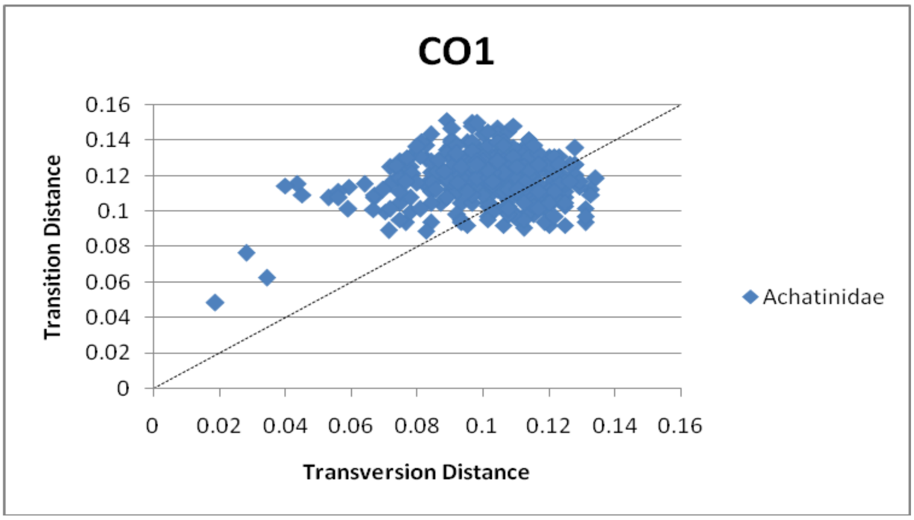


(**B**)

Figure 4.20: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the COI gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only.



(**A**)

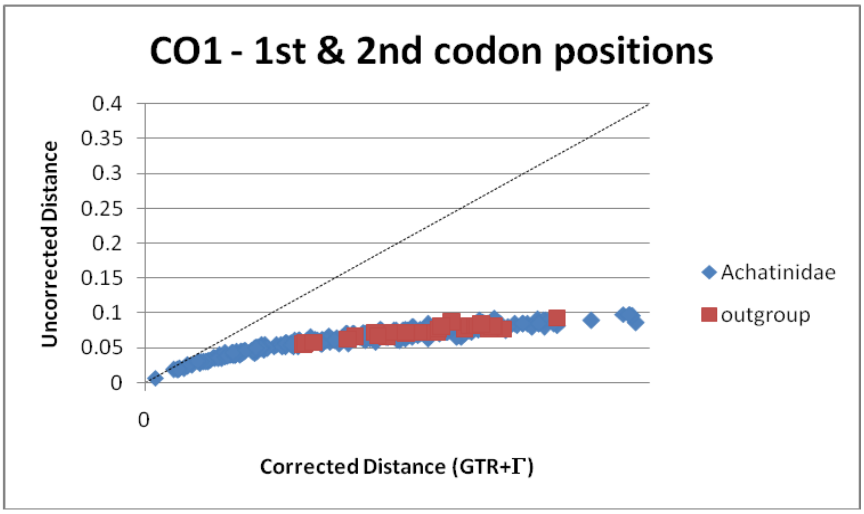


(**B**)

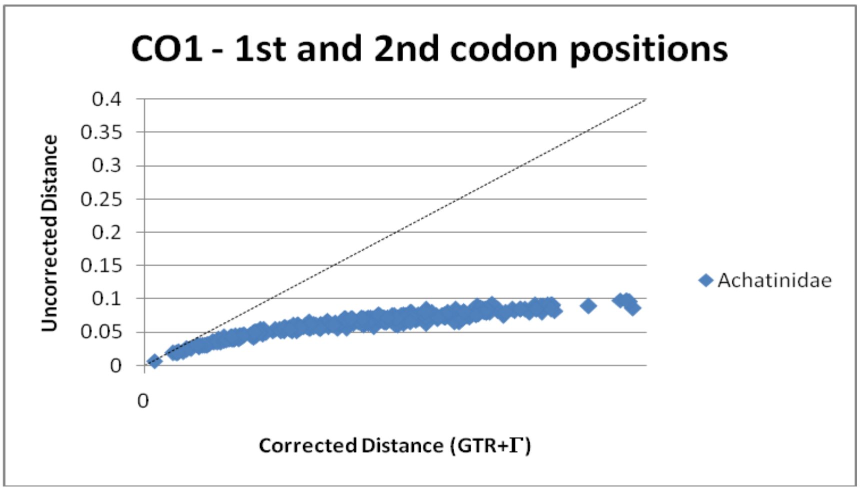
Figure 4.21: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances for the COI gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only.

Despite the presence of phylogenetic signal, the problem of saturation remained as shown in Plot 1. In order to evaluate whether saturation of the COI gene was restricted to 3rd codon positions, the combined 1st and 2nd codon positions and the 3rd codon positions were evaluated separately.

For the 1st and 2nd codon positions of the COI gene, Plot 1 (Figure 4.22) revealed a curve for the corrected distances using the optimal GTR+Γ model, with the deviation from linearity beginning at an uncorrected (*p*) distance of approximately 0.03 for both the Achatinidae only and including the outgroup taxon. The plots were still increasing slightly and had not reached a plateau, implying that the 1st and 2nd codon positions of COI had not yet reached saturation.



(**A**)

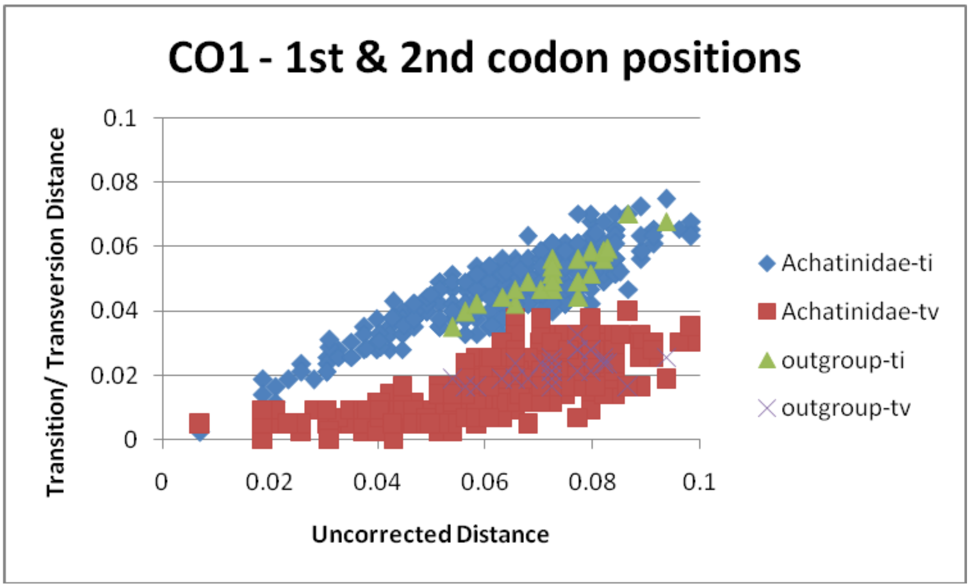


(**B**)

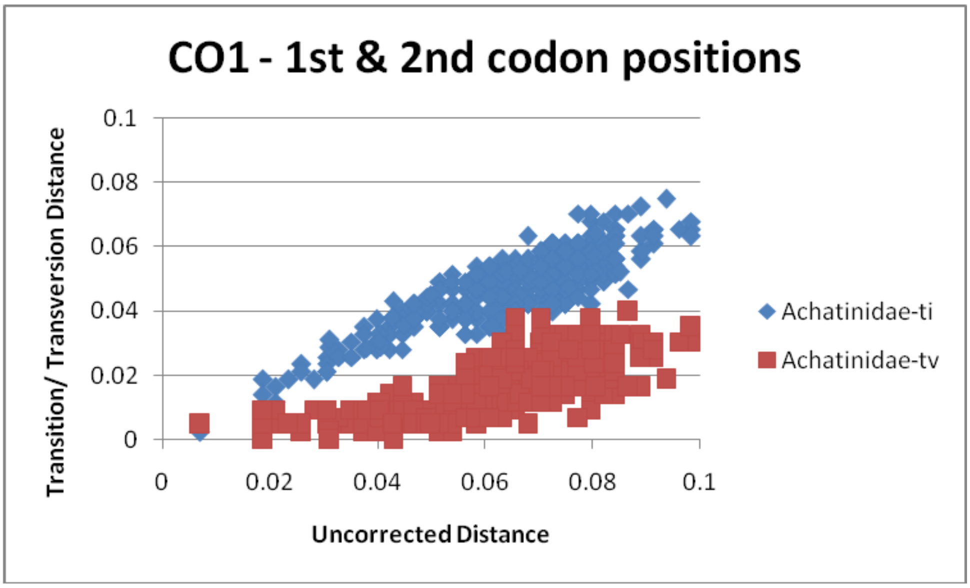
Figure 4.22: Plots of pairwise uncorrected distance versus corrected (GTR+Γ) distance for the 1st and 2nd codon positions of the COI gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only.

Plot 2 (Figure 4.23) for the 1st and 2nd codon positions of the COI gene revealed a linear increase of both transitions and transversions for the Achatinidae and when the outgroup taxon was included, with the transitions being higher than the transversions, while plot 3 (Figure 4.24) revealed that all but three pairwise comparisons had higher rates of transversions than transitions. These findings suggested that the 1st and 2nd codon positions were not saturated.

A g1 value of -0.309 was obtained based on 28 taxa and 64 parsimony-informative sites, which was significantly smaller than the critical value of -0.12 based on 25 taxa and 50 parsimony-informative sites. The 1st and 2nd codon positions of the COI gene therefore exhibited phylogenetic signal.

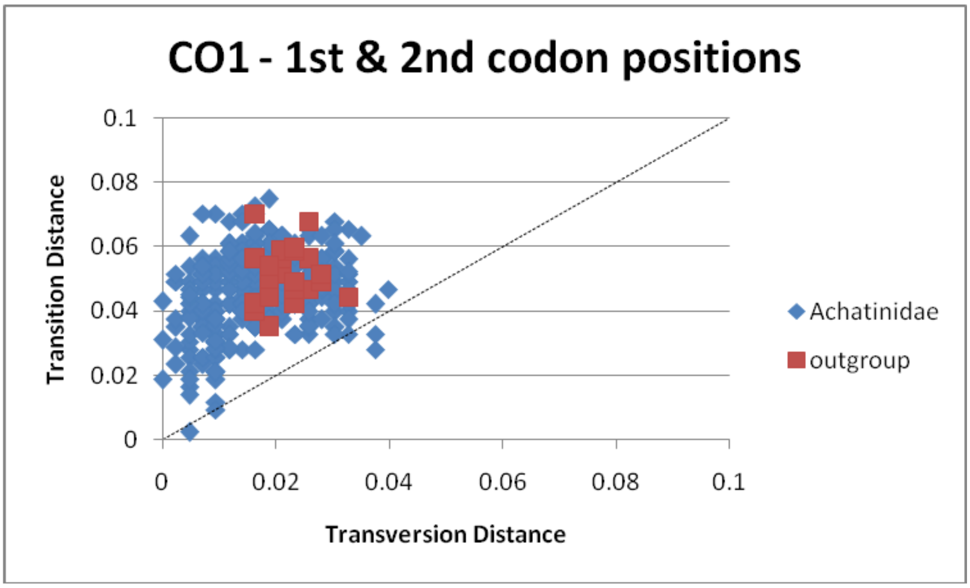


(**A**)

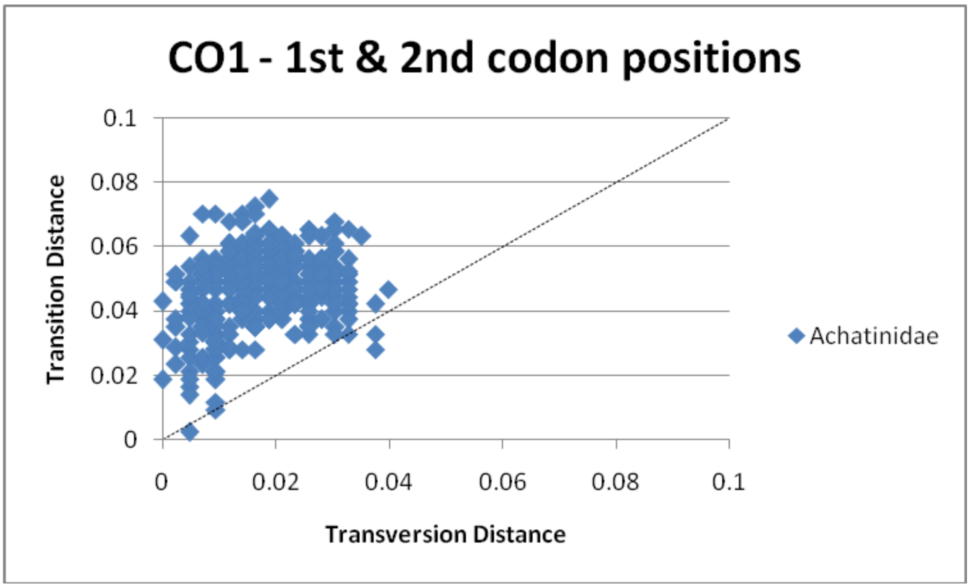


(**B**)

Figure 4.23: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the 1st and 2nd codon positions of the COI gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only.



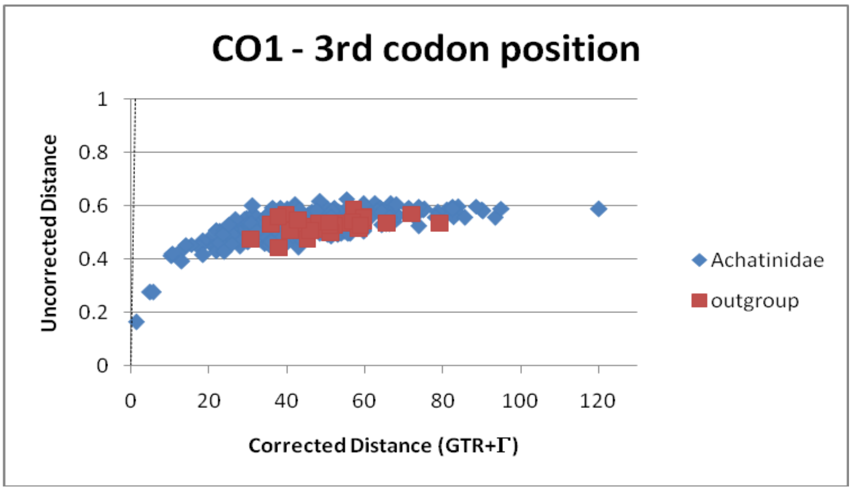
(**A**)



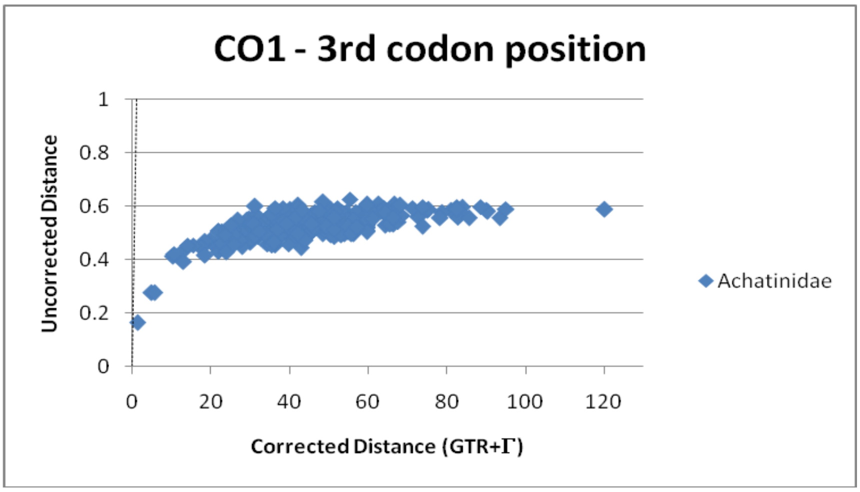
(**B**)

Figure 4.24: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances for the 1st and 2nd codon positions of the COI gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only.

For the 3rd codon position of the COI gene, Plot 1 (Figure 4.25) showed that the optimal GTR+Γ model was unable to correct the dataset for multiple hits as demonstrated by the nearly horizontal trend for both plots. The uncorrected distances also ranged from 0.164 to 0.625 while corrected distances ranged from 1.303 to 120.141 (see also Table 4.1). This indicated severe saturation for the 3rd codon position.



(**A**)

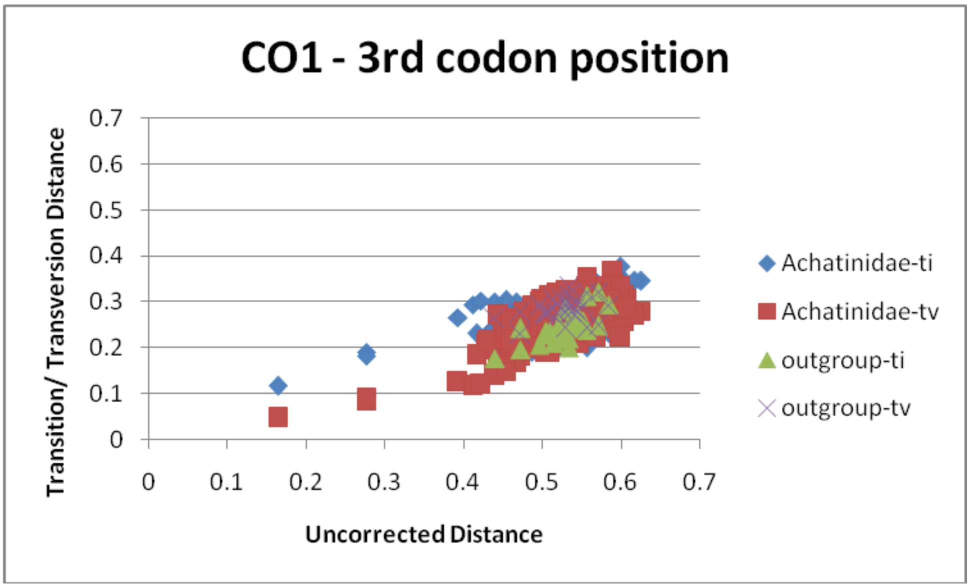


(**B**)

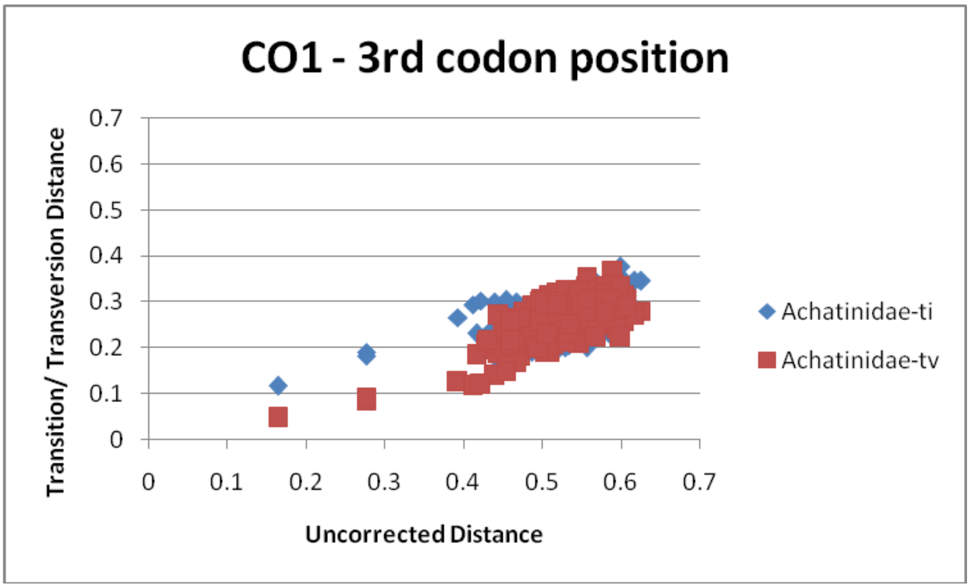
Figure 4.25: Plots of pairwise uncorrected distance against corrected distance for the 3rd codon position of the COI gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only.

Plot 2 (Figure 4.26) for all taxa as well as for the Achatinidae only revealed transversions overlapping with transitions. Plot 3 (Figure 4.27) demonstrated that approximately half of the pairwise comparisons had higher rates of transversions than transitions.

The g1 test score for the COI gene based on 28 taxa and 212 parsimony-informative sites was -0.457, significantly smaller than the critical value of -0.1 for 25 taxa and 100 parsimony-informative sites. The 3rd codon position therefore exhibited phylogenetic signal.

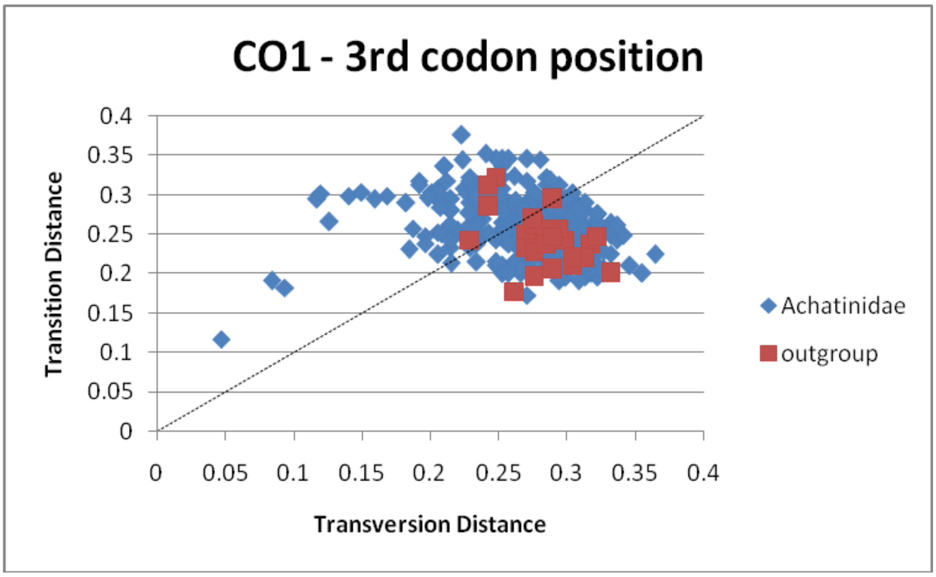


(**A**)

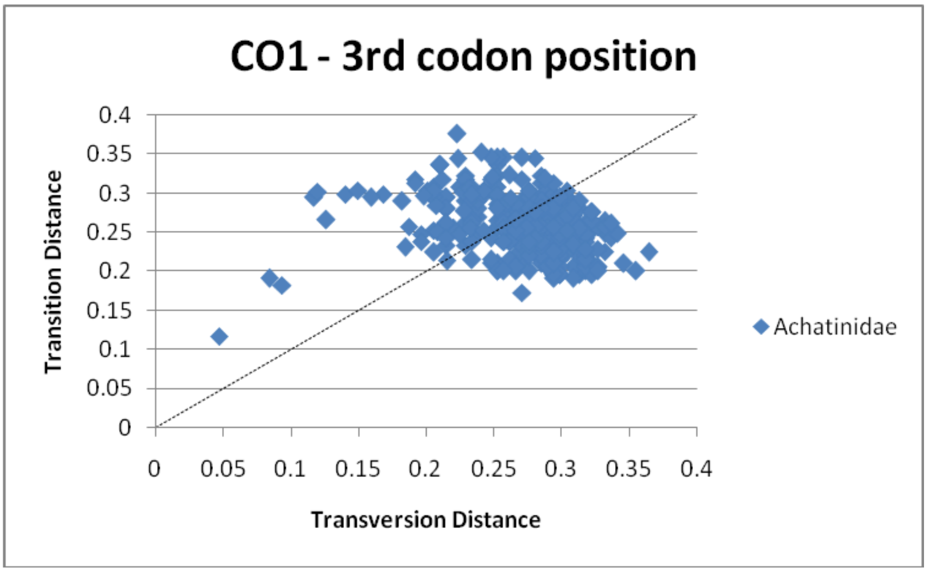


(**B**)

Figure 4.26: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the 3rd codon position of the COI gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only.



(**A**)

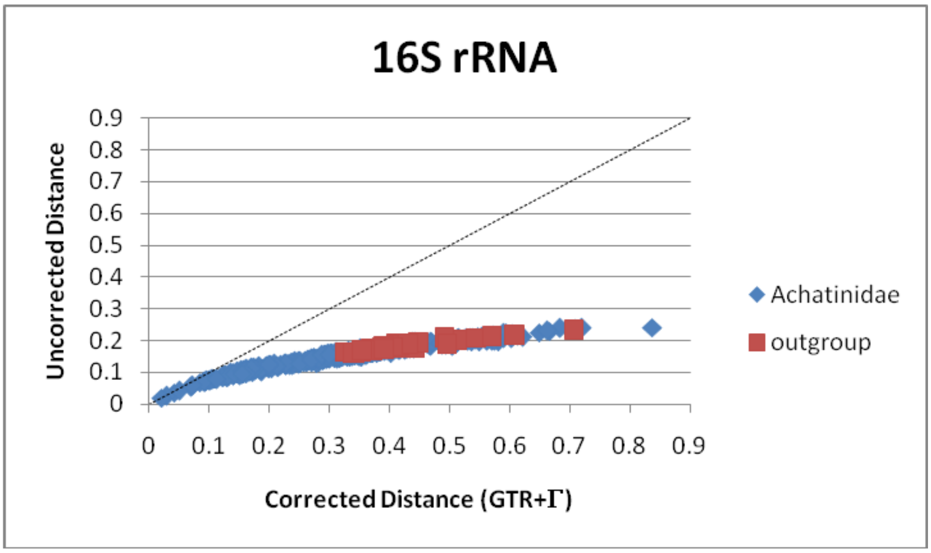


(**B**)

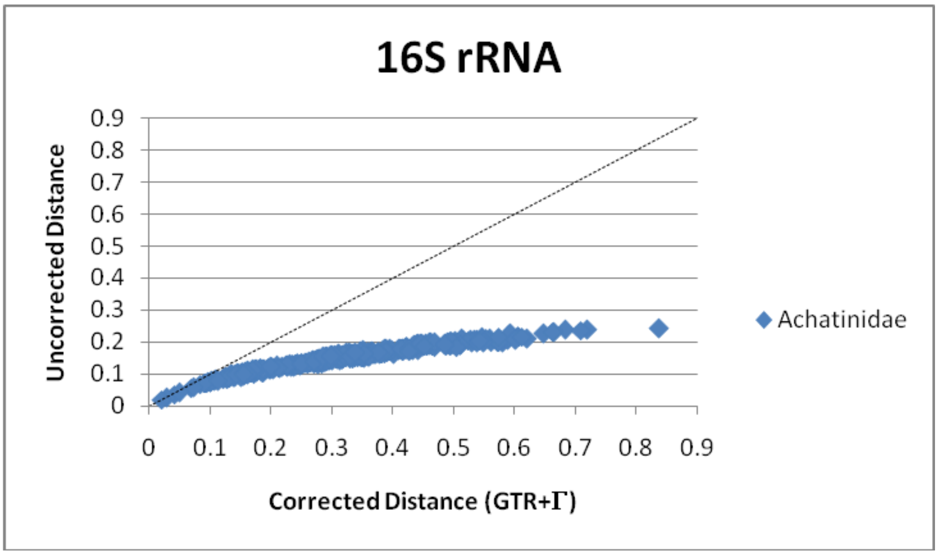
Figure 4.27: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances for the 3^{rd} codon position of the COI gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only.

Despite the presence of phylogenetic signal as indicated by the g1 test, the strong evidence for saturation of the entire COI gene suggested that the gene should not be used in its entirety for phylogenetic analyses. The results also revealed that saturation was restricted to the 3rd codon position despite showing phylogenetic signal based on the g1 test. These contradictory results from the saturation tests and the g1 test are most likely due to the presence of taxa with very similar sequences that led to a strong left skew of tree length distribution based on parsimony in the g1 test. In these instances, the saturation tests took precedence over the g1 test in deciding whether or not datasets should be included. Phylogenetic analyses for the COI gene were therefore limited to the 1st and 2nd codon positions only.

For the 16S rRNA gene, Plot 1 (Figure 4.28) produced corrected distances based on the optimal GTR+Γ model that curved from linearity at an uncorrected (*p*) distance of 0.04 but was still increasing and had not reached a plateau. These findings did not indicate any saturation.



(**A**)



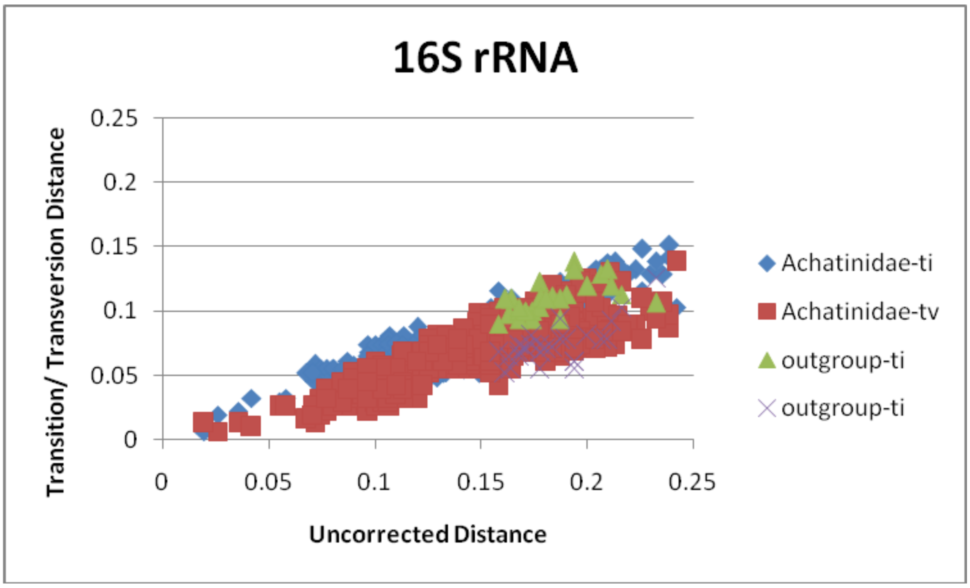
(**B**)

Figure 4.28: Plots of pairwise uncorrected distance against corrected (GTR+Γ) distance for the 16S rRNA gene in (**A**) the Achatinidae and the subulinid outgroup *Rumina decollata* and (**B**) the Achatinidae only.

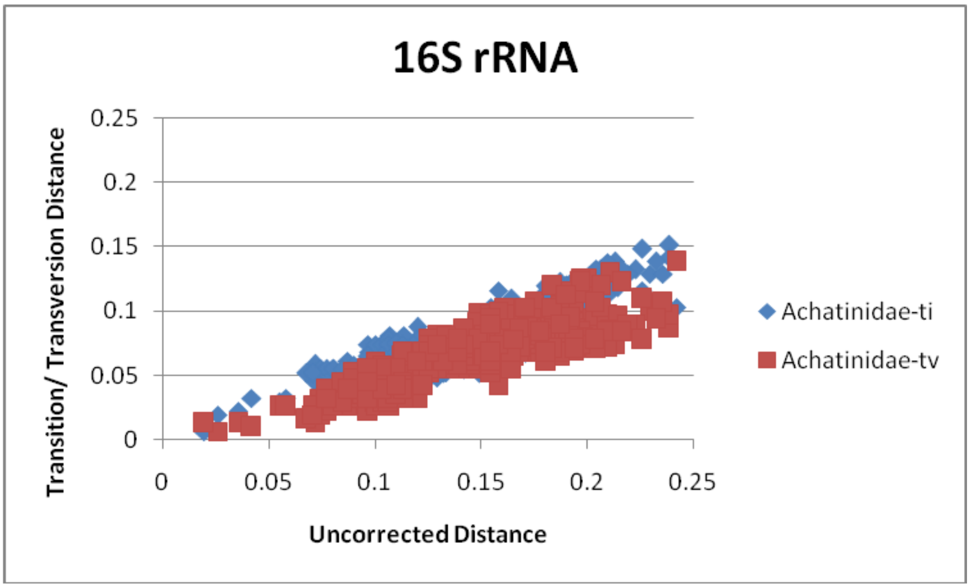
Plot 2 (Figure 4.29) showed an unmistakable overlap between transitions and transversions for the Achatinidae only and including the streptaxid outgroup. However, both plots were still increasing with no evidence of curving for either transitions or transversions. Plot 3 (Figure 4.30) revealed that many pairwise comparisons had higher rates of transversions than transitions, although more than half of the transitions were still higher than transversions.

A g1 value of -0.507 was obtained based on 29 taxa and 110 parsimony-informative sites, which was significantly smaller than the critical value of -0.1 at p=0.05 for 25 taxa and 100 parsimony-informative sites. Phylogenetic signal was therefore evident in the 16S rRNA gene.

The lack of evidence for saturation and the presence of strong phylogenetic signal implied that the 16S rRNA gene could to infer the phylogenetic relationship of the Achatnidae.

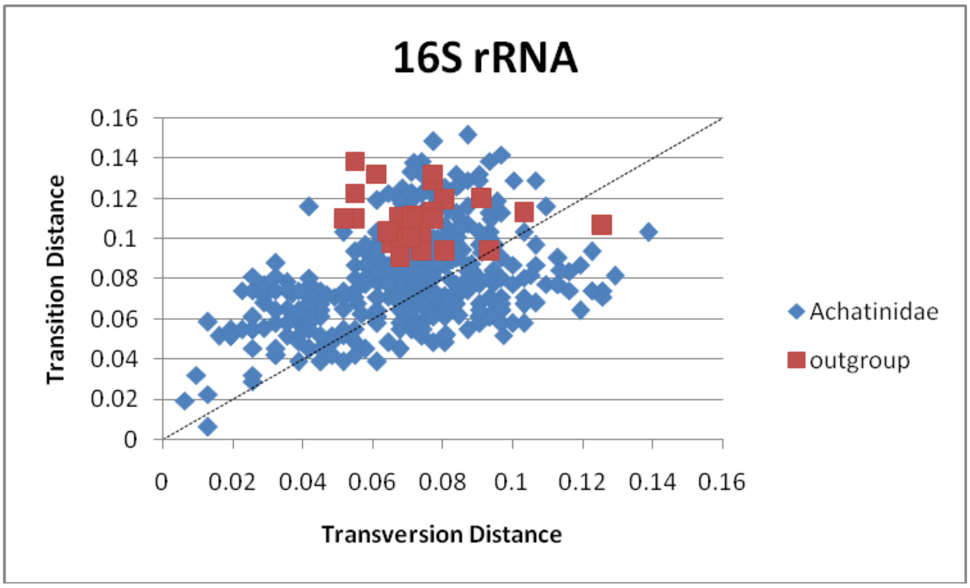


(A)

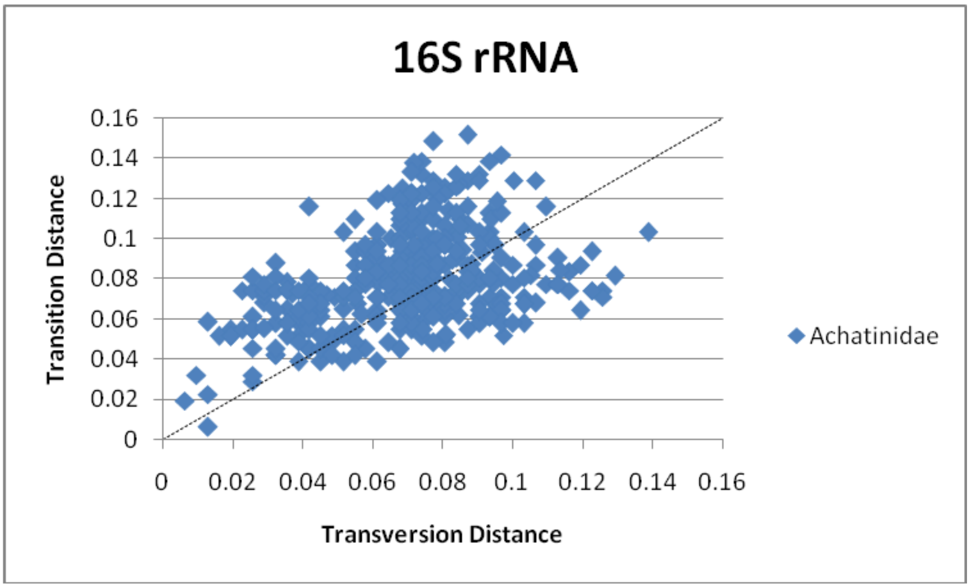


(B)

Figure 4.29: Plots of uncorrected pairwise transition (ti) and transversion (tv) distances against pairwise total uncorrected distances for the 16S rRNA gene in (A) the Achatinidae and the subulinid outgroup *Rumina decollata* and (B) the Achatinidae only.



(A)



(B)

Figure 4.30: Plots of uncorrected pairwise transition (ti) distances against transversion (tv) distances (A) the Achatinidae and the subulinid outgroup *Rumina decollata* and (B) the Achatinidae only.

4.3.2.2. Inferring the presence of paralogous sequences in the actin dataset and assessing its utility for phylogenetic analyses

To infer the presence of paralogous sequences, the actin sequences (obtained by direct sequencing of PCR products) were examined for ambiguous sites. Ambiguous sites were detected in 22 out of 28 achatinid taxa (Appendix 4.7, p. 509), which implied the presence of more than one copy of the actin gene in the Achatinidae. The presence of multiple actin copies was further supported when seven distinct cloned sequences were observed for *Cochlitoma granulata* (see Appendix 3.8, pp. 435-437; note that the clone data for *Cochlitoma granulata* is also discussed as part of the discussion on paralogy of the actin gene in the Achatinoidea, Section 3.3.2.2, Chapter 3, pp. 155-159). A total of 72 variable sites were detected among the seven clones as opposed to only 9 ambiguities in the direct sequence. The majority of these variable sites (55) were attributed to Clones 3 and 6 that were not picked up by the direct sequence. As discussed in chapter 3, the reason for the failure of the direct sequences to identify as ambiguous sites all of the variation among the clones is not clear, but as the PCR-direct sequence is effectively a consensus of the different actin copies within an individual, it is possible that rare copies of the gene might be averaged out.

Four approaches were carried out to determine whether the observed paralogy in actin was likely to mislead phylogeny. First, a neighbor-joining tree of all the actin sequences and the clones of *C. granulata* was generated to determine if the clones were monophyletic. As discussed previously in Section 3.3.2.2 of Chapter 3, the results revealed that some clones (Clones 1, 2, 4 and 5) formed a monophyletic group together with the direct sequence for *C. granulata* while others (Clones 3 and 6) fell elsewhere in the tree (see also Appendix 3.9, p. 438). Second, pairwise comparison between closely related taxa across the Achatinidae based on actin sequence identity (i.e. least number of nucleotide differences) showed that for some pairwise comparisons, the number of ambiguous sites for at least one taxon in the pair were either very close to the number of total nucleotide differences (i.e. *Achatina* (*Achatina*) *achatina* and *Archachatina marginata*; *Achatina* (*Achatina*) *damarensis* and *Metachatina kraussi*; and *Cochlitoma montistempli* and *C. omissa*) or were larger than the total differences (i.e. *Achatina* (*Achatina*) *damarensis* and *Atopocochlis exarata*; *C. dimidiata* and *Atopocochlis exarata*; *C. varicosa* and *C.* sp. cf. *vestita*; *Limicolaria kambeul* and *L. martenssii*; and *Limicolariopsis* sp. and *Achatina* (*Achatina*) *damarensis*). (See also Table 4.3.) These observations suggested that the divergence among the actin copies within some taxa were just as deep if not deeper than the divergence of the taxa themselves and that phylogenetic signal could be obscured at and above the genus level for these taxa. Third, a partition homogeneity test was supposed to evaluate whether or not the actin sequences exhibited significant difference in the phylogenetic signal with respect to the other genes. However, the test was not successfully carried out due to the polytomies exhibited by the actin gene using maximum parsimony. It was therefore not possible to assess the utility of the actin sequence for phylogenetic analyses in the Achatinidae using the partition homogeneity test. Last, the actin phylogeny was evaluated for concordance with the rRNA gene cluster phylogeny, and results showed little concordance. For example, *Cochlitoma marinae* had a very divergent sequence relative to the other achatinids, particularly the other Southern African *Cochlitoma* species; it fell at the base of the Achatinidae (see Appendix 4.8 on p. 510 for the actin phylogenies and Figure 4.31A on p. 252 for the rRNA gene phylogeny). Based on these results, the presence of multiple copies of the actin gene was having a significant effect on phylogeny; the actin gene was therefore excluded from further phylogenetic analyses.

Table 4.3. Comparison of the actin ambiguous sites and nucleotide differences for each achatinid and its closest relative. Closest relative for each taxon is determined based on the actin sequence identity (least number of nucleotide differences). Note that in scoring for the total differences, comparison between an ambiguous site and an unambiguous site is counted as different even if one of the possible nucleotides for the ambiguous site is the same as that found in the unambiguous site being compared (e.g. A vs. R, which is either A or G). See also Table 2.8 of p. 73 for assignment of ambiguous positions.

Species (total ambiguous sites)	**Closest relative with least number of differences (total ambiguous sites)**	**Total number of nucleotide differences**
WEST AFRICAN		
Achatina (*Achatina*) *achatina* (45)	*Archachatina marginata* (27)	48
Archachatina marginata (27)	*Achatina* (*Achatina*) *achatina* (45)	48
EAST AFRICAN		
Achatina (*Lissachatina*) *fulica* (18)	*Achatina* (*Lissachatina*) *immaculata* (15)	27
Achatina (*Lissachatina*) *immaculata* (15)	*Achatina* (*Lissachatina*) *fulica* (18)	27
Achatina (*Lissachatina*) *reticulata* (33)	*Achatina* (*Euaethiopina*) *loveridgei* (0)	39
Achatina (*Lissachatina*) *zanzibarica* (1)	*Achatina* (*Euaethiopina*) *loveridgei* (0)	13
Achatina (*Euaethiopina*) *loveridgei* (0)	*Achatina* (*Lissachatina*) *zanzibarica* (1)	13
OTHERS		
Achatina (*Achatina*) *bisculpta* (32)	*Limicolaria kambeul* (30)	49
Achatina (*Achatina*) *damarensis* (34)	*Atopocochlis exarata* (29)	33
Achatina (*Achatina*) *stuhlmanni* (2)	*Cochlitoma churchilliana* (0) *Cochlitoma montisptempli* (0) *Cochlitoma ustulata* (0) *Cochlitoma zebra* (0)	29
Atopocochlis exarata (29)	*Achatina* (*Achatina*) *damarensis* (34)	33
Limicolaria kambeul (30)	*Limicolaria martenssii* (33)	31
Limicolaria martenssii (33)	*Limicolaria kambeul* (30)	31
Limicolariopsis sp. (40)	*Achatina* (*Achatina*) *damarensis* (34)	42
SOUTHERN		
Cochlitoma varicosa (27)	*Cochlitoma* sp. cf. *vestita* (30)	18
Cochlitoma dimidiata (31)	*Atopocochlis exarata* (29)	33
Cochlitoma sp. cf. *vestita* (30)	*Cochlitoma varicosa* (27)	18
Cochlitoma marinae (4)	*Cochlitoma semidecussata* (0)	124
Cochlitoma churchilliana (0)	*Cochlitoma zebra* (0)	8
Cochlitoma kilburni (1)	*Cochlitoma zebra* (0)	5
Cochlitoma granulata (9)	*Cochlitoma omissa* (6) *Cochlitoma semidecussata* (0) *Cochlitoma ustulata* (0)	15
Cochlitoma simplex (2)	*Cochlitoma zebra* (0)	10
Cochlitoma montisptempli (0)	*Cochlitoma omissa* (6)	5
Cochlitoma omissa (6)	*Cochlitoma montisptempli* (0)	5
Cochlitoma semidecussata (0)	*Cochlitoma ustulata* (0)	11
Cochlitoma ustulata (0)	*Cochlitoma churchilliana* (0) *Cochlitoma semidecussata* (0) *Cochlitoma zebra* (0)	11
Cochlitoma zebra (0)	*Cochlitoma kilburni* (1)	5
Metachatina kraussi (52)	*Achatina* (*Achatina*) *damarensis* (34)	59
SUBULINIDAE (OUTGROUP)		
Rumina decollata (29)	*Cochlitoma churchilliana* (0)	82

4.3.2.3. Partition homogeneity test for combining datasets

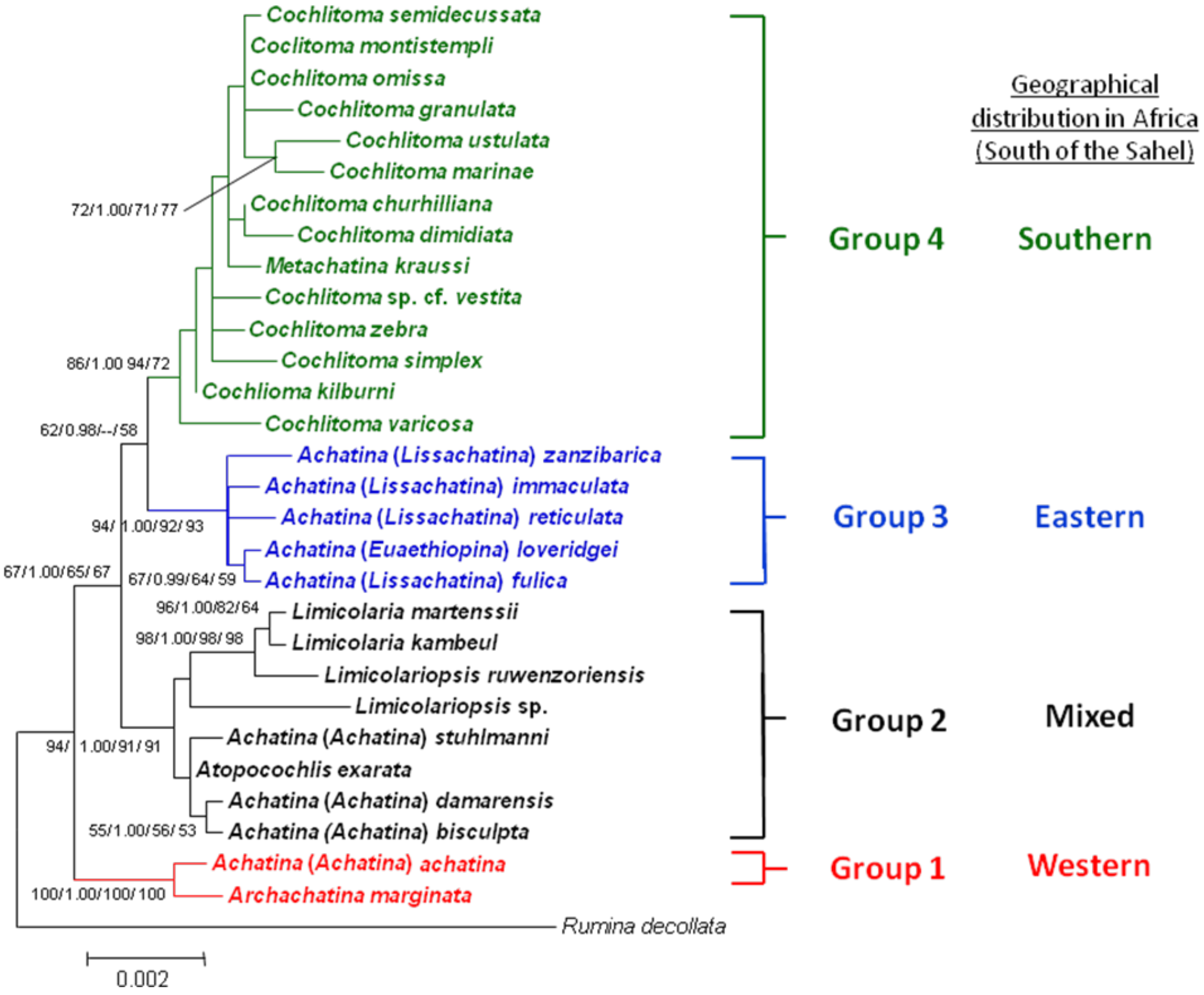
A partition homogeneity test was done separately for the dataset incorporating the rRNA cluster, histone 3, the 1st and 2nd codon positions of the COI, and the 16S rRNA (5586 nucleotides total) for all taxa with complete DNA sequences as well as the dataset that excluded actin (4713 total). However, PAUP* version 4.0b10 was unable to compute the *P* value for 1000 tree replicates using maximum parsimony. This was due to the presence of polytomies in the topology of the trees generated by maximum parsimony that severely slowed down PAUP. It was therefore not possible to assess whether the gene sequences could be combined as a single dataset using the partition homogeneity test. The decision to combine, therefore, relied on whether the single gene phylogenies exhibited some degree of concordance with each other, which they did for some groups of taxa based on the results in Section 4.3.3.1, pp. 259-261. On this basis, the rRNA cluster, histone 3, the 1st and 2nd codon positions of the COI, and the 16S rRNA were combined into a single dataset.

4.3.3. Molecular phylogeny

The maximum likelihood (ML) phylogenies for the rRNA cluster, histone 3, COI (1st and 2nd codon positions only) and 16S rRNA are shown in Figure 4.31 and those of the concatenated sequences from the four genes in Figure 4.32. For the concatenated sequences, two sets of phylogenetic analyses were done. In the first, only taxa with sequences from all four genes were used in the phylogeny; thus, *Achatina* (*Euaethiopina*) *loveridgei* (histone 3 and COI data missing) and *Limicolariopsis ruwenzoirensis* (histone 3, COI and 16S rRNA data missing) were excluded (Figure 4.30A). In the second, all taxa were included in the analyses (Figure 4.30B), with missing data assigned in the analyses for taxa with incomplete datasets. The bootstrap support values for ML, neighbor-joining (NJ) and maximum parsimony (MP) analyses and the posterior probabilities for Bayesian inference (BI) analysis are also shown. For the BI, NJ and MP phylogenies for the genes and the concatenated sequences, see Appendices 4.9-4.14, pp. 511-522.

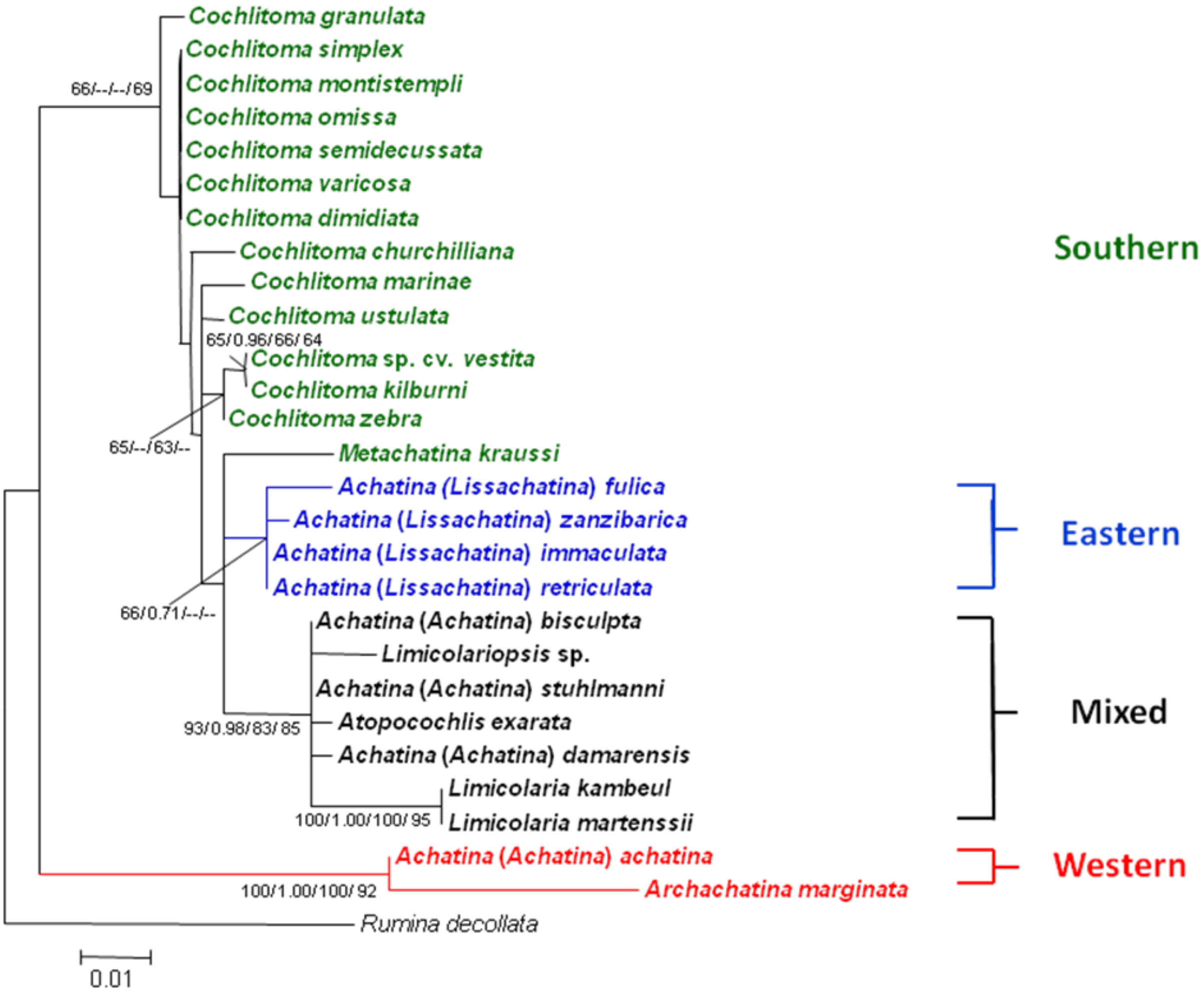
Figure 4.31: (See next four pages.) Maximum likelihood phylogenetic trees of the Achatinidae based on (**A**) the rRNA gene cluster (3648 nucleotides); (**B**) the histone 3 gene (328 nucleotides); (**C**) the COI gene (641 nucleotides) and (**D**) the 16S rRNA gene (310 nucleotides). The phylogenies were rooted on the subulinid *Rumina decollata*. Values on the nodes represent bootstrap support (1000 replicates) for ML, posterior probabilities (based on the last 1000 trees) for BI, and bootstrap support (1000 replicates) for NJ and MP, respectively. For BI, the optimized number of generations to explore the tree space was 2,000,000 for all the genes; the optimized heating temperatures for each gene were as follows: rRNA cluster-0.1; histone 3-0.075; 1st and 2nd codon positions of COI-0.075; 16S rRNA-0.1. The optimal model for the rRNA cluster was TN93; however, this model is not available in MrBayes, so the GTR model was instead used after determining that there was no significant difference between the TN93 and GTR models and that the GTR model was significantly better than HKY85 (see also Appendix 4.6, p. 508). The scale bar for (**A**) represents 2 substitutional changes per 1000 nucleotide positions; that of (**B**) represents 5 substitutional changes per 100 nucleotides; that of (**C**) represents 1 substitutional change per 100 nucleotides; and that of **(D)** represents 10 substitutional changes per 100 nucleotides.

Figure 4.31 (contd.)



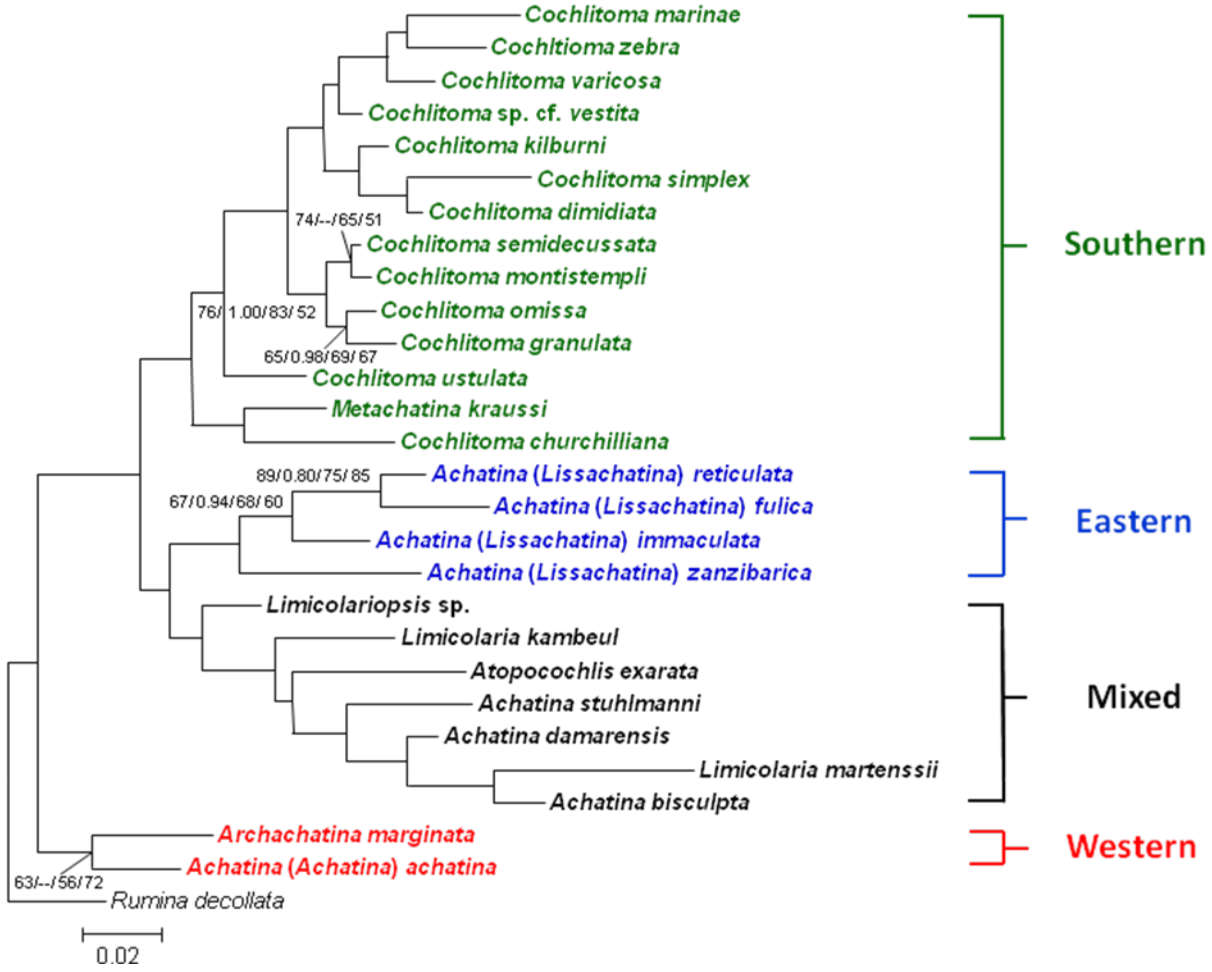
(A) rRNA gene cluster

Figure 4.31 (contd.)



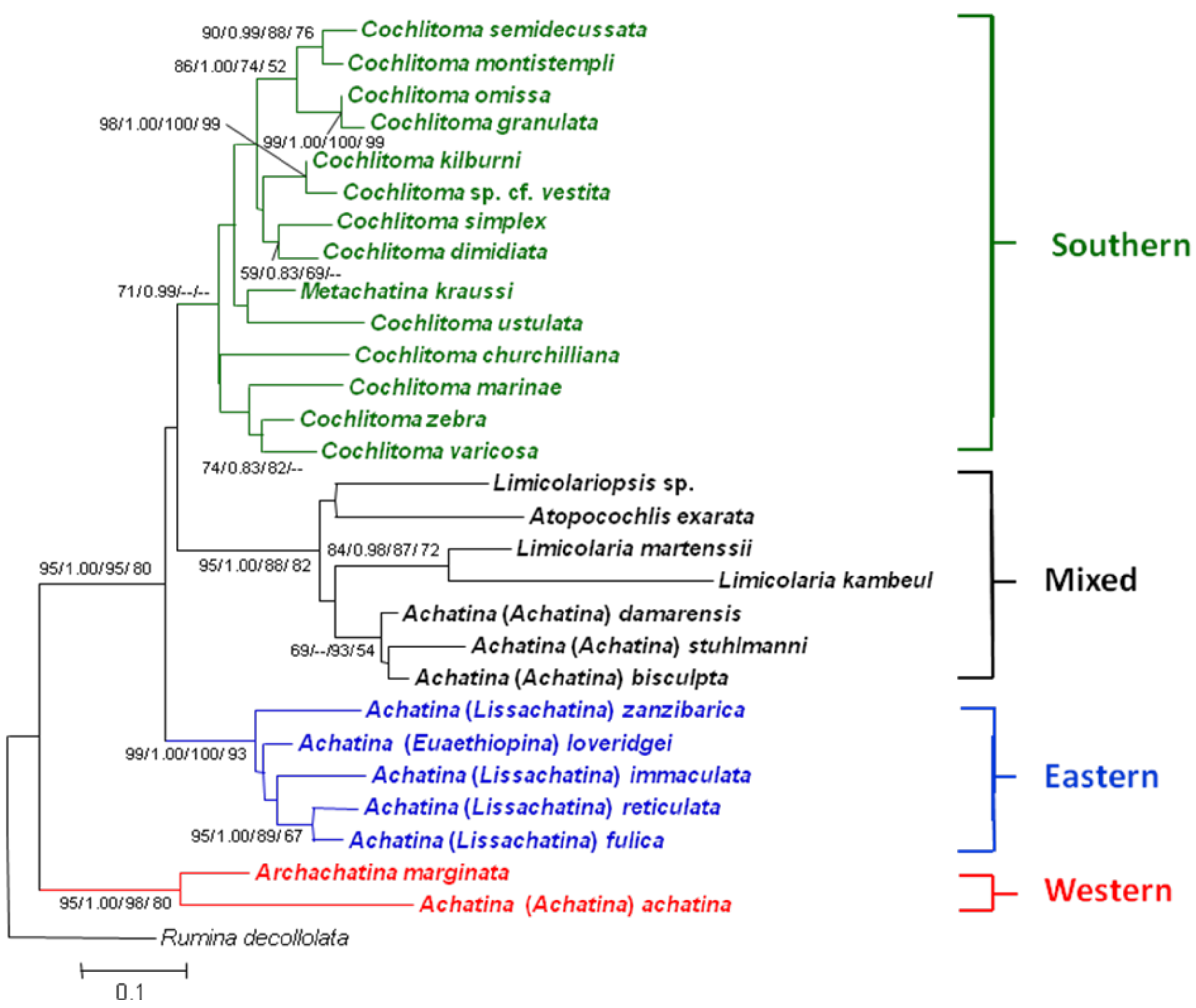
(B) Histone 3

Figure 4.31 (contd.)



(C) COI (1st and 2nd codon positions only)

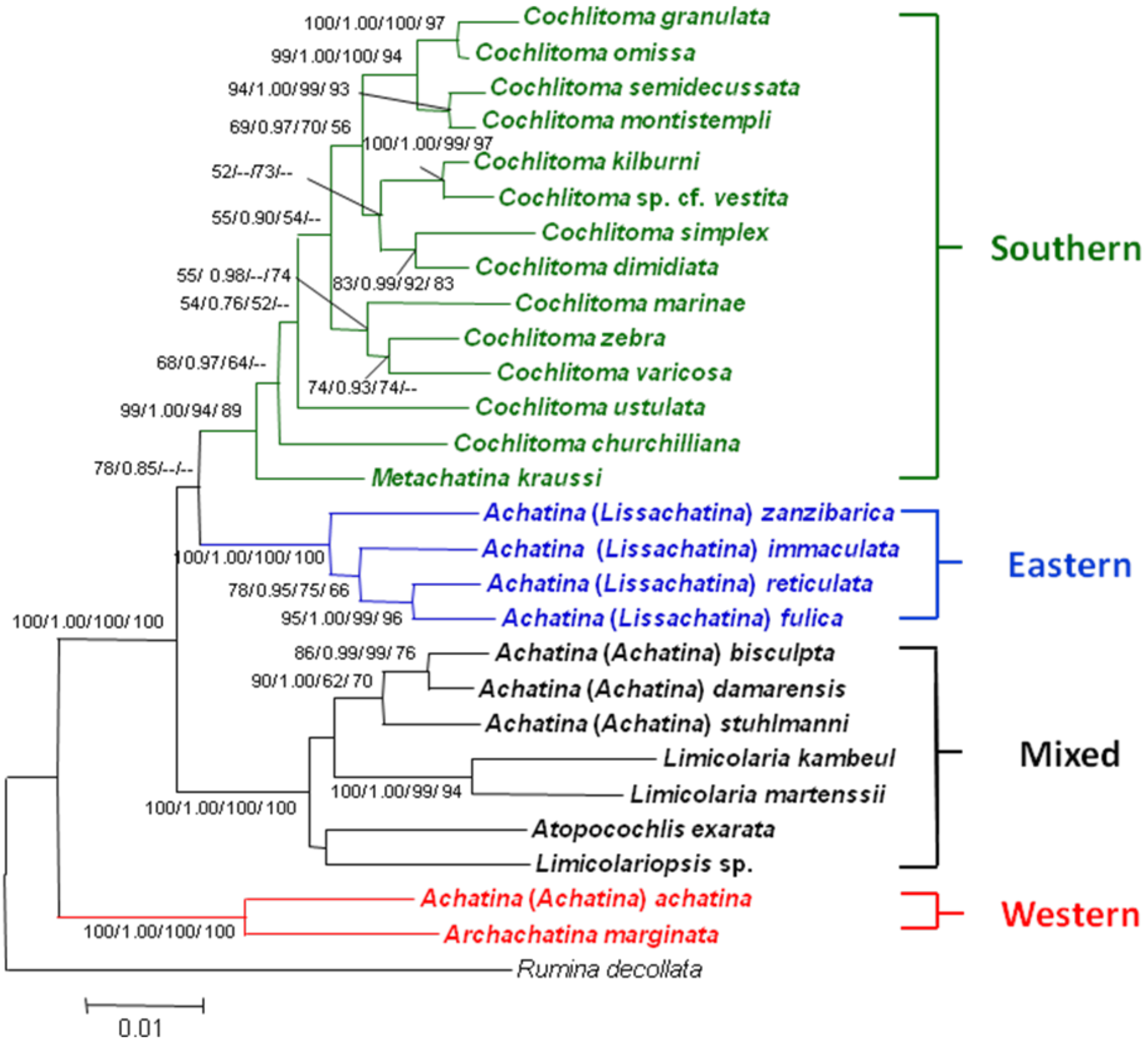
Figure 4.31 (contd.)



(D) 16S rRNA

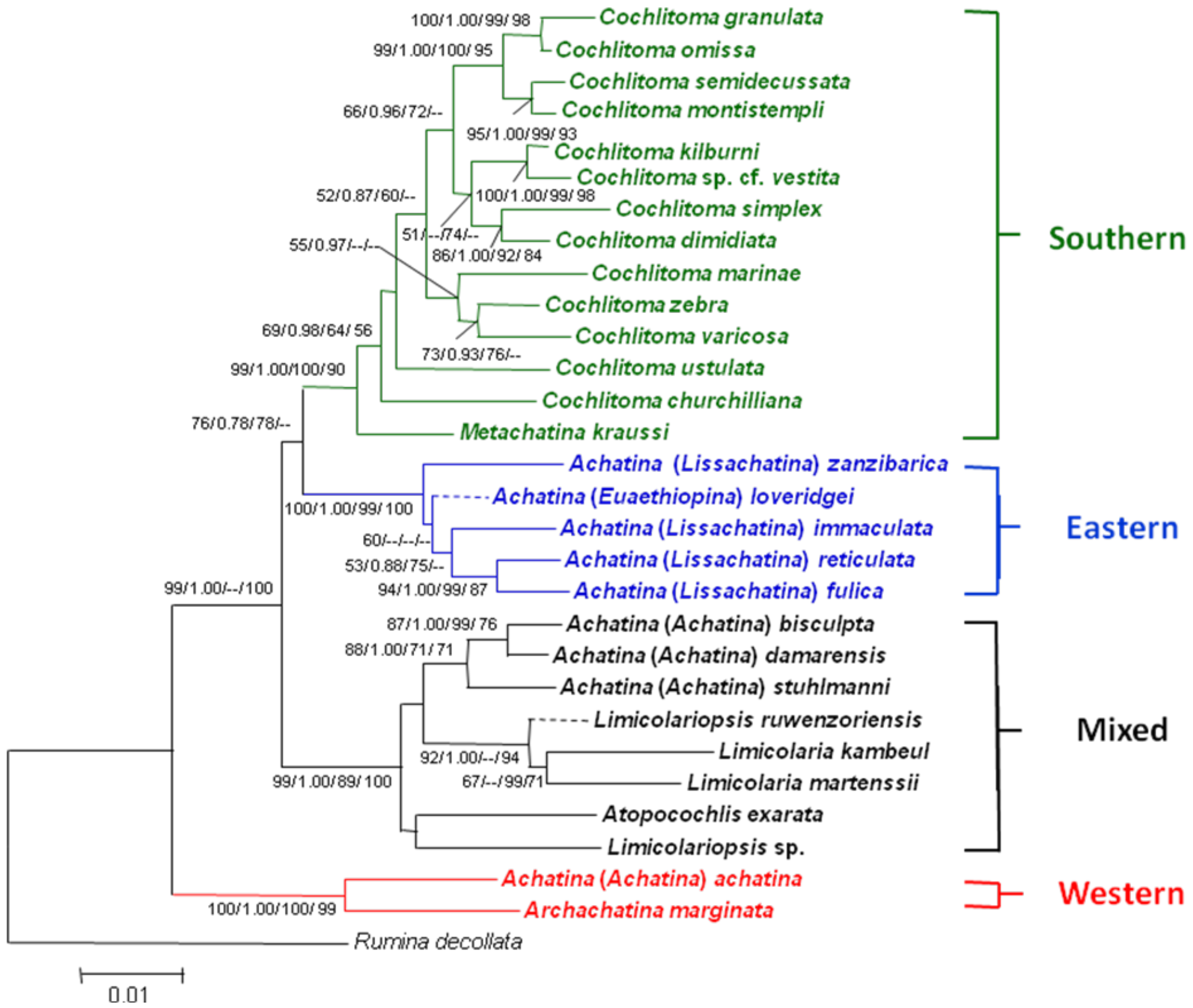
Figure 4.32: (See next two pages.) Maximum likelihood phylogenetic trees of the Achatinidae based on a concatenated sequence of 4403 nucleotides derived from the combined dataset of the rRNA cluster, H3 genes and the 1st and 2nd codon positions of the COI gene. The phylogeny in (**A**) includes only those taxa which have complete sequence data for all sequence regions while that in (**B**) includes all taxa including some with missing data. Both *Achatina* (*Euaethiopina*) *loveridgei* and *Limicolariopsis ruwenzoriensis* have missing datasets for the histone 3 and COI genes. Both phylogenies are rooted on the subulinid *Rumina decollata.* Values on the nodes represent bootstrap support (1000 replicates) for ML, posterior probabilities (based on the last 1000 trees) for BI, and bootstrap support (1000 replicates) for NJ and MP, respectively. Bootstrap support less than 50% and posterior probabilities less than 0.7 are not shown. For BI, the optimized number of generations to explore the tree space was 1,000,000 while the optimized heating temperature was 0.1 for both trees. The scale bars represent 1 substitutional change per 100 nucleotides. Branches for taxa with missing data are marked with dashes.

Figure 4.32 (contd.)



(A) Combined dataset (taxa with complete gene sequences only)

Figure 4.32 (contd.)



(B) combined dataset (all taxa)

4.3.3.1. Single gene phylogenies

For the rRNA gene cluster (Fig 4.31A), four major groups emerged that reflect certain geographical distributions. Group 1 at the base of the tree incorporated the two West African achatinids: *Achatina* (*Achatina*) *achatina* and *Archachatina marginata* (100% ML bootstraps, *P*=1.0 BI, 100% NJ bootstraps and 100% MP bootstraps). Group 2 incorporated several achatinids with mixed geographic distributions (94% ML bootstraps, *P*=1.0 BI, 91% NJ bootstraps and 91% MP bootstraps). These included the West African (São Thomé) *Atopocochlis exarata*, the Southern African *Achatina* (*Achatina*) *bisculpta*, the Southwestern African *Achatina* (*Achatina*) *damarensis*, the Central African *Achatina* (*Achatina*) *stuhlmanni* and *Limicolaria martenssii*, the tropical African (i.e. Uganda and Kenya) *Limicolariopsis ruwenzoriensis* and *Limicolariopsis* sp. and the widely distributed (from Senegal to Sudan and Somalia) *Limicolaria kambeul.* The other two groups formed sister clades. Group 3 incorporated the East African *Achatina* (*Lissachatina*) species, *A.* (*L.*) *fulica, A.* (*L.*) *immaculata, A.* (*L.*) *reticulata* and *A.* (*L.*) *zanzibarica*, as well as the East African *Achatina* (*Euaethiopina*) species, *A.* (*E.*) *loveridgei* (94% ML bootstraps, *P*=1.00 BI, 92% NJ bootstraps and 93% MP bootstraps). Group 4 included the Southern African *Cochlitoma* as well as *Metachatina kraussi* (86% ML bootstraps, *P*=1.0 BI, 94% NJ bootstraps and 72% MP bootstraps).

For the histone 3 gene (Figure 4.31B), three of the four groups identified in the rRNA gene phylogenies were recovered. These were the West African (Group 1) achatinids (100% ML bootstraps, *P*=1.00 BI, 100% NJ bootstraps and 92% MP bootstraps), the mixed group (Group 2) (93% ML bootstraps, *P*=0.98 BI, 83% NJ bootstraps and 85% MP bootstraps) and the East African group (Group 3), although support for this group was equivocal (66% ML bootstraps, *P*=0.71 BI and less than 50%

NJ and MP bootstraps). The Southern African group (group 4) resolved in the rRNA tree did not form a monophyletic unit in the H3 tree but instead was resolved as a paraphyletic group in that it included the Eastern (Group 3) and Mixed (Group 2) groups. In fact, *Metachatina kraussi*, a Southern African taxon, clustered with Groups 2 and 3, although this grouping is not well supported.

For the 1st and 2nd codon positions of the COI gene (Figure 4.31C), all four groups were recovered but there was generally less structure in the topology of the phylogeny and little support for groupings. Of the four groups, only the West African group (Group 1) received moderate support (63% ML bootstraps, *P*<0.7 BI, 56% NJ bootstraps and 72% MP bootstraps).

For the 16S rRNA gene (Figure 4.31D), all four groups were recovered with good to moderate support: the West African group (Group 1) (95% ML bootstraps, *P*=1.00 BI, 98% NJ bootstraps and 80% MP bootstraps); the mixed group (Group 2) (95% ML bootstraps, *P*=1.00 BI, 88% NJ bootstraps and 82% MP bootstraps); the East African group (Group 3) (99% ML bootstraps, *P*=1.00 BI, 100% NJ bootstraps and 93% MP bootstraps); and the Southern African group (Group 4) (71% ML bootstraps, *P*=0.99 BI, and less than 50% NJ and MP bootstraps).

4.3.3.2. Combined gene phylogenies

The combined analysis for the rRNA cluster, H3, the 1st and 2nd codon positions of COI and 16S rRNA, but excluding *Achatina* (*Euaethiopina*) *loveridgei* and *Limicolariopsis ruwenzoriensis* as they had some gene sequences missing, recovered all four groups present in the rRNA phylogeny and exhibited longer internal branches with better support (Figure 4.32A). The West African group (Group 1) still fell at the base of the Achatinidae (100% ML bootstraps, *P*=1.00 BI, 100% NJ and 100% MP bootstraps) while the other achatinids clustered together (100% ML bootstraps, *P*=1.0 BI, 100% NJ bootstraps and 100% MP bootstraps). Within this cluster were the mixed group (Group 2) (100% ML bootstraps, *P*=1.00 BI, 100% NJ and 100% MP bootstraps), the East African group (Group 3) (100% ML bootstraps, *P*=1.00 BI, 100% NJ and 100% MP bootstraps) and the Southern African group (Group 4) (99% ML bootstraps, *P*=1.00 BI, 94% NJ and 89% MP bootstraps), with *Metachatina kraussi* falling at the base of the latter. Groups 3 and 4 clustered as sister clades within the tree.

When all taxa were included in the combined analysis (including the two taxa with missing data), all groups found in the rRNA phylogeny were recovered and in general received higher support (Figure 4.32B). The West African group (Group 1) again fell at the base of the Achatinidae (100% ML bootstraps, *P*=1.0 BI, 100% NJ and 99% MP bootstraps) while the remaining achatinids formed a separate clade with increased support in comparison to the rRNA cluster except for NJ (99% ML bootstraps, *P*=1.0 BI, less than 50% NJ bootstraps and 100% MP bootstraps). Within this clade and consistent with the rRNA tree were the mixed group (Group 2) with increased support (99% ML bootstraps, *P*=1.0 BI, 89% NJ and 100% MP bootstraps) and the clade incorporating the East African and Southern African groups with increased support except for MP (76% ML bootstraps, *P*=0.78 BI, 78% NJ and less than 50% MP bootstraps). The East African group (Group 3) also received increased support (100% ML bootstraps, *P*=1.00 BI, 99% NJ and 100% MP bootstraps) as did the Southern African group (Group 3) (99% ML bootstraps, *P*=1.0 BI, 100% NJ and 90% MP bootstraps). Some well-supported groupings were also observed within groups 2-4. Within the mixed group (Group 2), for instance, there was strong support for the clustering of *Achatina* (*Achatina*) *bisculpta, A.* (*A.*) *damarensis* and *A.* (*A.*) *stuhlmanni* (88% ML bootstraps, *P*=1.0 BI, 71% NJ bootstraps and 71% MP bootstraps) as well as

Limicolaria kambeul, *L. martenssii* and *Limicolariopsis ruwenzoriensis* (92% ML bootstraps, *P*=1.0 BI, less than 50% NJ bootstraps and 94% MP bootstraps). Within the East African group (Group 3), *Achatina* (*Lissachatina*) *fulica* clustered with *A.* (*L.*) *immaculata* (94% ML bootstraps, *P*=1.0 BI, 99% NJ bootstraps and 87% MP bootstraps). Within the Southern African group (Group 4), *Metachatina kraussi* again fell at the base. Very strong support was also shown for several groups. These were *Cochlitoma omissa* and *C. granulata* (100% ML bootstraps, *P*=1.0 BI, 99% NJ bootstraps and 98% MP bootstraps); *C. montistempli* and *C. semidecussata* (95% ML bootstraps, *P*=1.0 BI, 99% NJ bootstraps and 93% MP bootstraps); *C. kilburni* and *C.* sp. cf. *vestita* (100% ML bootstraps, *P*=1.0 BI, 99% NJ bootstraps and 98% MP bootstraps); *C. dimidiata* and *C. simplex* (86% ML bootstraps, *P*=1.0 BI, 92% NJ bootstraps and 84% MP bootstraps); and *C. varicosa* and *C. zebra* (73% ML bootstraps, *P*=0.93 BI, 76% NJ bootstraps and less than 50% MP bootstraps). The geographic distributions of the members of the four groups are shown in Fig. 4.33.

Figure 4.33: Geographic distribution of the achatinid taxa used in this study (distribution data from Bequaert, 1950; Mead, 1950; Schileyko, 1999; and Raut & Barker, 2002 as well as the actual sites from which some of the taxa were collected).

3.3.3.3. Hypothesis testing of *Achatina* (*Achatina*) based on taxonomy

The four members of the subgenus *Achatina* (*A. achatina*, *A. bisculpta*, *A. damarensis* and *A. stuhlmanni*) were not recovered as monophyletic, with *Achatina* (*Achatina*) *achatina* clustering with *Archachatina marginata*; these taxa were subjected to hypothesis testing using the Shimodaira-Hasegawa (1999) test. Constraining the NJ trees for the four single gene and combined gene phylogenies to show monophyly of the subgenus *Achatina* produced likelihood scores that were significantly worse ($p<0.01$) than those of the optimal trees except for the 1st and 2nd codon positions of the COI gene ($p=0.177$) (see Table 4.4 for details). The results confirmed the non-monophyly of the subgenus *Achatina*.

Table 4.4: Hypothesis testing for the monophyly of *Achatina* (*Achatina*) using the Shimodaira-Hasegawa test.

Gene	**Likelihood Score**		***P* for SH[a] Test (Conclusion[b])**
	Optimal NJ tree	**Constrained NJ tree**	
rRNA cluster	6146.48364	6240.31789	0.002 (Significant)
Histone 3	909.37626	949.45797	0.001 (Significant)
COI (1st and 2nd codons)	1995.68125	2004.66467	0.177 (Not significant)
16S rRNA	2876.32254	2906.36582	0.008 (Significant)
Combined	12509.66094	12643.04203	<0.001 (Significant)
Combined-all taxa	12640.55433	12756.19951	<0.001 (Significant)

[a] SH test – Shimodaira-Hasegawa Test
[b] Significant at $P<0.05$

4.4. Discussion

4.4.1. Single versus combined gene phylogenies

Among the five genes used for the Achatinidae, the nuclear rRNA cluster provided the most resolved structure of the internal branches with the four major groups based on biogeography receiving good support. The terminal nodes, however, were not well supported, suggesting that the gene is too conserved for that level. The nuclear histone 3 gene yielded even less structure with only three groups recovered and very few terminal nodes received support. The gene was also too conserved as evidenced by the presence of five sets of identical sequences among 16 taxa. On the other hand, the two mitochondrial genes were more variable and were therefore evolving faster than the two nuclear genes. Of the two, the 16S rRNA gene gave support to most terminal nodes while at the same time recovering the four major groups. The COI had less structure than 16S because the groups were not well supported. Fewer sites were used for COI as the third codon positions were excluded due to their saturated condition, which is indicative of their faster rate of evolution. The fifth gene, the nuclear actin, was also not included due to significant levels of paralogy that disrupted phylogenetic signal.

When the four genes were combined, both the terminal branches and the internal nodes received support based on ML, NJ and MP bootstraps as well as BI posterior probabilities. Underlying signal was also detected in the combined phylogenies with very good support that was not evident in the single gene phylogenies (i.e. the basal position of *Metachatina kraussi* in the Southern African group).

4.4.2. Evolutionary history of the Achatinidae based on molecular data

The existence of no fossils earlier than the Pleistocene (0.01-1.8 MYA) (Zilch, 1959-1960; Solem, 1979) suggests that the Achatinidae are a relatively recent group (Tillier, 1989), although Raut & Barker (2002) believed them to be much older than the fossil record. Mead (1991) suggested that the primitive achatinids occurred in the region of the Lower Guinea in West Africa, and he postulated that the achatinids radiated from there to the other parts of Africa south of the Sahel. Tillier (1989) described the achatinids as giant subulinids, although the taxonomy of the latter is still in a state of flux, and Tillier could not identify with certainty from which subulinid group the achatinids arose.

This study presents the first attempt to elucidate the phylogeny of the Achatinidae using molecular data. Phylogenies derived from the combined nuclear rRNA cluster and histone 3 genes and the mitochondrial cytochrome c oxidase 1 and 16S rRNA genes demonstrated groupings that roughly corresponded to the geographical distributions of the Achatinidae. These groups were the West African group (Group 1) found at the base of the tree followed by the mixed group (Group 2), the East African (Group 3) group and Southern African (Group 4) group, the last two of which clustering as sister clades. Group 2 included species found in the other three regions as well as some that are present in Central Africa.

The West African *Achatina* (*Achatina*) *achatina* (found in the region of Upper Guinea of West Africa; Bequaert, 1950) and *Archachatina marginata* (found in the region of West Africa east of the Dahomey gap, Bequaert, 1950) both fell at the base of the tree, which supports Mead's (1991 hypothesis that the achatinids originated in the west, particularly in the Gabon-Cameroon region. Both species share a penis sheath that only covers half of the penis (Mead, 1950). In fact, *Archachatina* Albers was erected as a distinct genus from *Achatina* purely on conchological criteria, primarily on the form of the shell apices. The large obtuse apex of *Archachatina* is a result of the large embryonic whorls that form in their large eggs (about 19 by 14.5 mm); *Achatina* possesses an acute apex as a result of its small eggs (Bequaert, 1950).

The mixed group includes several species with varying distribution patterns, including the São Thomé endemic *Atopocochlis exarata*. Mead (1991) included *Atopocochlis exarata* as one of the most primitive achatinids together with *Callistoplepa*, *Leptocala*, *Tripachatina* and *Columna*, none of which was sampled in this study due to inability to obtain fresh material. The reproductive structures of *A. exarata* include a very short penis sheath similar to that of *Achatina* (*Achatina*) *achatina* and *Archachatina marginata* and an enlarged vagina (Mead, 1950); the vas deferens is also enclosed by the penis sheath, unlike in the other “primitive” achatinids like *Callistoplepa* and *Leptocala* where the vas deferens is free (Schileyko, 1999). The molecular data as well as the morphological features of the genitalia puts into question the position of *Atopocochlis exarata* among the “primitive” achatinids as suggested by Mead (1991). Another group within the mixed group with high support is the grouping of the two *Limicolaria* species. Both have a distinct penis papilla (Mead, 1979b; 1991). Also within the mixed group are *Achatina* (*Achatina*) *bisculpta* and *Achatina* (*Achatina*) *damarensis*, which clustered together with strong support. In both species, the basal vas deferens and penis are either intimately and tightly connected to the penial retractor muscles, as in the case *A.* (*A.*) *bisculpta* (Sirgel, 2000), or cocooned by them, as in the case of *A.* (*A.*) *damarensis* (Mead, 1950, 1991; Van Bruggen, 1970). These two taxa clustered with *A. stuhlmanni*, and all three belong to the subgenus *Achatina*, though these taxa did not cluster with another member of the subgenus, *A. achatina*, which grouped with *Archachatina marginata*. The non-monophyly of this subgenus was further supported by the Shimodaira-Hasegawa test. The validity of this taxon therefore warrants re-examination.

The Southern African and East African groups together form a sister clade with the mixed group according to the combined gene phylogenies. Indeed, both *Achatina* (*Lissachatina*) from East Africa and *Cochlitoma* of Southern Africa share a "long spermathecal [=gametolytic] duct [that] places the spermatheca [=gametolytic sac] on the uterine portion of the spermoviduct, well above the junction of" the apical vas deferens and the uterine portion of the spermoviduct (Mead, 1991, p. 553). Such a characteristic is probably derived as it is not found in the Western group, which falls at the base of the Achatinidae based on the single and combined gene phylogenies.

The presence of the penial groove in *Cochlitoma* is most likely a derived character as it is not present in *Metachatina kraussi* found at the base of the southern African clade in the combined gene phylogenies, thus lending support to the assumption of Mead (1991) that *Cochlitoma* is an 'advanced' genus. This topology was not evident in the single gene phylogenies and was only revealed as an underlying signal when the genes were combined, as shown by the higher bootstrap and posterior probability supports. The clustering of *Cochlitoma* species within the Southern African group based on the molecular phylogenies supports Mead's (2004) recognition of *Cochlitoma* as a distinct genus rather than a subgenus of Western African *Archachatina* even if they share similar conchological features.

The members of the East African group under *Achatina* (*Lissachatina*) have extroversion muscles as well as a muscular, bulboid enlargement of the basal vagina (Mead, 1991, 1995). The results from the molecular data in this study support Mead's view that *Lissachatina* be distinguished from the West and central African *Achatina* species. Furthermore, judging from the topology of the East African group in relation to other *Achatina* species in the molecular trees, coupled with the distinct morphological characteristics of both the male and female conduits of the reproductive tract, it is clear that there is no basis for including *Lissachatina* within *Achatina* and *Lissachatina* should be recognized as a distinct genus as with *Cochlitoma*. Within the East African group, *Achatina* (*Lissachatina*) *fulica* clustered with *A.* (*L.*) *reticulata*. They differ morphologically in that *A. reticulata* has a short penis sheath that does not cover the entire penis (Mead, 1950). As with *Atopocochlis exarata*, the presence of a short penis sheath in *A. reticulata* is hypothesized to be a derived state and does not indicate plesiomorphic condition or ‘primitive’ state *sensu* Mead. It can be noted that the Southern African *Metachatina kraussi* (Mead, 1950) and *Cochlitoma granulata* (Mead, 2004) also possess a short penis sheath. The subgenus *Euaethiopina*, represented by *A.* (*E.*) *loveridgei*, has a shell that is more elongated ovoid than that of *Lissachatina*, which is more broadly ovate to obesely fusiform; the two taxa also have distinct coloration (Bequaert, 1950; Schileyko, 1999). However, *Achatina* (*Euaethiopina*) *loveridgei* is very similar to *Achatina* (*Lissachatina*) *zanzibarica* with respect to its reproductive anatomy (Mead, 1950). Its placement within *Lissachatina* based on molecular data, coupled with the evidence based on reproductive anatomy, would suggest that *A. loveridgei* should be moved to *Lissachatina*.

All these results support the hypothesis that the achatinids migrated to the central region from the west, then radiated to the east and south. As further support to this hypothesis, van Bruggen (1986) noted that terrestrial snails and slugs of the Afrotropical region (south of the Sahel) occur in four major centres of endemism: 1) Southern Africa; 2) East Africa; 3) North-East Africa; and 4) Central/West Africa. He also observed the highest taxon density for the Achatinidae in West Africa that extended to Central Africa, followed by East and North-East Africa and finally Southern Africa.

Aside from the Achatinidae, there are 33 other families of terrestrial gastropods in the Afrotropical region, of which eight are endemic. Of these, three families (Maizaniidae, Gymnarionidae and Urocyclidae) are found in all four major centres like the Achatinidae; one family (Aillyidae) is found only in West Africa and another (Thyrophorellidae) is restricted to São Thomé off the coast of West Africa. The remaining endemic families (Aperidae, Dorcasiidae and Prestonellidae) are distributed in Southern Africa (van Bruggen, 1986). Diamond and Hamilton (1980) also found that forest passerine birds roughly occur in the four endemic centres, either limited to one or a few of these centres or occurring in all. These centres most likely served as refugia for forest-dependent animals, such as terrestrial gastropods and passerine birds, when forests contracted due to changing rainfall patterns as a result of alternating glacial and interglacial periods during the Quaternary, particularly the Holocene (18,000 years ago), which in turn gave opportunities for vicariant speciation to occur (van Bruggen, 1986). However, Raut & Barker (2002) acknowledged that much of the speciation process, particularly for the terrestrial gastropods, could have predated the changing forest cover of the Holocene.

4.4.3. Limitations of the study and the next step

A number of achatinid groups were not available for this study. Among these are genera found in West Africa considered primitive by Mead (1991) in that the penis sheath is very short and does not enclose the vas deferens. These include *Leptocala* and *Callistoplepa*. If Mead's hypothesis is correct, then these genera should fall at the base of the tree. Furthermore, as West Africa harbors a high number of endemic species of achatinids (van Bruggen, 1986), it is desirable to include as many of these species as possible in future investigations. Of particular interest are the sinistral *Columna columna* and *Archachatina bicarinata*. Equally interesting is the relationship of the East African *Bequaertina* with *Lissachatina*.

4.5. Summary

This study is the first attempt to reconstruct the phylogeny of the Achatinidae using molecular data derived from the nuclear rRNA cluster, actin and histone 3 genes and the mitochondrial cytochrome c oxidase subunit 1 and 16S rRNA genes. Results demonstrated four distinct groups that to a large extent follow the geographical distribution of the sampled taxa and validate groupings previously erected on the basis of reproductive morphology. At the base of the trees are West African species followed by a group which includes taxa with varying geographical distributions ranging from the western, central, eastern and southern regions. Two other groups probably arose from the mixed group and form sister clades: one is the East African group that includes *Achatina* (*Lissachatina*) *fulica*; the other group encompasses most of the Southern African species. The results support Mead's recognition of Southern African *Cochlitoma* as a genus separate from the West African *Archachatina*. The results likewise support Mead's (1950) distinction of the Eastern subgenus *Lissachatina* from the western and central *Achatina* and demonstrate that there is no basis for continuing to include *Lissachatina* as a subgenus of *Achatina*.

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CHAPTER 5 - Genetic variation in global populations of *Achatina fulica*

5.1. Introduction

The Giant African Land Snail, *Achatina* (*Lissachatina*) *fulica* Bowdich, is a tropical species with a widespread distribution across East Africa, the Indo-Pacific and the Caribbean. Its natural range is East Africa, but its current global distribution is primarily due to human intervention (Raut & Barker, 2002). It is a serious crop pest that can easily spread into new areas where it causes significant damage to vegetables and other food crops (Mead, 1979; Raut & Barker, 2002). The World Conservation Union (IUCN) has listed *A. fulica* in its 100 most invasive species (Lowe *et al.*, 2000), and among the land snails in the world, it is probably the most invasive (Raut & Barker, 2002). Its success as an invasive species is probably attributable to its high reproductive capacity and its generalist food behavior, feeding on a wide range of plants and detritus (Raut & Barker, 2002). The tendency for people to transport the snails and release them into the wild either intentionally or inadvertently also helps to spread them further (Thiengo *et al.*, 2007). The snail also serves as the intermediate host of the rat lungworm *Angiostrongylus cantonensis* that causes eosinophilic meningitis in humans (Marquardt *et al.*, 2000).

5.1.1. The Dispersal of *Achatina fulica* from East Africa

The ease with which *Achatina fulica* spreads into new areas is attributed to the availability of several pathways of dispersal for the snail. A pathway, which pertains to an activity that involves the introduction of a species, can be accidental or deliberate (Cowie & Robinson, 2003). *Achatina fulica* is deliberately introduced into new areas for the purposes of consumption, as pets, aesthetics or ornaments, religious symbols, or for medicinal or research use (Mead, 1979; Kliks & Palumbo, 1992; Cowie & Robinson, 2003; Budha & Naggs, 2008). On the other hand, *A. fulica* is accidentally introduced when it "hitchhikes" with agricultural and horticultural products, the packaging or containers of any commodity, or even on vehicles such as cars and trucks (Cowie & Robinson, 2003). *Achatina fulica* can also escape from local farm operations where they are bred for their meat (Paiva, 1999).

Achatina fulica has a pan-tropical distribution brought about within the last 200 years by its human-aided dispersal (Fig. 5.1). The snail is indigenous to the coast of East Africa (probably originating in Kenya and Tanzania) but was introduced into the nearby islands of Madagascar, Mauritius, the Comoros, Mayotte and Reunion prior to 1800 (Bequaert, 1950). The snail was then brought to India and Sri Lanka by naturalists in the early 1900s (Naggs, 1997; Raut & Barker, 2002) and spread to Nepal to the north (Budha & Naggs, 2008) and to the Malay Peninsula to the southeast via sea routes in cargo vessels (Mead, 1961). Immediately before and during the Second World War, Japanese merchants and soldiers spread *A. fulica* further into Southeast Asia, Taiwan, and many islands of the Pacific as they were used for food and medicinal purposes and sometimes as pets (Kliks & Palumbo, 1992). By the late 1980's, *A. fulica* had been reported in the Caribbean, particularly in Guadeloupe and Martinique (Schotman, 1989) and later on in St. Lucia and Barbados by 2000 (Fields *et al.*, 2006) and in Antigua by 2008 (NAPPO-PAS, 2008). By the 1990's, *A. fulica* had already established itself in South America, particularly Brazil (Paiva, 1999; Carvalho de Vasconcellos & Pile, 2001; Thiengo *et al.*, 2007), Colombia, Ecuador and Peru (Borrero *et al.*, 2009). Recently, the snail has been observed in the Ivory Coast, Ghana and Morocco in West and Northwest Africa (Raut & Barker, 2002). Although *A. fulica* has reached Australia, Japan, and the United States mainland in the past, authorities in these countries have successfully eradicated *A. fulica* for fear of its potential for causing damage to agriculture (Mead, 1961; Kliks & Palumbo, 1992). As an exotic pet (Kliks & Palumbo, 1992), *A. fulica* is now present in temperate countries such as the UK and France.

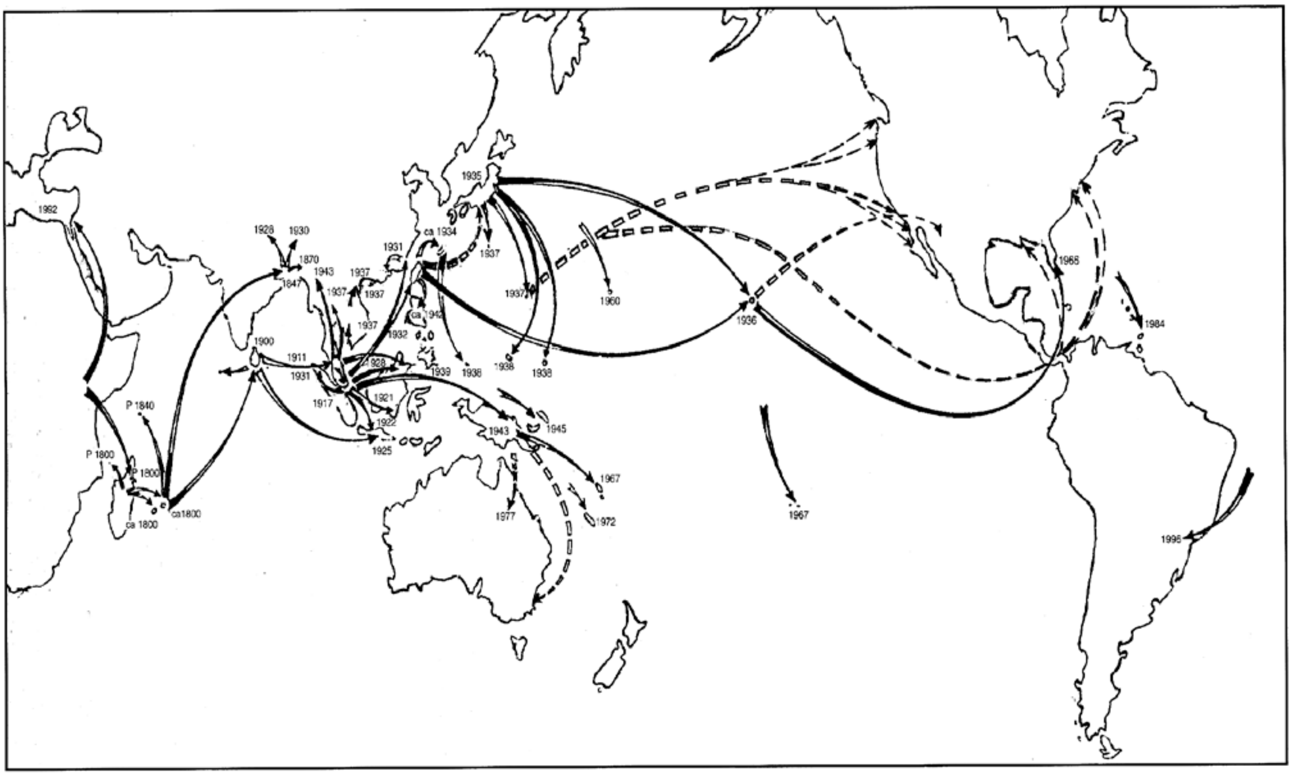

Figure 5.1: Dispersal route of *Achatina fulica* from East Africa. Years indicate approximate dates when the snail was first observed in each region. Solid lines denote successful introductions while broken lines denote introductions that were intercepted. (From Raut & Barker, 2002).

5.1.2. Genetic variation in introduced species

The genetic composition of the population of an introduced species in a new area may affect the success of that population. Invasion may involve founder events in which a population of a few individuals carries a reduced amount of genetic variation in comparison to the source population. Over time, this leads to a population bottleneck in which individuals suffer from a lack of genetic variation and where massive shifts in allele frequencies are observed (Dlugosch & Parker, 2008). This becomes particularly problematic to the invasive species if the loss of variation includes adaptive traits that could have improved their chance of establishing in a new habitat, preventing extinction and increasing population growth (Kolbe *et al*., 2007). Although some data do show lack of genetic diversity in introduced species, as seen in the apple snails *Pila conica* and *Pomacea canalicuata* in Hawaii (Tran Chuong *et al*., 2008), other data on invasive species reveal that many populations do not exhibit such lack of diversity. One possible explanation is the role of multiple introductions in augmenting the genetic diversity of the invasive species. Multiple introductions may involve separate dispersal events over a long period of time in which new genes from recently introduced populations are spread among the individuals in the established population (Dlugosch & Parker, 2008). This was evident in the cheatgrass, *Bromus tectorum*, in which multiple introductions from Europe and Southwest Asia counteracted the effect of bottlenecking in introduced populations in western North America (Novack & Mack, 1993). Kolbe *et al.* (2007) also noted the same pattern in eight species of *Anolis* lizards introduced in Florida and the Dominican Republic from the northern Caribbean using the ND2, tRNA-Trp and tRNA-Ala genes of the mitochondrial DNA. Their results revealed that 80% of introductions were derived from multiple native sources. Furthermore, haplotypes that were found in distinct geographic locations in the native range occurred as variants within the introduced populations. They proposed a two-step process in introductions marked by the initial decrease in genetic variation as a result of founder events and bottlenecking followed by an increase in genetic variation if multiple introductions from different sources take place.

Despite the detailed historical and anecdotal information concerning the spread of *Achatina fulica*, no systematic evaluation of its genetic variation across global populations has been undertaken. It is therefore not known whether multiple introductions of *A. fulica* from different sources have occurred in any part of its new range or whether the introduced populations are undergoing bottlenecking. In either case, these factors could have a profound impact on the success of *A. fulica* as an introduced species.

5.1.3. Mitochondrial molecular markers for evaluating genetic variation in snail populations and elucidating their population history

Data derived from molecular genetic variation in snail populations can yield useful information about the routes of introduction or dispersal and colonization of a particular snail species into new areas (Davison, 2000; Gittenberger *et al.*, 2004; Pinceel *et al.*, 2005; Rawlings *et al.*, 2007). Mitochondrial genes have been used as the markers of choice to assess variation within and between snail populations because they generally evolve faster than nuclear genes and are maternally inherited and therefore not subject to recombination (Brown, 1985; Avise *et al.*, 1987). For example, Davison (2000) analyzed a fragment of the mitochondrial 16S rRNA gene using single-stranded conformational polymorphism (SSCP) analysis and DNA sequencing to identify different haplotypes from populations of the banded grove snail *Cepaea nemoralis* from Britain and Ireland. The fragment he used for the SSCP analysis corresponded to the variable domain IV segment of the secondary structure of the post-transcribed 16S rRNA gene (Lydeard *et al.*, 2000) for which Palumbi (1996) designed universal primers. Davison's work revealed two mitochondrial lineages that had an east-west distribution, suggesting two possible routes of colonization of Britain after the last ice age. Pinceel *et al.* (2005) also used the same variable domain IV segment of the 16S rRNA gene as part of their population genetic survey of the terrestrial slug *Arion* *subfuscus* in northeastern USA and Europe. They likewise used SSCP and DNA sequencing. Their results revealed the existence of two distinct 16S rRNA haplotyes in the USA representing at least two independent introductions from the British Isles on the one hand and mainland Europe on the other. In another study, Gittenberger *et al.* (2004) sequenced a fragment of the cytochrome c oxidase subunit I (COI) gene for several populations of the snail *Arianta arbustorum* and three other species of *Arianta* to elucidate the evolutionary history of the two shell forms of *A. arbustorum*.

5.1.5. Objective of the study

This study aimed to assess the genetic variation in global populations of *Achatina fulica*. Comparison of recently dispersed *A. fulica* populations from across the globe with those from East Africa and adjacent islands were undertaken to determine where the recently introduced global populations of *A. fulica* originated and whether they represent single or multiple introductions. To this effect, the genetic diversity of *A. fulica* populations from East Africa, the Indian subcontinent, Southeast Asia, the Pacific and the Caribbean were evaluated using single stranded conformational polymorphism (SSCP) analysis of the 16S ribosomal (r) RNA gene.

5.2. Materials and methods

5.2.1. Sample collection

In total, 382 individuals of *Achatina fulica* from 19 populations across the globe were sampled. Two populations were obtained from East Africa: Kampala, Uganda (5 snails) and Dar Es Salaam, Tanzania (38 snails). Three populations were from Indian Ocean islands near East Africa: Mayotte (50 snails) off the coast of Mozambique;

Souillac, Mauritius (45 snails) east of Madagascar; and Mahe, Seychelles (2 snails) northeast of Madagascar. Samples from Nepal (22 snails) represented the Indian subcontinent while those from Southeast Asia included Myanmar/ Burma (20 snails), Thailand (20 snails), the Philippines (2 population samples with 20 snails each), Malaysia (20 snails) and Singapore (20 snails). The Pacific was represented by Ogasawara/ Bonin (12 snails), New Caledonia (21 snails), Hawaii (20 snails), Moorea (10 snails) and Tahiti (5 snails). Two populations were obtained from the Caribbean: Martinique (20 snails) and Barbados (12 snails). The Martinique specimens were a captive bred population of F1 offspring bred from Martinique parents by F. Adnai. See also Table 5.1.

Table 5.1: Locality, collector and sample size of global populations of *Achatina fulica* used in the study

Locality	Collector	Sample size
Kampala, Uganda	B. Rowson	5
Dar Es Salaam, Tanzania	C. Ngereza	38
Mayotte	F. Barthelat	50
Souillac, Mauritius	O. Griffiths	45
Mahe, Seychelles	J. Gerlach	2
Bharatpur, Nepal	P. Budha	22
Yangon, Myanmar/ Burma	F. Naggs	20
Trok Nong Area, Chantaburi, Thailand	S. Panha & C. Sutcharit	20
Hahajima, Ogasawara/ Bonin Islands	A. Davison	12
University of the Philippines, Diliman, Quezon City, Philippines	I. Fontanilla	20
Los Baños, Philippines	M. Carandang	20
Singapore	M. Posa	20
Kota Kinabalu, Sabah, Malaysia	M. Schilthuizen & T. Liew	20
Noumea, New Caledonia	C. Wade	21
Moaroa Valley, Tahiti, French Polynesia	T. Coote	5
Haapiti Valley, Moorea, French Polynesia	T. Coote	10
Kaneohe, Oahu, Hawaii	K. Hayes	20
Martinique (captive bred F1 population, Nancy, Lorraine, France)	F. Adnai	20
Barbados	A. Norville	12

5.2.2. PCR and SSCP analysis using the 16S rRNA gene

Small tissue slices (approximately 8 mm^3) were cut from the foot muscle of each snail and subjected to the NaOH direct lysis DNA extraction method for snails (Section 2.1.2 of Chapter 2, pp 39-40).

A 400 bp PCR fragment used for SSCP analysis can only detect 80% of single nucleotide differences whereas smaller fragments have an increased probability of the detection of differences (Sunnucks *et al*., 2000). For the 16S rRNA gene, a primer pair, 16S1i and 16S_SSCP2i, was designed to produce a 293 bp fragment of domain IV of the post-transcribed 16S rRNA (Lydeard *et al.*, 2000). Note that primers 16S1i and 16S_SSCP2i bind to positions 781-802 and 1049-1068, respectively, of the 16S rRNA gene of *Cepaea nemoralis* (GenBank NC_001816). Details of the primer pair are shown in Table 2.5 of Chapter 2, p. 53.

The amplified PCR products were then subjected to SSCP analysis (Section 2.8 of Chapter 2, pp. 66-70). The bands in the native acrylamide gel were visualized using silver staining, after which haplotypes were identified and scored. Representative samples bearing unique haplotype gel profiles were checked for single nucleotide differences by re-amplifying the PCR product from the DNA sample and sequencing the amplified fragment. Both sense and anti-sense strands were sequenced directly using an Applied Biosystems 3730 DNA sequencer and BigDye version 3.1 termination cycle sequencing chemistry (Section 2.6 of Chapter 2, pp. 59-61). The sequences were subsequently assembled in the STADEN package version 1.5.3 (Staden *et al.*, 2000) and aligned manually within GDE Version 2.2 (Smith *et al.*, 1994).

5.2.3. Phylogenetic and network analyses of the 16S rRNA haplotypes

To determine the evolutionary relationships of the different 16S haplotypes, the best model for sequence evolution with optimized parameters was determined and an NJ tree was generated in PAUP* Version 4.0b10 package (Swofford, 2002) (see Section 2.9.8 of Chapter 2, p. 84). *Achatina reticulata* was used as an outgroup as this species had the smallest uncorrected distance to *A. fulica* based on the same 16S rRNA SSCP fragment (see Appendix 5.1, p. 523). A median joining network of the haplotypes (Bandelt *et al.*, 1999) was also drawn using the Network Version 4.502 program (http://www.fluxus-engineering.com).

5.3. Results

5.3.1. PCR and SSCP analysis of the 16S rRNA gene

PCR and SSCP analysis carried out on 382 snails from 19 populations yielded 15 unique 16S rRNA haplotypes (Figure 5.2).

Figure 5.2: Gel profiles of 15 haplotypes (labeled A – O) based on a 293 bp fragment in domain IV of the 16S rRNA gene. (Haplotype O was run on a separate gel alongside haplotype I, which was used as basis of comparison.) Samples were run on a 50% native polyacrylamide gel at 180 V for 24 hours. The bands were visualized by silver staining.

PCR-direct sequencing of the haplotypes revealed 17 variable sites (Figure 5.3). Two of these sites (pos. 285-286) were found to be indels.

Nucleotide Position

```
                        1 1 1 1 1 1 1 1 2 2 2 2 2 2 2
                    1 4 0 0 4 5 5 5 5 9 0 1 5 8 8 8 8
                    9 2 2 6 5 1 5 6 8 7 5 7 8 1 2 5 6
                    . . . . . . . . . . . . .   . . .
Haplotype A         GACCCATAATTAATTTT
Haplotype B         AG...............
Haplotype C         A.......G.......-
Haplotype D         A...............-
Haplotype E         AC......G.......-
Haplotype F         A.....C.G.......-
Haplotype G         A..T............-
Haplotype H         A.......G........
Haplotype I         A.T..G.T.C.......
Haplotype J         A.T..G.T......A.-
Haplotype K         A...........G..--
Haplotype L         A.G..G.T.CC....--
Haplotype M         A.T..G.T.C......-
Haplotype N         A.T.TG.T...G....-
Haplotype O         A...T........A..-
```

Figure 5.3: Seventeen variable sites across the 15 haplotypes. The number shown above each site refers to the variable site based on the 16S rRNA SSCP fragment.

A summary of the frequency and distribution of these haplotypes is shown in Table 5.2 and Figure 5.4. Seven haplotypes were found in the two East African populations: Uganda with one haplotype (O) and Tanzania with six haplotypes (I, J, K, L, M, and N). Among the Indian Ocean islands, Mayotte yielded the highest number of haplotypes with six (A, B, C, D, G and H), three of which were also found in Mauritius (C, D and H) and one in Seychelles (C). However, of the haplotypes found in Africa and on the Indian Ocean islands, only haplotype C was found in the populations surveyed outside East Africa and the Indian Ocean islands, thus making type C the only pan-tropical haplotype. There was also one unique haplotype (E) detected in the Los Baños site in the Philippines where it was found in conjunction with haplotype C. Another unique haplotype (F) was found in New Caledonia in the Pacific and Barbados in the Caribbean where it was the only haplotype identified for both populations.

Table 5.2: Summary of the geographic distribution and frequency of the 16S rRNA haplotypes from *Achatina fulica* populations as evaluated by SSCP analysis.

Locality	**Sample size (& no. of haplotypes)**	**Haplotype name (& no. of individuals)**
Kampala, Uganda	5 (1)	O (5)
Dar Es Salaam, Tanzania	38 (6)	I (11) J (1) K (12) L (10) M (2) N (2)
Mayotte	50 (6)	A (1) B (1) C (6) D (40) G (1) H (1)
Souillac, Mauritius	45 (3)	C (34) D (9) H (2)
Mahe, Seychelles	2 (1)	C (2)
Bharatpur, Nepal	22 (1)	C (22)
Yangon, Myanmar/ Burma	20 (1)	C (20)
Trok Nong Area, Chantaburi, Thailand	20 (1)	C (20)
Hahasima, Ogasawara/ Bonin	12 (1)	C (12)
Quezon City, Philippines	20 (1)	C (20)
Los Baños, Philippines	20 (2)	C (17) E (3)
Singapore	20 (1)	C (20)
Kota Kinabalu, Sabah, Malaysia	20 (1)	C (20)
Noumea, New Caledonia	21 (1)	F (21)
Moaroa Valley, Tahiti, French Polynesia	5 (1)	C (5)
Haapiti Valley, Moorea, French Polynesia	10 (1)	C (10)
Kaneohe, Oahu, Hawaii	20 (1)	C (20)
Martinique (captive bred F1 population, Nancy, Lorraine, France)	20 (1)	C (20)
Barbados	12 (1)	F (12)
TOTAL	**382 (15)**	**A (1) I (11)** **B (1) J (1)** **C (248) K (12)** **D (49) L (10)** **E (3) M (2)** **F (33) N (2)** **G (1) O (5)** **H (3)**

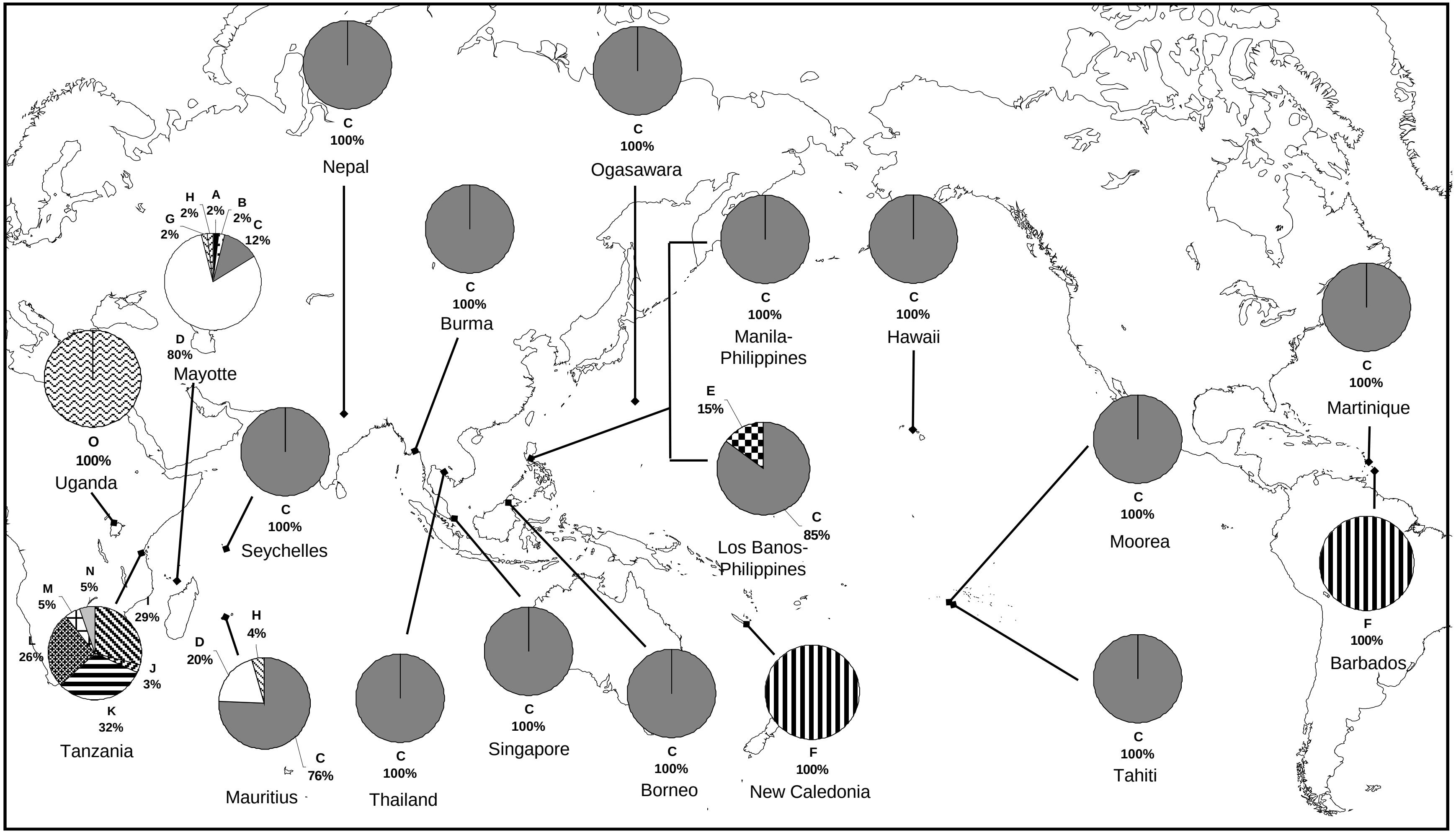

Figure 5.4: Distribution map of the 15 *Lissachatina fulica* populations and their 16S rRNA haplotypes.

5.3.2. Phylogenetic and network analyses of the 16S rRNA haplotypes

A neighbor-joining phylogenetic tree showing the interrelationships among the 15 haplotypes is shown in Figure 5.5 (see also alignment in Appendix 5.2, pp. 523-524). The tree was built using the optimal HKY85 model of DNA sequence evolution (see Appendix 5.3 for the LRT results, p. 525) and is rooted on *A. reticulata*. In general, there is very little phylogenetic structure within the tree and the interrelationships among the haplotypes remain largely unresolved. Nevertheless, two clades are apparent. The first comprises five of the six Tanzanian haplotypes (I, J, L, M and N) and is supported in 96% NJ bootstraps. The second comprises the pan-tropical (Mayotte) haplotype C, the East African (Mayotte) haplotype H, the Philippine haplotype E and the New Caledonian/Barbados haplotype F, albeit with only 54% NJ bootstrap support.

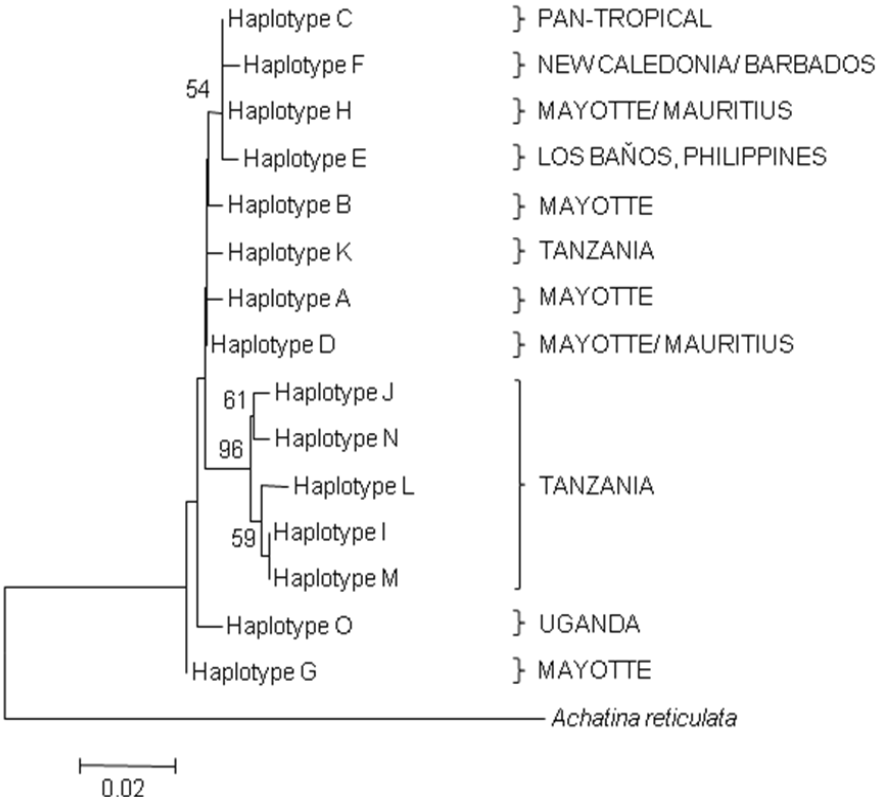

Figure 5.5: Neighbor-joining tree of the 15 *Achatina fulica* 16S rRNA haplotypes based on 293 unambiguously aligned nucleotide sites and using the optimal HKY model. The tree was rooted on the East African *Achatina reticulata*. Bootstrap values indicate the percentage support for individual branches based on 1000 replicates. Bootstrap values lower than 50% are not shown. The scale bar represents two substitutional changes per 100 nucleotide positions.

Median network analysis (Figure 5.6) showed that the Tanzanian haplotypes (I, J, L, M and N) that formed a clade in the NJ tree were also grouped together in the network analysis where they were linked to the Mayotte haplotype D with three substitutions. The Tanzanian haplotype K was also linked to haplotype D by two substitutional steps but was separated from the other Tanzanian haplotypes. Other haplotypes linked to the Mayotte haplotye D were the Ugandan haplotype O, Mayotte haplotype G and the pantropical (Mayotte) haplotype C with one substitutional step each. Mayotte haplotype H, in turn, was linked to haplotype C by one substitution. Mayotte haplotypes A and B probably originated independently by one substitutional step from a hypothetical haplotype, which, in turn, was probably only one substitutional step away from either D or H. The non-African haplotypes (E and F) arose through a single mutation each from the pantropical (Mayotte) haplotype C.

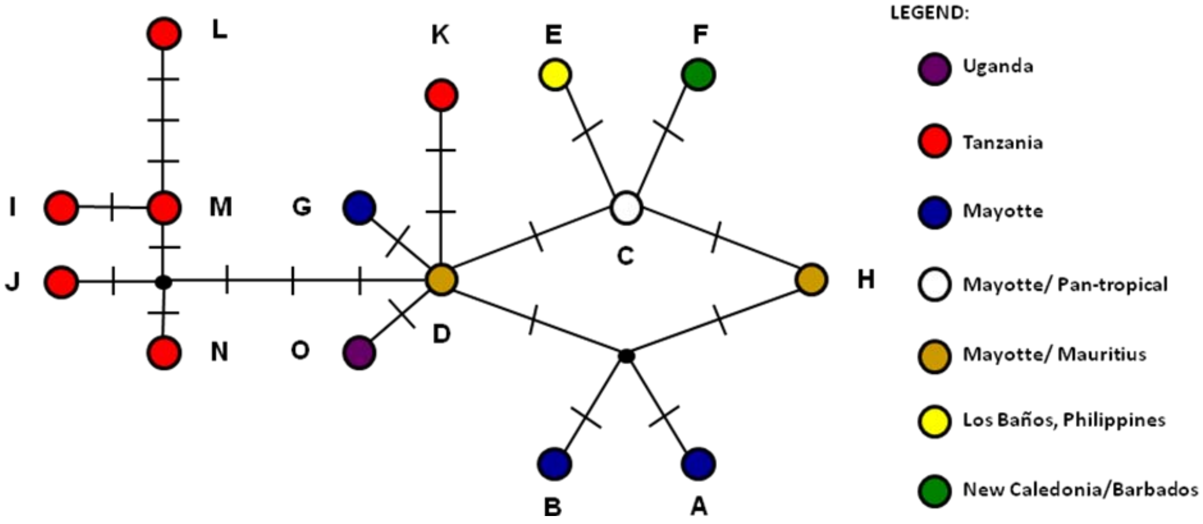

Figure 5.6: Median-joining network of the 15 *Achatina fulica* 16S haplotypes. Each mutation between haplotypes is represented by a bar. Unsampled putative haplotypes are represented by black dots.

5.4. Discussion

Results of the SSCP analysis, NJ tree and median-joining network indicated that all *Achatina fulica* populations outside East Africa and adjacent islands descended from haplotype C, presumably from a few individuals, as there is a complete absence of any other East African haplotypes among the non-African populations. Multiple introductions that could offset the lack of genetic variation as a consequence of founder events were therefore not detected. In India in particular, historical records suggest that the prevalence of *Achatina fulica* could be traced back to the introduction of two individuals from Mauritius to Calcutta by the malacologist William Benson in 1847 (Naggs, 1997). These snails were released by Benson's friend into his garden (Naggs,

1997) and then began to proliferate and slowly spread to the rest of India and later to Nepal (Raut & Barker, 2002; Budha & Naggs, 2008). Though samples were not available from India, particularly from Calcutta, they are expected to bear haplotype C because the population from Nepal also harbored this haplotype. Haplotype C was also the most common haplotype found in Mauritius, the source of Benson's *A. fulica*. The Giant African Land Snail was introduced separately to Sri Lanka from India and Mauritius by Oliver Collett sometime in 1900 (Mead, 1961; Naggs, 1997), and it would be worthwhile to investigate if *A. fulica* individuals in that island are also of the C haplotype or if they harbor other African haplotypes. It is highly likely, however, that the Sri Lankan *A fulica* would carry the C haplotype as the snail populations from Peninsular Malaysia were derived from Sri Lanka, and Peninsular Malaysia, in turn, became the source of the snail for Burma, Singapore and Thailand (Mead, 1961), all of which bear the C haplotype; Singapore also became the source of the snail for Borneo (Jarrett, 1931), and the population there also carried the C haplotype. A similar case to India also took place in Hawaii where the snails descended from two individuals introduced there from Taiwan (Formosa) in 1936 (Pemberton, 1938), which in turn got the snail from Singapore after 1917 (Mead, 1961). As the *A. fulica* populations in Hawaii and Singapore are of the C haplotype, *A. fulica* populations in Taiwan would therefore also be expected to harbor the C haplotype.

The median-joining network demonstrated that the non-African haplotypes E (Philippines) and F (New Caledonia and Barbados) were probably recent mutations and were derived from haplotype C. To date, haplotype E has only been found in the Philippines where it is present alongside the pantropical haplotype C. It is therefore likely that haplotype E originated in the Philippines and since we know that *Achatina fulica* was introduced in the Philippines in 1931 (Muniappan *et al.*, 1986) this would suggest that the single nucleotide substitution from C to E took place within the last 70 years or so.

The presence of F in areas that are far apart from each other such as New Caledonia in the Pacific and Barbados in the Caribbean would indicate that either both areas had the same source or that the snails from Barbados originated from New Caledonia as the snail was introduced earlier in New Caledonia (Lambert, 1974). A less likely possibility is that haplotype F arose independently by mutation in both places. Further sampling in New Caledonia would determine if the mutation from C to F took place there or elsewhere. To date, only haplotype F has been found in New Caledonia but so far sampling has been restricted to a single site in Noumea.

The relationship of the East African haplotypes from Tanzania and Uganda with Mayotte is less clear due to limited sampling in the region. It is believed that the Giant African Land Snail was introduced first in Madagascar from Kenya prior to 1800, and it is these Madagascan *A. fulica* snails that were eventually introduced to nearby islands (Bequaert, 1950; Raut & Barker, 2002) such as Mayotte. This raises some very important questions. Is haplotype C found in Madagascar and mainland East Africa? If so, then this would suggest that C was originally present in East Africa and was brought to nearby islands such as Mayotte. If C is *not* present in mainland East Africa, then this would indicate that this haplotype originated on islands off East Africa, possibly on Madagasacar or indeed even on Mayotte itself. This question also applies to the other Mayotte haplotypes. Are they also found in Madagascar and mainland East Africa? Clearly, sampling from East Africa and Madagascar is necessary in order to answer these questions and get a clearer picture of the pattern of genetic variation in *A. fulica* populations in East Africa.

The use in this study of a single mitochondrial gene marker such as the 16S rRNA was sufficient to show that all the non-African *Achatina fulica* populations were very closely related and are undergoing bottlenecking as measured by the reduction or loss of genetic variation due to founder events. Whether or not this observation extends to other genes warrants further investigation. Using different markers to measure genetic variation can lead to conflicting results because these markers evolve independently of each other or may have varying degrees of sensitivity. This was proven to be the case when the effectiveness of various molecular markers on native and introduced North American house finches (*Carpodacus mexicanus*) were compared. Hawley *et al.* (2008) found that AFLP, mitochondrial DNA RFLP and allozyme markers did not show statistically significant difference in the degree of variability between introduced and native finches whereas 12 microsatellite loci and ND2 mitochondrial sequences did. They recommended that rapidly evolving single-locus haploid mitochondrial markers be used in conjunction with multi-locus variable nuclear microsatellite markers to detect the presence of recent bottlenecks.

Whether the lack of genetic variation has any effect on the overall fitness of the *A. fulica* populations is another matter altogether. Mead (1979) noted that the snail frequently undergoes three phases after establishment in a new area: (1) an exponential increase characterized by large individuals; (2) a stable phase of variable duration; and (3) decline exemplified by small individuals. Civeyrel and Simberloff (1996) also cited similar patterns in other introduced species; these include the cane toad (*Bufo marinus*) in Australia, the red-billed leiothrix (*Leiothrix lutea*) in Oahu, Hawaii and the weasel (*Mustela nivalis*) in New Zealand. Mead (1979) speculated that the decline in *A. fulica* could be attributed to the snail's susceptibility to the bacterium *Aeromonas hydrophila*, which causes leucodermic lesions. He based his theory on a study by Dean *et al*. (1970)

in which the bacterium, then called *Aeromonas liquefaciens* but was later synonymised with *Aeromonas hydrophila* by Ewing & Hugh (1974), was isolated from the snails and a positive correlation was detected between the presence of the bacteria and the manifestation of leucodermic lesions. What leads to the susceptibility is unknown, but Raut & Barker (2002) cited two possible explanations. One is the breakdown of natural resistance caused by stress in a densely populated environment (Mead, 1979) and the other is the increased chance of transmission of the bacterium due to crowding (Civeyrel & Simberloff, 1996). An alternative explanation is the depletion of food supply as a result of high population density, leading to starvation of the snails and tmaking them more susceptible to bacterial infection (Civeyrel & Simberloff, 1996) or to any other disease-causing vector. Cowie (pers. comm.) offered yet another explanation in which he speculated that native and genetically diverse populations of *A. fulica* were naturally neither abundant nor large because they harboured the bacterium (or other disease agent). When the introduced populations were released from the disease agent pressure, it allowed them to become abundant and larger; eventually, however, the disease made its way to the new region and re-associated with the snails, reducing population density and snail size.

Whether or not the decline phenomenon observed in introduced *Achatina fulica* populations in many areas across the globe is a consequence of founder events is difficult to say. It should be noted that in general, the loss of genetic variation (i.e. heterozygosity and presence of rare alleles) may seriously affect the ability of future generations to adapt to changing environments and subsequently trigger a decline (Backeljau *et al.*, 2001). This was seen in the house finch, *Carpodacus mexicanus*, in which resistance to experimentally infected *Mycoplasma gallispectum* is associated with increasing multilocus heterozygosity in 12 microsatellites (Hawley *et al.*, 2005). This led Hawley *et al.* (2008) to speculate that the susceptibility of the house finch to the bacterium in its introduced range in eastern North America, the site of an epidemic in 1994, could be attributed to the reduced genetic variation of the introduced populations as a consequence of founder events. Indeed, their study (2008) revealed reduced genetic variability among the introduced populations of *C. mexicanus* as demonstrated by microsatellite and mitochondrial DNA data. A similar situation could also be taking place among global populations of *A. fulica* in which reduced heterozygosity or variability due to founder events could lead to susceptibility to bacteria or other disease-causing agents in the Giant African Land Snail.

As already mentioned in previously, this study is limited by the availability of sampling, and many crucial areas were not covered, particularly from East Africa (i.e. Kenya and Madagascar), the Indian subcontinent (Calcutta in India and Sri Lanka) and even in the Caribbean and South America (Brazil). The logical next step is to gather samples from these localities. Sampling from Kenya and Madagascar will most likely provide additional haplotypes not found in Uganda, Tanzania and Mayotte, which could give a clearer picture of the pattern of genetic variation in East Africa. Samples from Calcutta in India would determine if indeed the snails in India descended from two haplotype C individuals (if only C are found) or if multiple introductions took place (if other haplotypes are found). Likewise, samples from Sri Lanka would determine whether other haplotypes are present on the island, which could indicate more than one introduction. Sri Lanka is crucial as it served as a source of the Giant African Land Snail for some countries like Malaysia that ultimately became the source for many other countries. Additional sampling from the other Caribbean islands such as Guadeloupe could show if other areas also harbor haplotype F and if introduction occurred from different sources. The presence of *A. fulica* in Brazil is a result of recent introduction to raise snails for food (Paiva, 1999; Carvalho de Vasoncellos & Pile, 2001; Thiengo *et al.*, 2007) and was probably derived from Indonesia (Thiengo *et al.*, 2007). Sampling from either Brazil or Indonesia will determine whether the pantropical haplotype C is also present in these areas or whether the populations in these areas comprise other haplotypes. Other South American countries such as Colombia, Ecuador and Peru are also worth investigating to track the spread of the snail in the continent.

5.5. Summary

The extent of genetic diversity in *Achatina fulica* populations was investigated using single-stranded conformational polymorphism (SSCP) analysis. A fragment of the 16S rRNA gene found within the variable domain IV was used as marker for the SSCP analysis. Fifteen haplotypes were identified from populations of *A. fulica*, but only haplotype C emerged to spread across the globe. Two non-African haplotypes (E from the Philippines and F from New Caledonia and Barbados) were recent mutations derived from haplotype C as shown by the neighbor-joining phylogenetic and median-joining network analyses. Non-East African populations of *A. fulica* therefore exhibited a lack of genetic variation based on the 16S rRNA marker, implying bottlenecking has taken place in these populations.

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CHAPTER 6 - The SSU rRNA gene as a genetic marker for identifying infective 3^{rd} juvenile stage *Angiostrongylus cantonensis* from known gastropod intermediate hosts[1]

6.1. Introduction

The rat lungworm, *Angiostrongylus cantonensis* (Chen), is a nematode parasite of murid rodents (Ubelaker, 1986; Marquardt *et al.*, 2000). Its life cycle requires invertebrate intermediate hosts such as snails and slugs (Roberts & Janovy, 2005). The lungworm can also accidentally infect humans where it causes eosinophilic meningoencephalitis (EME) or neurologic angiostrongyliasis, a disease of the central nervous system that leads to headache, vomiting, nausea, neck stiffness and photophobia (Kliks & Palumbo, 1992; Senanayake *et al.*, 2003; see also Section 1.8.5 of Chapter 1, pp. 26-28). Humans become infected with the 3^{rd} juvenile stage *A. cantonensis* by handling infected snails (Wan & Weng, 2004) or by eating raw/undercooked infected snails or contaminated salad crops (Marquardt *et al.*, 2000). Reported cases of gastropod, rat and human infection reflect the wide geographic distribution of *A. cantonensis*, from East Africa and Madagascar to the Indian subcontinent, East and Southeast Asia, Australia, most islands in the Pacific (Kliks & Palumbo, 1992; Marquardt *et al.*, 2000) and the Caribbean (Raccurt *et al.*, 2003; Waugh *et al.*, 2005).

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[1] This chapter was published as “Fontanilla, I.K.C. and Wade, C.M. 2008. The small subunit (SSU) ribosomal (r) RNA gene as a genetic marker for identifying infective 3^{rd} juvenile stage *Angiostrongylus cantonensis*. Acta Tropica 105: 181-186.”

6.1.1. Problems with identifying nematodes: the angiostrongylids as examples

Accurately identifying medically important nematodes such as *A. cantonensis* is crucial in diagnosing and controlling the diseases that they cause (Gasser & Newton, 2000). However, it is difficult to identify worms to species level due to a lack of suitable morphological characters in both the adult (Newton *et al*., 1998a; Roberts & Janovy, 2005) and, more importantly, the infective juvenile stages (Newton *et al*., 1998a). Some examples of these medically important nematodes include various species of the hookworm *Ancylostoma* as well as the other hookworm *Necator americanus*, in which the juveniles of these worms, which are difficult to distinguish from one another, infect humans either through the oral route or by penetration of the skin and cause hookworm disease. Other examples include different species of *Strongyloides*, most notably *S. stercoralis*, whose juveniles infect humans by contact through contaminated water or soil and cause strongyloidiasis, leading to damage of the skin, lungs and intestines; juveniles of *Strongyloides* are also difficult to detect and identify (Roberts & Janovy, 2005).

Identification of members of the order Strongylida such as the angiostrongylids relies heavily on expert knowledge of the morphological characteristics of the copulatory bursa found only in adult males, which it uses to wrap around the body of the female during copulation (Newton *et al*., 1998a; Roberts & Janovy, 2005). For example, adult *A. cantonensis* can only be distinguished from the closely related species *A. vasorum* (Baillet) by differences in the copulatory bursa; in *A. cantonensis* the lateral rays arise from a single trunk whereas in *A. vasorum* the lateral rays arise separately (see Fig. 1.3 in Chapter 1, p. 23) (Ubelaker, 1986). Complicating the identification of nematodes is the ambiguity of morphological characters of the juvenile worms (Newton *et al*., 1998a). For instance, the infective 3rd juvenile stages of *A. cantonensis* and *A.*

vasorum are differentiated only through the fine point termination of the tail of the former and the digitiform termination of the tail in the latter (Ash, 1970, see Fig. 6.1). Whether juveniles of other *Angiostrongylus* species can also be distinguished based on differences in the tail is not known, and some of these species may possibly exhibit similar tail terminations to those of either *A. cantonensis* or *A. vasorum*. In order to identify these juvenile angiostrongylids with certainty, they must be fed to laboratory mice until such time the adults can be observed (Wallace & Rosen, 1969). However, this process takes time, is tedious and does not guarantee that all the juveniles will mature into adults. A viable alternative is clearly needed to identify the 3rd juvenile stage *A. cantonensis*.

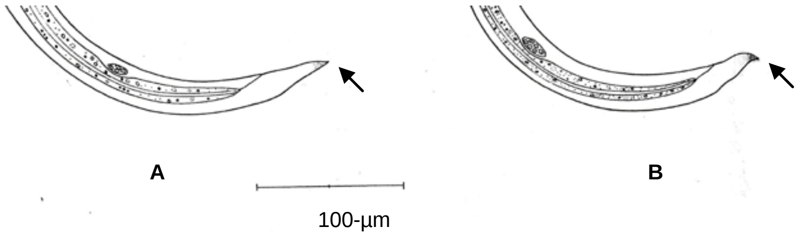


Figure 6.1: Posterior portion of the infective third juvenile stage of **(A)** *Angiostrongylus cantonensis* and **(B)** *Angiostrongylus vasorum*. Arrows indicate the type of termination of the tail for each nematode (e.g. fine point for *A. cantonensis* and digitiform, not fine point for *A. vasorum*). Taken from Ash (1970).

6.1.2. Identifying nematodes using molecular markers

In lieu of morphological expertise, the problem of identifying nematodes accurately and rapidly can be addressed by using various molecular genetic markers that are applicable at any stage of a nematode's development. Examples of these molecular markers are nuclear genes such as the ribosomal RNA genes and their internal transcribed spacers (ITS) (Newton *et al.*, 1998a; Gasser, 1999; Floyd *et al.*, 2002; Blaxter *et al.*, 2005) and mitochondrial genes like cytochrome c oxidase I (Caldeira *et* *al.*, 2003; Hebert *et al.*, 2003; Blaxter *et al.*, 2005). Using these markers requires PCR-based techniques that include polymerase chain reaction-restriction fragment length polymorphisms (PCR-RFLP) analysis and PCR-direct sequencing (Gasser, 1999).

In PCR-RFLP, PCR products from DNA target regions are digested by restriction enzymes. Depending on the sequence variations within the restriction sites that may result in either their recognition or non-recognition by restriction enzymes, fragments of varying lengths will be produced among different species. Through gel electrophoresis, each species can potentially generate a unique banding profile based on these fragments (Gasser, 1999). Newton *et al.* (1998a) employed this technique on the ITS-2 region between the 5.8S and the large subunit (LSU) ribosomal (r) RNA genes to characterize 24 previously described nematode species in the order Strongylida that parasitise livestock. The banding patterns they obtained from both adults and 3rd stage juveniles were unique for each of the species they surveyed except for *Cooperia oncophora* and *C. surnabada*. The ITS-2 can therefore be used to identify most of these parasites at specific developmental stages at which morphological characters are ambiguous. In another study, Caldeira *et al.* (2003) also used PCR-RFLP on the ITS2 as well as the mitochondrial cytochrome c oxidase subunit 1 to distinguish closely related taxa in the Angiostrongylidae such as *A. cantonensis, A. costaricensis* and *A. vasorum* using 3rd stage juveniles and adults. However, this technique cannot detect nucleotide substitutions outside the restriction site. Closely related species may share restriction sites but differ outside these restriction sites, thereby producing identical banding patterns after gel electrophoresis.

A more reliable molecular method of identifying nematodes is direct sequencing (Bhadury *et al.*, 2006). The ribosomal genes, which are advantageous for several reasons, have often been used for this purpose. First, they consist of highly variable and phylogenetically informative regions interspersed with conserved regions that are suitable for primer-binding sites (Palumbi, 1996). Second, they are present as multiple copies of the same sequence (~50-100 copies in nematodes) arranged in tandem arrays across the genome, thus making them easier to PCR amplify (Floyd *et al.*, 2002). Finally, they show very little variation within a species due to concerted evolution (Gasser & Newton, 2000; Floyd *et al.*, 2002). When Newton *et al.* (1998a) generated the same banding profile for *Cooperia oncophora* and *C. surnabada* using PCR-RFLP of the ITS-2, they sequenced this region and discovered that these two taxa have identical sequences, which supports their hypothesis that they may in fact belong to the same species (Newton *et al.*, 1998b). In another example, Bhadury *et al.* (2006) employed a marker near the 5' end of the SSU rRNA gene to rapidly identify marine nematodes collected from southwest England. When they compared their sequences to public databases and conducted phylogenetic analyses, over 97% of their sequences corresponded with the correct species designation based on their morphological identification, and they concluded that amplifying and sequencing a specific region of the SSU rRNA gene could be utilized to rapidly identify nematodes. They accounted for the 3% misidentification either as DNA contamination or distortion of morphological features during ethanol preservation of the nematodes. In another study, Santos *et al.* (2006) successfully employed direct sequencing of the SSU rRNA to detect and identify nematode species in the family Anisakidae (i.e. *Anisakis simplex*, *Contraceacum maculates*, *Pseudoterranova decipiens* and *Hysterothylacium aduncus*) that parasitise the commercially important sardine *Sardina pilchardus*. Humans get infected by the juvenile stages of these nematodes by eating raw or inadequately processed fish. Still other studies by Qvarnstrom *et al*. (2007) and Hollingsworth *et al.* (2007), which were done concurrently with this study, used a 1134 bp fragment of the

SSU to successfully detect by direct sequencing the presence of *A. cantonensis* from tissue and mucus secretions from gastropod intermediate hosts, primarily the semi-slug *Parmarion* cf. *martensi* in Hawaii. However, only *A. cantonensis* (Carreno & Nadler, 2003) and *A. vasorum* (Chilton *et al*., 2006) SSU sequences were available to Qvarnstrom *et al*. (2007) and Hollingsworth *et al.* (2007), and their studies were therefore unable to exclude the possibility of detecting other closely related *Angiostrongylus* species. Moreover, sequencing the entire SSU rRNA gene to identify nematodes is not practical if a shorter fragment will suffice. Floyd *et al.* (2002) noted that 50% of the variations found in the SSU rRNA gene of nematodes occur in the first one third from the 5' end (approximately 450 bp), and sequences available for this region for many nematodes in GenBank could distinguish different species. They also considered individuals to belong to the same species if their sequences of the 5' end of the SSU rRNA gene are more than 99.5% identical.

6.1.3. Objectives of the study

The main objective of this study was to develop a quick and reliable molecular method for the identification of infective 3rd juvenile stage *Angiostrongylus cantonensis* based on PCR-direct sequencing a fragment of the small subunit (SSU) ribosomal (r) RNA gene. The SSU rRNA gene was chosen because it is well represented in nematodes in public databases (Floyd *et al.*, 2002) and is variable enough to permit differentiation of closely related nematode species (Gasser & Newton, 2000). The SSU sequence of *A. cantonensis* (voucher specimen no. 92610 of the US National Parasite Collection; identified using published descriptions) became available in Genbank during the course of my PhD studies (Accession AY295804, Carreno & Nadler, 2003) while that of *A. vasorum* (Accession AJ920365, Chilton *et al.*, 2006) became available after I had already sequenced another individual from the same species (see below). However, there are no full length SSU sequences for many other closely related species that could be mistaken for *A. cantonensis*. To ascertain whether the SSU rRNA gene is indeed suitable to distinguish *A. cantonensis,* the full length SSU for several species of *Angiostrongylus* was sequenced and a suitable variable marker region within the gene determined. In particular, species closely related to *A. cantonensis* were chosen, such as those grouped together by Ubelaker (1986) under *Parastrongylus* based on the morphological characteristics of the male copulatory bursa and host specificity. To test the efficacy of the marker for identifying the 3rd juvenile stage *A. cantonensis,* worms were extracted and identified from gastropod intermediate hosts from a trial area, the Philippines, particularly in Manila, which is known for its prevalence of the parasite (De Leon & Saulog, 1965; Nishimura & Yogore, 1965) and its suburb Quezon City (Salazar & Cabrera, 1969). Furthermore, Salazar & Cabrera (1969) positively identified 3rd juvenile stage *A. cantonensis* in several gastropod intermediate hosts such as the widespread giant African land snail, *Achatina fulica* (with an infection rate of 4.52%), and the common black slug *Laevicaulis alte* (18.18% infected).

As this study resulted in new SSU sequences for several *Angiostrongylus* species, and with two other angiostrongylid SSU sequences already available in GenBank (Carreno & Nadler, 2003; Chilton *et al.*, 2006), a second objective was to conduct phylogenetic analyses of the Angiostrongylidae. These analyses had a dual purpose: to test the monophyly of the group as well as to test Ubelaker's (1986) hypothesis that some members of the genus *Angiostrongylus,* including *A. cantonensis,* are distinct and should be reclassified under the genus *Parastrongylus*.

6.2. Materials and methods

6.2.1. Sequence variation in angiostrongylid worms

Nearly the entire length of the SSU rRNA gene was obtained for four species of Angiostrongylidae: *Angiostrongylus costaricensis, A. dujardini, A. malaysiensis* and *A. vasorum*. These species were identified, based on published descriptions of the morphological characters of the adult and their definitive hosts, by the taxonomic experts listed in Table 6.1

Table 6.1: Detailed information of the angiostrongylid worms used in this study.

Specimen	Host	Location	Collector/Provider
Angiostrongylus costaricensis	*Sigmodon hispidus* (cotton rat) & *Biomphalaria glabrata* (blood fluke planorbid snail)	Maintained in the Department of Parasitology, Hamamatsu University School of Medicine, Japan	Akira Ishih
Angiostrongylus dujardini	*Clethrionomys glareolus* (red-backed mouse)	Prades, Pyrenees-Orientales, France	Serge Morand & Carlos Feliu
Angiostrongylus malaysiensis	*Rattus tiomanicus* (Malaysian field rat)	Endau-Rompin National Park, Johor, Malaysia	Siti Nursheena Mohd Zain
Angiostrongylus vasorum	*Vulpes vulpes* (common fox)	Swansea, Great Britain	Eric Morgan

With the exception of *A. vasorum*, the DNA of which was provided by Eric Morgan of the University of Bristol School of Biological Sciences, all other samples were subjected to DNA extraction following the NaOH direct lysis protocol of Floyd *et al.* (2002) (see Section 2.1.4 of Chapter 2, pp. 41-42).

For the PCR, the 4 overlapping primer sets (see Section 2.2.1.2 of Chapter 2, pp. 53-54) of Blaxter *et al.* (1998) were used to amplify nearly the entire fragment (approximately 1670 nucleotides) of the SSU rDNA gene. PCR amplification, gel migration and purification of PCR products from agarose gels were done as previously described (see Sections 2.2.1.2 – 2.4 of Chapter 2, pp. 53-59). Both sense and anti-sense strands were sequenced directly using an Applied Biosystems 3730 DNA sequencer and BigDye version 3.1 termination cycle sequencing chemistry (see Section 2.6 of Chapter 2, pp. 59-61).

Sequences were assembled using the STADEN package version 1.5.3 (Staden *et al.*, 2000) and aligned manually within the Genetic Data Environment (GDE) Version 2.2 (Smith *et al.*, 1994) together with the previously published SSU sequence of *Angiostrongylus cantonensis* (Carreno & Nadler, 2003). The primer set that amplified the most variable region that is also unique to *A. cantonensis* was chosen to identify the parasite.

6.2.2. Using the SSU rRNA gene to identify *Angiostrongylus cantonensis* in a trial population

The widely distributed Giant African Land Snail, *Achatina fulica*, and the black slug *Laevicaulis alte* were sampled for *A. cantonensis* from a grassy area within the College of Science complex at the University of the Philippines, Diliman campus in Quezon City, Philippines (samples collected by I. Fontanilla). *Angiostrongylus cantonensis* is common in Manila and its suburb Quezon City. Moreover, as rats frequent the Dilman collection site, snails and slugs were highly likely to be infected with *A. cantonensis*.

Snails and slugs were cut into small pieces and digested overnight in a Petri dish containing Ash's (1970) digestive fluid (0.7% pepsin in 0.5% HCl). Individual nematodes were collected under a dissecting microscope using a yellow-tipped pipette

(20-200-μl capacity) and transferred into wells containing 100-μl TE buffer in a 96-well microtitre plate. The worms were then stored in a -20 ^{0}C freezer until use.

DNA extraction, PCR amplification and direct sequencing were undertaken for each nematode using the same protocols described in Section 6.2.1 except that only the primer set that amplified the most variable region among the *Angiostrongylus* species was used (Primer Set A – see results). In cases in which the PCR amplifies products from both the nematode and the snail or slug host, the nematode band can be clearly distinguished as it is smaller (~480 bp) than the snail/slug host band (~510 bp). Once the purified PCR products were obtained, only the antisense strand (amplified by SSU_R09 of Set A) was directly sequenced.

Nematode sequences were processed using the STADEN package, after which distinct nematode sequences were identified and a BLAST search in GenBank was carried out to determine an exact match or identify the closest similarity for each sequence. To complement the BLAST results, a neighbor-joining (NJ) tree based on 376 unambiguously aligned nucleotide sites was generated in order to illustrate the phylogenetic position of the nematode sequences relative to all known nematode sequences in GenBank (GB Release No. 157, see Appendix 6.1, pp 526-536) as well as the new *Angiostrongylus* sequences obtained in this study. The phylogeny was rooted on 4 non-nematode taxa: *Chordodes morgani* (AF036639, Blaxter *et al.*, 1998) and *Gordius aquaticus* (X87985, Winnepenninckx *et al.*, 1995) of Phylum Nematomorpha, *Priapulus caudatus* (Z38009, Aleshin *et al.*, 1998) of Phylum Priapulida, and *Brachionus plicatis* (U49911, Aguinaldo *et al.*, 1997) of Phylum Rotifera. (See Appendix 6.2, pp 537-603 for the Nematoda alignment). The optimal model for DNA sequence evolution was determined using likelihood by estimating the log likelihood scores in PAUP* for the JC69 (Jukes & Cantor, 1969), F81 (Felsenstein, 1981), K2P

(Kimura, 1980), HKY85 (Hasegawa *et al.*, 1985), TN93 (Tamura & Nei, 1993) and the GTR (Rodriguez *et al.*, 1990) models as well as their variants that incorporated gamma distributed rates (Γ) (Yang, 1993) followed by comparing these scores for significant differences using the Likelihood Ratio Test (LRT) as described in Section 2.9.5 of Chapter 2, pp. 73-77). Bootstrap resampling (Felsenstein, 1985) with 1000 replicates was carried out. Once the phylogenetic positions of the nematode sequences were identified with specific clades, other nematode taxa that do not belong to these clades were removed in order to construct a smaller NJ tree based on the same fragment (376 sites) and using the best model with optimised parameters; however, a suitable outgroup [*Plectus acuminatus* (AF037628, Blaxter *et al.*, 1998), which falls immediately outside of the Rhabditida clade of Meldal *et al.* (2006) –see results] was retained.

6.2.3. Phylogeny of the Angiostrongylidae

In order to investigate relationships among the Angiostrongylidae, the full length SSU rRNA of all *Angiostrongylus* species that were not sequenced prior to this study as well as *A. cantonensis* from Carreno & Nadler (2003) were aligned with the rest of the sub-order Metastrongylina/ superfamily Metastrongyloidea and phylogenetic trees constructed. Two taxa from the Trichostrongylina, which falls immediately outside of the Metastrongylina based on phylogenetic studies of the Metastrongyloidea (Carreno & Nadler, 2003) and the Strongylida (Chilton *et al.*, 2006), were included in the alignment to serve as outgroups (Table 6.2). Phylogenies were constructed from the aligned dataset using the model based maximum likelihood (ML), Bayesian inference (BI) and neighbor-joining (NJ) methods as well as the non-model based maximum parsimony (MP) method (Section 2.9.8 of Chapter 2, pp. 82-85). A total of 1628 unambiguously aligned nucleotide sites were used for the phylogenies. The sequences were first checked for base composition bias using the Chi square test in PAUP* (version 4.0b10) program (Swofford, 2002). The optimal model for DNA sequence evolution was then determined for the model-based methods. Bootstrap resampling (Felsenstein, 1985) with 1000 replicates for MP and NJ and 100 replicates for ML was also carried out. Bayesian inference (BI) was performed on the MrBayes (version 3.1.2) package (Ronquist & Huelsenbeck, 2003) using four chains of Markov Chain Monte Carlo algorithm to explore the tree space for 2 million generations with sampling at every 100 generations. The heating parameter was set to 0.125 to ensure adequate chain swapping. A consensus tree was constructed using the last 1000 trees (burnin=19001 samples).

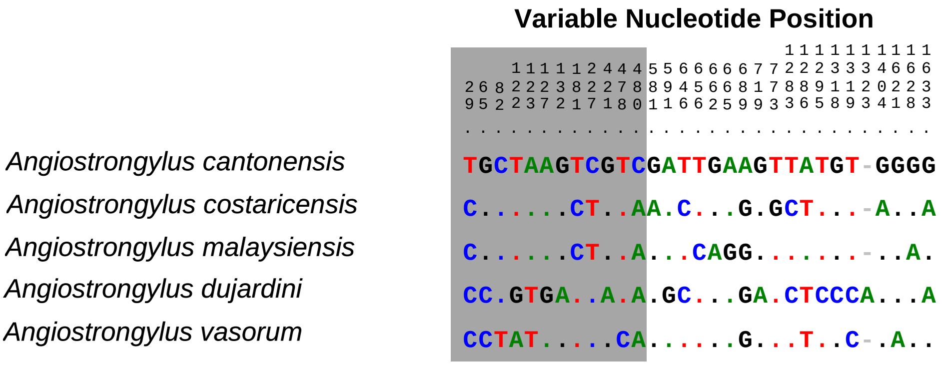
Table 6.2: Taxa used for the sequence analysis of the angiostrongylid worms.

Sub-order	Family	Species	Reference	GenBank Accession #
Metastrongylina (Superfamily Metastrongyloidea)	Angiostrongylidae	*Angiostrongylus costaricensis* (Morera & Cespedes, 1971)	This study	EF514913
		Angiostrongylus dujardini (Drozdz & Doby, 1969)	This study	EF514915
		Angiostrongylus malaysiensis (Bhaibulaya & Cross, 1971)	This study	EF514914
		Angiostrongylus cantonensis (Chen, 1935)	Carreno & Nadler (2003)	AY295804
		Angiostrongylus vasorum (Baillet, 1866)	This study	EF514916
		Aelurostrongylus abstrusus (Raillet, 1898)	Chilton *et al.* (2006)	AJ920366
		Didelphostrongylus hayesi Prestwood, 1976	Carreno & Nadler (2003)	AY295806
	Crenosomatidae	*Crenosoma mephitidis* Hobmaier, 1941	Carreno & Nadler (2003)	AY295805
		Otostrongylus circumlitus (Railliet, 1899)	Carreno & Nadler (2003)	AY295813
		Troglostrongylus wilsoni (Stough, 1953)	Carreno & Nadler (2003)	AY295820
	Filaroididae	*Filaroides martis* (Werner, 1782)	Carreno & Nadler (2003)	AY295807
		Oslerus osleri (Cobbold, 1889)	Carreno & Nadler (2003)	AY295812
		Parafilaroides decorus Dougherty & Herman, 1947	Carreno & Nadler (2003)	AY295814
	Metastrongylidae	*Metastrongylus salmi* (Gedoelst, 1823)	Carreno & Nadler (2003)	AY295809
	Protostrongylidae	*Muellerius capillaris* (Müeller, 1889)	Carreno & Nadler (2003)	AY295810
		Parelaphostrongylus odocoilei (Hobmaier & Hobmaier, 1934)	Carreno & Nadler (2003)	AY295815
	Pseudaliidae	*Halocercus invaginatus* (Quekett, 1841)	Carreno & Nadler (2003)	AY295808
		Pseudalius inflexus (Rudolphi, 1808)	Carreno & Nadler (2003)	AY295816
		Stenurus minor (Kühn, 1829)	Carreno & Nadler (2003)	AY295817
		Torynurus convolutus (Kühn, 1829)	Carreno & Nadler (2003)	AY295818
	Skrjabingylidae	*Skrjabingylus chitwoodrum* Hill, 1939	Carreno & Nadler (2003)	AY295819
Trichostrongylina (Superfamily Trichostrongylina) --OUTGROUP--	Molineidae	*Nematodirus battus* (Crofton and Thomas, 1951)	Zarlenga *et al.* (1994)	U01230
	Heligmonellidae	*Nippostrongylus brasiliensis* (Travassos, 1914)	Blaxter *et al.* (1998)	AF036597

6.3. Results

6.3.1. Sequence variation in the angiostrongylid worms

When the sequences of all five *Angiostrongylus* species available to date (including the four new *Angiostrongylus* sequences obtained in this study) were compared, a total of 31 variable sites were found, including an indel at position 1323 (Fig. 6.2). A pairwise comparison of the number of differences between any two *Angiostrongylus* species (Table 6.3) reveals that the least number of differences (9) was found between *A. cantonensis* and *A. malaysiensis* whereas the greatest number of differences (22) was seen between *A. malaysiensis* and *A. dujardini*. The sequences of the SSU rRNA clearly demonstrate that *A. cantonensis* has a distinct sequence that could be used to distinguish it from the other angiostrongylid worms in this study. Furthermore, 12 out of the 31 sites (or more than a third of the total) were within the first 480 bp from the 5' end. Moreover, *A. cantonensis* is distinct from all other *Angiostrongylus* species in this 480 bp 5' region. These findings demonstrate that the first 480 bp fragment of the SSU rRNA gene, which is amplified by primer Set A (see Section 2.2.1.2, pp. 53-54, and Table 2.6, p. 54 of Chapter 2), is a suitable marker to identify *A. cantonensis* and set it apart from other *Angiostrongylus* species sequenced to date, including three of its closest relatives, *A. costaricensis*, *A. dujardini* and *A. malaysiensis*, based on the morphology of the copulatory bursa (Ubelaker, 1986).



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                                                      Variable Nucleotide Position
                                                                              1111111111
                                           111112444556666677222333466 6
                                        2682223822788945668178891120223
                                        9522372171801166259933658934183
                                        ...............................
Angiostrongylus cantonensis             TGCTAAGTCGTCGATTGAAGTTATGT-GGGG
Angiostrongylus costaricensis           C......CT..AA.C...G.GCT...-A..A
Angiostrongylus malaysiensis            C......CT..A...CAGG.......-..A.
Angiostrongylus dujardini               CC.GTGA..A.A.GC...GA.CTCCCA...A
Angiostrongylus vasorum                 CCTAT....CA......G...T..C-.A..
```

Figure 6.2: Variable sites across the SSU rDNA region for the previously sequenced *Angiostrongylus cantonensis* (Carreno & Nadler, 2003) and the four other angiostrongylid worms sequenced in this study. The number shown directly above each site pertains to the variable site relative to the SSU rRNA sequence of *A. cantonensis* (GenBank AY295804). The grey area corresponds to the 480 bp marker used for this study.

Table 6.3: Matrix showing the number of differences between any two *Angiostrongylus* species**.**

	A. cantonensis	***A. costaricensis***	***A. malaysiensis***	***A. dujardini***
A. costaricensis	12			
A. malaysiensis	9	11		
A. dujardini	19	16	22	
A. vasorum	11	15	14	16

6.3.2. Using the SSU rRNA gene to identify *Angiostrongylus cantonensis* in a trial population

In total, 27 nematodes were extracted from 15 *Achatina fulica* individuals (with 6 nematodes) and 19 *Laevicaulis alte* individuals (with 21 nematodes) from the University of the Philippines, Diliman campus in Quezon City. The 480 bp fragment at the 5' end of the SSU rRNA gene identified as a suitable marker for the discrimination of *A. cantonensis* (see Section 6.3.2, fragment amplified by Primer Set A) was then amplified for each nematode extracted. The results yielded two distinct nematode sequences (Philippine Sequences 1 and 2). Table 6.4 lists the distribution of these nematode sequences.

Table 6.4: Summary of the distribution of the two Philippine nematode sequences from the University of the Philippines, Diliman campus in Quezon City.

Nematode sequence	**Gastropod host**	**Number of nematodes**
Philippine Sequence 1	*Achatina fulica*	1
	Laevicaulis alte	20
Philippine Sequence 2	*Achatina fulica*	5
	Laevicaulis alte	1

The two Philippine nematode sequences were then subjected to a BLAST search in GenBank (GB Release No. 157, 22 December 2006), to identify an exact match or closest identity to a named nematode species. BLAST results showed Philippine Sequence 1 is identical to *Angiostrongylus cantonensis*. On the other hand, Philippine Sequence 2 did not match any named taxon in GenBank based on BLAST results but can only be assigned to its closest sequence identity to a named nematode species, which is *Oslerus osleri*, a dog lungworm, at 99% BLAST identity; since the value is less than 99.5% to be considered the same species as *O. osleri* based on Floyd *et al.* (2002), the exact species identification of Philippine Sequence 2 could therefore not be known as of GB Release No. 157.

To complement the BLAST results, a neighbor-joining tree of the Nematoda was generated in order to illustrate the phylogenetic position of the new nematode sequences relative to all 349 nematode taxa having at least the first 480 nucleotides of the 5’ end of the SSU rRNA in GenBank (GB Release No. 157) as well as the new *Angiostrongylus* sequences obtained in this study. A GTR+Γ model was used to correct distances for multiple hits after it was determined to be the best model (see Appendix 6.3A, p. 604). As this phylogeny is based on a small marker intended for barcoding purposes, it should not be expected to accurately show the deep-level evolutionary relationships amongst the nematodes (see Hajibabaei *et al.*, 2007 for a discussion of the limitations of “barcode” markers in phylogenetic studies). Nevertheless, the phylogeny clearly demonstrates that the two Philippine sequences and all the *Angiostrongylus* taxa fall within the Rhabditida clade (as defined by Meldal *et al.*, 2006). Another NJ phylogeny of the same gene fragment (376 nucleotide sites) was then constructed (Fig. 6.3B) using 229 rhabditid taxa and rooted on the plectid nematode *Plectus acuminatus*. A GTR+Γ model was determined to be the best model and was subsequently used for this analysis (see Appendix 6.3B, p. 604). The two Philippine nematode sequences and the *Angiostrongylus* taxa all fall within the Strongyloidea. Philippine Sequence 1 clusters with *Angiostrongylus cantonensis* (AY295804, Carreno & Nadler, 2003) with 100% BLAST identity. Philippine Sequence 2 clusters with *Oslerus osleri* (AY295812, Carreno & Nadler, 2003) with 99% BLAST identity.

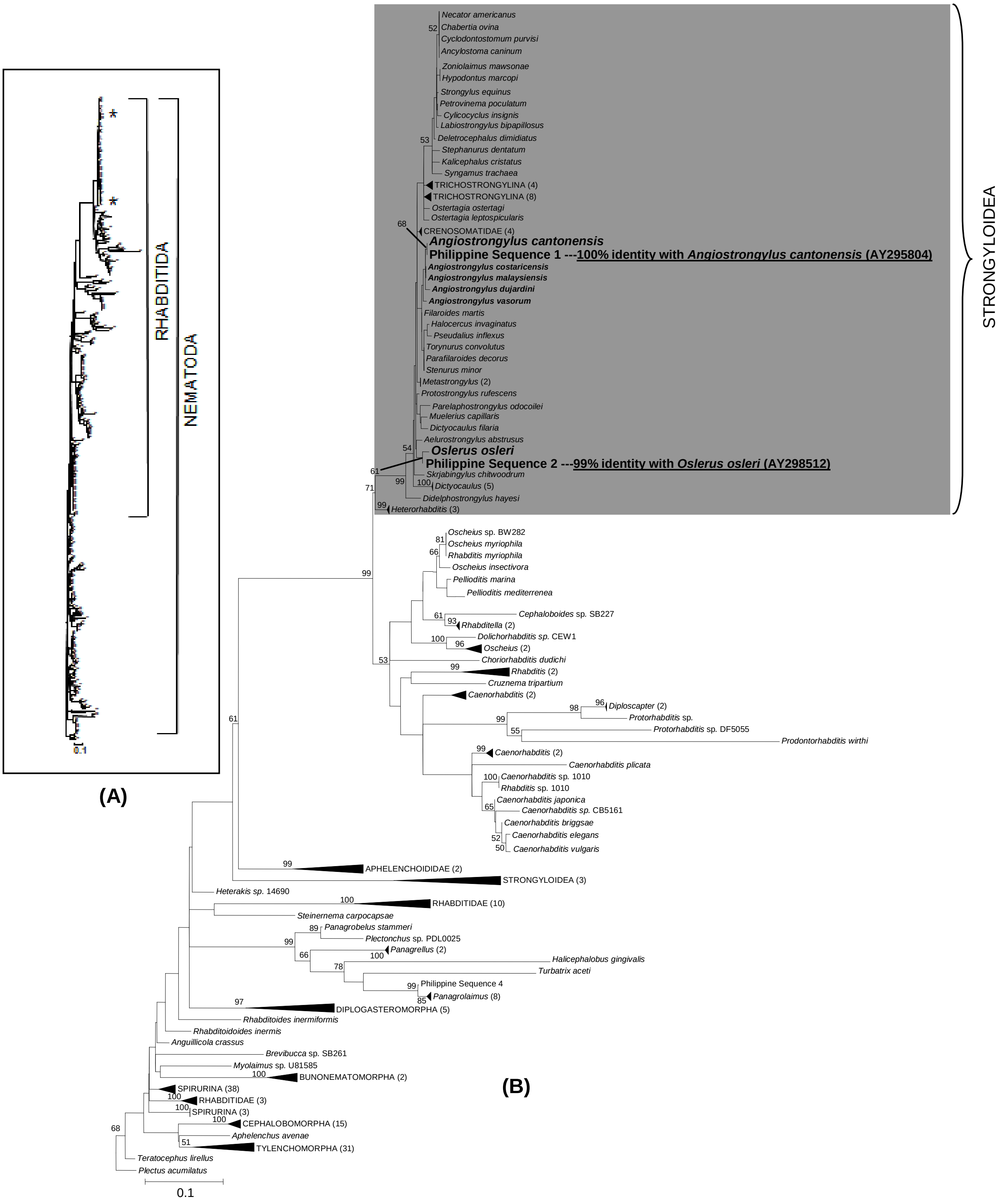


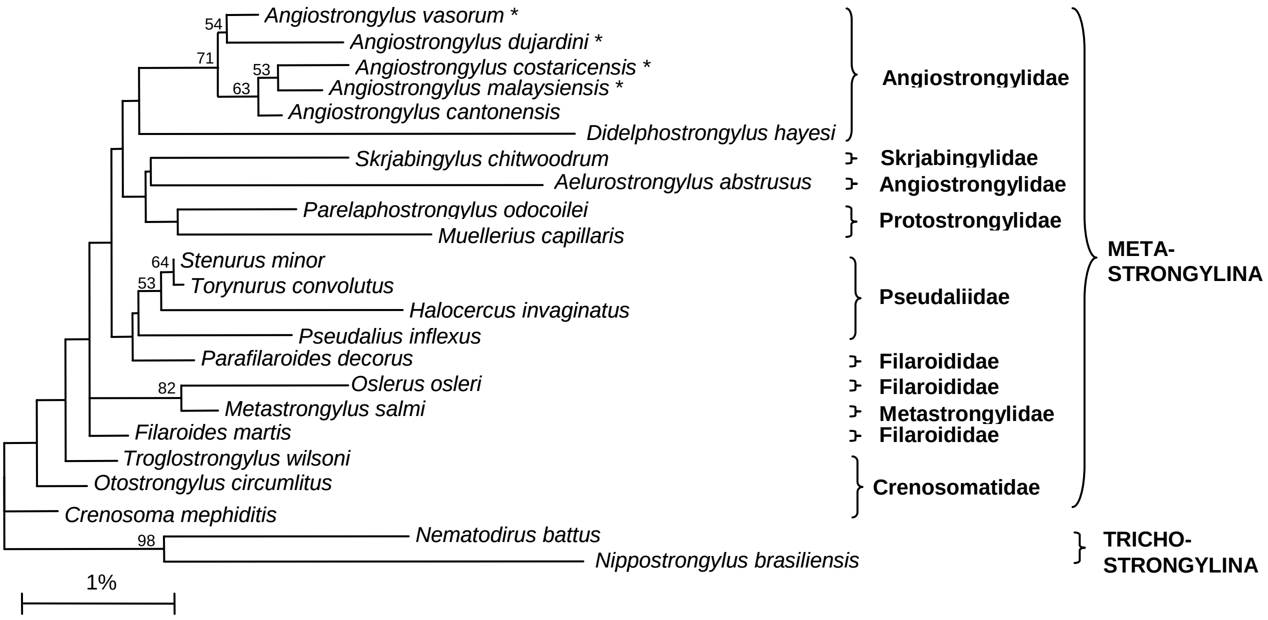
Figure 6.3: Neighbor-joining (NJ) phylogenetic trees based on 376 unambiguously aligned nucleotide sties of the SSU rRNA gene. **(A)** NJ tree of the Nematoda (349 taxa excluding the new nematode sequences from the Philippines) rooted on 4 non-nematode taxa: *Chordodes morgani* (Nematomorpha), *Gordius aquaticus* (Nematomorpha), *Priapulus caudatus* (Priapulida) and *Brachionus plicatis* (Rotifera). Both Philippine nematode sequences, as indicated by (*), fall within the Rhabditida clade. The scale bar shows one nucleotide change per ten nucleotide positions. **(B)** NJ tree of the Rhabditida (229 taxa excluding Philippine sequences) from (A), which is rooted on the nematode plectid worm *Plectus acuminatus*, and showing the positions (indicated by lines) of the 7 Philippine nematode sequences as well as their GenBank BLAST results from Table 6.6. Bootstrap values indicate the percentage support for individual branches based on 1000 replicates. Bootstrap values lower than 50% are not shown. Numbers in parentheses denote the number of species within a clade.

6.3.3. Phylogeny of the Angiostrongylidae

Phylogenetic analyses were undertaken to determine the relationships among the *Angiostrongylus* species sequenced to date (including the four angiostrongylid species sequenced for the first time in this study) and to determine the phylogenetic position of the Angiostrongylidae within the Sub-order Metastrongylina/ Superfamily Metastrongyloidea. (See alignment on Appendix 6.4, pp. 605-615.) Tests for base composition biases using the Chi square test in PAUP* showed no composition bias (P=1.0). GTR+Γ was determined to be the best model (Appendix 6.5, p. 616) and was subsequently used for tree building in the model-based tree construction methods (ML, BI and NJ).

The maximum likelihood (ML), Bayesian inference (BI), neighbor-joining (NJ) and maximum parsimony (MP) phylogenies are shown in Figure 6.4. The trees were constructed using 1628 unambiguously aligned nucleotide sites and were rooted on the trichostrongylids *Nematodirus battus* (GenBank U01230, Zarlenga *et al.*, 1994) and *Nippostrongylus brasiliensis* (Genbank AF036597, Blaxter *et al.*, 1998).

Figure 6.4: (See next two pages.) Phylogenetic trees of the angiostrongylids and worms in other families of the sub-order Metastrongylina based on the SSU rRNA gene using (**A**) maximum likelihood, (**B**) Bayesian analysis, (**C**) neighbor-joining and (**D**) maximum parsimony based on majority rule consensus of 3 equally parsimonious trees. The phylogenies are constructed from 1628 unambiguously aligned nucleotide sites and are rooted on the trichostrongylid worms *Nematodirus battus* (GenBank U01230) and *Nippostrongylus brasiliensis* (Genbank AF036597). Bootstrap values in (**A**) indicate the percentage support for individual branches based on 100 replicates. Bootstrap values lower than 50% are not shown. Bayesian posterior probabilities in (**B**) indicate support for individual branches in the Bayesian analysis based on the last 1000 trees. Posterior probabilites lower than 0.7 are not shown. Bootstrap values in (**C**) and (**D**) indicate the percentage support for individual branches based on 1000 replicates. The scale bars for (**A**), (**B**) and (**C**) represent one substitutional change per 100 nucleotide positions. *Angiostrongylus* species not sequenced in previous studies are highlighted with (*).


Angiostrongylus vasorum *
Angiostrongylus dujardini *
Angiostrongylus costaricensis *
Angiostrongylus malaysiensis *
Angiostrongylus cantonensis
Didelphostrongylus hayesi
Skrjabingylus chitwoodrum
Aelurostrongylus abstrusus
Parelaphostrongylus odocoilei
Muellerius capillaris
Stenurus minor
Torynurus convolutus
Halocercus invaginatus
Pseudalius inflexus
Parafilaroides decorus
Oslerus osleri
Metastrongylus salmi
Filaroides martis
Troglostrongylus wilsoni
Otostrongylus circumlitus
Crenosoma mephiditis
Nematodirus battus
Nippostrongylus brasiliensis
54
71
53
63
64
53
82
98
1%
Angiostrongylidae
Skrjabingylidae
Angiostrongylidae
Protostrongylidae
Pseudaliidae
Filaroididae
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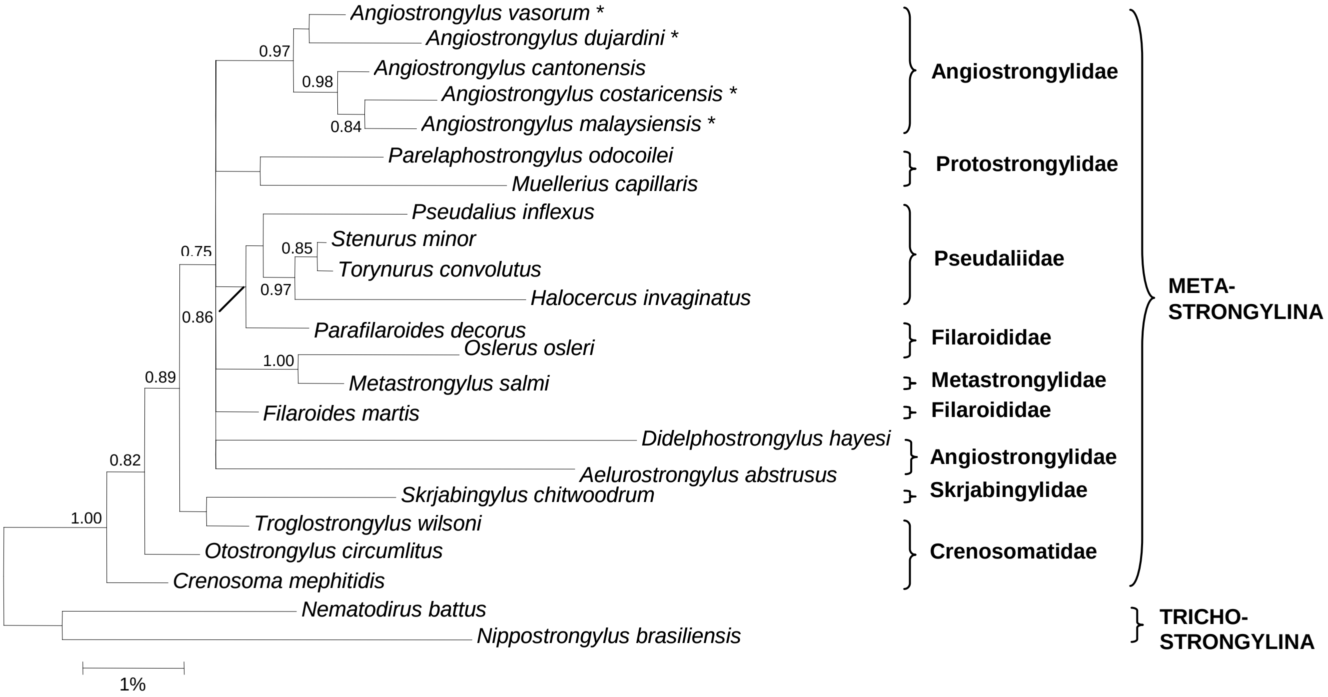
Filaroididae
Crenosomatidae
META-
STRONGYLINA
TRICHO-
STRONGYLINA

(A) - ML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Muellerius capillaris
Pseudalius inflexus
Stenurus minor
Torynurus convolutus
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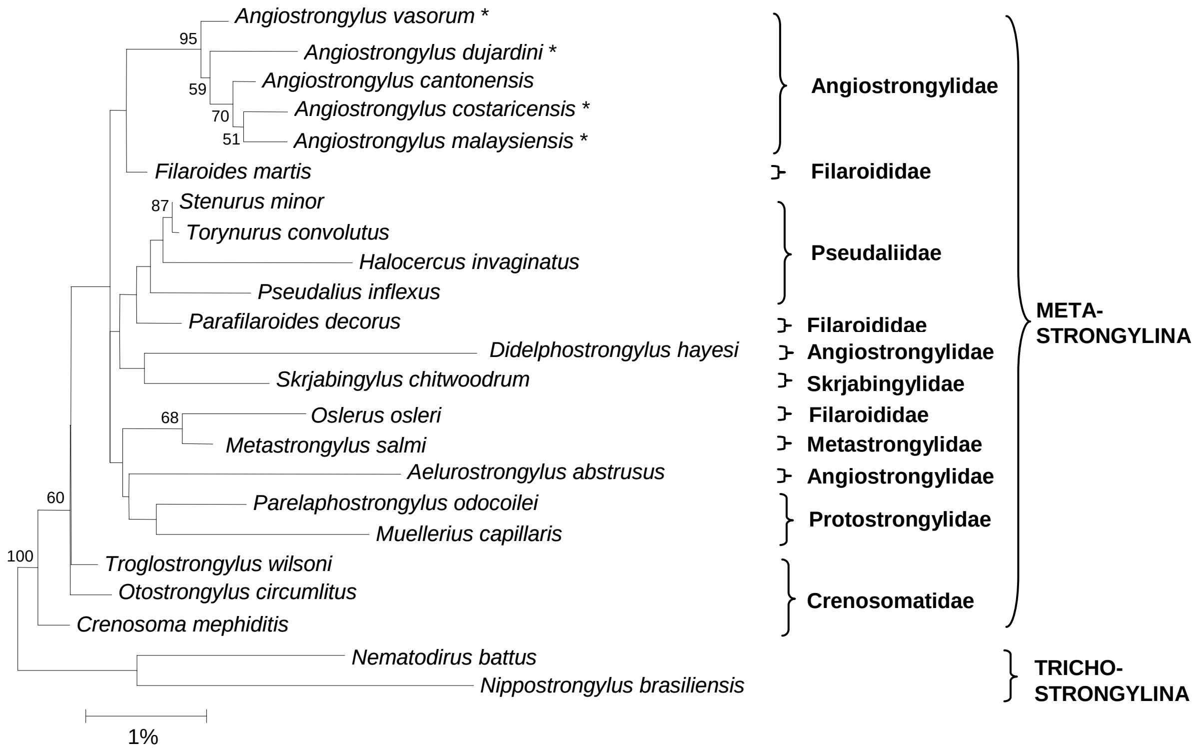
Metastrongylus salmi
Filaroides martis
Didelphostrongylus hayesi
Aelurostrongylus abstrusus
Skrjabingylus chitwoodrum
Troglostrongylus wilsoni
Otostrongylus circumlitus
Crenosoma mephitidis
Nematodirus battus
Nippostrongylus brasiliensis
0.97
0.98
0.84
0.75
0.85
0.97
0.86
1.00
0.89
0.82
1.00
1%
Angiostrongylidae
Protostrongylidae
Pseudaliidae
Filaroididae
Metastrongylidae
Filaroididae
Angiostrongylidae
Skrjabingylidae
Crenosomatidae
META-
STRONGYLINA
TRICHO-
STRONGYLINA

(B) - BI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Angiostrongylus dujardini *
59
Angiostrongylus cantonensis
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Angiostrongylus costaricensis *
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Angiostrongylus malaysiensis *
Filaroides martis
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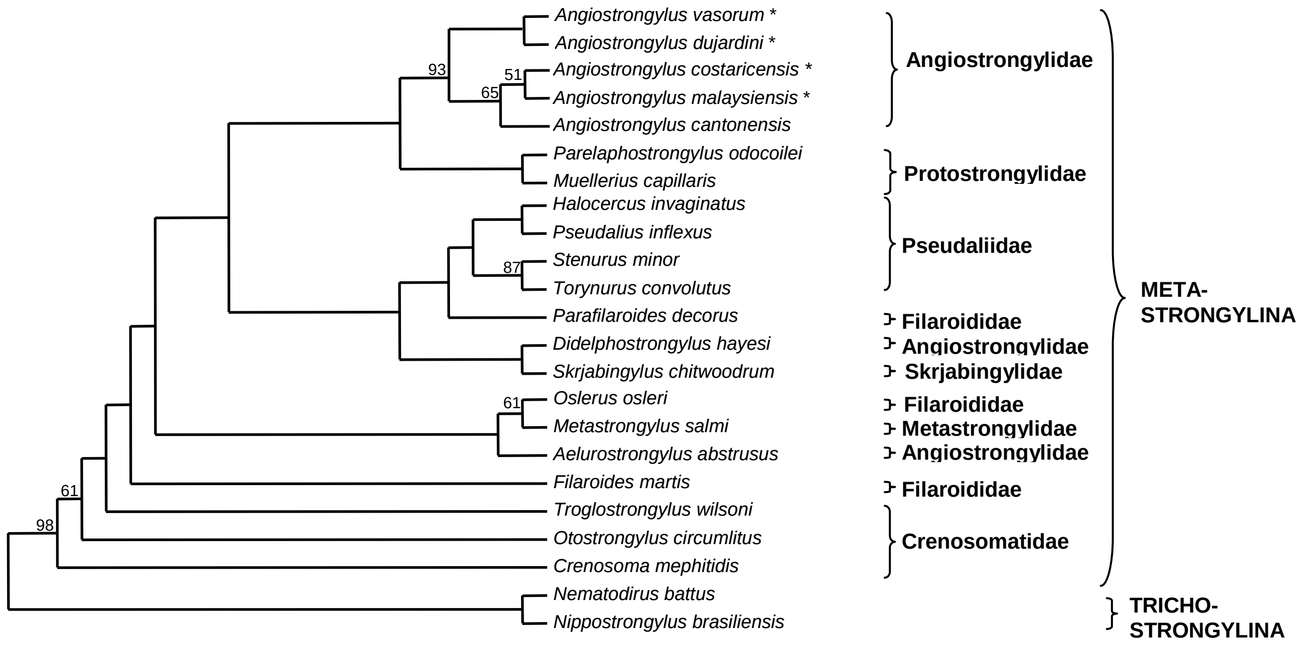
Stenurus minor
Torynurus convolutus
Halocercus invaginatus
Pseudalius inflexus
Parafilaroides decorus
Didelphostrongylus hayesi
Skrjabingylus chitwoodrum
68
Oslerus osleri
Metastrongylus salmi
Aelurostrongylus abstrusus
60
Parelaphostrongylus odocoilei
Muellerius capillaris
100
Troglostrongylus wilsoni
Otostrongylus circumlitus
Crenosoma mephiditis
Nematodirus battus
Nippostrongylus brasiliensis
1%
Angiostrongylidae
Filaroididae
Pseudaliidae
Filaroididae
Angiostrongylidae
Skrjabingylidae
Filaroididae
Metastrongylidae
Angiostrongylidae
Protostrongylidae
Crenosomatidae
META-
STRONGYLINA
TRICHO-
STRONGYLINA

(C) - NJ


Angiostrongylus vasorum *
Angiostrongylus dujardini *
93
51
Angiostrongylus costaricensis *
65
Angiostrongylus malaysiensis *
Angiostrongylus cantonensis
Parelaphostrongylus odocoilei
Muellerius capillaris
Halocercus invaginatus
Pseudalius inflexus
Stenurus minor
87
Torynurus convolutus
Parafilaroides decorus
Didelphostrongylus hayesi
Skrjabingylus chitwoodrum
61
Oslerus osleri
Metastrongylus salmi
Aelurostrongylus abstrusus
Filaroides martis
61
Troglostrongylus wilsoni
98
Otostrongylus circumlitus
Crenosoma mephitidis
Nematodirus battus
Nippostrongylus brasiliensis
Angiostrongylidae
Protostrongylidae
Pseudaliidae
Filaroididae
Angiostrongylidae
Skrjabingylidae
Filaroididae
Metastrongylidae
Angiostrongylidae
Filaroididae
Crenosomatidae
META-
STRONGYLINA
TRICHO-
STRONGYLINA

(D) - MP

The four phylogenies reveal several important points. First, monophyly of the Angiostrongylidae is neither conclusively supported nor rejected. For instance, in the ML tree (Fig. 6.4A) *Aelurostrongylus abstrusus* fell outside the main angiostrongylid group, while in Bayesian (Fig. 6.4B), NJ (Fig. 6.4C) and MP (Fig. 6.4D) analyses, both *Aelurostrongylus abstrusus* and *Didelphostrongylus hayesi* fell outside the main angiostrongylid group, though bootstrap support and posterior probabilities for these branches in the four trees were less than 50% and 0.7, respectively. Second, the phylogenies did not seem to support the distinction between *Angiostrongylus* and *Parastrongylus* as proposed by Ubelaker (1986) based on differences in morphology of the male bursa and the mammalian final host. The grouping of *A. vasorum*, [retained in the genus *Angiostrongylus* by Ubelaker (1986)] with *A. dujardini* [included in the genus *Parastrongylus* (Ubelaker, 1986)], was equivocal in these analyses (*P*=0.67 BI, 54% ML bootstraps, 30.2% NJ bootstraps and 43.9% MP bootstraps). Lastly, *Angiostrongylus cantonensis* was distinct from all other angiostrongylids and clustered with the *A. costaricensis* and *A. malaysiensis* group (*P*=0.98 BI, 68% ML bootstraps, 70% NJ bootstraps and 65% MP bootstraps).

6.4. Discussion

6.4.1. Suitability of the 5’ end of the SSU rRNA gene as a molecular marker for *Angiostrongylus cantonensis*

A total of five *Angiostrongylus* species (including four from this study) have now been sequenced for almost the entire region (approximately 1670 nucleotides) of the SSU rRNA gene. All sequences are distinct and can therefore distinguish the *Angiostrongylus* species. However, this almost complete SSU rRNA gene region is too long to be used as a molecular marker to rapidly and accurately identify specific taxa. When the first 480 bp of the 5’ end of the gene was compared across the different *Angiostrongylus* taxa, 12 variable sites (more than a third of the total number of variations for the entire gene) were found. Furthermore, *A. cantonensis* exhibited a unique sequence for this region even when compared to its closest relatives *A. costaricensis*, *A. dujardini* and *A. malaysiensis* (based on morphology and host specificity). Furthermore, this segment of the SSU is available for the majority of the named nematodes in GenBank and encompasses the segment Bhadury *et al*. (2006) used to identify their marine nematodes. These factors make the first 480 bp region eminently suitable as a molecular marker to identify *A. cantonensis* in nematode surveys.

6.4.2. Molecular identification of nematodes from a trial population of *Achatina fulica* and *Laevicaulis alte* in the Philippines

Two distinct nematode sequences were detected by the SSU marker when applied to a trial population of intermediate hosts. Of these, Philippine Sequence 1 was identified as *A. cantonensis* on account of its 100% identity based on GenBank BLAST results of the variable region at the 5’ end of the SSU rRNA gene. One hundred percent sequence identity could either mean ‘the same taxon’ or that ‘there is insufficient variation to define taxa’ (Floyd *et al.*, 2002). In the case of Philippine Sequence 1, its designation as *A. cantonensis* is valid as the current study already ascertained the uniqueness of the segment of the gene surveyed for this species in comparison to other closely related *Angiostrongylus* species (Figure 6.3).

This study clearly demonstrates the possibility of identifying infective 3rd juvenile stage *A. cantonensis* isolated from slug and snail intermediate hosts using the

5' end of the rRNA gene. This molecular approach to identification is a reliable alternative to morphological identifcation of nematode samples, especially in cases in which morphological characters are ambiguous in juvenile stages, thus rendering positive identification difficult.

6.4.3. Phylogenetic position of the Angiostrongylidae and the *Angiostrongylus* species within the Metastrongylina

Members of the Angiostrongylidae share certain features such as a posterior vulva but no buccal cavity or lips and the ability to infect a wide range of mammals as final hosts, including marsupials, insectivores, carnivores and rodents (Anderson, 2000; Roberts & Janovy, 2005). However, results from this study based on the SSU rRNA gene do not strongly support the monophyly of this group and show that only the *Angiostrongylus* species form a distinct group. Carreno and Nadler (2003) have already hinted that there is wide morphological diversity within the Angiostrongylidae. A further examination of the Angiostrongylidae that includes a broader taxonomic coverage of the group is required to determine its validity.

Ubelaker (1986) moved certain *Angiostrongylus* species, such as *A. cantonensis, A. costaricensis, A. dujardini, A. mackerrrasae, A. malaysiensis, A. petrowi, A. ryjikovi, A. sandarsae, A. schmidti*, and *A. siamensis* to the genus *Parastrongylus*, which was first described by Baylis (1928) based on *Parastrongylus tateronae* as the type species. This is to distinguish *Parastrongylus* from *Angiostrongylus*, first described by Baillet (1866) based on *A. vasorum* as the type species and includes *A. chabaudi* and *A. raillieti*. This distinction was based on differences of the morphology of the male bursa and the mammalian final host. However, this distinction is not widely accepted, and molecular data from this study based on five *Angiostrongylus* species neither conclusively support nor reject this distinction.

6.5. Conclusion

An alternative approach to morphological identification of infective 3rd juvenile stage *Angiostrongylus cantonensis* was developed and successfully employed using the 5' end of the SSU rRNA gene (~480 bp). Sequences of other closely related *Angiostrongylus* species were obtained for this region to ascertain the uniqueness of the marker for *A. cantonensis*. When the SSU rRNA marker was used on nematode populations extracted from the giant African land snail, *Achatina fulica*, and the black slug, *Laevicaulis alte*, from the Philippines, the infective 3rd juvenile stage *A. cantonensis* was detected without difficulty. The technique developed in this study therefore enables the rapid and accurate identification of medically important nematode taxa when morphological analysis proves difficult or inadequate.

Phylogenetic analyses based on the full length SSU rRNA of the Metastrongylina with 5 *Angiostrongylus* species and 2 other angiostrongylids do not support the monophyly of the Angiostrongylidae. The same data neither support nor reject Ubelaker's distinction of *Parastrongylus* from *Angiostrongylus.*

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CHAPTER 7 - Survey of *Angiostrongylus cantonensis* (and other nematodes) from global populations of the giant African snail, *Achatina fulica* (and other snails)

7.1. Introduction

Angiostrongylus cantonensis, like one of its gastropod intermediate hosts *Achatina fulica*, has a global distribution (Marquardt *et al.*, 2000) and is a major concern from a human health perspective as it causes the food-borne disease eosinophilic meningoencephalitis (EME) or angiostrongyliasis (Kliks & Palumbo, 1992; Prociv *et al.*, 2000). The presence of *A. cantonensis* in rats in New Orleans, USA (Campbell & Little, 1988) and the recent outbreak of EME among medical students visiting Jamaica (Waugh *et al.*, 2005) illustrate the expanding distribution of the parasite. The life cycle of *A. cantonensis* involves a gastropod intermediate host and a murid rodent definitive host (Fig. 1.4, Chapter 1, p. 25); interestingly, the parasite is not highly specific to either its intermediate or its definitive host, which could help to explain its global distribution (Prociv *et al.*, 2000). The route for human infection by *A. cantonensis* is mostly through the gastropod intermediate host. The consumption of contaminated salad crops or raw/undercooked snails (Marquardt *et al.*, 2000) either as an alternative food source during famine (Kliks & Palumbo, 1992) or as delicacies (Chau *et al*., 2003), their use as medicine (Kliks & Palumbo, 1992) and the predilection of humans to keep gastropods as pets (Wan & Weng, 2004) has led to sudden outbreaks or isolated cases of eosinophilic meningoencephalitis due to 3rd juvenile stage *A. cantonensis* infection (Kliks & Palumbo, 1992). Some of these outbreaks were attributed to the Giant African Land Snail, *Achatina fulica* (Kliks & Palumbo, 1992), which Alicata (1966) suggested as primarily responsible for the spread of the parasite to Southeast Asia and the Pacific.

7.1.1. Dispersal of *Angiostrongylus cantonensis* from East Africa: Alicata's hypothesis

First reported in rats in Canton, China in 1933 (Chen, 1935), *Angiostrongylus cantonensis* has a wide distribution and infects a range of intermediate and final hosts (Alicata, 1966, Fig. 7.1). The parasite was thought to have spread from East Africa towards the Indian subcontinent until it reached the Malay Peninsula (Alicata, 1966; Marquardt *et al.*, 2000). From there it migrated northwards to Indochina, southern China, Taiwan, and Okinawa, and eastwards to the Philippines, New Guinea, Australia, New Zealand, and several islands and island groups of the Pacific including Palau, Guam, Pohnpei, Pingelap, Moen, Ponape, Mariana, Wallis, Solomon, New Hebrides, New Guinea, Fiji, Loyalty, New Caledonia, Tahiti, Tonga, Rarotonga, Raiatea, Samoa, Tokelau and Hawaii (Kliks & Palumbo, 1992). *Angiostrongylus cantonensis* has also been reported in Western Africa (Ivory Coast, Liberia and Nigeria) (Kliks & Palumbo, 1992; Marquardt *et al.*, 2000), the Middle East (Egypt) (Marquardt *et al.*, 2000), North America (Campbell & Little, 1988; New *et al.*, 1995), and the Caribbean (Cuba, Puerto Rico, Jamaica and Haiti) (Pascual *et al.*, 1981; Andersen *et al.*, 1986; Lindo *et al*., 2002; Raccurt *et al.*, 2003). Prociv *et al.* (2000) observed a general pattern in the recognition of *A. cantonensis* in new locations that begins with the initial detection in rats and occasionally in captive primates, followed by reported human cases of EME, and finally by the recovery of worms from some patients. Subsequent surveys of gastropod intermediate hosts in these new locations oftentimes lead to the detection of the parasite following confirmation by infecting the juveniles in laboratory rats, as in the study of Wallace & Rosen (1969).

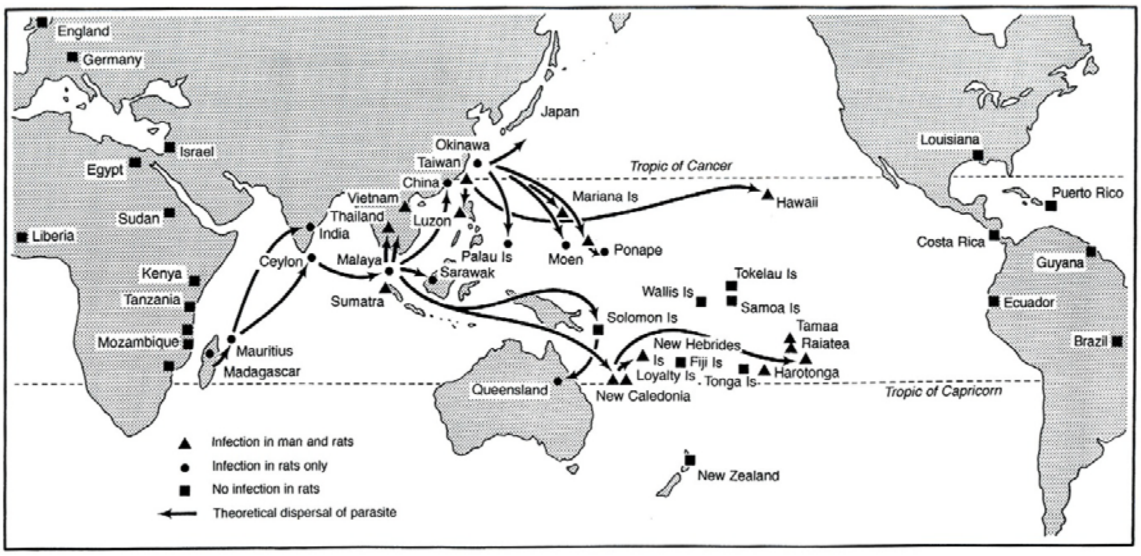

Figure 7.1: Probable dispersal route of *Angiostrongylus cantonensis*. (From Marquardt *et al*., 2000.)

Alicata's (1966) hypothesis that the worm most probably originated from East Africa and migrated to East Asia and the Pacific is based on three observations. First, *A. cantonensis* is not found in all major Pacific islands despite the prevailing similar environmental conditions. Second, reported cases of eosinophilic meningoencephalitis in the Pacific are relatively recent, from just after the Second World War. Third, the parasite was only reported during the latter half of the 20th century in East Asia, the Pacific and Australia. This hypothesis was further supported by the total absence of the worm in 1967 in Central America (Costa Rica and Puerto Rico) and South America (Brazil, Ecuador and Guyana) based on a survey of 1810 rats (Alicata, 1967) only to appear later on in Cuba in 1973 (Pascual *et al.*, 1981), Puerto Rico in 1984 (Andersen *et al.*, 1986), Jamaica in 2000 (Waugh *et al.*, 2005) and Haiti in 2002 (Raccurt *et al.*, 2003; Marquardt *et al*., 2000). The parasite was also reported for the first time in North America in New Orleans in 1986 (Campbell & Little, 1988).

It is not yet clear how *A. cantonensis* spread from the Pacific Basin to the Caribbean and beyond, although Kliks and Palumbo (1992) pointed to rats as culprits.

They suspected that infected rats from Indochina were accidentally brought to Cuba between 1966 and 1975 during the Vietnam War, which led to cases of EME beginning in 1973. From there it spread to Puerto Rico where the worms were detected in adult rats in 1981. How the worms got to West Africa, particularly the Ivory Coast and Nigeria is less clear. The first and only case of eosinophilic meningoencephalitis in the Ivory Coast was reported in 1979 (Nozais *et al.*, 1980). In Nigeria, adult worms were also recovered from rats in Port Harcourt but not in Ibadan (Kliks & Palumbo, 1992). Nematodes were also found in Giant African Land Snails in Port Harcourt, reported by Kliks and Palumbo as *Achatina fulica*, though they are more likely to be *Achatina achatina* based on the prevalence of this snail in that area and the fact that *A. fulica* has not yet been officially recorded there.

7.1.2. Perceived role of *Achatina fulica* in the spread of *A. cantonensis*

Alicata (1966) pinned his East Africa origin for *A. cantonensis* on the nearly parallel distribution of the parasite with one of its intermediate hosts, *Achatina fulica*, particularly in Southeast Asia and the Pacific. He based his hypothesis on the observations he made when he surveyed 8 areas from East Africa to the Western Pacific, in which he checked for the presence of *A. cantonensis* in adult rats. He found the parasite in Madagascar, Mauritius, Sri Lanka and Borneo but not in Mozambique, Kenya, Tanzania and India. By combining his findings with what was known at that time regarding the dispersal route of *A. fulica* and the reported cases of rat and human infections of *A. cantonensis,* he concluded that the rapid spread of the snail led to the spread of the parasite based on the following reasons. First, he observed *A. cantonensis* along the dispersal route of the snail. Second, he found the parasite in rats in places where *A. fulica* was introduced. Last, he also noted the close time relationship between the introduction of the snail and the first reported case of EME in several Pacific islands. In the case of West Africa, however, the presence of *A. cantonensis* there can not be pinned on *A. fulica.* Although Kliks and Palumbo (1992) reported the presence of the parasite in *A. fulica,* this was probably a result of a misidentification of another giant African snail, probably *Achatina achatina.*

7.1.3. Dispersal of *Angiostrongylus cantonensis* from South and Southeast Asia: Drozdz *et al.*'s alternative hypothesis

An alternative hypothesis for the dispersal of *A. cantonensis* was proposed by Drozdz *et al*. (1975) in which they postulated that the parasite originated in South and Southeast Asia rather than East Africa and that the murid rodent definitive hosts and not *Achatina fulica* were responsible for the current distribution of *A. cantonensis*. First, they argued that the occurrence within close geographical regions (Indo-Malayan region and Australia) of closely related *Angiostrongylus* species and their respective *Rattus* final hosts would indicate a very long host-parasite association that probably encompassed the radiation of murid rodents in Asia. Such is probably the case for *A. cantonensis* (China, Southeast Asia) in *R. rattus* and *R. norvegicus, A. malaysiensis* (Malaysia) in *R. jalorensis,* and *A. mackerrasae* (Australia) in *R. fuscipes*. Second, they believed that the adaptation of rat hosts such as *Rattus rattus* and *R. norvegicus,* which originated in South and Southeast Asia, to survive high dosage infections (150 parasites per individual) would have taken a long time to evolve, which could not have happened had the parasite originated in East Africa and spread to Asia in a short period of time as postulated by Alicata (1966). They therefore concluded that *Achatina fulica* is a recent introduction in the parasite's life cycle. As further support of this hypothesis, *A. cantonensis* has so far only been found in Madagascar in *Rattus rattus,* a recent human introduction to the island (Drodz *et al.*, 1975; Prociv *et al.*, 2000); no other endemic murid rodent is found in Madagascar (Drodz *et al*., 1975). Prociv *et al.* (2000) believed that the role of *A. fulica* in the dispersal of *A. cantonensis* was over-emphasised as the parasite was more likely to have been introduced into new areas by rats, owing to their cosmopolitan distribution, and that local snails and slugs had just as easily assumed the role of intermediate hosts. Furthermore, Civeyrel & Simberloff (1996) pointed the possibility of other introduced snails, such as *Euglandina*, *Edentulina* and *Gonaxis*, in spreading the parasite.

7.1.4. Other nematodes in *Achatina fulica*

In addition to *Angiostrongylus cantonensis*, other nematodes may also be present in *Achatina fulica*. Indeed, land snails and slugs in general have often been used by nematodes either as intermediate hosts or as definitive hosts (Grewal *et al.*, 2003). There are 61 known nematode species that utilise molluscs as intermediate hosts, with 49 belonging to the superfamily Metastrongyloidea; 47 known nematode species use molluscs as definitive hosts, 33 of which belong to the order Rhabditida (Grewal *et al.*, 2003). Both groups are included in the Rhabditida clade by Meldal *et al.* (2006) based on phylogenetic analyses using the small subunit (SSU) ribosomal (r) RNA gene. In the case of *Achatina fulica*, previous studies have already demonstrated the presence of nematodes. For instance, the metastrongyloid lungworm *Oslerus ostratus* (=*Anafilaroides rostratus*), which parasitises cats as the final host and is closely related to the dog lungworm *Oslerus osleri*, can also infect *Achatina fulica* as an intermediate host (Grewal *et al.*, 2003). Another nematode, *Rhabditis* sp., was found in *A. fulica* populations in Thailand in which the parasite utilised the snail as a definitive host but without causing any noticeable damage (Viyada, 2005). Juvenile nematodes were also noted in the mucus of *A. fulica* in Brazil though their identities were not reported (Fonseca & Nascimento, 2004).

7.1.5. Objectives of the study

Alicata's (1966) hypothesis states that the Giant African Land Snail, *Achatina fulica*, caused the spread of *Angiostrongylus cantonensis*, particularly in Southeast Asia and the Pacific, whereas Drozdz *et al.*'s (1975) hypothesis points to murid rodents. The objectives of this study were to (1) survey global populations of *Achatina fulica* for the presence of *Angiostrongylus cantonensis* using the technique developed in Chapter 6 that employed the 5' end of the small subunit rRNA gene for rapid identification of the parasite, and (2) investigate the role of *A. fulica* in the dispersal of *A. cantonensis* (as proposed by Alicata, 1966) by comparing the movement of the snail through population genetic analysis with the movement of the parasite also through population genetic analysis using a suitable molecular marker. Both objectives, however, were dependent on the availability of sufficient population samples of both the parasite and the snail. While the focus was on *A. cantonensis* infection in *A. fulica*, where samples of other snails and slugs were obtained within the distribution range of the parasite (in this case two other species, *Laevicaulis alte* and *Achatina* sp.), they were also surveyed for *A. cantonensis* infection. This is the first systematic attempt to survey *A. cantonensis* from global populations of a known intermediate host using molecular identification. If Alicata's hypothesis is correct, then the nematode parasite should be present within the dispersal route of the snail intermediate host, and the dispersal patterns of the snail and the parasite based on population genetic analysis should also be similar.

7.2. Materials and methods

7.2.1. Samples and localities

Ten global populations of *Achatina fulica*, two West African populations of *Achatina* sp. and two Philippine populations of *Laevicaulis alte* were sampled for *Angiostrongylus cantonensis*. The *Achatina fulica* and *Laevicaulis alte* sample populations from UP Diliman used in Chapter 6 were also included in this survey. For the Ivory Coast *Achatina* sp. samples, the exact location of the sampling site was not identified as the snails were confiscated by customs officials at Waterloo Station in London from a man trying to smuggle the snails in October 2005. Details of the samples, their sampling localities and collectors are provided in Table 7.1.

Table 7.1: Snail samples, collectors and localities

Locality	Species	Collector
Bharatpur, Nepal	*Achatina fulica*	P. Budha
Yangon, Myanmar	*Achatina fulica*	F. Naggs
Trok Nong Area, near Phlieu Waterfall National Park, Chantaburi, Eastern Thailand near Cambodia	*Achatina fulica*	S. Panha & C. Sutcharit
Hahajima, Ogasawara, Japan	*Achatina fulica*	A. Davison
UP Diliman Campus, Quezon City, Philippines	*Achatina fulica*	I. Fontanilla
Batasan Hills, Quezon City, Philippines	*Achatina fulica*	E. Fontanilla & I. Fontanilla
Subic Bay Forest Reserve, Zambales, Philippines	*Achatina fulica*	M.R. Posa
Singapore	*Achatina fulica*	M.R. Posa
Haapiti Valley, Moorea, French Polynesia	*Achatina fulica*	T. Coote
Moaroa Valley, Tahiti, French Polynesia	*Achatina fulica*	T. Coote
Ivory Coast	*Achatina* sp.	Intercepted by customs officials at Waterloo Station in London from a man from the Ivory Coast (October 2005)
Ibadan, Nigeria	*Achatina* sp.	F. Opeyemi
UP Diliman Campus, Quezon City, Philippines	*Laevicaulis alte*	I. Fontanilla
Batasan Hills, Quezon City, Philippines	*Laevicaulis alte*	E. Fontanilla & I. Fontanilla

7.2.2. DNA extraction, PCR amplification and sequencing

The protocols in this section follow those developed in Chapter 6. The snails were cut into small pieces and digested overnight in Ash's digestive fluid, after which the worms were individually collected using yellow-tipped pipettes and stored at -20^0C in TE buffer until use (see Section 6.2.2 of Chapter 6, pp. 305-307). DNA extraction, PCR amplification, gel extraction and purification were carried out for each nematode using the protocols in Chapter 2, Section 2.1.4, pp. 41-42 and Sections 2.2 - 2.4, pp. 42-59, except that only Primer Set A (SSU_F07 and SSU_R09) for the 5' end of the SSU rRNA was used to amplify an approximately 480 bp PCR product. The purified PCR products were subsequently sequenced using the SSU_R09 primer and the peaks visualised using an Applied Biosystems 3730 DNA sequencer and BigDye version 3.1 termination cycle sequencing chemistry (Section 2.6 of Chapter 2, pp. 59-61). PCR amplification and sequencing of a second molecular marker for the population genetic analyses of the snail and parasite samples (second objective) were no longer carried out due to the limited and patchy sampling of the parasite and the difficulty of obtaining live snail intermediate host (see results and discussion).

7.2.3. Sequence analyses

Individual nematode sequences were processed using the STADEN package (Staden *et al.*, 2000) and the presence of *Angiostrongylus cantonensis* was determined by BLAST search in GenBank based on the 5' end of the SSU rRNA gene. Where possible, the non-angiostrongylid nematodes were also identified based on the closest sequence match to a named nematode species. If a 100% BLAST sequence identity to a named nematode species was obtained, it could mean the same taxon or that there is insufficient variation to distinguish taxa (Floyd *et al.*, 2002). In the case of

Angiostrongylus, results in Chapter 6 have already shown that the five closely related species of *Angiostrongylus,* which include *A. cantonensis,* can be distinguished from each other based on the 5' end of the SSU rRNA gene. To complement the BLAST results, a neighbor-joining phylogeny was then constructed to visualise the relationship of the nematode sequences against all known nematode taxa in Genbank as well as the *Angiostrongylus* species obtained in Chapter 6. The phylogeny was based on 376 unambiguously aligned nucleotide sites and rooted on 4 non-nematode taxa: *Chordodes morgani* (AF036639, Blaxter *et al.*, 1998) and *Gordius aquaticus (*X87985, Winnepenninckx *et al.*, 1995) of Phylum Nematomorpha, *Priapulus caudatus* (Z38009, Aleshin *et al.*, 1998) of Phylum Priapulida, and *Brachionus plicatis* (U49911, Aguinaldo *et al.*, 1997) of Phylum Rotifera (for alignment, see Appendix 6.2, pp. 537-603). The sequences were checked for base composition bias using the Chi square test in PAUP* (version 4.0b10) (Swofford, 2002), after which the optimal model for DNA sequence evolution was determined by comparing, through the Likelihood Ratio Test (LRT), the likelihood scores of the following: JC69 (Jukes & Cantor, 1969), F81 (Felsenstein, 1981), K2P (Kimura, 1980), HKY85 (Hasegawa *et al.*, 1985), TN93 (Tamura & Nei, 1993) and the GTR (Rodriguez *et al.*, 1990) models as well as their variants that incorporated gamma distributed rates (Γ) (Yang, 1993). Bootstrap resampling (Felsenstein, 1985) with 1000 replicates was then carried out (see Section 2.9.9 of Chapter 2, pp. 85-86). Once the clades to which the nematode sequences belong were identified, a second NJ tree based on the same gene fragment (376 sites) with optimised parameters was constructed but this time excluding the taxa that do not belong to these clades.

7.3. Results

A total of 191 *Achatina fulica* from 10 global populations, 25 *Achatina* sp. from 2 West African populations and 39 *Laevicaulis alte* from 2 Philippine populations were surveyed for *A. cantonensis* infections. Of the 10 global populations of *Achatina fulica*, 6 yielded nematodes; these were Thailand (20 snails sampled), Ogasawara (12 snails), UP Diliman-Philippines (15 snails), Batasan Hills-Philippines (50 snails), Singapore (33 snails) and Tahiti (5 snails). Population samples from Ogasawara and Tahiti had a 100% infection rate. Population samples from Myanmar (20 snails), Nepal (22 snails), Zambales-Philippines (4 snails) and Moorea (10 snails) had a 0% infection rate. The two *Achatina* sp. populations from West Africa, namely the Ivory Coast (22 snails) and Nigeria (3 snails), as well as the two Philippine populations of *Laevicaulis alte*, UP Diliman (19 slugs) and Batasan Hills (20 slugs), also manifested nematode infection, with the population sample from Nigeria exhibiting a 100% infection rate. See also Table 7.2.

Table 7.2: Population sizes and percentage of nematode infection

Locality	Species	Sample Size	% Infected
Bharatpur, Nepal	*Achatina fulica*	22	0
Yangon, Myanmar	*Achatina fulica*	20	0
Chantaburi, Eastern Thailand	*Achatina fulica*	20	5.0%
Hahajima, Ogasawara, Japan	*Achatina fulica*	12	100.0%
UP Diliman Campus, Philippines	*Achatina fulica*	15	6.7%
Batasan Hills, Philippines	*Achatina fulica*	50	14.0%
Subic Bay Forest Reserve, Philippines	*Achatina fulica*	4	0
Singapore	*Achatina fulica*	33	15.2%
Haapiti Valley, Moorea	*Achatina fulica*	10	0
Moaroa Valley, Tahiti	*Achatina fulica*	5	100.0%
Ivory Coast	*Achatina* sp.	22	18.2%
Ibadan, Nigeria	*Achatina* sp.	3	100.0%
UP Diliman Campus, Philippines	*Laevicaulis alte*	19	21.1%
Batasan Hills, Philippines	*Laevicaulis alte*	20	30.0%

A total of 25 distinct nematode sequences were identified from the snail and slug populations. For the *Achatina fulica* populations, a single unique nematode sequence was found in the Thailand population; two nematode sequences were each found in the UP Diliman-Philippines, Ogasawara and Tahiti populations; three were found in the Batasan-Philippines population, and four in the Singapore population. For the West African *Achatina* sp. populations, three unique nematode sequences were found in Nigeria and seven in the Ivory Coast. For the Philippine *Laevicaulis alte* populations, the same two nematode sequences found in *A. fulica* were also found in the UP Diliman *L. alte* population, whereas two unique sequences were found in the Batasan Hills population in addition to a nematode sequence that it shares with the *A. fulica* population from that site. One of the Tahiti sequences (Tahiti Sequence 1) is identical to one of the Philippines sequences (Philippines Sequence 1), which was present in the UP Diliman population of *Achatina fulica* and in both UP Diliman and Batasan Hills populations of *Laevicaulis alte.* A summary of the frequency and distribution of these nematode sequences is given in Table 7.3.

Table 7.3: Distribution and frequencies of the nematode sequences across global populations of *Achatina fulica*, West African populations of *Achatina* sp. and Philippine populations of *Laevicaulis alte*. Note that Philippines Sequence 1 and Tahiti Sequence 1 are 100% identical.

Locality	**Host**	**Nematode Sequences**	**Number (Frequency relative to the total nematodes found in the whole snail population)**
Nepal	*Achatina fulica*	None	None
Myanmar	*Achatina fulica*	None	None
Thailand	*Achatina fulica*	Thailand Sequence 1	1 (100.0%)
Ogasawara, Japan	*Achatina fulica*	Ogasawara Sequence 1	2 (2.3%)
		Ogasawara Sequence 2	86 (97.7%)
UP Diliman, Philippines	*Achatina fulica*	Philippines Sequence 1 (=Tahiti Sequence 1)	1 (16.7%)
		Philippines Sequence 2	5 (83.3%)
Batasan, Philippines	*Achatina fulica*	Philippines Sequence 5	6 (33.3%)
		Philippines Sequence 6	1 (5.6%)
		Philippines Sequence 7	11 (61.1%)
Subic Forest Reserve, Philippines	*Achatina fulica*	None	None
Singapore	*Achatina fulica*	Singapore Sequence 1	6 (9.7%)
		Singapore Sequence 2	1 (1.6%)
		Singapore Sequence 3	1 (1.6%)
		Singapore Sequence 4	54 (87.1%)
Tahiti	*Achatina fulica*	Tahiti Sequence 1 (=Philippines Sequence 1)	91 (98.9%)
		Tahiti Sequence 2	1 (1.1%)
Moorea	*Achatina fulica*	None	None
Ivory Coast	*Achatina* sp.	Ivory Coast Sequence 1	2 (8.7%)
		Ivory Coast Sequence 2	11 (47.8%)
		Ivory Coast Sequence 3	1 (4.3%)
		Ivory Coast Sequence 4	1 (4.3%)
		Ivory Coast Sequence 5	5 (21.7%)
		Ivory Coast Sequence 6	1 (4.3%)
		Ivory Coast Sequence 7	2 (8.7%)
Nigeria	*Achatina* sp.	Nigeria Sequence 1	1 (1.8%)
		Nigeria Sequence 2	1 (1.8%)
		Nigeria Sequence 3	54 (96.4%)
UP Diliman, Philippines	*Laevicaulis alte*	Philippines Sequence 1 (=Tahiti Sequence 1)	20 (95.2%)
		Philippines Sequence 2	1 (4.8%)
Batasan, Philippines	*Laevicaulis alte*	Philippines Sequence 1 (=Tahiti Sequence 1)	8 (80%)
		Philippines Sequence 3	1 (10%)
		Philippines Sequence 4	1 (10%)

Nine snails from six localities (UP Diliman-Philippines, Batasan Hills-Philippines, Ogasawara, Singapore, Tahiti and Ivory Coast) were infected by more than one type of worm based on the SSU rRNA sequences. Table 7.4 summarises the multiple infections of these snails.

Table 7.4: Snails infected with more than one type of worm based on the sequence of the 5' end of the SSU rRNA gene.

Locality	Host #	Nematode Sequence	Number (Frequency*)
UP Diliman, Philippines	*Achatina fulica* D51	Philippines Sequence 1	1 (16.7%)
		Philippines Sequence 2	5 (83.3%)
Batasan Hills, Philippines	*Achatina fulica* B42	Philippines Sequence 5	1 (33.3%)
		Philippines Sequence 7	2 (66.67%)
	Achatina fulica B43	Philippines Sequence 5	1 (50%)
		Philippines Sequence 7	1 (50%)
Ogasawara, Japan	*Achatina fulica* OJ2	Ogasawara Sequence 1	1 (8.3%)
		Ogasawara Sequence 2	11 (91.7%)
	Achatina fulica OJ3	Ogasawara Sequence 1	1 (14.3%)
		Ogasawara Sequence 2	6 (85.7%)
Singapore	*Achatina fulica* Si63	Singapore Sequence 1	4 (80.0%)
		Singapore Sequence 2	1 (8.3%)
Tahiti	*Achatina fulica* T1	Tahiti Sequence 1	11 (91.7%)
		Tahiti Sequence 2	1 (1.1%)
Ivory Coast	*Achatina* sp. IVC19	Ivory Coast Sequence 2	11 (84.6%)
		Ivory Coast Sequence 3	1 (7.7%)
		Ivory Coast Sequence 4	1 (7.7%)
	Achatina sp. IVC22	Ivory Coast Sequence 6	2 (66.7%)
		Ivory Coast Sequence 7	1 (33.3%)

*Frequency is relative to the total nematodes found per snail.

The 25 nematode sequences were then subjected to a BLAST search in GenBank (GB Release No. 158, 15 February 2007) to identify an exact match or closest identity to named nematode species. Two of these sequences, namely Tahiti Sequence 1/ Philippines Sequence 1 and Tahiti Sequence 2, are angiostrongylids based on the BLAST results. However, only Tahiti Sequence 1/Philippines Sequence 1 has a 100% match with *Angiostrongylus cantonensis* (AY295804, Carreno & Nadler, 2003). Among the non-angiostrongylids, Philippines Sequence 5 is the only other nematode sequence to have a 100% BLAST identity to a named species in GenBank. This sequence is identical to *Ancylostoma caninum* (AJ920347, Chilton *et al.*, 2006). As the other sequences did not match any named taxon in GenBank based on BLAST results, only the closest sequence identity to a named nematode species could be assigned; their exact species identification based on the BLAST results could therefore not be known as of GB Release No. 158. For instance, the second highest sequence similarity attained was 99%; this was the case for Philippines Sequence 2 (for *Oslerus osleri*), Singapore Sequence 4 (for *Oslerus osleri*), Tahiti Sequence 2 (for *Angiostorngylus cantonensis*), Ivory Coast Sequence 1 (for *Metastrongylus elongatus* and *M. salmi*) and Nigeria Sequence 2 (for *Ancylostoma caninum*). On the other hand, Singapore Sequence 1 and Philippines Sequence 3 have the lowest sequence identity (87% BLAST identity for both with *Pellioditis marina*, a marine nematode, which, being terrestrial nematodes, Singapore Sequence 1 and Philippines Sequence 3 clearly are not). A summary of the BLAST results is shown in Table 7.5.

Table 7.5: GenBank BLAST results for the nematode sequences

Sequence	BLAST Result
Thailand Sequence 1	96% identity with *Heterakis sp.* 14690 (AF083003) [Ascaridida]
Ogasawara Sequence 1	93% identity with *Panagrolaimus subelongatus* (AY284681) [Panagrolaimidae]
Ogasawara Sequence 2	93% identity with *Phasmarhabditis hermaphrodita* (DQ639981) [Rhabditida]
Philippines Sequence 1 (=Tahiti Sequence 1)	100% identity with *Angiostrongylus cantonensis* (AY295804) [Strongyloidea]
Philippines Sequence 2	99% identity with *Oslerus osleri* (AY295812) [Strongyloidea] (but different from Singapore Sequence 4)
Philippines Sequence 3	87% identity with *Pellioditis marina* (AF038021) [Rhabditidae] (but different from Singapore Sequence 1)
Philippines Sequence 4	97% identity with *Panagrolaimus* c.f. *rigidus* (DQ285636) [Panagrolaimidae]
Philippines Sequence 5	100% identity with *Ancylostoma caninum* (AJ920347) [Strongyloidea]
Philippines Sequence 6	93% identity with *Pelliodits marina* (AF038021) [Rhabditidae]
Philippines Sequence 7	97% identity with *Caenorhabditis vulgaris* (U13931) [Rhabditidae]
Singapore Sequence 1	87% identity with *Pellioditis marina* (AF038021) [Rhabditidae]
Singapore Sequence 2	95% identity with *Heterakis sp.* 14690 (AF083003) [Ascaridida]
Singapore Sequence 3	98% identity with *Caenorhabditis briggsae* (U13929) [Rhabditidae]
Singapore Sequence 4	99% identity with *Oslerus osleri* (AY295812) [Strongyloidea] (but different from Singapore Sequence 2)
Tahiti Sequence 1 (=Philippines Sequence 1)	100% identity with *Angiostrongylus cantonensis* (AY295804) [Strongyloidea]
Tahiti Sequence 2	97% identity with *Angiostrongylus cantonensis* (AY295804) [Strongyloidea]
Ivory Coast Sequence 1	99% identity with *Metastrongylus elongatus* (AJ920363) [Strongyloidea] 99% identity with *Metastrongylus salmi* (AY295801) [Strongyloidea]
Ivory Coast Sequence 2	98% identity with *Metastrongylus elongatus* (AJ920363) [Strongyloidea] 98% identity with *Metastrongylus salmi* (AY295801) [Strongyloidea]
Ivory Coast Sequence 3	98% identity with *Protostrongylus rufescens* (AJ920364) [Strongyloidea]
Ivory Coast Sequence 4	98% identity with *Oslerus osleri* (AY295812) [Strongyloidea] (but different from Ivory Coast sequence 6)
Ivory Coast Sequence 5	97% identity with *Heterakis gallinarum* (DQ503462) [Ascaridida]
Ivory Coast Sequence 6	98% identity with *Oslerus osleri* (AY295812) [Strongyloidea] (but different from Ivory Coast sequence 4)
Ivory Coast Sequence 7	97% identity with *Oslerus osleri* (AY295812) [Strongyloidea]
Nigeria Sequence 1	97% identity with *Protostrongylus rufescens* (AJ920364) [Strongyloidea]
Nigeria Sequence 2	99% identity with *Ancylostoma caninum* (AJ920347) [Strongyloidea]
Nigeria Sequence 3	97% identity with *Metastrongylus elongatus* (AJ920363) [Strongyloidea] 97% identity with *Metastrongylus salmi* (AY295801) [Strongyloidea]

To complement the BLAST results, a neighbor-joining tree of the Nematoda based on 376 unambiguously aligned nucleotide sites of the 5’ end of the SSU rRNA gene (Fig. 7.2A) was then generated to visualise the relationships of the 25 nematode sequences with all 361 nematode taxa having at least the first 480 nucleotides of the 5’ end of the SSU rRNA in GenBank (GB Release No. 158, see Appendix 6.2) as well as the new sequences from the four *Angiostrongylus* species in Chapter 6. The GTR+Γ model was used to construct the tree after it was determined to be the best model

(Appendix 7.1A, p. 617). According to this phylogeny, all 25 nematode sequences fall within the Rhabditida clade (Meldal *et al.*, 2006). A smaller NJ phylogeny of the same gene fragment (376 nucleotide sites) was constructed (Fig. 7.2B) for the Rhabditida clade using all 241 rhabditid SSU sequences available in GenBank (GB Release No. 158) as well as the other *Angiostrongylus* sequences and rooted on the plectid nematode *Plectus acuminatus* (AF037628, Blaxter *et al.*, 1998). The GTR+Γ model was determined to be the best model and was subsequently used for this analysis (Appendix 7.1B, p. 617). This NJ phylogeny shows that 22 out of the 25 nematode sequences, including the two angiostrongylid sequences (Philippines Sequence 1/ Tahiti Sequence 1 and Tahiti Sequence 2), are distributed across three major clades in the tree: the Strongyloidea, the Rhabditidae and the Panagrolaimidae. The three remaining nematode sequences (Ivory Sequence 5, Singapore Sequence 2 and Thailand Sequence 1) group with the two *Heterakis* species found outside the three aforementioned clades. The groupings of the nematode sequences to the different clades correspond to the taxonomic grouping of the closest match(es) of each of the nematode sequences according to BLAST (see also Table 7.5).

The Strongyloidea clade includes the 2 angiostrongylid sequences: Tahiti Sequence 1/ Philippines Sequence 1 and Tahiti Sequence 2. Tahiti Sequence 1/ Philippines Sequence 1 has 100% BLAST identity to the sequence of *Angiostrongylus cantonensis* on Genbank (AY295804, Carreno & Nadler, 2003) and clusters with *A. cantonensis* in the tree, while the sequences from the other *Angiostrongylus* species sequenced in Chapter 6 fall outside this cluster. Tahiti Sequence 2 also clusters with *A. cantonensis* in the tree but has a BLAST identity of 97% with *A. cantonensis*.

There are 12 non-angiostrongylid sequences that are also included in the Strongyloidea; these are the 3 Nigeria sequences, 6 out of 7 Ivory Coast sequences, 2

Philippines sequences and Singapore Sequence 4. Nigeria Sequence 1 clusters with the deer muscleworm *Parelaphostrongylus odocoilei*, the hair lungworm *Muellerius capillaris*, and the sheep lungworm *Dictyocaulus filaria*, though it has a 97% BLAST identity with the goat and sheep lungworm *Protostrongylus rufescens* (AJ920364, Chilton *et al.*, 2006) (see Table 7.5). Nigeria Sequence 2 and Philippines Sequence 5 cluster with the dog hookworms *Ancylostoma caninum* and *Necator americanus*; both sequences are most similar to *Ancylostoma caninum* (AJ920347, Chilton *et al.*, 2006) with 99% and 100% BLAST identities, respectively. Nigeria Sequence 3 clusters with Ivory Coast Sequence 7, though they have different BLAST identities; Nigeria Sequence 3 has a 97% BLAST identity with both pig lungworms *Metastrongylus elongatus* (AJ920363, Chilton *et al.*, 2006) and *M. salmi* (AY295609, Carreno & Nadler, 2003) while Ivory Coast Sequence 7 has a 97% BLAST identity with the filaroid dog lungworm *Oslerus osleri* (AY295812, Carreno & Nadler, 2003). Ivory Coast Sequence 1 groups with *Metastrongylus elongatus* (AJ920363) and *M. salmi* (AY295609) with 99% BLAST identity for both taxa. Ivory Coast Sequence 2 clusters with the cat lungworm *Aelurostrongylus abstrusus* (Chilton *et al.*, 2006), though it has a 98% BLAST identity with both *Metastrongylus elongatus* (AJ920363) and *M. salmi* (AY295609) (see Table 7.5). Ivory Coast Sequence 3 clusters with *Protostrongylus rufescens* (AJ920364) with 98% BLAST identity. Ivory Coast Sequences 4 and 6 cluster together and both have a 98% BLAST identity with *Oslerus osleri* (AY295812) though the two sequence types are not identical with each other (see Table 7.5). Both Philippines Sequence 2 and Singapore Sequence 4 cluster with *Oslerus osleri* (AY295812) with 99% BLAST identity though they are not identical with each other (see Table 7.5).

The Rhabditidae clade includes six nematode sequences: Singapore Sequences 1 and 3, Philippines Sequences 3, 6 and 7 and Ogasawara Sequence 2. Singapore Sequence 1 and Philippines Sequence 3 cluster together, and in turn group with the free-living marine nematode *Pellioditis mediterranea,* though both have an 87% BLAST identity with *Pellioditis marina* (AF038021, Fitch, 2000). Philippines Sequence 6 forms a sister group taxon with a group of rhabditids that include the *Pellioditis* species and has a 93% BLAST identity with *Pellioditis marina* (AF038021). Singapore Sequence 3 clusters with *Caenorhabditis* spp., free-living soil nematodes, along with Philippines Sequence 7; Singapore Sequence 3 is 98% identical with *Caenorhabditis briggsae* (U13929, Fitch *et al.*, 1995) while Philippines Sequence 7 is 97% identical with *Caenorhabditis vulgaris* (U13931) based on BLAST results. Ogasawara Sequence 2 groups with the two *Phasmarhabditis* taxa and has a 93% BLAST identity with *Phasmarhabditis hermaphrodita*.

Two nematode sequences, Ogasawara Sequence 1 and Philippines Sequence 4, are included in the Panagrolaimidae clade; the former has a 93% BLAST identity with the soil nematode *Panagrolaimus subelongatus* (AY284681, Holterman *et al*., 2006) while the latter has a 97% identity with *Panagrolaimus* c.f. *rigidus* (DQ285636, Houthoofd *et al.*, 2006).

The three remaining nematode sequences, Singapore Sequence 2, Thailand Sequence 1 and Ivory Coast Sequence 5, all cluster with the bird parasites in the genus *Heterakis*; Singapore Sequence 2 and Thailand Sequence 1 are 95% and 96% identical, respectively, with *Heterakis* sp. isolate 14690 (AF083003, Fitch, 2000) based on BLAST results whereas Ivory Coast Sequence 5 has a 97% BLAST identity with *Heterakis galinarum* (DQ503462, Smythe *et al.*, 2006).

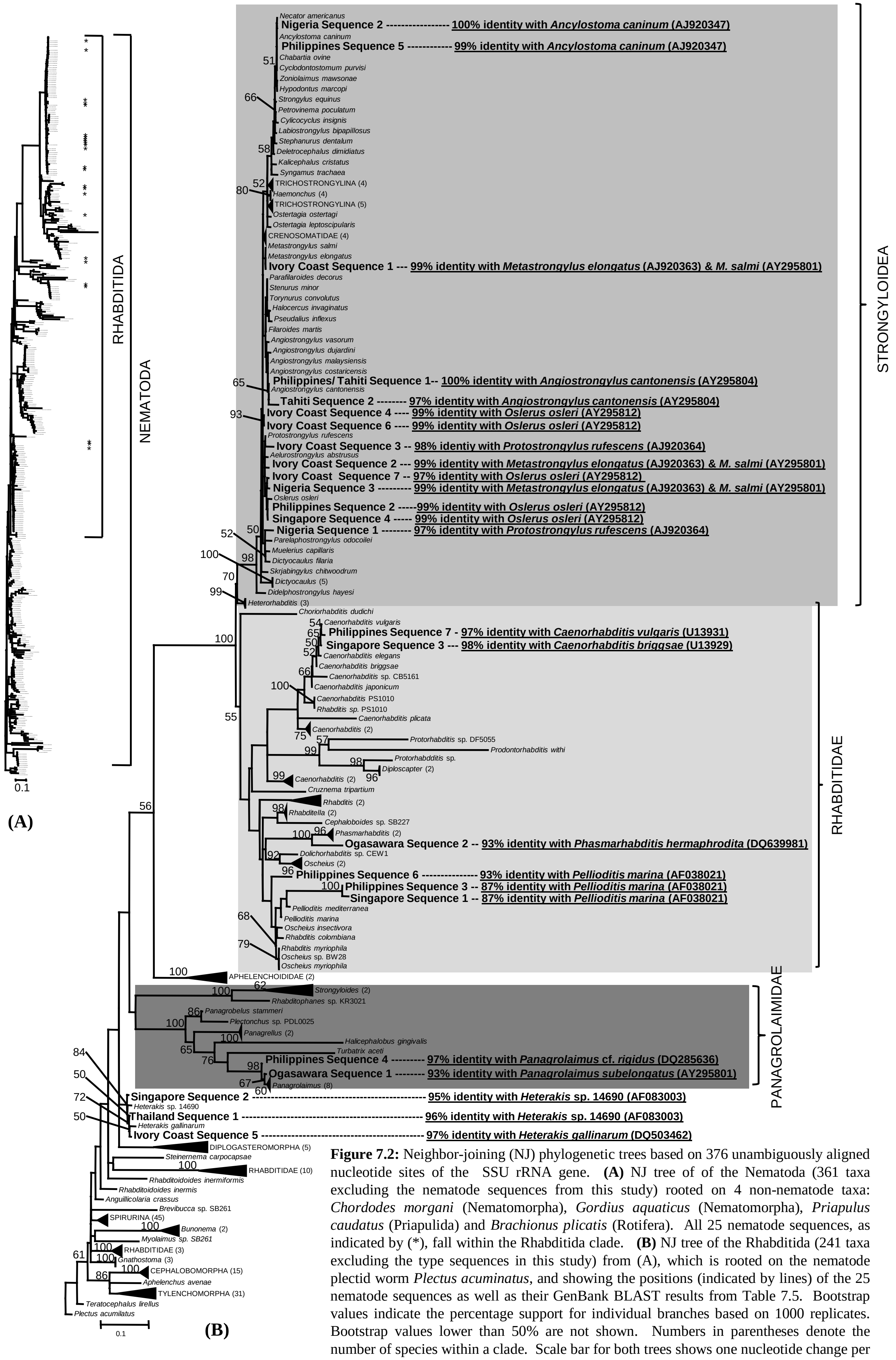

Figure 7.2: Neighbor-joining (NJ) phylogenetic trees based on 376 unambiguously aligned nucleotide sites of the SSU rRNA gene. **(A)** NJ tree of of the Nematoda (361 taxa excluding the nematode sequences from this study) rooted on 4 non-nematode taxa: *Chordodes morgani* (Nematomorpha), *Gordius aquaticus* (Nematomorpha), *Priapulus caudatus* (Priapulida) and *Brachionus plicatis* (Rotifera). All 25 nematode sequences, as indicated by (*), fall within the Rhabditida clade. **(B)** NJ tree of the Rhabditida (241 taxa excluding the type sequences in this study) from (A), which is rooted on the nematode plectid worm *Plectus acuminatus*, and showing the positions (indicated by lines) of the 25 nematode sequences as well as their GenBank BLAST results from Table 7.5. Bootstrap values indicate the percentage support for individual branches based on 1000 replicates. Bootstrap values lower than 50% are not shown. Numbers in parentheses denote the number of species within a clade. Scale bar for both trees shows one nucleotide change per ten nucleotide positions.

7.4. Discussion

7.4.1. *Angiostrongylus cantonensis* infection in snail and slug populations

The results of this study demonstrate the presence of *Angiostrongylus cantonensis* from *Achatina fulica* populations in the Philippines and Tahiti among the areas within the route of dispersal of *Achatina fulica*; in the case of the Philippines, the worm was also detected in the black slug *Laevicaulis alte*. This was demonstrated by the 100% BLAST identity of Philippines Sequence 1/Tahiti 1 with *A. cantonensis* based on the 5' end of the SSU rRNA gene and its distinction from all other *Angiostrongylus* species sequenced to date. Historically, cases of rat and mollusc infections in the Philippines (Garcia, 1979) and rat, gastropod and human infections in Tahiti *(*Alicata, 1966; Wallace & Rosen, 1969; Bronstein *et al.*, 1977) have been recorded. Although Wallace and Rosen (1969) surveyed Tahiti for the presence of *Angiostrongylus cantonensis* in gastropod intermediate hosts between 1965 and 1966 and found 3rd stage juveniles in areas where the rats were known to be infected with the parasite, they did not confirm the identity of the juveniles by feeding them to laboratory rats. Their survey did not include *A. fulica* among the gastropods they examined as they did not encounter the snail, noting that it was only reported in Tahiti in 1967 (Raut & Barker, 2002). This study therefore provides the first ever reported case of *A. cantonensis* infection in *A. fulica* in Tahiti. The first recorded case of human infection in Tahiti by the nematode parasite occurred in 1957 and rat infection in 1961 (Alicata, 1966), several years before *A. fulica* was supposedly introduced. In the case of Tahiti, at least, Alicata (1966) hypothesised that *A. cantonensis* was not brought there by *A. fulica*. Nevertheless, the results show that the Tahitian *Achatina fulica* is used as an intermediate host of *A. cantonensis*. Alicata (1966) also found *A. fulica* in Hawaii to be infected with the parasite, and he concluded that if the snails and the worms are found in the same area, then it is highly likely that the majority of the snails in the population will be infected.

The other *A. fulica* populations surveyed in the current study that are within the dispersal route of *A. fulica* proved negative for *A. cantonensis.* Among these areas, Thailand, Japan and Singapore had prior reported cases of *A. cantonensis*. In the case of Thailand, *A. cantonensis* was "found" in the edible land snail, *Hemiplecta distincta*, from 16 provinces where a total of 467 snails were surveyed (Panha, 1988). However, it was not definitively identified by feeding the nematodes to laboratory rats; instead, identification relied more on the morphological features of the juveniles. The sampling site in Thailand for this study (with only 20 snails surveyed but with no *A. cantonensis* infection) is also near the border with Cambodia where the parasite was detected in both humans and rats (Brumpt *et al.*, 1968). In Japan, *A. cantonensis* was reported from 27 cases of human infections, the majority of which are from the Okinawa Prefecture in the Pacific south of the Japanese main islands (Nakazawa *et al.*, 1992). In Ogasawara (with 12 snails surveyed in this study), there are no reported cases of *A. cantonensis* to date; Ogasawara is another group of islands in the Pacific southeast of the main Japanese islands. In Singapore (33 snails surveyed), there is one previous case of eosinophilic meningoencephalitis in a woman who was suspected of acquiring the parasite from eating contaminated raw vegetables, though it was more likely that these vegetables were imported from a nearby country where these worms are found (Lim *et al.*, 2004). For the remaining areas, Nepal, Myanmar and Moorea, there are no known reported cases to date that demonstrate the presence of *Angiostrongylus cantonensis*, though no systematic attempts to survey the snails and rats for worms in these areas have been done so far.

For West Africa, neither the *Achatina* sp. sample population from Ibadan, Nigeria (3 snails surveyed) nor that of the Ivory Coast (22 snails surveyed) yielded *A. cantonensis*. However, both countries had prior reported cases of *A. cantonensis* infections. A previous survey conducted on 22 rats in Ibadan in 1989 also failed to recover the parasite (Kliks & Palumbo, 1992), although it was detected in rats in Port Harcourt 450 km to the southeast (Udonsi, 1989; Kliks & Palumbo, 1992). In the Ivory Coast, the only recorded incidence was based on a single patient in 1979 that manifested the disease (Nozais *et al.*, 1980).

Angiostrongylus cantonensis was found in only two of the global populations of *A. fulica* sampled in this study. These results are therefore insufficient to permit any consideration of the role of *A. fulica* in the dispersal of *A. cantonensis*. The low success in finding the parasite in the snail intermediate host could have been caused by several factors. For one, the absence of *A. cantonensis* in *A. fulica* populations within the snail's route of dispersal, with the exception of the Philippines and Tahiti, may be due to the patchy distribution of the parasite. This was shown in a previous study by Bisseru (1971) in which he surveyed the presence of *A. cantonensis* in *A. fulica* populations from 27 sites in West Malaysia and found two sites with no parasite in any of the snails. One of these sites, Padang Besar, Perlis, with 100 snails sampled, is less than 65 km from Alor Star, Kedah, with 70 snails sampled and with an infection rate of 28.5%. Further to the patchy distribution of the parasite, the snail intermediate host itself could also have a patchy distribution and be uncommon in some of the sampling sites, thus reducing the probability of finding the parasites. For example, the Subic Bay Forest Reserve in the Philippines only yielded four individuals despite rigourous searching. In addition to the issue of patchy distribution, this study was also affected by sampling limitation; in particular, sampling was severely hampered by the availability of live snail samples that could be brought out of the sampling sites. For instance, governmental restrictions in India and Sri Lanka prevent the export of live snails from these countries. Based on these factors, a comprehensive global survey of *A. fulica* populations was not possible.

Angiostrongylus cantonensis is not stringent as to its choice of intermediate and definitive hosts (Prociv *et al.*, 2000); therefore, the current distribution range of the parasite could be attributed to more than just one host. Indeed, the parasite is known to have been established in many localities where *A. fulica* is absent or has arrived after *A. cantonensis*. Already mentioned is Tahiti, to which the parasite could have been brought either by contaminated rats or by molluscs other than *A. fulica* that were probably imported by labourers from Indochina and Indonesia in the 1950s (Alicata, 1966). Other examples include Brisbane, Australia, where the parasite was found in the exotic rats *R. norvegicus* and *R. rattus* (Yong *et al.*, 1981), and New Orleans, USA where the worm was recovered from *R. rattus* (Campbell & Little, 1988). In both cases, local snails and slugs were also found to harbor *A. cantonensis* either in the wild (Yong *et al.*, 1981) or experimentally (Campbell & Little, 1988). Furthermore, other intermediate hosts with similar routes of dispersal to that of *A. fulica* could just as easily have aided the dispersal of *A. cantonensis*. One candidate is the black slug, *Laevicaulis alte*, which originated from Africa (Solem, 1964) and has spread across the globe in association with humans (Hoffman, 1925); the slug is also known to harbor *A. cantonensis* as demonstrated by Salazar and Cabrera (1969) and by the results from this study. It is therefore highly likely that the dispersal of the nematode is attributed to a complex combination of rats and mollusc intermediate hosts, and a systematic survey of all possible taxa that could harbour *A. cantonensis* as well as the population genetic analysis of global populations of the parasite and its hosts, juxtaposed with the information regarding the first reported cases of infection in new areas, is perhaps the only way to trace the dispersal of *A. cantonensis*.

7.4.2. The presence of other worms in snail and slug populations

Nematodes other than *Angiostrongylus cantonensis* can likewise infect terrestrial snails and slugs such as *Achatina fulica* and *Laevicaulis alte.* The BLAST results and the phylogenetic analysis in this study clearly revealed 23 unique nematode species from the snails and slugs that fall within the Rhabditida clade and which have not yet been characterised molecularly using the 18S rRNA gene as they did not have a match with any named nematode taxa in GenBank. Some of these nematode species were also found to infect the same snail, as in the case of two *Achatina* sp. from the Ivory Coast, three *Achatina fulica* from the Philippines and one *A. fulica* each from Singapore, Ogasawara and Tahiti. Infection in gastropods by more than one species of nematodes is not uncommon, although localization of these parasites to specific organs does occur (Morand *et al.,* 2004). In another study, Viyada (2005) surveyed 200 adult *A. fulica* from two provinces in Thailand in which he found *Rhabditis* sp. in the alimentary tract. He suggested that this species could have been an accidental parasite of the snail as no noticeable damage to the host was observed.

Some species of nematodes pass through a dauer stage, a non-feeding alternative 3rd juvenile stage that is resistant to stress and can survive for several months without feeding. In free living soil nematodes such as *Caenorhabditis elegans*, the dauer stage is utilised for dispersal and forms associations with invertebrate hosts or even feeds on carcasses of animals. For instance, *C. elegans* was found in snails (*Helix, Oxychilus* and *Pomatias*), isopods (*Oniscus asellus*) and a glomeris myriapod, indicating a wide host specificity for a nematode originally thought to be free-living (Barriere & Felix, 2005). Some of the nematode infections in this study could have been attributed to associations with the dauer stage; for example, Singapore Sequence 3 has a 98% identity with the free-living soil nematode *Caenorhabditis briggsae* while Philippines Sequence 7 has a 97% identity with *C. vulgaris*.

Grewal *et al.* (2003) listed 108 nematodes species that are known to be parasitic on gastropods and divided them into those that use gastropods as intermediate hosts and those that use gastropods as definitive hosts. For the first group of gastropod-parasitizing nematodes, the majority belong to the order Strongylida while the rest are from the Ascaridia, Spirurida and Rhabditida. Based on the results of this study, 13 nematode sequences fall within the Strongyloidea: Tahiti Sequence 2, Nigeria Sequences 1, 2 and 3, Ivory Coast Sequences 1, 2, 3, 4, 6 and 7, Philippines Sequences 2 and 5 and Singapore Sequence 4. A further three sequences cluster with the *Heterakis* species from the Ascaridia: Singapore Sequence 2, Thailand Sequence 1 and Ivory Coast Sequence 5. Based on their phylogenetic positions, these nematodes were probably juveniles and most likely used *Achatina fulica* and *Achatina* sp. as intermediate hosts. For the second group of gastropod-parasitizing nematodes, the majority belong to the Rhabditida (Grewal *et al.*, 2003). Six other sequences in this study fall within the Rhabditidae: Singapore Sequences 1 and 3, Philippines Sequences 3, 6 and 7, and Ogasawara Sequence 2. These nematodes were probably adults that used the snails and slugs as definitive hosts. On the other hand, Ogasawara Sequence 1 and Philippines Sequence 4 did not fall in either group described by Grewal *et al.* (2003) as they cluster with the Panagrolaimidae, a group of bacteria-feeding soil nematodes. It is highly likely that the *A. fulica* samples from Ogasawara and the Philippines *L. alte* that was infected with the nematode bearing Philippines Sequence 4 became accidental hosts of these probable free-living soil nematodes.

There were instances in the study when a nematode sequence clustered with a particular taxon or group of taxa in the phylogenetic analysis and yet was most similar to another species based on the BLAST result. This was true for Nigeria Sequences 1 and 3 and Ivory Coast Sequence 2. It should be noted that the BLAST results were based on approximately 480 nucleotide sites whereas the phylogenetic analysis utilised only 376 sites as the rest could not be unambiguously aligned and that the clades generated were not well supported at the tips. For this reason, BLAST results take precedence as they identify the closest sequence match to named nematode taxa found in GenBank using all available nucleotide sites obtained while the phylogenetic analyses only determine which clades the unknown sequence types belong to based on a subset of the sequence information obtained.

7.4.3. Limitations and the next step

This study was heavily dependent on the availability of live samples of *Achatina fulica* and other gastropod intermediate hosts. Alicata's hypothesis was not sufficiently tested precisely because of the patchy and limited sampling of live snails and parasites, and the second objective (comparison of the population genetics of the snail and the parasite to check for similarity in their dispersal) was therefore not met as only the population genetics of global samples of *Achatina fulica* based on the 16S rRNA gene was available (see Chapter 5). Many areas were not covered because of governmental restrictions on the export of live snails, the difficulty of finding these snails by collectors and keeping them alive whilst in transit, the unwillingness of some couriers to ship live specimens, and the UK government's restrictions on the importation of such live snails from different countries. One practical solution will be to collect the samples and extract the worms in the field. Another is to develop a technique that will detect the presence of *A. cantonensis* through PCR in ethanol-preserved specimens, though this technique will not be able to determine the parasite load (number of parasites present) per individual snail.

Owing to the fact that *Angiostrongylus cantonensis* has a patchy distribution as demonstrated by the survey from three sampling sites in the Philippines, several sampling sites per locality should also be covered. In addition, other gastropod intermediate hosts that could have had a role in the dispersal of *A. cantonensis* should be surveyed alongside *A. fulica*.

7.5. Summary

Within the route of dispersal of *Achatina fulica*, *Angiostrongylus cantonensis* was only found in *A. fulica* populations in the Philippines and Tahiti as well as the *Laevicaulis alte* populations in the Philippines. The results for Tahiti provide the first recorded case of *A. cantonensis* infection for *A. fulica* in that island. Due to the patchy distribution of *A. cantonensis* and the limited sampling of the snail intermediate host, the results from this study are insufficient to test Alicata's hypothesis that the Giant African Land Snail is primarily responsible for the spread of the parasite. Further sampling is therefore required. *Angiostrongylus cantonensis* has a wide range of suitable intermediate hosts, and gastropods such as the black slug *Laevicaulis alte*, which this study clearly demonstrated to harbor the parasite, should also be considered in future studies to determine their role in the dispersal of the parasite. Other worms found in *Achatina fulica*, *Achatina* sp. and *Laevicaulis alte* include 12 strongyloid species and 3 ascarid species that probably used the snails as intermediate hosts and 5 rhabditid species that probably used the snails as definitive hosts. One panagrolaimid nematode species each from Ogasawara and the Philippines most likely used *A. fulica* and *L. alte*, respectively, as accidental hosts.

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CHAPTER 8 – Summary

The Giant African Snail *Achatina* (*Lissachatina*) *fulica* is a pest species that originated in East Africa but currently has a pantropical distribution brought about by human activities. It is also a known intermediate host of the rat lungworm, *Angiostrongylus cantonensis*, which can infect humans and cause eosinophilic meningoencephalitis.

Achatina fulica belongs to the Stylommatophora, a group of land snails and slugs that has two pairs of caudal tentacles, a contractile pneumostome and no operculum. Recent molecular phylogenetic study based on the rRNA gene cluster has shown a clear dichotomy of the Stylommatophora into the ‘non-achatinoid’ clade and the ‘achatinoid’ clade, which includes *A. fulica*. Within the ‘achatinoid clade’ is the Achatinoidea, which includes the Achatinidae, Coeliaxidae, Ferussaciidae, Glessulidae, Subulinidae and Thyrophorellidae. The phylogeny of the Achatinoidea was investigated further using 24 taxa across 6 families based on 3 nuclear genes (rRNA cluster, actin and histone 3) and 2 mitochondrial genes (CO1 and 16S rRNA). The 3rd codon position of the CO1 gene and the 16S rRNA were later excluded as they were found to be saturated. All strongly-supported groups in the rRNA phylogeny were recovered in the combined gene phylogenies with longer internal branches and receiving similar or slightly better statistical support. The study demonstrated the monophyly of the Achatinidae but not the Ferussaciidae, Coeliaxidae and the Subulinidae. These results suggest the need to re-evaluate of the Ferussaciidae, Coeliaxidae and Subulinidae as valid groupings.

The first systematic attempt to reconstruct the phylogeny of the Achatinidae was also conducted using 26 species from 7 genera based on the same genes used to evaluate the relationships of the Achatinoidea. The nuclear actin gene and the 3rd codon position of the mitochondrial CO1 gene were subsequently excluded due to the presence of paralogous sequences in the former that affected the phylogeny and the severe saturation of the latter. Results showed four distinct groups that to a large extent follow the geographical distributions of the taxa used in the survey. These were the West African group that fell at the base of the tree, a mixed group consisting of members with distributions ranging from the western, central, eastern and southern regions, and two groups that formed sister clades and which probably arose from the mixed group: the Southern African group and the East African group, which included *A. fulica*. The East African group incorporated all members of the subgenus *Lissachatina* of *Achatina*, which also exhibit distinct features of the reproductive organ, as well as the subgenus *Euaethiopina* of *Achatina*. Evidence from both molecular and morphological data would suggest that *Lissachatina* should be elevated to genus status.

The extent of genetic variation among global populations of *A. fulica* was also investigated using a fragment of the 16S rRNA gene to determine how many genetic types emerged from East Africa. Of the 15 distinct haplotypes observed, 13 were found in East Africa and nearby Indian Ocean islands while the rest of the global populations shared only haplotype C that came out of East Africa. Two non-African haplotypes (E from the Philippines and F from New Caledonia and Barbados) were probably recent mutations derived from C. This would indicate that the global populations of *A. fulica* descended from a small group of individuals that shared the same haplotype and that these populations could be experiencing genetic bottlenecks as a consequence of lack of variation.

The role of *A. fulica* in spreading the rat lungworm *Angiostrongylus cantonensis* was evaluated. It is believed that the rat lungworm, like *A. fulica*, also originated in East Africa, and the nearly parallel distribution of the snail intermediate host and the parasite is noted. A molecular marker was first developed using a small segment of the SSU rRNA gene to rapidly identify the worm from snail tissues. This marker was also found to discriminate between closely related species of *Angiostrongylus*. Using this molecular marker, global populations of *A. fulica* were surveyed to detect the presence of *A. cantonensis* within the route of dispersal of *A. fulica*. The parasite was only found in the Philippines and Tahiti. The results for Tahiti provide the first recorded case of *A. cantonensis* infection for *Achatina fulica* in that country. The limited sampling of *A. fulica* and the patchy distribution of *A. cantonensis* could explain the lack of *A. cantonensis* among the populations sampled, with the exception of the Philippines and Tahiti. It is therefore difficult to assess if the snail has a role in the spread of the parasite, and the possibility of other gastropods such as *Laevicaulis alte* contributing to the spread of *A. cantonensis* is not discounted.

APPENDIX

Appendix 2.1: Command lines for generating likelihood scores for the 12 models in PAUP*

2.1.1. JC69

1. paup> log file=filename.JC69models.paupout (this saves an output file)
2. paup> execute dataset.nex
3. paup> set criterion=distance (sets the optimality criterion to distance)
4. paup> dset distance=ml (specifies the distance measure to maximum likelihood for the estimation of the likelihood score for the model, which will be used for the LRT)
5. paup> lset nst=1 basefreq=equal rates=equal pinvar=0 (this specifies the assumptions of the JC69 model, which are equal frequency for all bases and equal rate of substitutions)
6. paup> nj (this generates a neighbor-joining tree based on the assumptions of the model)
7. paup> likelihoods /basefreq=equal rates=equal pinvar=0 (this estimates a likelihood score based on the model)

2.1.2. JC69+Γ (continued from JC69)

8. paup> likelihoods /basefreq=equal rates=gamma shape=estimate ncat=16 pinvar=0 (this adds the among site gamma rate variation with 16 categories dividing the discrete approximation of the gamma distribution)

9. paup> lset nst=1 basefreq=equal rates=gamma shape=previous ncat=16 pinvar=0
10. paup> nj
11. repeat 8-10 until the parameters and likelihood score do not change; note the likelihood score.

2.1.3. F81

1. paup> log file=filename.F81models.paupout
2. paup> execute dataset.nex
3. paup> set criterion=distance
4. paup> dset distance=ml
5. paup> lset nst=1 basefreq=estimate rates=equal pinvar=0 (this specifies the assumptions of the F81 model, which are unequal base frequencies and equal rate of substitutions)
6. paup> nj
7. paup> likelihoods /basefreq=estimate rates=equal pinvar=0
8. paup> lset nst=1 basefreq=previous rates=equal pinvar=0
9. nj
10. repeat 7-9 until parameters and likelihood score do not change; note the likelihood score.

2.1.4. F81+Γ (continued from F81)

11. paup> likelihoods /basefreq=estimate rates=gamma shape=estimate ncat=16 pinvar=0
12. paup> lset nst=1 basefreq=previous rates=gamma shape=previous ncat=16 pinvar=0
13. paup> nj
14. repeat 11-13 until the parameters and likelihood score do not change; note the likelihood score.

2.1.5. K2P

1. paup> log file=filename.K2Pmodels.paupout
2. paup> execute dataset.nex
3. paup> set criterion=distance
4. paup> dset distance=ml
5. paup> lset nst=2 basefreq=equal tratio=estimate rates=equal pinvar=0 (this specifies the assumptions of the K2P model, which are equal frequency of bases and different substitution rates for transtitions and transversions)
6. paup> nj
7. paup> likelihoods /basefreq=equal tratio=estimate rates=equal pinvar=0
8. paup> lset nst=2 basefreq=equal tratio=previous rates=equal pinvar=0
9. paup> nj
10. repeat 7-9 until parameters and likelihood score do not change; note the likelihood score.

2.1.6. K2P+Γ (continued from K2P)

11. paup> likelihoods /basefreq=equal tratio=estimate rates=gamma shape=estimate ncat=16 pinvar=0
12. paup> lset nst=2 basefreq=equal tratio=previous rates=gamma shape=previous ncat=16 pinvar=0
13. paup> nj
14. repeat 11-13 until the parameters and likelihood score do not change; note the likelihood score.

2.1.7. HKY85

1. paup> log file=filename.HKY85models.paupout
2. paup> execute dataset.nex
3. paup> set criterion=distance
4. paup> dset distance=ml
5. paup> lset nst=2 basefreq=estimate tratio=estimate rates=equal pinvar=0 (this specifies the assumptions of the HKY85 model, which are unequal base frequencies and different substitution rates for transitions and transversions)
6. paup> nj
7. paup> likelihoods /basefreq=estimate tratio=estimate rates=equal pinvar=0
8. paup> lset nst=2 basefreq=previous tratio=previous rates=equal pinvar=0
9. paup> nj

10. repeat 7-9 until parameters and likelihood score do not change; note the likelihood score.

2.1.8. HKY85+Γ (continued from HKY85)

11. paup> likelihoods /basefreq=estimate tratio=estimate rates=gamma shape=estimate ncat=16 pinvar=0
12. paup> lset nst=2 basefreq=previous tratio=previous rates=gamma shape=previous ncat=16 pinvar=0
13. paup> nj
14. repeat 11-13 until the parameters and likelihood score do not change; note the likelihood score.

2.1.9. TN93

1. paup> log file=filename.TN93models.paupout
2. paup> execute dataset.nex
3. paup> set criterion=distance
4. paup> dset distance=ml
5. paup> lset nst=6 basefreq=estimate rmatrix=estimate rates=equal pinvar=0 rclass=(a b a a e a) (this specifies the assumptions of the TN93 model, which are unequal base frequencies and different substitution rates for transitions in purines and pyrimidines and transversions)
6. paup> nj

7. paup> likelihoods /basefreq=estimate rmatrix=estimate rates=equal pinvar=0 rclass=(a b a a e a)
8. paup> lset nst=6 basefreq=previous rmatrix=previous rates=equal pinvar=0 rclass=(a b a a e a)
9. paup> nj
10. repeat 7-9 until parameters and likelihood score do not change; note the likelihood score.

2.1.10. TN93+Γ (continued from TN93)

11. paup> likelihoods /basefreq=estimate rmatrix=estimate rates=gamma shape=estimate ncat=16 pinvar=0 rclass=(a b a a e a)
12. paup> lset nst=6 basefreq=previous rmatrix=previous rates=gamma shape=previous ncat=16 pinvar=0 rclass=(a b a a e a)
13. paup> nj
14. repeat 11-13 until the parameters and likelihood score do not change; note the likelihood score.

2.1.11. GTR

1. paup> log file=filename.GTRmodels.paupout
2. paup> execute dataset.nex
3. paup> set criterion=distance
4. paup> dset distance=ml

5. paup> lset nst=6 basefreq=estimate rmatrix=estimate rates=equal pinvar=0 (this specifies the assumptions of the GTR model, which are unequal base frequencies and different substitution rates)
6. paup> nj
7. paup> likelihoods /basefreq=estimate rmatrix=estimate rates=equal pinvar=0
8. paup> lset nst=6 basefreq=previous rmatrix=previous rates=equal pinvar=0
9. paup> nj
10. repeat 7-9 until parameters and likelihood score do not change; note the likelihood score.

2.1.12. GTR+Γ (continued from GTR)

11. paup> likelihoods /basefreq=estimate rmatrix=estimate rates=gamma shape=estimate ncat=16 pinvar=0
12. paup> lset nst=6 basefreq=previous rmatrix=previous rates=gamma shape=previous ncat=16 pinvar=0
13. paup> nj
14. repeat 11-13 until the parameters and likelihood score do not change; note the likelihood score.

Appendix 2.2: Command lines in PAUP* for estimating the uncorrected and corrected distances as well as the transition and transversion values

1. paup> log file=filename.distances.paupout
2. paup> execute dataset.nex
3. paup> set criterion=distance
4. paup>dset distance=p
5. paup> showdist (this generates the uncorrected total pairwise distances)
6. paup> savedist /format=onecolumn file=filename.distances.p.1col (this saves the pairwise uncorrected total distances in one column)
7. paup> dset subst=ti (this specifies that the transition distances will be computed)
8. showdist (this generates the transition distances)
9. paup>savedist /format=onecolumn file=filename.distances.p.ti.1col
10. paup> dset subst=tv (this specifies that the transversion distances will be computed)
11. showdist (this generates the transversion distances)
12. paup>savedist /format=onecolumn file=filename.distances.p.tv.1col
13. paup> dset subst=all (this restores the setting to pertain to total distances)
14. paup> set criterion=distance
15. paup> dset distance=ml
16. set the predetermined optimal criterion using the lset command
17. paup> showdist (this generates the corrected total distances)
18. paup> savedist /format=onecolumn file=filename.distances.ml.model.1col

Appendix 2.3: Command lines for the different tree-construction methods

2.3.1. Maximum likelihood (ML) method

The ML method was done in PHYML Version 2.4.4 package (Guindon *et al.*, 2005). The parameters of the optimal model was specified when the dataset analyzed.

Enter the sequence file name > sequence.file.phy
er the sequence file name > sequence.file.phy

Settings:

D:	Data type (DNA/AA)	DNA
I:	Input sequences interleaved (or sequenctial)	interleaved
S:	Analyze multiple data sets	no
B:	Non parametric bootstrap analysis	yes
	Number of replicates >	1000
	Print bootstrap trees (and statistics) ? [Y/n]	y
M:	Model of nucleotide substitution	(depending on optimal model)
E:	Base frequency estimates (empirical/ML)	ML
V:	Proportion of invariable sites (fixed/estimated)	fixed (p-invar = 0.00)
R:	One category of substitution rate [yes/no]	no (if with gamma distribution)
C:	Number of substitution rate categories	16 (if with gamma distribution)

A:	Gamma distribution parameter (fixed/estimated)	estimated (if with gamma distribution)
	Optimize alpha ? [Y/n]	Y
U:	Input tree (BIONJ/user tree)	BIONJ
O:	Optimize tree topology	yes

2.3.2. Bayesian inference

Bayesian inference (BI) analysis was carried out in the MrBayes Version 3.1.2 package (Ronquist & Huelsenbeck, 2003). The program was set to run with four independent chains, each of which aimed to converge on a stable likelihood value from a number of generations. Below are the command lines for approximating the posterior probabilities.

1. MrBayes > log start file=filename.mbout (this saves an output file)
2. MrBayes > execute filename
3. MrBayes > lset nst=1/2/6 rates=equal/gamma Ngammacat=16 (only for gamma distributed rates) (this states the model in which the tree will be based)
4. MrBayes >showmodel (this is to show the model settings)
5. MrBayes > help mcmcp (this is to show default settings of the Markov Chain Monte Carlo analysis)
6. MrBayes > mcmcp Nruns=1 Ngen=2000000 Temp=0.075 or 0.1 or 0.125 (the number of generations to be run as defined by Ngen and the temperature to heat the chains as defined by Temp need to be optimized as described below;

initially, values of 2000000 for Ngen and 0.1 for Temp are used and later on changed if necessary)

7. MrBayes > mcmc (this is to run the analysis)

At the end of the run, the program asked if the analysis should be continued. The word ‘yes’ was typed when the values from the four columns did not converge to similar likelihood scores. The number of additional generations (e.g. 1000000) was indicated to resume the analysis. Otherwise, the word ‘no’ was typed. When the cold chain (value enclosed with bracket) did not switch randomly across the four chains, the analysis was repeated but the Temp setting was changed.

When the analysis was completed, the state exchange information was displayed. As a rule of thumb, the values found on the upper diagonal, which expressed the acceptance rates of the Metropolis-Hastings mcmc sampler, should range between 0.1 and 0.7. When the acceptance rates were too low, the analysis was repeated but using a lower Temp. When the rates were too high, the analysis was repeated with a higher Temp.

8. MrBayes > sump burnin=value (e.g. 19001 if 2000000 generations were made; this summarizes the samples of model parameters)

Note: The value given indicated the number of samples to be discarded. A sample contained 100 generations; however, the first generation is always sampled and should be included in the samples to be discarded.

9. MrBayes > sumt burnin =value (e.g. 19001 if 2000000 generations were made; this summarized the samples of trees and branch lengths)

2.3.3. Neighbor-joining (NJ) method

The NJ method was done in PAUP* by starting out with the same parameters set by the identified optimal model for DNA sequence evolution, which was then followed by the commands listed below.

1. paup> nj brlens=yes (to display the table of branch lengths)
2. paup> savetrees /format=phylip brlens file=filename.nj.tree.phy (to save the tree in phylip format)
3. paup> savetrees /format=nexus brlens file=filename.nj.tree.nex (to save the tree in nexus format)
4. paup>bootstrap nreps=1000 method=nj keepall=yes treefile=filename.nj.boottree (to calculate and save the bootstrap values for 1000 replicates)
5. paup>quit

2.3.4. Maximum parsimony (MP) method

The MP method was also carried out in Paup*; this did not employ any models of DNA sequence evolution.

1. paup>set maxtrees=100 increase=auto
2. paup> set criterion=parsimony
3. paup> hsearch swap=tbr addseq=random nreps=10 start=stepwise (this is to make a heuristic or non-exhaustive search of the most parsimonious trees)
4. paup> showtrees all
5. paup> savetrees /fmt=phylip brlens=yes file=filename.mp.phy

6. paup> savetrees /fmt=nexus brlens=yes file=filename.mp.nex
7. paup> contree /majrule=yes file=filename.mp.constree (this generates a consensus tree of all the equally most parsimonious trees found)
8. paup> bootstrap nreps=1000 search=heuristic keepall=yes file=filename.mpboot.treefile (to calculate and save the bootstrap values for 1000 replicates)

Appendix 2.4: Command lines for the partition homogeneity test in PAUP* to determine if individual genes could be combined as a single dataset.

1. paup> execute concatenated.file.nex
2. paup> charpartition gene1:1-3435, gene2:3436-4296, gene3:4297-4624. (this is to specify which segment of the concatenated sequence belongs to which gene)
3. paup> hompart partition=genes nreps=1000 seed=123 search=heuristic (this is to perform a homogeneity test with 1000 homogeneity replicates searched heuristically using a random seed number of 123)

Appendix 2.5: The command lines to run the Shimodaira-Hasegawa test in PAUP* to compare for significant difference between optimal and constrained trees

1. paup> execute concatenated.file.nex
2. set the parameters of the optimal model
3. paup> constraints taxonmonophyly (MONOPHYLY) = ((1,2)) (where numbers refer to the taxon numbers; this specifies which taxa were constrained to form a clade based on an *a priori* hypothesis that they are monophyletic)
4. paup> nj brlens=yes enforce=yes constraints=taxonmonophyly (this generated a constrained neighbor-joining tree)
5. paup> savetrees /format=nexus brlens file=taxonmonophyly.nex (this saved the constrained neighbor-joining tree)
6. execute trees.file (this file should include both the constrained tree from no. 5 as well as the optimal neighbor-joining tree)
7. paup> showtrees all (this displayed both trees)
8. paup> lsocres all/shtest=rell (this computed for the likelihood scores of the two trees based on the estimated likelihood method and compared for significant difference between the two likelihood scores at *P*=0.05 level of significance)

Appendix 3.1: Alignment of the LSU rRNA gene for the Achatinoidea and three streptaxid outgroup taxa. Positions included for the phylogenetic analyses were marked by “`m`” within “`NUCEOTIDES INCLUDED`”.

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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    10         20         30         40         50         60
Achatina fulica             ATTGCAGAAC ACATTGAACA TCGACACCTT GAACGCACAT GGCGGCCTCG GG-TCCATCC
Achatina achatina           ATTGCAGAAC ACATTGAACA TCGACACCTT GAACGCACAT GGCGGCCTCG GG-TCCATCC
Achatina stuhlmanni         -----AGAAC ACATTGAACA TCGACACCTT GAACGCACAT GGCGGCCTCG GG-TCCATCC
Cochlitoma ustulata         ---------- ---TTGAACA TCGACACCTT GAACGCACAT GGCGGCCTCG GG-TCCATCC
Allopeas clavulinum         -----AGAAC ACATTGAACA TCGACACCTT GAACGCAAAT GGCGGCCTCG GG-GCCATCC
Bocageia sp.                ATTGCAGAAC ACATTGAACA TCGATACCTT GAACGCACAT GGCGGCCTCG GG-TCCATCC
Eutomopeas layardi          ATTGCAGAAC ACATTGAACA TCGACACCTT GAACGCAAAT GGCGGCCTCG GG-GCCATCC
Leptinaria lamellata        ATTGCAGAAC ACATTGAACA TCGACACCTT GAACGCAAAT GGCGGCCTCG GG-GCCATCC
Paropeas achatinaceum       ATTGCAGAAC ACATTGAACA TCGACACCTT GAACGCAAAT GGCGGCCTCG GG-GCCATCC
Riebeckia sp.               -------AAC ACATTGAACA TCGACACCTT GAACGCACAT GGCGGCCTCG GG-TCCATCC
Rumina decollata            ATTGCAGAAC ACATTGAACA TCGACACCTT GAACGCACAT GGCGGCCTCG GG-TCCATCC
Subulina octona             ---------- ---------- TCGACACCTT GAACGCACAT GGCGGCCTCG GG-TCCATCC
Subulina striatella         ATTGCAGAAC ACATTGAACA TCGACACCTT GAACGCACAT GGCGGCCTCG GG-TCCATCC
Subulina vitrea             ---------- -------ACA TCGATACCTT GAACGCATAT GGCGGCCTCG GG-TCCATCC
Subulona sp.                ---------- ---------- ------CCTT GAACGCATAT GGCGGCCTCG GGCTCCATCC
Tortaxis erectus            ATTGCAGAAC ACATTGAACA TCGACACCTT GAACGCACAT GGCGGCCTCG GG-TCCATCC
Xerocerastus sp.            ATTGCAGAAC ACATTGAACA TCGACACCTT GAACGCACAT GGCGGCCTCG GG-TCCATCC
Zootecus insularis          ATTGCAGAAC ACATTGAACA TCGACACCTT GAACGCACAT GGCGGCCTCG GG-TCCATCC
Coeliaxis blandii           -------AAC ACATTGAACA TCGACACCTT GAACGCACAT GGCGGCCTCG GG-TCCATCC
Pyrgina umbilicata          -------AAC ACATTGAACA TCGACATCTT GAACGCAAAT GGCGGCCTCG GG-GCCATCC
Glessula ceylanica          ATTGCAGAAC ACATTGAACA TCGATACCTT GAACGCACAT GGCGGCCTCG GG-TCCATCC
Cecilioides gokweanus       ---------- ---------- ---ACATCTT GAACGCAAAT GGCGGCCTCG GG-TCCATCC
Ferussacia folliculus       ---GCAGAAC ACATTGAACA TCGACACCTT GAACGCACAT GGCGGCCTCG GG-TCCATCC
Thyrophorella thomensis     ATTGCAGAAC ACATTGAACA TcGACATCTT GAACGCAAAT GGCGGCCTCG GG-GCCATCC
Gibbulinella dewinteri      ---------- ---------- ------NCTT GNACGCANAT GGCGGCCNCG GG-TCNNTCC
Gonaxis quadrilateralis     -----AGAAC ACATTGAACA TCGACAACTT GAACGCATAT GGCGGCCTCG GG-TCAATCC
Gonospira sp.               -----AGAAC ACATTGAACA TCGACAACTT GAACGCATAT GGCGGCCTCG GG-TAAATCC
NUCLEOTIDES INCLUDED        ---------- ------mmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mm-mmmmmmm


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    70         80         90        100        110        120
Achatina fulica             CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AG---TACAA AGCCTTCGCT TCGTATGAGG
Achatina achatina           CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AG---TACAA AGCCTTCGCT TCGCATGTGG
Achatina stuhlmanni         CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AG---TACAA AGCCTTCGCT TCGTATGCGG
Cochlitoma ustulata         CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AG---TACAA AGCCCTCGCT TCGTATGTGG
Allopeas clavulinum         CGGGGCCACG CCCGTCTGAG GGTCGGCGAA AA---AACCA AACCATCGCT TCTCTTCTTC
Bocageia sp.                CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AA----TCAA AGCAATCGCT TCCTGTTTGG
Eutomopeas layardi          CGGGGCCACG CCCGTCTGAG GGTCGGCGAA AA----ATCA AACCATCGCT CCTCTT-TTC
Leptinaria lamellata        CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AA----ACTA AACAATCGCT TCAGTT-TTT
Paropeas achatinaceum       CGGGGCCACG CCCGTCTGAG GGTCGGCGAA AA----ACCA AACCATCGCT TCTTTTTTTT
Riebeckia sp.               CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AA---TCAAA AGCAATCGCT TCGAGATGGC
Rumina decollata            CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AG----TCAA AGCCTTCGCT TCGCTTCTGG
Subulina octona             CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AG--TCGCAA AGCAATCGCT TCGGTTTGTT
Subulina striatella         CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AG--TCTCAA AGCAATCGCT TCCGTTTATA
Subulina vitrea             CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AA----TCAA AGCAATCGCT TCTATTTTGG
Subulona sp.                CGGNGCCACG CCCGTCTGAG GGTCGGCGAG AATCTTAATA AGCATTCGCT TCTTATCGGA
Tortaxis erectus            CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AG--TATCAA AGCAATCGCT TCGCACTAAA
Xerocerastus sp.            CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AR----TCAA AGCATTCGCT TCGCTTTTTT
Zootecus insularis          CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AG----ACAA AGCCATCGCT TCGCTTTTTT
Coeliaxis blandii           CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AA----TCAA AGCAATCGCT TCGAGCTGGG
Pyrgina umbilicata          CGGGGCCACG CCCGTCTGAG GGTCGGCGAA AA----ATCA AACAATCGCT TCTCCTCAGA
Glessula ceylanica          CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AA---GTCAA AGCAATCGCT TCGAATTTGA
Cecilioides gokweanus       CGGGGCCACG CCCGTCTGAG GGTCGGCGAG AA----ACTA CACCATCGCT TCGCTTTATG
Ferussacia folliculus       CGAGGCCACG CCCGTCTGAG GGTCGGCGAG AG------AA ACTCATCGCT TTTCATTTGC
Thyrophorella thomensis     CGGGGCCACG CCCGTCTGAG GGTCGGCGAA AT----ATCA AACAATCGCT TCTCTTCAG-
Gibbulinella dewinteri      CGAGGCCACG CCCGTCTGAG GGTGGGGAGT CTTAAAAAAA GCCGTTCGCT TTCATGTTGG
Gonaxis quadrilateralis     CGAGGCCACG CCCGTCTGAG GGTCGGCGAG AC---TTATA AGCATTCGCT TTTTCCGTTG
Gonospira sp.               CGAGGCCACG CCCGTCTGAG GGTCGGCGAG TC--TTAAAA GCCGTTCGCT TTCTGCTGAC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm ---------- ---------- ----------
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    130        140        150        160        170        180
Achatina fulica             -CAGCAGGTC TCGCTC---A ATTTATTCCG AGATCCGTCC AGCTCTTC-- ---CTCTATC
Achatina achatina           GCAGCAGGTC TCG------- ATTTATTCCG AGATCCGTCT A-TACTTC-- NTGNTCTANT
Achatina stuhlmanni         -CAGCAGGTC TCGCTT--AA ATTTCCGTCC AGATCTTC-- ---------- ---CTCTATC
Cochlitoma ustulata         -CAGCAGGTC TCGCTC---A ATTTATTCCA AGATCCGTCT AGCTCTTC-- ---CTCTATC
Allopeas clavulinum         TTACCAGACC AAAGGCCG-C ACGCCGTCGG GGTCTTTCGC TCTTCCGAAG CTCGAAGGGA
Bocageia sp.                CTCGGGGTTC TAACTAAACC CGTTCGCGCG CGTCCTTCTT CTTTTTCCCG AGCTCGTGCG
Eutomopeas layardi          TATGTGACCA AAGGCCCACA CGCCGTCGTG AGACAGGTCT TTCGCTCATC CGAAGCTCGA
Leptinaria lamellata        ATGACAACTG GCATTCCCGT TTCTTCCGAG CTCGAGGAAG AGCGGGAGAG CCGCCGAAGC
Paropeas achatinaceum       CTTATCAGAC CAAAGGCAGC GCGCCGTCGG TGT--ATCGT TCTTCCGAAG CTCGAAGGGA
Riebeckia sp.               GGTAACAGGT CGCCTC-AAA CAAGCTGCTC CGATCCGATC GCCGCCGTTT CTTCCCGGGC
Rumina decollata            -CAGCTGGTC CGGTTC---- ---------- ---------- ---------- --------TA
Subulina octona             -CTCGACAGC GGGTCTCCAG CCTCCAGAGA AGGCTT---- ---------- ----------
Subulina striatella         -GTGACGGCG GGTCTCCAGC TTCCGATCGT CCCCACAACT TCCTTCGCGC TCGGCAGGGA
Subulina vitrea             CACAGGGGTC TCCCGTTGGG GGGTTGGCTG GCAAGGCAAG GCAGGCATAT TTTCTTTCTC
Subulona sp.                GAA------- NNNNNNNNNN NNNNN----- ---------- ---------- ----------
Tortaxis erectus            -CCGACGAGT GGTCGTCCTT CCCCAACTTG GCTCTGAGTT TGCGGGCGGG CAGGCCGACC
Xerocerastus sp.            GGTNAACGGG TCCNCCTTGN TCAGNNAATT CCGTTC-CAT TGNGCTCGCG GGAAACAAAA
Zootecus insularis          TTTTTYCTTT AAAAAAAAAA ATGCACCGGG TTTTGCTTAT TCCCACCATG TCGTTCTCGC
Coeliaxis blandii           TTGGGTCGTC TCGAAGTCCG ATCAGCTCAG TCCGTTCCTC CGCGCTCATC GTGGGAGGAT
Pyrgina umbilicata          GACCAAAGGC ACTCGCCGTC CGTCCGTCGG CCTTCCTAAG CTCGAAGGAA GCGCTTGATG
Glessula ceylanica          CATGGGTCAC ACAATTTCNA ANANACTTCN AANAATNCTT TTTTNTCCCC GCTTTTGAAA
Cecilioides gokweanus       GCAACAGGTT TCCCCG-TCT TCTTCCGAGC T--------- ---------- ----------
Ferussacia folliculus       CCTAAGGATT CGACCTTGCC ACCTCTGTGT TCGTGTTAGA GGGAGAAGGT GCAGAATTCG
Thyrophorella thomensis     -ATCAAAGGC ACTCTCGC-C CGTCCGTCGG CCTTCCTAAG CTCGAAGGAA AGGCTTGATG
Gibbulinella dewinteri      ACTGGTAGGC CTACGCGGGC CGTCGCCAGC AGGTTTGGCT TTTGCGGGAG GGCATATTTT
Gonaxis quadrilateralis     GACTGCTGCT CGGGCCACCG TCTGTCTGGG TGANGAGGGG NATTGACGCN TCAACTCGTT
Gonospira sp.               TGGAAGGCAA CCGTCGGTCT GTCACAGGCG CGGAGGAAAG TCCCTCTCGT GTTGCGACGT
NUCLEOTIDES INCLUDED        ---------- ---------- ---------- ---------- ---------- ----------


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    190        200        210        220        230        240
Achatina fulica             C-ATCCGCGG -CTCGTGCGG A--GGGGTTA CAGAGAGGAA GAAT-CGGGC G---------
Achatina achatina           G-NCGTCCCG CTGCTCGTGC T---GGGACA CGGAAAAGAA GAATTGGACN N---------
Achatina stuhlmanni         T--TCCGCGG -CTCGTGCGG -------GGA CAGAAAGAAA GAAT-CTGTC G---------
Cochlitoma ustulata         T-ATCCGCGG -CTCGTGCGG T---GGAGGA CAGAAAGGCG ---------- ----------
Allopeas clavulinum         GAGCGCAGAC ATGGTGGCGA TGGGCCGCAG CAGAAGCGCT TTGGGCTCTC GTAGGTCGAT
Bocageia sp.                GGTTGAGA-- ---------- ---------- ---------- ---------- ----------
Eutomopeas layardi          AGGGAGGGCG AAGACCGCCG CGACTGCGAT GGGCCGCAGC AGGAGCGCGT TGGGCTCTCG
Leptinaria lamellata        GCATTGGGCT TTCGCGGGAC GCGCAGGGCA CGTGCTCGTC CGTCGCGCTC TCGTACCGCG
Paropeas achatinaceum       GGGCGAAGAT ACGATGACGT CGGGCCGCCG CAGAAGCGCG TTGGGCTGTC GTAGGTCGAT
Riebeckia sp.               TCGTGGGAGG ATTCAAGTGG TTAGTTAGGA GGATGCTTTC GAGAGGTGAC CGTCGAAGCG
Rumina decollata            CCACGTCGTT TTTCACTCCG TGCTCGTGCG AGGGAGAAGC TGCGTCGTGG ATGA------
Subulina octona             ---------- ---------- ---------- ---------- ---------- ----------
Subulina striatella         GGGTTTGGGT GACGTTT--- ---------- ---------- ---------- ----------
Subulina vitrea             CTAATTTTTT TCATTTTCTT CCCGCCCGTG CGCTCTGACG GGCGCGGGTA GAGAGTGAAA
Subulona sp.                ---------- ---------- ---------- ---------- ---------- ----------
Tortaxis erectus            GTCGAAGCGC GCTGGGCATT CCGAGGATGA GTGCTCCTCC ACATGTCATC CCCG------
Xerocerastus sp.            A--------- -NNNNNNNNN N--------- ---------- ---------- ----------
Zootecus insularis          TCCGCCGTTC TTGGGATGAA AAGCGGCTCG TGGAGTGGCC GAA------- ----------
Coeliaxis blandii           ACAAAAGGCG GGGCGCGACT NAAATGNGAC CGTACAATCG CACTGGGCT- ----NNNNNN
Pyrgina umbilicata          ATGACGACGG GCTTGCTGCC GCAGAAGCGC TTTGAG-CTG TCGTGGGTCG TCAGTGACCC
Glessula ceylanica          AAAAA----- NNNNNNNNN- ---------- ---------- ---------- ----------
Cecilioides gokweanus       ---------- ---------- ---------- ---------- ---------- ----------
Ferussacia folliculus       CGGAAGCGCA CTGGGCTTTC GAGAATCACA CCATTCTCGC TCGAAAATAA AGAATGAAGT
Thyrophorella thomensis     ACGACG-GGC TGCTGCTGCC GCAGAAGCGC TTTGGGCCTT TCGTGGGTCG TCAGCGACCC
Gibbulinella dewinteri      TTTTTTGCCC ACTCGCGTTA CCAGCGGCGT CCGTGAAGAC CGAAGAAAGC GCTTCTGAGC
Gonaxis quadrilateralis     ACGGTGTGGT TGTCCCGAGG AGGAGGAAAA GCGCTCCGGG CTTTCGCGGN TGGGCAAAAA
Gonospira sp.               CCGGTTGCCG AGAAAGCGGT ATGGGCCTTC GCGGATGATG ACGTGCATCC CCGCGGCCTC
NUCLEOTIDES INCLUDED        ---------- ---------- ---------- ---------- ---------- ----------
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   250        260        270        280        290        300
Achatina fulica             ---------- ---------- ---------- ---------- ---------- ----------
Achatina achatina           ---------- ---------- ---------- ---------- ---------- ----------
Achatina stuhlmanni         ---------- ---------- ---------- ---------- ---------- ----------
Cochlitoma ustulata         ---------- ---------- ---------- ---------- ---------- --------GC
Allopeas clavulinum         TTCAACGACC ACCGTGGCCT CAAGTACATC GTGCGCCTGC CCCGTCCGTT TT--AATCGG
Bocageia sp.                ---------- ---------- ---------- ---------- ---------- ------TTAA
Eutomopeas layardi          TAGGTCGATT TCTACGACCG CCGTGGCCTC AAGTACATCG TGCGCCTGCC CCTGTCCGTT
Leptinaria lamellata        TTGCCTCAAG TACGTAGTGC GCCCGCCCTG TCCGATCAAT CGGTCCGTTG TGCTCTCGAC
Paropeas achatinaceum       TTCAACGACC CCCGTAGCCT CAAGTACATC GTGCGCCTGC CCTGTCCGTT TTTTAATCGG
Riebeckia sp.               CAATGGGCTT TCGAGGATGC TTGCTGCCTA TNATGGANGG AAAAAAGGAT GGCTCGCTCC
Rumina decollata            ---------- ---------- ---------- ---------- ---------- ----------
Subulina octona             ---------- ---------- ---------- ---------- ---------- ----------
Subulina striatella         ---------- ---------- ---------- ---------- ---------- ----------
Subulina vitrea             ATACAGGAAA AGAAGAAGAG CCGCGGCCGC CGTCGCCGCA CG-----CCA TTTTACTTTT
Subulona sp.                ---------- -----NNNNN NNNNNNNNNN NNNNNNNNN- ---TTTTTTT TTTTTGTTA-
Tortaxis erectus            ---------- ---------- ---------- ---------- ---------- ----------
Xerocerastus sp.            ---------- ---------- ---------- ---------- ---------- ----------
Zootecus insularis          ---------- ---------- ---------- ---------- ---------- ----------
Coeliaxis blandii           NNNN------ ---------- ---------- ---------- ---------- ----------
Pyrgina umbilicata          TCGTGGCTTC AAGTACAACG TGCGCCTGCC CCTGTCCGTT TTAGTCGGTC TCGTTAGCTC
Glessula ceylanica          ---------- ---------- ---------- ---------- ---------- ----------
Cecilioides gokweanus       ---------- ---------- ---------- ---------- ---------- ----------
Ferussacia folliculus       GGTTTCCGTT GCCTGAAGTA CTGAAAAAAA CTGCGTCCTC TGTCCGTTCT AGCTAGCTCA
Thyrophorella thomensis     TCGTGGCCTC AAGTACAACG TGCGCCTGCC CCTGTCCGTT TTGGTCGGTC TCGTTAGCTC
Gibbulinella dewinteri      CTTCGCGGAT CGCATGATCC CCGTGGCTTC AAGTGTACTC GATGCGCGCG CGCCCTTTGC
Gonaxis quadrilateralis     TCANCCCCGT GGCCACAAGT GTAAAAGATG CGCGCGTGTC TGCTGANCTG CCGCCTGCCT
Gonospira sp.               AAGTGCAAGC GTTGAGGGAG CGTCTTAGCT GCTGCTTCTG TCCCGCGACC TAAACGTGGA
NUCLEOTIDES INCLUDED        ---------- ---------- ---------- ---------- ---------- ----------
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   310        320        330        340        350        360
Achatina fulica             -GAGAAGGAA GAAGAAGAGA CCG------- TCGA-AGCGC TGTGGGCCGT --CGTGGGAG
Achatina achatina           ATANNGAAGG G-AAGAGAGG CCG------- TCGA-AGCGC TCTGGGCCGT --CGTGGGAG
Achatina stuhlmanni         -------GAG AAGAAAGAGA CCG------- TCGA-AGCGC TGTGGGCCGT --CGTGGGAT
Cochlitoma ustulata         GAAGGAAGAA GAAGAAGAGA CCG------- TCGA-AGCGC TGTGGGCCGT --CGTGGGAG
Allopeas clavulinum         TCTCGATGGT TCTC------ --TAACCGTC GGAGCGCTCG CTCGCTCGCC GTCCGTCTGG
Bocageia sp.                TAGGGCCGTG CTGATG---- ---AAGA-AG CGCACTGGGC TCT--CGAGG AGAGAAGAAC
Eutomopeas layardi          TTAATCGGTG TCGATGGCTC TCTAGCCGTC TGAGCGCTCG CTCGCTCGCC GTCCGTCTGG
Leptinaria lamellata        CGGAGCGCTC GCCGTCAGTC TGGCAGGACT CGGCTCGCAT AAAAGCATGA AATCGAGCCT
Paropeas achatinaceum       TCTC------ ---------- ---TACCGTC GGAGCGCTCG CTCGCTCGCC GTCCGTCTGG
Riebeckia sp.               TTTTTTTTT- ---------- ---------N NNNNNNNNN- ---------- ----------
Rumina decollata            ---------- ----TGAAGA CCG------- TCGA-AGCGC ACTGGGCTTT --CGAGGACG
Subulina octona             ---------- -----GGTGA CCG------- TAGA-AGCGC CCTGGGCTCT --CGAGGAGG
Subulina striatella         -----GAAGA GGCTTGGCGA CCG------- TGGA-AGCGC CCTGGGCTGT --CGAGGAGG
Subulina vitrea             AACGTGAGAG GACCCG---- ----GAGAAG CGCACTGGGC TTT--CGAGC TAAAGAAACA
Subulona sp.                ---------- ---------- ---------- ---------- ---------- ----------
Tortaxis erectus            ---------- ------TGGC CTGAAGTACA AAATTTATGC GCCGTCCCGT CCAACCGAGC
Xerocerastus sp.            ---------- ---------- ---------N NNNNNNNNN- ---------- ----------
Zootecus insularis          ---------- ---GACG--- ----TCGAAG CGTTCTGGCC TT---CGAGG ACGAGGAGGA
Coeliaxis blandii           ---------- ---------- ---------- NNNNNNNNNN ---------- ----------
Pyrgina umbilicata          TCGATGATCG TCTCCGAGCG CTAGCTAGCT CGCTCGCTCG CCGTCCGTCT GGCAGGACTC
Glessula ceylanica          ---------- ---------- --------NN NNNNNNNN-- ---------- ----------
Cecilioides gokweanus       ---------C GGTTGG---- ---ATGA-AG CGAGGTTAGC CGC--CGAAG CGCCTTGGGT
Ferussacia folliculus       CGAGTACGCC ATCTCGTCTA CTTGCCGTTA TGTCTGGCAG GACTCGGCTC GCTAATTCGA
Thyrophorella thomensis     TCGATGATCG TCT--GAGCG ATAGC----- ---TCGCTCG CCGTCCGTCT GGCAGGACTC
Gibbulinella dewinteri      GCGACCCTTC CCGCCATTTA GCGGCCCGCC GAACCGCGGC AGGACTCGGC TCGTGATGAC
Gonaxis quadrilateralis     CTCGGGGAAT TGGTTGGNTT CCCAGCGCNC CNCGACGAAG AAACCTTTCT GCATCCNCCG
Gonospira sp.               CAGGGCGGAG AGCACACAAC ATCTCCTTTT TTTCTTGTCA TCCGCCGGAT CGTGGCGGGA
NUCLEOTIDES INCLUDED        ---------- ---------- ---------- ---------- ---------- ----------
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    370        380        390        400        410        420
Achatina fulica             GAGGAAGAA- ----GGGTTT T--------- ---TTTCCAC CC-TT-CCCC CGTGGCCTCA
Achatina achatina           AGGAGGAGAG G--------- GATTTTGGAT TTTTCTTCTT TC-TTCCCCC CGTGGCCTCA
Achatina stuhlmanni         GAGGAATAAC T---GGGTTT TTCCCAG--- --TTTTTTTC TC-TT-CCCC CGTGGCCTCA
Cochlitoma ustulata         GAGGAAGAAG T---GCTTTT TTTT------ ------TCTC TC-TT-TCCC CGGGGCCTCC
Allopeas clavulinum         CAGGACTCGG CTCG---CTT TTTCGTGCAT CGAGCCTACC AGACCACGTC CGAA---GAA
Bocageia sp.                A-CA---CTT TCCCCGTGGC CTGAAGTACA CGTTGCGTCG TCGTTTGTCC TTTGAGCGGC
Eutomopeas layardi          CAGG---ACT CGGCTCGCTT TTTCTTGCAT CGAGCCTGCC AGACCCCCGT CCGAAGAAGG
Leptinaria lamellata        GTCG---ACC GTCCGAAGAA GCGGCCTGCG CGCAAAATAT CCGCTAGAGA GAGAAGGACC
Paropeas achatinaceum       CAGGACTCGG CTCG---CTC AATCTTGCAT CGAGCCTGCC AGACCACGTC CCAA---GAA
Riebeckia sp.               ---------- ---------N NNNNNNNNN- ---------- ---------- --------NN
Rumina decollata            AGGAGGAT-C G---AGTTTT CTCT------ -----TTCCA CC-TT-CCCT CGTAGCCTCA
Subulina octona             A--------- ---------- ---------- ----TGGCTC TTTTCCTCCC CGTGGCTTCA
Subulina striatella         AGGAGACGTA TG-------- ---TATGCTC TGTCGTCGTC GTCCTCTCCC CGTGGCTTCA
Subulina vitrea             AAACCGAAGT TAGCCCGAT- --GCCTGAAG TACACGTTGC GTCGTCAGTC CTTTGAGCGG
Subulona sp.                ---------- ---------- ---------- ---------- ---------- ----------
Tortaxis erectus            GCCCACGC-- -CCAACACCA CGCTCCGCTC GCCGTCCGTC TGGCAGGACT CGGCTCGCTT
Xerocerastus sp.            ---------- ---------N NNNNNNNNN- ---------- ---------- --------NN
Zootecus insularis          T-GC------ ---------- -----TTGCT TTATTTTCCT CCTTCTTCCC CGTGGCCTCA
Coeliaxis blandii           ---------- ---------N NNNNNNNNN- ---------- ---------- --------NN
Pyrgina umbilicata          GGCT---CGC TTTATATTAT CGCCTCGAGC CTGCAGACTC CGTCCAAAGA AGAAGGCGGC
Glessula ceylanica          ---------- -------NNN NNNNNNN--- ---------- ---------- ------NNNN
Cecilioides gokweanus       CT-----TCG CGGAGGACGC GGATACTGTG CTCGTTATGC GTATCTGAAA CCTCCCCGTG
Ferussacia folliculus       GCCT---GTC AAAGACAACT TGTCCGTAAG CGGCTCGTGT CGTGACGATG ATAGGTGCCG
Thyrophorella thomensis     GGCT---CGC ATTATAATAT CGCCTCGAGC CTGCAGACTC GGTCC---GA AGAAGGCGGC
Gibbulinella dewinteri      GCTA---TCG AGCCTGCCCG GTCGTCCGAG CGTTGCGGTG CCTAACGGCG GAGGAGAGGT
Gonaxis quadrilateralis     AACC---GTT GCAGGACTCG GCTCGTGGTT GTGTGGGTGG CGGCGGCGAC GANGCTGTCC
Gonospira sp.               CTCG---GCT CGCGGTGACC AGAACATCGA GCCTGCTCGG TCAGTCTTGT ACTACGGCGG
NUCLEOTIDES INCLUDED        ---------- ---------- ---------- ---------- ---------- ----------


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    430        440        450        460        470        480
Achatina fulica             AGTACACGCA TGCGCCGTCC TCGTCATTTC AGCGACTCTT TCGCT---CG CCCGGAGCGC
Achatina achatina           AGTGCAC-GG TGCGCCGTCC -CGTCAGTTT AGCGACTCTT TCGCT---TG CCCCGAGCGC
Achatina stuhlmanni         AGTACACGCA TGCGCCGTCC TCGTCATTTT AGCGACTCTT TCGCT---CG CCCGGAGCGC
Cochlitoma ustulata         AGTACACCCA TGCGCCGTCC TCGGCATTTC AGCAACTCCT TCGCTGGTCG CCCGGAGCGG
Allopeas clavulinum         GGCGGCCTGC TTGCATGTCC TTCCGATCGC GGTTG----- ------GAGA GTGGGACCGA
Bocageia sp.                CGGTCTTCGC TCATCTCATC CGAAACGCTC GTGATGTTCG TTCGCTCGCC GTCCGTCTGG
Eutomopeas layardi          CGGCTTGCTT GCTTGCGTTG CGTTCTGATG GCGGATGGAG GGCCGAGATC GACTTTGGCT
Leptinaria lamellata        GATGGCGGCG TCGCCAGGAG CGCAGGGAAG AGAGTAAGCT TTGCTCTCTT TCCTCCTCCC
Paropeas achatinaceum       GGCGGCTTGC TTGCACCGCG TTCGGATGAG TGGAT----- --TATGAGAC CGGTTTCGGC
Riebeckia sp.               NNNNNNNN-- ---------- ---------- ---------- ---------- ----------
Rumina decollata            AGTACACGAA TGCGCCGTCC CCGTCATCTG AGCA------ ---TCGCTCT CTCGAAGCGC
Subulina octona             AGTACTCGCG ATGCGT---- ---------- ----CGCCCA GTCAATTTTT GTTTGCGGCA
Subulina striatella         AGTGCTCGAT GCGTCGT--- ---------- -CCAGTCAAT TTCTTTTGCG GCGGCACGCT
Subulina vitrea             TC-------- TCCTTCGCTC TTCTACGAAG CCATTCTTCG TTCGCTTGCC -GTCCGTCT-
Subulona sp.                ---------- ---------- ---------- ---------- ---------- ----------
Tortaxis erectus            ACTCGAAACC AAATC----- ---------- ----GAGCCT GTCGGACCAG CCCGAATCGG
Xerocerastus sp.            NNNNNNNN-- ---------- ---TTGGAAG ACGAGGACCT TTGAACCGCC TTGGCATTGG
Zootecus insularis          AGTACATGTA TGCGTCGTCC CGTCATCTGA GCGGCTACAT CGCTCTCTCG GAGCGCTCAT
Coeliaxis blandii           NNNNNNNN-- ---------- ---------- ---------- ---NNNNNNN NNN---AAAA
Pyrgina umbilicata          TTGCTTGCCT GCTGGCTGTG CTCGTTACGA TTGGATTGAG GGTGAGATCG ATTTCGGCGG
Glessula ceylanica          NNNNNN---- ---------- ---------- ---------- ---------- ----------
Cecilioides gokweanus       GCCTGAAGTA CGCCTATGCG TCGTCTGCCC GGAGAGCAGC TCACTATCGT CCGCTCGCCG
Ferussacia folliculus       TGCAGTGGGG TCTGGCTTTG AGGATGCCAG GAAGATGTGA GATGCCACCG TTTGGCGGCT
Thyrophorella thomensis     TTGCTTGCTT TGCTCGATTA CGGTCG---- -------GAG GGTGAGATCG ATTTCGGCGG
Gibbulinella dewinteri      GGCCTTGTGT GGAGGCTGCG CGCGTCCGCA GCTGCAGAGC AGCAGCAGAA TCGTACGATG
Gonaxis quadrilateralis     CTTCCCATTC NAGCNTGCTC GGTCGCNNTG CTGAAANAAG GGTTNTTGCG GACAAACGTG
Gonospira sp.               TTCTTGAAAA ACGAGAGCTT GTTTTGTGCG GTGAGGCGCC TCCTCTGGAT TCCTACAGAG
NUCLEOTIDES INCLUDED        ---------- ---------- ---------- ---------- ---------- ----------
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    490        500        510        520        530        540
Achatina fulica             T-CATCTTCG TTT-GTTCGC TCGCCGTCCG TCCGGCAGGA CTCGGCTCGC TTCTTT----
Achatina achatina           C-CGTCTTCG TTC-GTTCGC ----CGTCCG TCCGGCAGGA CTCGGGTCGC TT--------
Achatina stuhlmanni         TCCATCTTCG TTT-GTTCGC TCGCCGTCCG TCCGGCAGGA CTCGGCTCGC TTCTTTTTT-
Cochlitoma ustulata         T-CATCTTCG TTT-GTTCGC TCGCCGKCCG TCCGGCAGGA CTCGGCTCGC TTCTTTTTTT
Allopeas clavulinum         TTTCGGCGGC GCCCAGCAAC ATTCATCAAT TTTCAA---- ---------- ----------
Bocageia sp.                CAGGACTCGG CTCGCTTAAT GACTCAAATC GAGCCTGCTG GCGCGTCTGA AAACGGCACG
Eutomopeas layardi          GCGCCAGAAA CATATGTATT TTTAA----- ---------- ---------- ----------
Leptinaria lamellata        GTATTCTTTT GATTTTCTCT TCCA------ ---------- ---------- ----------
Paropeas achatinaceum       AGCGCCAGAA TTTTTTTTGT TTTTACACTT TTTCAA---- ---------- ----------
Riebeckia sp.               ---------- ---------- ---------- ---------- ---------- ----------
Rumina decollata            T-CATCTTCG TTC-GCTCGC CGTCCGTCTG ----GCAGGA CTCGGCTCGC TGTG------
Subulina octona             CGCTCTTTCG TTCGCTCGCC CGTCCGTCT- ---GGCAGGA CTCGGCTCGC TTAGTTTT--
Subulina striatella         CTTTCGTTCG CTCGCCCGTC CGTCCGTCC- ---GGCAGGA CTCGGCTCGC TTTATTTT--
Subulina vitrea             ---GGCAGGA CTCGGCTCGC TGTGAGACAG ACAAAACTGT ATCGAGCCTG CCGGTCGAAT
Subulona sp.                ---------- ---------- ---------- ---------- ---------- ----------
Tortaxis erectus            CTGTGCTGTG TGGTGTATCA AGGAGTGCGG CCTGCTCCGC GGCGGTGCCA AAATTTATCC
Xerocerastus sp.            AGGATTTGAG GGAAGGATTA ATTTCTCCTC CTCATTTCCC CGTTGCCTCA AGTGCACGCA
Zootecus insularis          CTTCGTTCGC TCGCCGTCCG TCTGGCAGGA CTCGGCTCGC TGTGGGAACA TAAGCACAAA
Coeliaxis blandii           AAACGGCTTG CGGATGCAAT GATGTTAAAA AGGCCTGCGA CGGTAAGGGT CGGCGCCCAA
Pyrgina umbilicata          CGCTCTCATT TTTAAAATAT CAA------- ---------- ---------- ----------
Glessula ceylanica          ---------- ---------- ---------- -------GAG GGAAATAAAA GCGTTTGCCG
Cecilioides gokweanus       TCCGTCTGGC CGGACTCGGC TCGCTTCGTA AACGAACACA ATCGAGCCGG CCTGACAGTC
Ferussacia folliculus       TCGTT----- ---------- ---------- ---------- ---------- ----------
Thyrophorella thomensis     TGCTCATTAT TGTGTCCTCT TCTTTCAA-- ---------- ---------- ----------
Gibbulinella dewinteri      AT-------- ---------- ---------- ---------- ---------- ----------
Gonaxis quadrilateralis     CGTGCGCCCA CAACAAGGTG GCAGAGGCAC AAAAGTGNNT GCTTGA---- ----------
Gonospira sp.               AA-------- ---------- ---------- ---------- ---------- ----------
NUCLEOTIDES INCLUDED        ---------- ---------- ---------- ---------- ---------- ----------


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    550        560        570        580        590        600
Achatina fulica             -----AACAA ATCGAGCCTG CCAGAC---C GTCCGAAGCG GCTAGGG-AT TG-CGAAGTG
Achatina achatina           --------TT ATCGAGCCTG CCAGAC---T GTCCGAAGCG GCTAGCG-GT TG-CGAAGTG
Achatina stuhlmanni         ---------A ATCGAGCCTG CCAGAC---C GTCCGAAGCG GCTAGCG-AT TG-CGAAGTG
Cochlitoma ustulata         T--------A ATCGAGCCTG CCAGAC---C GTCCGAAGCG GCTAGCGGAT TG-CGAAGTG
Allopeas clavulinum         ---------- ---------- ---------- ---------- ---------- ----------
Bocageia sp.                CGGTATGAAC AGTGAGGAGA GAGATGATTA GCGCTGTTGC CGGCTGCGAC GGCGCCAGGC
Eutomopeas layardi          ---------- ---------- ---------- ---------- ---------- ----------
Leptinaria lamellata        ---------- ---------- ---------- ---------- ---------- ----------
Paropeas achatinaceum       ---------- ---------- ---------- ---------- ---------- ----------
Riebeckia sp.               ---------- ---------- ---------- ---------- ---------- ----------
Rumina decollata            -----AATAA AACGAGCCTG CCGAC----C GTCCGAAGTG GCATGCGGTT TCGAAGTGTG
Subulina octona             --------CA CTCGAGCCTG TCAGTA--CT GTCCGAAACG GCGA------ ---AGGACGG
Subulina striatella         ---------- CTCGAGCCTG TCGGTAC--T GTCCGAAACG GCGAGTGGGG TGGGTGACGG
Subulina vitrea             GTCCGAAGCG GCTAGCGCTT ATTTGATGAG GTTATGGCCG AGAGAAAGAA GTGTGTGGGA
Subulona sp.                ---------- ---------- ---------- ---------- ---------- ----------
Tortaxis erectus            ATTTGAAC-- ---------- ---------- ---------- ---------- ----------
Xerocerastus sp.            TGGTCGTCCC GTCATCTGAG CGGCTACATC GCTCTCTCTC GGAGCGCTCA TCTTCGTTCG
Zootecus insularis          TCGAGCCTGC CGACCGTCCG AAGCGGCTTG CTGTATCGAG GAGAGCGTGA GAGGGCGGGA
Coeliaxis blandii           GGAGGGCAAG ACTTCGTCTC GTTTCATA-- ---------- ---------- ----------
Pyrgina umbilicata          ---------- ---------- ---------- ---------- ---------- ----------
Glessula ceylanica          CGACGGTGCC CACCAAGTTT TTATTCACTA ---------- ---------- ----------
Cecilioides gokweanus       CGTGAACGGC TTGCGGCGTT CGAGTTGCCA ATCGACGCCA CTAATCCGCA GCAAATTTTG
Ferussacia folliculus       ---------- ---------- ---------- ---------- ---------- ----------
Thyrophorella thomensis     ---------- ---------- ---------- ---------- ---------- ----------
Gibbulinella dewinteri      ---------- ---------- ---------- ---------- ---------- ----------
Gonaxis quadrilateralis     ---------- ---------- ---------- ---------- ---------- ----------
Gonospira sp.               ---------- ---------- ---------- ---------- ---------- ----------
NUCLEOTIDES INCLUDED        ---------- ---------- ---------- ---------- ---------- ----------
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    610        620        630        640        650        660
Achatina fulica             GGG-----CG CGCAAGCGCA TGGG----TC TGCTGCGGCG GCGCCA---- ----------
Achatina achatina           GGT---GGCG GGCAAGCG-A TCGG----TC T---GCGGCG GCGCCAGCA- ----------
Achatina stuhlmanni         GGG---CGCC CGCGAGCGGA TTGGGGGGTC TGCTGTGGCG GCGCCA---- ----------
Cochlitoma ustulata         GGG--CGCGC GAGCGCA--- TGGG----TC TGTTGCGGCG GCGCCA---- ----------
Allopeas clavulinum         ---------- ---------- ---------- ---------- ---------- ----------
Bocageia sp.                AGTTTTTGTA TTTTTTCATA ---------- ---------- ---------- ----------
Eutomopeas layardi          ---------- ---------- ---------- ---------- ---------- ----------
Leptinaria lamellata        ---------- ---------- ---------- ---------- ---------- ----------
Paropeas achatinaceum       ---------- ---------- ---------- ---------- ---------- ----------
Riebeckia sp.               TACTACATAA ACCGTTTCGC A--------- ---------- ---------- ----------
Rumina decollata            AGAGGGCGAT TGCCGCGGCG GCGCCAATTT TTTTTTGTCC GTTCTAAA-- ----------
Subulina octona             AGGCAGTCGA GAGCCGCAAC GACGACGGCG CCCCGTGGT- ---------- -AATGTGTCA
Subulina striatella         AAGCAGTCGA TGGCTAGCGA AAGCGACGGC GCCCGTGGTC TATTTACCGT ACGTCGTCGT
Subulina vitrea             CCGCGACGTC GCCTATTTGT AAAAAAAATT TGTTTATTTT TCTTTAC--- ----------
Subulona sp.                ---------- ---------- ---------- ---------- ---------- ----------
Tortaxis erectus            ---------- ---------- ---------- ---------- ---------- ----------
Xerocerastus sp.            CTCGCCGTCC GTCCGGCAGG ACTCGGCTCG CTGTGAAAAC AAAGCACACT ATTCGAGCCT
Zootecus insularis          TTGCTGCGGC GGCGCCAACT TTTTGTTTTT CTTTCTAAA- ---------- ----------
Coeliaxis blandii           ---------- ---------- ---------- ---------- ---------- ----------
Pyrgina umbilicata          ---------- ---------- ---------- ---------- ---------- ----------
Glessula ceylanica          ---------- ---------- ---------- ---------- ---------- ----------
Cecilioides gokweanus       CTTTTTTTTT ---------- ---------- ---------- ---------- ----------
Ferussacia folliculus       ---------- ---------- ---------- ---------- ---------- ----------
Thyrophorella thomensis     ---------- ---------- ---------- ---------- ---------- ----------
Gibbulinella dewinteri      ---------- ---------- ---------- ---------- ---------- ----------
Gonaxis quadrilateralis     ---------- ---------- ---------- ---------- ---------- ----------
Gonospira sp.               ---------- ---------- ---------- ---------- ---------- ----------
NUCLEOTIDES INCLUDED        ---------- ---------- ---------- ---------- ---------- ----------


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    670        680        690        700        710        720
Achatina fulica             GTCTTTCT-- -------AAA ATCTTTCTTT A--------- ---------- ----------
Achatina achatina           GTCTCTATAA CGACGACGTT TNNTTTAAAA TTTTTA---- ---------- ----------
Achatina stuhlmanni         GTCTTTCT-- -------AAA ATTTTTCTTT A--------- ---------- ----------
Cochlitoma ustulata         GTCTTTCT-- ---------- TTCTTTCTTT A--------- ---------- ----------
Allopeas clavulinum         ---------- ---------- ---------- ---------- ---------- ----------
Bocageia sp.                ---------- ---------- ---------- ---------- ---------- ----------
Eutomopeas layardi          ---------- ---------- ---------- ---------- ---------- ----------
Leptinaria lamellata        ---------- ---------- ---------- ---------- ---------- ----------
Paropeas achatinaceum       ---------- ---------- ---------- ---------- ---------- ----------
Riebeckia sp.               ---------- ---------- ---------- ---------- ---------- ----------
Rumina decollata            ---------- ---------- ---------- ---------- ---------- ----------
Subulina octona             TACTATTATT T--------- ---------- ---------- ---------- ----------
Subulina striatella         ACGAATCATT T--------- ---------- ---------- ---------- ----------
Subulina vitrea             ---------- ---------- ---------- ---------- ---------- ----------
Subulona sp.                ---------- ---------- ---------- ---------- ---------- ----------
Tortaxis erectus            ---------- ---------- ---------- ---------- ---------- ----------
Xerocerastus sp.            GCC-GACCCC GTCCGAAGCG GCTTGCGGTT TTGAAGTTTG AGGCGCGCCG CGCCCCGCTC
Zootecus insularis          ---------- ---------- ---------- ---------- ---------- ----------
Coeliaxis blandii           ---------- ---------- ---------- ---------- ---------- ----------
Pyrgina umbilicata          ---------- ---------- ---------- ---------- ---------- ----------
Glessula ceylanica          ---------- ---------- ---------- ---------- ---------- ----------
Cecilioides gokweanus       ---------- ---------- ---------- ---------- ---------- ----------
Ferussacia folliculus       ---------- ---------- ---------- ---------- ---------- ----------
Thyrophorella thomensis     ---------- ---------- ---------- ---------- ---------- ----------
Gibbulinella dewinteri      ---------- ---------- ---------- ---------- ---------- ----------
Gonaxis quadrilateralis     ---------- ---------- ---------- ---------- ---------- ----------
Gonospira sp.               ---------- ---------- ---------- ---------- ---------- ----------
NUCLEOTIDES INCLUDED        ---------- ---------- ---------- ---------- ---------- ----------
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    730        740        750        760        770        780
Achatina fulica             ---------- ---------- ---------- ---------- ---------- --------T-
Achatina achatina           ---------- ---------- ---------- ---------- ---------- --------T-
Achatina stuhlmanni         ---------- ---------- ---------- ---------- ---------- --------T-
Cochlitoma ustulata         ---------- ---------- ---------- ---------- ---------- --------T-
Allopeas clavulinum         ---------- ---------- ---------- ---------- ---------- --------T-
Bocageia sp.                ---------- ---------- ---------- ---------- ---------- --------T-
Eutomopeas layardi          ---------- ---------- ---------- ---------- ---------- --------T-
Leptinaria lamellata        ---------- ---------- ---------- ---------- ---------- --------T-
Paropeas achatinaceum       ---------- ---------- ---------- ---------- ---------- --------T-
Riebeckia sp.               ---------- ---------- ---------- ---------- ---------- --------T-
Rumina decollata            ---------- ---------- ---------- ---------- ---------- --------T-
Subulina octona             ---------- ---------- ---------- ---------- ---------- --------C-
Subulina striatella         ---------- ---------- ---------- ---------- ---------- --------C-
Subulina vitrea             ---------- ---------- ---------- ---------- ---------- --------T-
Subulona sp.                ---------- ---------- ---------- ---------- ---------- --------T-
Tortaxis erectus            ---------- ---------- ---------- ---------- ---------- --------T-
Xerocerastus sp.            GAGAGGTGGA GGAGGGCGAT TGCTGCCGCG GAGGCGCCAG TATTTANTAT TTTCTAAAT-
Zootecus insularis          ---------- ---------- ---------- ---------- ---------- --------T-
Coeliaxis blandii           ---------- ---------- ---------- ---------- ---------- --------T-
Pyrgina umbilicata          ---------- ---------- ---------- ---------- ---------- --------T-
Glessula ceylanica          ---------- ---------- ---------- ---------- ---------- --------T-
Cecilioides gokweanus       ---------- ---------- ---------- ---------- ---------- --------T-
Ferussacia folliculus       ---------- ---------- ---------- ---------- ---------- --------T-
Thyrophorella thomensis     ---------- ---------- ---------- ---------- ---------- --------T-
Gibbulinella dewinteri      ---------- ---------- ---------- ---------- ---------- --------T-
Gonaxis quadrilateralis     ---------- ---------- ---------- ---------- ---------- --------TN
Gonospira sp.               ---------- ---------- ---------- ---------- ---------- --------T-
NUCLEOTIDES INCLUDED        ---------- ---------- ---------- ---------- ---------- --------m-


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    790        800        810        820        830        840
Achatina fulica             CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Achatina achatina           CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Achatina stuhlmanni         CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Cochlitoma ustulata         CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Allopeas clavulinum         CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Bocageia sp.                CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Eutomopeas layardi          CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Leptinaria lamellata        CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Paropeas achatinaceum       CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Riebeckia sp.               CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Rumina decollata            CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Subulina octona             CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Subulina striatella         CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Subulina vitrea             CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Subulona sp.                CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Tortaxis erectus            CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Xerocerastus sp.            CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Zootecus insularis          CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Coeliaxis blandii           CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Pyrgina umbilicata          CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Glessula ceylanica          CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Cecilioides gokweanus       CCGACCTCAG TTCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Ferussacia folliculus       CCGACCTCAG ATGGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Thyrophorella thomensis     CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Gibbulinella dewinteri      CCGACCTCAG ATCGGACGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Gonaxis quadrilateralis     CCGACCTCAG ATCGGAGGAG ATTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
Gonospira sp.               CCGACCTCAG ATCGGACGAG ACTACCCGCT GAATTTAAGC ATATAACTAA GCGGAGGAAA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    850        860        870        880        890        900
Achatina fulica             AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAATAGCC CAGCACCGAA
Achatina achatina           AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAATAGCC CAGCACCGAA
Achatina stuhlmanni         AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAATAGCC CAGCACCGAA
Cochlitoma ustulata         AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAATAGCC CAGCACCGAA
Allopeas clavulinum         AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAATAGCC CAGCACCGAA
Bocageia sp.                AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAAGAGCC CAGCACCGAA
Eutomopeas layardi          AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAATAGCC CAGCACCGAA
Leptinaria lamellata        AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAATAGCC CAGCACCGAA
Paropeas achatinaceum       AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAATAGCC CAGCACCGAA
Riebeckia sp.               AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAAGAGCC CAGCACCGAA
Rumina decollata            AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAAGAGCC CAGCACCGAA
Subulina octona             AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAAGAGCC CAGCACCGAA
Subulina striatella         AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAAGAGCC CAGCACCGAA
Subulina vitrea             AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAAGAGCC CAGCACCGAA
Subulona sp.                AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAAGAGCC CAGCACCGAA
Tortaxis erectus            AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAAGAGCC CAGCACCGAA
Xerocerastus sp.            AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAAGAGCC CAGCACCGAA
Zootecus insularis          AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAAGAGCC CAGCACCGAA
Coeliaxis blandii           AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAAGAGCC CAGCACCGAA
Pyrgina umbilicata          AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAATAGCC CAGCACCGAA
Glessula ceylanica          AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGT GGGAAGAGCC CAGCACCGAA
Cecilioides gokweanus       AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAATAGCC CAGCACCGAA
Ferussacia folliculus       AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGAAATAGCC CAGCACCGAA
Thyrophorella thomensis     AGAAACTAAC AAGGATTTCC CCAGTAACGG CGAGTGAAGC GGGAATAGCC CAGCACCGAA
Gibbulinella dewinteri      AGAAACTAAC AAGGATTCCC CCAGTAACGG CGAGTGAAGC GGGAAAGGCC CAGCACCGAA
Gonaxis quadrilateralis     AGAAACTAAC AAGGATTCCC CCAATAACGG CGAGTGAAGC GGGATAGGCC CAGCACTGAA
Gonospira sp.               AGAAACTAAC AAGGATTCCC CCAGTAACTG CGAGTGAAGC GGGAACGGCC CAGCACCGAA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    910        920        930        940        950        960
Achatina fulica             TCCCTCAGTG TCACGCTGGC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Achatina achatina           TCCCTCAGTG TCACGCTGAC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Achatina stuhlmanni         TCCCTCAGTG TCACGCTGAC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Cochlitoma ustulata         TCCCTCAGTG TCACGCTGAC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Allopeas clavulinum         TCCCCCAGTG TCACGCTGGC GGGAAATGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Bocageia sp.                TCCCCCAGTG TCACGCTGGC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Eutomopeas layardi          TCCCCCAGTG TCACGCTGGC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGCG
Leptinaria lamellata        TCCCCCAGTG TCACGCTGGC GGGAACTGTG GTGTGAGGGA CGCCACCAGC CGCATCAGAG
Paropeas achatinaceum       TCCCCCAGTG TCACGCTGGC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Riebeckia sp.               TCCCCCGGTG TCACGCCGGC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Rumina decollata            TCCCCCAGTG TCACGCTGGC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Subulina octona             TCCCTCAGTG TCACGCTGAC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Subulina striatella         TCCCTCAGTG TCACGCTGAC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Subulina vitrea             TCCCTCAGTG TCACGCTGGC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Subulona sp.                TCCCCCAGTG TCATGCTGGC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Tortaxis erectus            TCCCCCGGTG TCACGCCGGC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCTTCAGAG
Xerocerastus sp.            TCCCCCAGTG TCACGCTGGC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Zootecus insularis          TCCCCCAGTG TCACGCTGGC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Coeliaxis blandii           TCCCCCGGTG TCATGCCGGC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Pyrgina umbilicata          TCCCCCAGTG TCACGCTGGC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Glessula ceylanica          TCCCCCAGTG TCATGCTGGC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Cecilioides gokweanus       TCCCTCAGTG TCACGCTGGC GGGAACTGTG GTGTGAGGGA CGCCACCAGT CGCATCAGAG
Ferussacia folliculus       TCCCTCAGTG TCACGCTGAC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Thyrophorella thomensis     TCCCCCAGTG TCACGCTGGC GGGAACTGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Gibbulinella dewinteri      TTCCTCAGTG TCACGCTGAC GGGAAATGTG GTGTGTGGGA CGCCACCAGT CGCATCAGAG
Gonaxis quadrilateralis     TCCCTCAGTG TCACGCTGAC GGGAACTTTG GTGTGTGGGA CCCCACCAGT CGCATCAGAG
Gonospira sp.               TTCCTCAGTG TCACGCTGAC GGAAACTGTG GTGTGCGGGA CGCCACCAGT CGCATCAGAG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    970        980        990        1000       1010       1020
Achatina fulica             GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Achatina achatina           GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Achatina stuhlmanni         GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Cochlitoma ustulata         GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Allopeas clavulinum         GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Bocageia sp.                GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Eutomopeas layardi          GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Leptinaria lamellata        GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Paropeas achatinaceum       GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Riebeckia sp.               GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Rumina decollata            GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Subulina octona             GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Subulina striatella         GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Subulina vitrea             GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Subulona sp.                GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Tortaxis erectus            GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Xerocerastus sp.            GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Zootecus insularis          GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Coeliaxis blandii           GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Pyrgina umbilicata          GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Glessula ceylanica          GGTGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Cecilioides gokweanus       GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Ferussacia folliculus       GGTGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Thyrophorella thomensis     GGCGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Gibbulinella dewinteri      GGTGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Gonaxis quadrilateralis     GGTGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
Gonospira sp.               GGTGTCGAAG TCCTCCTGAT CGGGGCTTCA CCCAGAGCGG GTGTAAGGCC TTTGCAGGCG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    1030       1040       1050       1060       1070       1080
Achatina fulica             CCTCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Achatina achatina           CCTCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Achatina stuhlmanni         CCTCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Cochlitoma ustulata         CCACTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Allopeas clavulinum         CCCCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Bocageia sp.                CCTCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Eutomopeas layardi          CCCCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Leptinaria lamellata        CCTCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Paropeas achatinaceum       CCCCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Riebeckia sp.               CCTCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Rumina decollata            CCTCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Subulina octona             CCCCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Subulina striatella         CCTCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Subulina vitrea             CCTCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Subulona sp.                CCTCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Tortaxis erectus            CCACTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGT
Xerocerastus sp.            CCTCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Zootecus insularis          CCTCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Coeliaxis blandii           CCTCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Pyrgina umbilicata          CCCCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Glessula ceylanica          CCTCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Cecilioides gokweanus       CCTCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Ferussacia folliculus       CCTCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Thyrophorella thomensis     CCCCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Gibbulinella dewinteri      CTCCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Gonaxis quadrilateralis     CTCCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCAAAGC
Gonospira sp.               CTCCTCTGTG CGGCCGCGAG CGTCTCAGGA GTCGGGTTGT TTGGGAATGC AGCCCGAAGC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    1090       1100       1110       1120       1130       1140
Achatina fulica             GGGTGGTAAA CTCCATCTAA GGCTAAATAC T-GGCACGAG TCCGATAGCG GACAAGTACC
Achatina achatina           GGGTGGTAAA CTCCATCTAA GGCTAAATAC T-GGCACGAG TCCGATAGCG GACAAGTACC
Achatina stuhlmanni         GGGTGGTAAA CTCCATCTAA GGCTAAATAC T-GGCACGAG TCCGATAGCG GACAAGTACC
Cochlitoma ustulata         GGGTGGTAAA CTCCATCTAA GGCTAAATAC T-GGCACGAG TCCGATAGCG GACAAGTACC
Allopeas clavulinum         GGGTGGTAAA CTCCATCTAA GGCTAAATAC C-GGCACGAG TCCGATAGCG GACAAGTACC
Bocageia sp.                GGGTGGTAAA CTCCATCTAA GGCTAAATAC T-GGCACGAG TCCGATAGCG GACAAGTACC
Eutomopeas layardi          GGGTGGTAAA CTCCATCTAA GGCTAAATAC C-GGCACGAG TCCGATAGCG GACAAGTACC
Leptinaria lamellata        GGGTGGTAAA CTCCATCTAA GGCTAAATAC C-GGCACGAG TCCGATAGCG GACAAGTACC
Paropeas achatinaceum       GGGTGGTAAA CTCCATCTAA GGCTAAATAC C-GGCACGAG TCCGATAGCG GACAAGTACC
Riebeckia sp.               GGGTGGTAAA CTCCATCTAA GGCTAAATAC C-GGCACGAG TCCGATAGCG GACAAGTACC
Rumina decollata            GGGTGGTAAA CTCCATCTAA GGCTAAATAC T-TGCACGAG TCCGATAGCG GACAAGTACC
Subulina octona             GGGTGGTAAA CTCCATCTAA GGCTAAATAC C-GGCACGAG TCCGATAGCG GACAAGTACC
Subulina striatella         GGGTGGTAAA CTCCATCTAA GGCTAAATAC C-GGCACGAG TCCGATAGCG GACAAGTACC
Subulina vitrea             GGGTGGTAAA CTCCATCTAA GGCTAAATAC C-GGCACGAG TCCGATAGCG GACAAGTACC
Subulona sp.                GGGTGGTAAA CTCCATCTAA GGCTAAATAC C-GGCACGAG TCCGATAGCG GACAAGTACC
Tortaxis erectus            GGGTGGTAAA CTCCATCTAA GGCTAAATAC G-TGCACGAG TCCGATAGCG GACAAGTACC
Xerocerastus sp.            GGGTGGTAAA CTCCATCTAA GGCTAAATAC T-GGCACGAG TCCGATAGCG GACAAGTACC
Zootecus insularis          GGGTGGTAAA CTCCATCTAA GGCTAAATAC T-GGCACGAG TCCGATAGCG GACAAGTACC
Coeliaxis blandii           GGGTGGTAAA CTCCATCTAA GGCTAAATAC C-GGCACGAG TCCGATAGCG GACAAGTACC
Pyrgina umbilicata          GGGTGGTAAA CTCCATCTAA GGCTAAATAC C-GGCACGAG TCCGATAGCG GACAAGTACC
Glessula ceylanica          GGGTGGTAAA CTCCATCTAA GGCTAAATAC G-TGCACGAG TCCGATAGCG GACAAGTACC
Cecilioides gokweanus       GGGTGGTAAA CTCCATCTAA GGCTAAATAC C-GGCACGAG TCCGATAGCG GACAAGTACC
Ferussacia folliculus       GGGTGGTAAA CTCCATCTAA GGCTAAATAC G-TGCACGAG TCCGATAGCG GACAAGTACC
Thyrophorella thomensis     GGGTGGTAAA CTCCATCTAA GGCTAAATAC C-GGCACGAG TCCGATAGCG GACAAGTACC
Gibbulinella dewinteri      GGGTGGTAAA CTCCATCTAA GGCTAAATAC TTTGCACGAG TCCGATAGCG GACAAGTACC
Gonaxis quadrilateralis     GGGTGGTAAA CTCCATCTAA GGCTAAATAC T-GGCACGAG TCCGATAGCG GACAAGTACC
Gonospira sp.               GGGTGGTAAA CTCCATCTAA GGCTAAATAC T-GGCACGAG TCCGATAGCG GACAAGTACC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm m-mmmmmmmm mmmmmmmmmm mmmmmmmmmm


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    1150       1160       1170       1180       1190       1200
Achatina fulica             GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Achatina achatina           GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Achatina stuhlmanni         GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Cochlitoma ustulata         GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Allopeas clavulinum         GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Bocageia sp.                GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Eutomopeas layardi          GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Leptinaria lamellata        GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Paropeas achatinaceum       GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Riebeckia sp.               GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Rumina decollata            GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Subulina octona             GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Subulina striatella         GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Subulina vitrea             GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Subulona sp.                GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Tortaxis erectus            GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Xerocerastus sp.            GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Zootecus insularis          GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Coeliaxis blandii           GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Pyrgina umbilicata          GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Glessula ceylanica          GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Cecilioides gokweanus       GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Ferussacia folliculus       GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Thyrophorella thomensis     GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCTCAG
Gibbulinella dewinteri      GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Gonaxis quadrilateralis     GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
Gonospira sp.               GTGAGGGAAA GTTGAAAAGA ACTTTGAAGA GAGAGTTCAA GAGTACGTGA AACCGCCCAG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   1210       1220       1230       1240       1250       1260
Achatina fulica             AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCTCGG
Achatina achatina           AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCTCGG
Achatina stuhlmanni         AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCT-GG
Cochlitoma ustulata         AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCTCGG
Allopeas clavulinum         AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCT-GG
Bocageia sp.                AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCC-GG
Eutomopeas layardi          AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCT-GG
Leptinaria lamellata        AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCT-GG
Paropeas achatinaceum       AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCAGCCT-GG
Riebeckia sp.               AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCC-GG
Rumina decollata            AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCT-GG
Subulina octona             AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCT-GG
Subulina striatella         AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCT-GG
Subulina vitrea             AGGTAAACGG GTGGATCCGC AAATTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCT-GG
Subulona sp.                AGGTAAACGG GTGGATCCGC AAATTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCT-GG
Tortaxis erectus            AGGTAAACGG GTGGATCCGC AAAGTCGGCT CGCGGAATTC AGCGCGGCGC GCGGCCTGTG
Xerocerastus sp.            AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCT-GG
Zootecus insularis          AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCT-GG
Coeliaxis blandii           AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCT-GG
Pyrgina umbilicata          AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCT-GG
Glessula ceylanica          AGGTAAACGG GTGGATCCGC AAAGTCGGCT CGCGGAATTC AGCGCGGCGC GCGATCTGTG
Cecilioides gokweanus       AGGTAAACGG GTGGATCCGC AAAGTCGGCT CGCGGAATTC AGCGCGGCGC GCGGTTT-GG
Ferussacia folliculus       AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCAGCCT-GG
Thyrophorella thomensis     AGGTAAACGG GTGGATCCGC AAAGTCGGCC CGCGGAATTC AGCGCGGCGC GCGGCCT-GG
Gibbulinella dewinteri      AGGTAAACGG GTGGATCCGC AATGTCGGCC CGCGGAATTC AGCGCGGCGT GCGGTCG-GG
Gonaxis quadrilateralis     AGGTAAACGG GTGGATCCGC AATGTCGGCC CGCGGAATTC AGCGCGGCGT GCGGCCT-GG
Gonospira sp.               AGGCAAACGG GTGGATCCGC AATGTCGGCC CGCGGAATTC AGCGCGGCGT GCGGCTC-GG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmm-mm


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                                   1270       1280       1290       1300       1310       1320
Achatina fulica             GGCGATCGCG GCCGGGGATC CCTGGGACCC CGCCGCGGTG TCGATCCGGG CTCCGCCGCG
Achatina achatina           GGCGATCGCG GCCGGGGATC CCTGGGACCC CGCCGCGGTG TCGATCCGGG CTCCGCCGCG
Achatina stuhlmanni         GGCGATCGCG GCCGGGGATC CCTGGGACCC CGCCGCGGTG TCGATCCGGG CTCCGCCGCG
Cochlitoma ustulata         GGCGATCGCG GCCGGGGATC CCTGGGACCC CGCCGCGGTG TCGATCCGGG CTCCGCCGCG
Allopeas clavulinum         GGCGATCGCG GCCGGGGATC CCTGGGACCC CGCCGCGGTG TCGATCCGGG CTCCGCCGCG
Bocageia sp.                GGCGACTGCG GCCGGGGATC CCTGGGACCC CGCTGCGGTG TCGATCCGGG TTCCGCCGCG
Eutomopeas layardi          GGCGATCGCG GCCGGGGATC CCTGGGACCC CGCCGCGGTG TCGATCCGGG CTCCGCCGCG
Leptinaria lamellata        GGCGATTGCG GCCGGGGATC CCTGGGACCC CGCCGCGGTG TCGATCCGGG CTCCGCCGCG
Paropeas achatinaceum       GGCGATCGCG GCCGGGGATC CCTGGGACCC CGCCGCGGTG TCGATCCGGG CTCCGCCGCG
Riebeckia sp.               GACTATCGCA GCCGGGGATC CCTGGGACCC CGCCGCGGTG TCGCTCCGGG CTCCGCCGCG
Rumina decollata            GGCTATTGCG GCCGGGGATC CCTGGGACCC CGCCGCGGTG TCGATCCGGG CTCCGCCGCG
Subulina octona             GGCGATCGCT GCAGGGGATC CCTGGGACCC CGCTGTGGTG TCGATCCGGG CTCCGCCGCG
Subulina striatella         GGCGATCGCT GCCGGGGATC CCTGGGACCC CGCTGTGGTG TCGATCCGGG CTCCGCCGCG
Subulina vitrea             GGCGACTGCG GCCGGGGATC CCTGGGACCC CGCCGCGGTG TCGATCCGGG CTCCGCCGCG
Subulona sp.                GGCGACTGCG GCCGGGGATC CCTGGGAACC CGCCGCGGTG TCGATCCGGG CTCCGCCGCG
Tortaxis erectus            GGCGATCGCG GCCGGGGATC CCTGGGACCC CGCCGTGGTG TCGAACCGGG CTCCGCCGCG
Xerocerastus sp.            GGCGATCGCG GCCGGGGATC CCTGGGACCC CGCCGCGGTG TCGATCCGGG CTCCGCCGCG
Zootecus insularis          GGCGATCGCG GCCGGGGATC CCTGGGACCT CGCCGTGGTG TCGAACCGGG CTCCGCCGCG
Coeliaxis blandii           GGCGATCGCG GCCGGGGATC CCTGGGACCC CGCCGCGTCG TCGATCCGGG CTCCGCCGCG
Pyrgina umbilicata          GGCGATCGCG GCCGGGGATC CCTGGGACCC CGCCGCGGTG TCGATCCGGG CTCCGCCGCG
Glessula ceylanica          GGCGATTGCG GCCGGGGATC CCTGGGACCC CGCCGTGATG TCGAACCGGG TTCCGCCGCG
Cecilioides gokweanus       GGCGATTGCG GCCGGGGATC CCTGGGACCC CGCCGTGGTG TCGAACCAGA CTCCGCCGCG
Ferussacia folliculus       GACAATCGTG GCCGGGGATT CTTGGGACCC CGCTTCGGTG TCGAGCCGGG CTCCGCCGCG
Thyrophorella thomensis     GGCGATCGCG GCCGGGGATC CCTGGGACCC CGCCGCGGTG TCGATCCGGG CTCCGCCGCG
Gibbulinella dewinteri      GGCCGTCGTG GCAAGGGATC CCTGGGACCC TGCCGCGATG TCGAGCCCGG CCCCGCCGCG
Gonaxis quadrilateralis     GACCGTCGTG GCCAGGGATC CGTGGGACCC TGCCGCGATG TCGAGCCTGG CCCCGCCGCG
Gonospira sp.               GGACGTCGTG GCCAGGGATC CCTGGGACCC TGCCGCGATG TCGAGCTGGG CCTCGCCGCG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    1330       1340       1350       1360       1370       1380
Achatina fulica             TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCCGCTG GA--GCCGTC AGAGGCCGGG
Achatina achatina           TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCCGCTG GA--GCCGTC AGAGGCCGGG
Achatina stuhlmanni         TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCCGCTG GA--GCCGTC AGAGGCCGGG
Cochlitoma ustulata         TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCCGCTG GA--GCCGTC AGAGGCCGGG
Allopeas clavulinum         TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCTGC-G ----GTCGTC AGAGGCCGGG
Bocageia sp.                TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCTGACG G---GCCGTC AGAGGCCGGG
Eutomopeas layardi          TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCTGC-G ----GTCGTC AGAGGCCGGG
Leptinaria lamellata        TGCACTTTCC GCGGGCAGAG TGCCACAACC GTTTCTGC-G ----GCCGTC AGAGGCCGGG
Paropeas achatinaceum       TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCTGG-G ----GTCGTC AGAGGCCGGG
Riebeckia sp.               TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCTGG-T ----TCCGTC AGAGGCCGGG
Rumina decollata            TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCCGCGG GA--GCCGTC AGAGGTCGGA
Subulina octona             TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTTCGCTG GT--GCCGTC AGAGGCCGGG
Subulina striatella         TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTTCGCTG GT--GTCGTC AGAGGCCGGG
Subulina vitrea             TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCTGGCT GG--GCCGTC AGATGCCGGG
Subulona sp.                TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCTGGCT GG--GCCGTC AGATGCCGAG
Tortaxis erectus            TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCCGCGG GA--GCCGTC AGCAGCCGTG
Xerocerastus sp.            TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCCGCGG GA--GCCGTC AGAGGCCGGG
Zootecus insularis          TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCCGCGG GA--GCCGTC AGAGGCCGGA
Coeliaxis blandii           TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCCGG-C ----TCTGTC AGAGGCCGGG
Pyrgina umbilicata          TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCTGT-G ----GTCGTC AGAGGCCGGG
Glessula ceylanica          TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTTCGCTG GT--GCCGTC AGAGGCCGGG
Cecilioides gokweanus       TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCTGC-G ----GCCGCC AGAGGCCGGG
Ferussacia folliculus       TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCTGCGA GA--ACGGTC AGAAGTCCGG
Thyrophorella thomensis     TGCACTTTCC GCGGGCAGAG TGCCACAACC GGTTCTGT-G ----GTCGTC AGAGGCCAGG
Gibbulinella dewinteri      TGCACTTTCC GCGGGCAGTG GGCCACAACC GGTTCGGA-G ----GCGGTC AAAAGCCGGG
Gonaxis quadrilateralis     TGCACTTTCC GCGGGCAGTG GGCCACAACC GGTTCGGATT GAAGGCGGTC AAAAGCCGGG
Gonospira sp.               TGCACTTTCC GCGGGCAGTG GGCCACAACC GGTTCGGG-G ----GCGGTC AAAAGCCGGG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmm-- ----mmmmmm mmmmmmmmmm


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                                    1390       1400       1410       1420       1430       1440
Achatina fulica             C-GGGTTGTC GGTGGGGGCG CTTGC-GTCC CTACCAGCCC ---GCCCCGG CGGACGGCCT
Achatina achatina           C-GAGTTGTC GGTGGGGGCG CTTGC-GTCC CTACCAGCCC ---GCCCCGG CGGACGGCCT
Achatina stuhlmanni         C-GGGTTGTC GGTGGGGGCG CTTGC-GTCC CTACCAGCCC ---GCCCCGG CGGACGGCCT
Cochlitoma ustulata         C-GGGTTGTC GGTGGGGGCG CTTGC-GTCC CTACCAGCCC ---GCCCCGG CGGACGGCCT
Allopeas clavulinum         C-GGGTTGTC GGTGGGGGCG CTCGC-GTCC CTACCAGCCT ---GCCCCGG CGGACGGCCG
Bocageia sp.                C-GGGTTGTC GGTGGGGGCG CTCGC-GTCC CTACCAGCCC ---GCCTCGG CGGACGGCCT
Eutomopeas layardi          C-GGGTTGTC GGTGGGGGCG CTCGC-GTCC CTACCAGCCT ---GCCCCGG CGGACGGCCG
Leptinaria lamellata        C-GGGTTGTC GGTGGGGGCG CTCGC-GTCC CTACCAGCCT ---GCCTCGG CGGACGGCCG
Paropeas achatinaceum       C-GGGTTGTC GGTGGGGGCG CTCGC-GTCC CTACCAGCCT ---GCCCCGG CGGACGGCCG
Riebeckia sp.               C-GGGTTGTC GGTGGGGGCG CTTGC-GTCC CTACCAGCCC ---GCCCCGG CGGACGGCTC
Rumina decollata            C-GGGTTGTC GGTGGGGGCG CTCGC-GTCC CTACCAGCCC ---GCCCCGG CGGACGGCCT
Subulina octona             C-GGGTTGTC GGTGGGGGCG CTCGC-GTCC CTACCAGCCC ---GCCTCGG CGGACGGCCT
Subulina striatella         C-GGGTTGTC GGTGGGGGCG CTCGC-GTCC CTACCAGCCC ---GCCCCGG CGGACGGCCT
Subulina vitrea             T-GGGTTGTC GGTGGGGGCG CTCGC-GTCC CTACCAGCCC ---GCCTCGG CGGACGGCTC
Subulona sp.                AAGGGTTGTC GGTGGGGGCG CTCGCCGTCC CTACCAGCCC ---AACTCGG CGGACGGCCT
Tortaxis erectus            T-GGGTTGTC GGTCGGGGCG CTCGC-GTCC CTACCAGCCT ---GCAACGG CGGACGGCCT
Xerocerastus sp.            C-GGGTTGTC GGTGGGGGCG CTCGC-GTCC CTACCAGCTC ---GCCCCGG CGGACGGCCT
Zootecus insularis          C-GGGTTGTC GGTGGGGGCG CTCGC-GTCC CTACCAGCCC ---GCCCCGG CGGACGGCCT
Coeliaxis blandii           C-GGGTTGTC GGTGGGGGCG CTCGC-GTCC CTACCAGCCC GCCGCCCCGG CGGACGGCTC
Pyrgina umbilicata          C-GGGTTGTC GGTGGGGGCG CTTGC-GTCC CTACCAGCCT ---GCCCCGG CGGACGGCCG
Glessula ceylanica          C-GGGTTGTC GGTGGGGGCG CTCGC-GTCC CTACCAGCCT ---GTTACGG CGGACGGCCT
Cecilioides gokweanus       C-GGGTTGTC GGTGGGGGCG CTCGC-GTCC CTACCAGCCT ---GCCCCGG CGGACGGCCG
Ferussacia folliculus       T-GGGTTGTC GGTGGGGACG TTCGC-GTGC CTACCAGCCC ---GCTGAGG CGGACCGCTC
Thyrophorella thomensis     C-GGGTTGTC GGTGGGGGCG CTTGC-GTCC CTACCAGCCT ---GCCCCGG CGGACGGCCG
Gibbulinella dewinteri      C-GGGTTGTC GGTGGGGGCG TTCGC-GTCC CTACCAGCCT ---GCCCCGG CGAGCCGCCG
Gonaxis quadrilateralis     C-GGGTTGTC GGTGGGGGCG CTCGC-GTCC CTACCAGCCC ---GCCCCGG CGAGCCGCCG
Gonospira sp.               C-GGGTTGTC GGTGGGGGCG CTCGC-GTCC CTACCAGCCT ---TCCCCGG CGAGCCGCCG
NUCLEOTIDES INCLUDED        m-mmmmmmmm mmmmmmmmmm mmmmm-mmmm mmmmmmmmmm ---mmmmmmm mmmmmmmmmm
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                                    1450       1460       1470       1480       1490       1500
Achatina fulica             -CGGGACCGA GGAACCGCCG -CGCGCTTCG AGGCTACCCG GCCCCTCTGC GCGAGTCCGA
Achatina achatina           -CGGGACCGA GGGACCGCCG -CGCGCTTCG AGGCTACCCG ACCCCTCCGC GCGAGTCCGA
Achatina stuhlmanni         -CGGGACCGA GGAACTGCCG -CGCGCTTCG AGGCTACCCG ACCCCTCGGC GCGAGTCCGA
Cochlitoma ustulata         -CGGGACCGA GGAACCGCCG -CGCGCTTGG AGGCTACCCG ACCCCTCCGT GCGAGTCCGA
Allopeas clavulinum         -CGGGACCGA GGAACCGCCG -CGCACTTCG AGGCCGCCT- GCCCCTCCGC GCGAGTTCGA
Bocageia sp.                -CGGGACCGA GGAACCGCCG -CGCGCTTCG AGGCTACCT- GCCCCTCCGG GCGAGTTCGA
Eutomopeas layardi          -CGGGACCGA GGAACCGCCG -CGCGCTTCG AGGCCGCCT- GCCCCTCCGC GCGAGTTCGA
Leptinaria lamellata        -CGGGACCGA GGAACCGCCG -CGCGCTTCG AGGCCGCCT- GCCCCTCCGC GCGAGTTCGA
Paropeas achatinaceum       -CGGGACCGA GGAACCGCCG -CGCGCTTCG AGGCCGCCT- GCCCCTCCGC GCGAGTTCGA
Riebeckia sp.               -TGGGATCGA GGAACCGCCG -CGCGCTTCG AGGCTACCT- GCTCCTCCGG GCGAGTTCGA
Rumina decollata            -CGGGACCGA GGGACCGCCG -CACGCTTCG AGGCTACCT- GCTCCTCCGC GCGAGTCCGA
Subulina octona             -CGGGACCGA GGAACTGCCG -CGCGCTTCG AGGCTACCC- GCTCCTCCGC GCGAGTTCGA
Subulina striatella         -CGGGACCGA GGAACCGCCG -CGCGCTTCG AGGCTACCC- GCTCCTCCGC GCGAGTTCGA
Subulina vitrea             -CGGGACCGA GGAACCGCCG -CGTGCTTCG AGGCTACTC- GCTCCTCCGC GTGAGTTCGA
Subulona sp.                -CGGGACCGA GGAACCGCCG -CGCGCTTCG AGGCTGCTC- GCTCCTCCGC GCGAGTTCGA
Tortaxis erectus            -CGGGACCGA GGAACTGCCG -CGCGCTTTG AGGCTACCT- GCCCCTCCGC ACGAGTTCGA
Xerocerastus sp.            -CGGGACCGA GGGACCGCCG -CACGCTTCG AGGCTACCT- GCTCCTCAGC GCGAGTCCGA
Zootecus insularis          -CGGGACCGA GGGACCGCCG -CGCGCTTCG AGGCTACCT- GCTCCTCCGC GCGAGTTCGA
Coeliaxis blandii           -CGGGACCGA GGAACCGCCG -CGCGCTTCG AGGCTACCT- GCTCCTCCGG GCGAGTCCGA
Pyrgina umbilicata          -CGGGACCGA GGAACCGCCG -CGCGCTTCG AGGCAGCCT- GCCCCTCCGC GCGAGTTCGA
Glessula ceylanica          -CGGGACCGA GGAACTGCCG -CGCGCTTCG AGGCTACCT- GCTCCTCCGC ACGAGTTCGA
Cecilioides gokweanus       -CGGGACCGA GGAACAGCCG -CGCGCTTCG AGGCCACAT- GCCCCTCCGT GCGAGTCCGA
Ferussacia folliculus       -TGGGACCGA GGAACAGCCT TCGCGCTTCG AGGCTACCT- GCTCCTCCGT GTGAGTTCAA
Thyrophorella thomensis     -CGGGACCGA GGAACCGCCG -CGCGCTTCG AGGCTGCCT- GCCCCTCCGC GCGAGTTCGA
Gibbulinella dewinteri      GCCAGACCGA GGAACCGCCG -CTCGCTTCG AGGCTACCC- GCTCCTCAGG GTGAGTTCGA
Gonaxis quadrilateralis     -CCGGACCGA GGAACCGCCG -CTCGCTTCG AGGCTACCC- GCTCCTCGGG GTGAGTTCGA
Gonospira sp.               -CCGGACCGA GGAACCGCCG -CTCGCTTCG AGGCTGTCC- GCTCCTCAGG GTGAGTTCGA
NUCLEOTIDES INCLUDED        -mmmmmmmmm mmmmmmmmmm -mmmmmmmmm mmmmmmmmm- mmmmmmmmmm mmmmmmmmmm
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                                    1510       1520       1530       1540       1550       1560
Achatina fulica             CTGGGAGAGA CTGGGCAACC GTGTCTTCCG ACCGCTCGCG CGCGACCGGG CC-GGGCTAG
Achatina achatina           CTGGGAGAGA CTGGGCAACC GTGTCTCCCG ACCGCTCGCG TGCGACCGGG CC-GGGCTAG
Achatina stuhlmanni         CTGGGAGAGA CTGGGCAACC GTGTCTCCCG ACCGCTCGCG CAAGACCGGG CC-GGGCTAG
Cochlitoma ustulata         CTGGGAGAGA CTGGGCAACC GTGTCTTCCG ACCGCTCGCG CGCGACCGGG CC-GGGCTAG
Allopeas clavulinum         CTGGGAGAGA CTGGGCAACC GTGTCTTCCG ACCGCTCGCG TGCGACCGGG ATCGGGCCGG
Bocageia sp.                CTGGGAGAGA CTGGGCAACC GTGTCTTCCG ACCGCTCGCG CGTGATCGGG TT-GGGCTAG
Eutomopeas layardi          CTGGGAGAGA CTGGGCAACC GTGTCTTCCG ACCGCTCGCG TGCGACCGGG ATCGGGCCGG
Leptinaria lamellata        CTGGGAGAGA CTGGGCAACC GTGTCTCCCG ACCGCTCGCG -CTGACAGGG ATCGGGCCGG
Paropeas achatinaceum       CTGGGAGAGA CTGGGCAACC GTGTCTTCCG ACCGCTCGCG TGCGACCGGG ATCGGGCCGG
Riebeckia sp.               CTGGGAGAGA CTGGGCAACC GTGTCTKCCG ACCGCTCGCT CGCGATCGGG TTGGGGCTAG
Rumina decollata            CTGGGAGAGA CTGGGCAACC GTGTCTCCCG ACCGCTCGCG CGCGACCGGG CC-GGGCTAG
Subulina octona             CTGGGAGAGA CTGGGCAACC GTGTCTTCCG ACCGCTCGCG TGCGACCGGG CC-GGGATAG
Subulina striatella         CTGGGAGAGA CCGGGCAACC GTGTCTTCCG ACCGCTCGCG TGTGATCGGG CC-GGGATAG
Subulina vitrea             CCGGGAGAGA CTGGGCAACC GTGTCTCCCG ACTGCTCGCG CGCGACCGGG TT-GGGTCAG
Subulona sp.                CCGGGAGAGA CTGGGCAACC GTGTCTCCCT ACCGCTCGCG CGCGATTGGG TT-GGGCTAG
Tortaxis erectus            CTGGAAGAGA CTGGGTAACC GTGGCTTCCG AATGCTCGAG CGCGATCGGG CC-GGGCTAG
Xerocerastus sp.            CTGGGAGAGA CTGGGCAACC GTGTCTCCCG ACCGCTCGCG CGCGACCGAG CC-GGGCTAG
Zootecus insularis          CTGGGAGAGA CTGGGCAACC GTGTCTTCCG ACCGCTCGCG CGCGACCGGG CC-GGGCTAG
Coeliaxis blandii           CTGGGAGAGA CTGGGCAACC GTGTCTCCCG ACCGCTCGCT CGCGATCGGG TTGGGGTTAG
Pyrgina umbilicata          CTGGGAGAGA CTGGGCAACC GTGTCTCCCG ACCGCTCGCG TGCGACCGGG ATCGGGCCGG
Glessula ceylanica          CTGGGAGAGA CTGGGCAACC GTGTCTCCCG AATGCTCGAG CGTGACTGGG TC-GGGCTAA
Cecilioides gokweanus       CTGGGAGAGA CTGGGCAACC GTGTCTCCCG ACCGCTCGCG CGCGACCGGG ATCGTGTCGG
Ferussacia folliculus       CTGGGAGAGA CTGGGCAACC GTGTCTCCCG ACCGCTCGCA CGCGACCGGG TC-GGGCTAG
Thyrophorella thomensis     CTGGGAGAGA CTGGGCAACC GTGTCTCCCG ACCGCTCGCG CGCGACCGGG ATCGGGCCGG
Gibbulinella dewinteri      CTGGAAGAGA CTGGGCAACC GTGACTTCCG ACCGCTCATC CTCGATCGGG CC-GGGCTAG
Gonaxis quadrilateralis     CAGGAAGAGA CTGGGCAACC GTGTCTTCCG ACCGCTCATC CTCGACCGGG CC-GGGCTAG
Gonospira sp.               CTGGGAGAGA CTGGGCAACC GTGTCTTCCG ACCGCTCATC CTCGATCGGG CC-GGGCCAG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mm-mmmmmmm
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                                    1570       1580       1590       1600       1610       1620
Achatina fulica             CCGGGCGT-C GCG----ACT GTAA---CAG GGTTGGTGGC GAGTCCGTCG GCATTCCACC
Achatina achatina           CCGGGCGC-- G------ACT GAAG---CAG GGTTGGTGGC GAGTCCGTCG GCATTCCACC
Achatina stuhlmanni         CCGGGCGC-C GCG----ACT GTAA---CAG GGTTGGTGGC GAGTCCGTCG GCATTCCACC
Cochlitoma ustulata         CCGGGCGT-C GCG----ACT GTAA---CAG GGTTGGTGGC GAGTCCGTCG GCATTCCACC
Allopeas clavulinum         CCGGGTGC-C GCTTGT---- -------CAG GGTTTGTGGC GAGTCCGTCG GCATTCCACC
Bocageia sp.                CCGGGTGC-- GTTAGT---- -------GAG GGTTGGTGGC GAGTCCGTCG GCATTCCACC
Eutomopeas layardi          CCGGGCGC-C GCTTGT---- -------CAG GGTTTGTGGC GAGTCCGTCG GCATTCCACC
Leptinaria lamellata        CCGGGCGC-- GCACGC---- -------CAG GGTTTGTGGC GAGTCCGTCG GCATTCCACC
Paropeas achatinaceum       CCGGGCGC-C GCTTGT---- -------CAG GGTTTGTGGC GAGTCCGTCG GCATTCCACC
Riebeckia sp.               CCGGGCCG-C GCCAGT---- -------CAG GGTTTGTGGC GAGTCCGTCG GCATTCCACC
Rumina decollata            CCGGGCGT-- GCACA----- -------CGG GGTTGGTGGC GAGTCCGTCG GCATTCCACC
Subulina octona             CCGGGCGCGC GCACGCA--- -------CAG GGTTTGTGGC GAGTCCGTCG GCATTCCACC
Subulina striatella         CCGGGCGCGC GCATGCAG-- -------CAG GGTTTGTGGC GAGTCCGTCG GCATTCCACC
Subulina vitrea             CCGGGCAC-- GCCCGT---- -------CAG GGTTCGTGGC GAGTCCGTCG GCATTCCACC
Subulona sp.                CCGGGCGC-- GCCCGTC--- -------CAG GGTTCGTGGC GAGTCCGTCG GCATTCCACC
Tortaxis erectus            CCGGGCGC-- GCAACGCTT- -------CAG GGTTGGTGGC GAGTCCGTCG GCATTCCACC
Xerocerastus sp.            CCGGGCGT-- GCACA----- -------CTG GGTTGGTGGC GAGTCCGTCG GCATTCCACC
Zootecus insularis          CCGGGCGT-- GCACA----- -------CGG GGTTGGTGGC GAGTCCGTCG GCATTCCACC
Coeliaxis blandii           CCGGGCCG-C GCCAGT---- -------CAG GGTTTGTGGC GAGTCCGTCG GCATTCCACC
Pyrgina umbilicata          CCGGGCGC-C GCTCGT---- -------CAG GGTTTGTGGC GAGTCCGTCG GCATTCCACC
Glessula ceylanica          CCGGGCGT-- GCATTTT--- -------CAG GGTGTGTGGC GAGTCCGTCG GCATTCCACC
Cecilioides gokweanus       CCGGGTGC-- GTTCGT---- -------CAG GGTTTGTGGC GAGTCCGTCG GCATTCCACC
Ferussacia folliculus       CCGGGCGC-- GCGTCAGT-- -------CAG GGTTGGTGGC AAGTCTGTCG GCATTCCACC
Thyrophorella thomensis     CCGGGCGC-C GCTCGT---- -------CAG GGTTTGTGGC GAGTCCGTCG GCATTCCACC
Gibbulinella dewinteri      CCGGGCGA-- GCCGATTGG- -------CAG GGTTGGTGGC GAATCTGTCG GCATTCCACC
Gonaxis quadrilateralis     CCGGGCGA-- GCCTGTCGG- -------CAG GGTTGGTGGC GAATCTGTCG GCATTCCACC
Gonospira sp.               CCGGGCGA-- GCCGATTGG- -------CAG GGTTGGTGGC GAATCTGTCG GCATTCCACC
NUCLEOTIDES INCLUDED        mmmmmmmm-- mm-------- -------mmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    1630       1640       1650       1660       1670       1680
Achatina fulica             CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCGGTA
Achatina achatina           CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCGGTA
Achatina stuhlmanni         CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCGGTA
Cochlitoma ustulata         CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCGGTA
Allopeas clavulinum         CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCCGTA
Bocageia sp.                CGACCCGTCT TGAAACGCGG GACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCAGTA
Eutomopeas layardi          CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCCGTA
Leptinaria lamellata        CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCGGTA
Paropeas achatinaceum       CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCCGTA
Riebeckia sp.               CGACCCGTCT GGAAACACCG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCAGTA
Rumina decollata            CGACCCGTCT TGAAANNNNN -NCCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCWGTA
Subulina octona             CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCGGTA
Subulina striatella         CGACCCGTCT TGAAACAAGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCAGTA
Subulina vitrea             CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCGGTA
Subulona sp.                CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCTGTA
Tortaxis erectus            CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCTATA
Xerocerastus sp.            CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCGGTA
Zootecus insularis          CGACCCGTCT TGAAACAAGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCGGTA
Coeliaxis blandii           CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCRCTA
Pyrgina umbilicata          CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCCGTA
Glessula ceylanica          CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCGGTA
Cecilioides gokweanus       CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCTGTA
Ferussacia folliculus       CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCAGTA
Thyrophorella thomensis     CGACCCGTCT TGAAANNNNN -NCCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGCCGTA
Gibbulinella dewinteri      CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGTCGTA
Gonaxis quadrilateralis     CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGTCGTA
Gonospira sp.               CGACCCGTCT TGAAACACGG -ACCAAGGAG TCTAACATGC GCGCGAGTCA TTGGGTCGTA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm -mmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    1690       1700       1710       1720       1730       1740
Achatina fulica             CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTCT--- -----CGCGC GACCCAGGTG
Achatina achatina           CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTCT--- -----CGCGC GACCCAGGTG
Achatina stuhlmanni         CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTCT--- -----CGCGC GACCCAGGTG
Cochlitoma ustulata         CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTCT--- -----CGCGC GACCCAGGTG
Allopeas clavulinum         CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTTT--- ------CGGC GACCCAGGTG
Bocageia sp.                CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTCT--- ------CGGC GACCCAGGTG
Eutomopeas layardi          CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTTT--- ------CGGC GACCCAGGTG
Leptinaria lamellata        CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTCT--- ------CGGC GACCCAGGTG
Paropeas achatinaceum       CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTTT--- ------CGGC GACCCAGGTG
Riebeckia sp.               CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTCTT-- -----AGCGC GACCCAGGTG
Rumina decollata            CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTCT--- -----CNCGC GACCCAGGTG
Subulina octona             CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GCCT--- -----CGCGC GGCCCAGGTG
Subulina striatella         CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GCCT--- -----TGCGC GGCCCAGGTG
Subulina vitrea             CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTTT--- ------CGGC GGCCCAGGTG
Subulona sp.                CGAAACTCAA AGGCGAAGTG AAAGCGAGGG TC-GTTT--- ------CGGC GACCCAGGTG
Tortaxis erectus            CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTCT--- -----CGCGC GACCCAGGTG
Xerocerastus sp.            CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTCTC-- ------GCGC GGCCCAGGTG
Zootecus insularis          CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTCT--- -----CGCGC GACCCAGGTG
Coeliaxis blandii           CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTCGTTC GTTTCGGCGC GACCCAGGTG
Pyrgina umbilicata          CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTTT--- ------CGGC GACCCAGGTG
Glessula ceylanica          CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTTT--- -----CGCGC GACCTAGGTG
Cecilioides gokweanus       CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTCT--- -----CGCGC GACCCAGGTG
Ferussacia folliculus       CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GCC---- ------TGGC GACCCAGGTG
Thyrophorella thomensis     CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-GTTT--- ------CGGC GACCCAGGTG
Gibbulinella dewinteri      CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TCCTCCTC-- -----GCGGG GACCCAGGTG
Gonaxis quadrilateralis     CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TCCTCTTC-- -----GCGGA GACCCAGGTG
Gonospira sp.               CGAAACCCAA AGGCGCAGTG AAAGCGAGGG TC-TCCTC-- -----GCGGA GACCCAGGTG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mm-------- --------nn nnmmmmmmmm


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                                    1750       1760       1770       1780       1790       1800
Achatina fulica             GGATCCT-CC GCTCCT---- ---------- --------TC G---CGGGAG CGGT-GGCGC
Achatina achatina           GGATCCT-CC GCTCCT---- ---------- --------TC G---CGGGAG CGGT-GGCGC
Achatina stuhlmanni         GGATCCT-CC GCTCCT---- ---------- --------TC G---CGGGAG CGGT-GGCGC
Cochlitoma ustulata         GGATCCT-CC GCTCCT---- ---------- --------TC G---CGGGAG CGGT-GGCGC
Allopeas clavulinum         GGATCCT-CC CTACCCC--G CGTTATCGCG CGGGT----- ------GCGT GGGT-GGCGC
Bocageia sp.                GGATCCA-TC CTCCGCT--- ---------- ---------- ----CGCGGC GGGT-GGCGC
Eutomopeas layardi          GGATCCT-CC CTACCCC--G CGTTATCGCG CGGGT----- ------GCGT GGGT-GGCGC
Leptinaria lamellata        GGATCCT-CC CTACCCC-CG CGTTTCCGCG CGGGT----- -----TCTTG GGGT-GGCGC
Paropeas achatinaceum       GGATCCT-CC CTACCCC--G CGTTATCGCG CGGGT----- ------GCGT GGGT-GGCGC
Riebeckia sp.               GGATCCT-CC TCCTCCTCCT CCTTCCCCTC --GCGGGGGT G---GTGGTG GGGT-GGCGC
Rumina decollata            GGATCCT-CC ACCCCTCTCG ---------- ---------- -----GGGGG CGGT-GGCGC
Subulina octona             GGATCCT-CC ACTTC----- ---------- ---------- -------TGG TGGT-GGCGC
Subulina striatella         GGATCCT-CC ACTTC----- ---------- ---------- -------TGG TGGT-GGCGC
Subulina vitrea             GGATCCATCC CTCCGCC--- ----GCGAGC GCAAGCCCGC G---CGTCGG GGGT-GGCGC
Subulona sp.                GGATCCATCC CTCCTGTCTG CGCGAGCGCA AGCCCGCGTC GGCGGTCTGG GGGT-GGCGC
Tortaxis erectus            GGATCCT-CC GCTCTCTC-- ---------- ---------- -----GGGAG CGGT-GGCGC
Xerocerastus sp.            GGATCCT-CC ACCCCTCT-- ---------- ---------- ---CGGGGGG CGGT-GGCGC
Zootecus insularis          GGATCCT-CC ACTCCTC--- ---------- ---------- --TCGGGGGG CGGT-GGCGC
Coeliaxis blandii           GGATCCT-CC T--------- ---------- ---------- -------GAT AGGA-GGCGC
Pyrgina umbilicata          GGATCCT-CC CTACCCC--G CGTTCTCGCG CGGGT----- ------GCGT GGGT-GGCGC
Glessula ceylanica          GGATCCT-CC GCTCTC---- ---------- ---------- ---TCGGGAG CGGT-GGCGC
Cecilioides gokweanus       GGATCCT-CC CTGCCGG--- CCCGTTTACG CGGGT----- ---TCGTCGT GGGT-GGCGC
Ferussacia folliculus       GGATCCT-CT CCCGTCC--- ---------- ---------- ------GAGG GGGA-GGCGC
Thyrophorella thomensis     GGATCCT-CC CTACCCC--G CGTTCTCGCG CGGGT----- ------GCGT GGGT-GGCGC
Gibbulinella dewinteri      GGATCCTTCC TCTCCCACGC CTTCT-GGCG CG-------- ----GGGGGA GAGTTGGCGC
Gonaxis quadrilateralis     GGATCCT-TC CCTCCCCGTC ACATTTGGCG C--------- ------GGGG GGGCTGGCGC
Gonospira sp.               GGATCCT-GT CCTTCGCGCC ACATTTGGCG CG-------- ------GGTG AGGCTGGCGC
NUCLEOTIDES INCLUDED        mmmmmmm--- ---------- ---------- ---------- -------mmm mmmm-mmmmm
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                                   1810       1820       1830       1840       1850       1860
Achatina fulica             ACCACCGGCC CGTCCCGTCC GCGTCGTCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Achatina achatina           ACCACCGGCC CGTCCCGTCC GCGCCGTCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Achatina stuhlmanni         ACCACCGGCC CGTCCCGTCC GCGCCGTCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Cochlitoma ustulata         ACCACCGGCC CGTCCCGTCC GCGCCGTCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Allopeas clavulinum         ACCACCGGCC CGTCCCGTCC GCGTCGGCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Bocageia sp.                ACCACCGGCC CGTCCCATCC GCGCCGGCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Eutomopeas layardi          ACCACCGGCC CGTCCCGTCC GCGTCGGCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Leptinaria lamellata        ACCACCGGCC CGTCCCGTCC GCGTCGGCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Paropeas achatinaceum       ACCACCGGCC CGTCCCGTCC GCGTCGGCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Riebeckia sp.               ACCACCGGCC CGTCCCGTCC GCGTCGGCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Rumina decollata            ACCACCGGCC CGTCCCGTCY GCGYCGYCYG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Subulina octona             ACCACCGGCC CGTCCCGTCC GCGCCGTCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Subulina striatella         ACCACCGGCC CGTCCCGTCC GCGCCGTCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Subulina vitrea             ACCACCGGCC CGTCCCGTCC GCGTCGGCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Subulona sp.                ACCACCGGCC CGTCCCGTCC GCGTCGGCGG TGGGGCGGAG CAAGAGCGCG CACGCTGGGA
Tortaxis erectus            ACCACCGGCC CGTCCCGTCC GCGCTGTCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Xerocerastus sp.            ACCACCGGCC CGTCCCGTCC GCGCCGTCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Zootecus insularis          ACCACCGGCC CGTCCCGTCC GCGCTGTCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Coeliaxis blandii           ACCACCGGCC CGTCCCGTCC GCGTCGGCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Pyrgina umbilicata          ACCACCGGCC CGTCCCGTCC GCGCCGGCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Glessula ceylanica          ACCACCGGCC CGTCCCGTCC GCGTCGTCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Cecilioides gokweanus       ACCACCGGCC CGTCCCGTCC GCGTCGGCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Ferussacia folliculus       ACCACCGGCC CGTCCCGTCT GCGTCGGCAG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Thyrophorella thomensis     ACCACCGGCC CGTCCCGTCC GCGTCGGCGG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Gibbulinella dewinteri      ACCACCGGCC CGTCCCGTCT GCGTCGGCAG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Gonaxis quadrilateralis     ACCACCGGCC CGTCCCGTCT GCGTCGGCAG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
Gonospira sp.               ACCACCGGCC CGTCCCGTCT GCGTCGGCAG TGGGGCGGAG CAAGAGCGTG CACGCTGGGA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                   1870       1880       1890       1900       1910       1920
Achatina fulica             CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Achatina achatina           CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Achatina stuhlmanni         CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Cochlitoma ustulata         CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Allopeas clavulinum         CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Bocageia sp.                CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Eutomopeas layardi          CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Leptinaria lamellata        CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Paropeas achatinaceum       CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Riebeckia sp.               CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Rumina decollata            CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Subulina octona             CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Subulina striatella         CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Subulina vitrea             CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Subulona sp.                CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Tortaxis erectus            CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Xerocerastus sp.            CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Zootecus insularis          CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Coeliaxis blandii           CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Pyrgina umbilicata          CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Glessula ceylanica          CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Cecilioides gokweanus       CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Ferussacia folliculus       CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Thyrophorella thomensis     CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Gibbulinella dewinteri      CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Gonaxis quadrilateralis     CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
Gonospira sp.               CCCGAAAGAT GGTGAACTAT GCCTGAGTAG AACGAAGCCA GAGGAAACTC TGGTGGAGGT
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    1930       1940       1950       1960       1970       1980
Achatina fulica             TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Achatina achatina           TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Achatina stuhlmanni         TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Cochlitoma ustulata         TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Allopeas clavulinum         TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Bocageia sp.                TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Eutomopeas layardi          TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Leptinaria lamellata        TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Paropeas achatinaceum       TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Riebeckia sp.               TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Rumina decollata            TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Subulina octona             TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Subulina striatella         TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Subulina vitrea             TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Subulona sp.                TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Tortaxis erectus            TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Xerocerastus sp.            TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Zootecus insularis          TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Coeliaxis blandii           TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Pyrgina umbilicata          TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Glessula ceylanica          TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Cecilioides gokweanus       TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Ferussacia folliculus       TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Thyrophorella thomensis     TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Gibbulinella dewinteri      TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Gonaxis quadrilateralis     TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
Gonospira sp.               TCGTAGCGAT TCTGACGTGC AAATCGATCG TCAAACTTGG GTATAGGGGC GAAAGACTAA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    1990       2000       2010       2020       2030       2040
Achatina fulica             TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Achatina achatina           TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Achatina stuhlmanni         TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Cochlitoma ustulata         TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Allopeas clavulinum         TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Bocageia sp.                TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Eutomopeas layardi          TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Leptinaria lamellata        TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Paropeas achatinaceum       TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Riebeckia sp.               TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Rumina decollata            TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Subulina octona             TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Subulina striatella         TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Subulina vitrea             TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Subulona sp.                TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Tortaxis erectus            TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Xerocerastus sp.            TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Zootecus insularis          TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Coeliaxis blandii           TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Pyrgina umbilicata          TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Glessula ceylanica          TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Cecilioides gokweanus       TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Ferussacia folliculus       TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Thyrophorella thomensis     TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Gibbulinella dewinteri      TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Gonaxis quadrilateralis     TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
Gonospira sp.               TCGAACCATC TAGTAGCTGG TTCCCTCCGA AGTTTCCCTC AGGATAGCTG GCGCTCGATC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    2050       2060       2070       2080       2090       2100
Achatina fulica             GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Achatina achatina           GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Achatina stuhlmanni         GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Cochlitoma ustulata         GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Allopeas clavulinum         GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Bocageia sp.                GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Eutomopeas layardi          GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Leptinaria lamellata        GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Paropeas achatinaceum       GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Riebeckia sp.               GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Rumina decollata            GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Subulina octona             GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Subulina striatella         GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Subulina vitrea             GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Subulona sp.                GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Tortaxis erectus            GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Xerocerastus sp.            GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Zootecus insularis          GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Coeliaxis blandii           GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Pyrgina umbilicata          GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Glessula ceylanica          GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Cecilioides gokweanus       GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Ferussacia folliculus       GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Thyrophorella thomensis     GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Gibbulinella dewinteri      GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Gonaxis quadrilateralis     GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
Gonospira sp.               GCAGTTTTAT CCGGTAAAGC GAATGATTAG AGGTCTTGGG GACGAAACGA CCTCAACCTA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    2110       2120       2130       2140       2150       2160
Achatina fulica             TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA TT-GGAGCCG GGCGCGT---
Achatina achatina           TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA TT-GGAGCCG GGCGCGT---
Achatina stuhlmanni         TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA TT-GGAGCCG GGCGCGT---
Cochlitoma ustulata         TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA TT-GGAGCCG GGCGCGT---
Allopeas clavulinum         TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA CT-GGAGCCG GGCGCGT---
Bocageia sp.                TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA TT-GGAGCCG GGCG------
Eutomopeas layardi          TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA CT-GGAGCCG GGCGCGT---
Leptinaria lamellata        TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA CT-GGAGCCG GGCGCGT---
Paropeas achatinaceum       TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA AT-GGAGCCG GGCGCGT---
Riebeckia sp.               TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA CT-GGAGCCG GGCGTC----
Rumina decollata            TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA YT-GGAGCCG GGCGCGT---
Subulina octona             TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA CT-GGAGCCG GGCGCGT---
Subulina striatella         TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA CT-GGAGCCG GGCGCGT---
Subulina vitrea             TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA TTTGGAGCCG GGCGCGT--G
Subulona sp.                TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA TT-GGAGCCG GGCGCGTTTG
Tortaxis erectus            TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA TT-GGAGCCG GGCGCGT---
Xerocerastus sp.            TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA CT-GGAGCCG GGCGCGT---
Zootecus insularis          TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA CT-GGAGCCG GGCGCGT---
Coeliaxis blandii           TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA CT-GGAGCCG GGCG------
Pyrgina umbilicata          TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA CT-GGAGCCG GGCGCGT---
Glessula ceylanica          TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA TT-GGAGCCG GGCGCGT---
Cecilioides gokweanus       TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA CT-GGAGCCG GGCGCGT--G
Ferussacia folliculus       TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA TT-GGAGCCG GGCGCGT---
Thyrophorella thomensis     TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA CT-GGAGCCG GGCGCGT---
Gibbulinella dewinteri      TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA AT-GGAGCCG GGCGCGT---
Gonaxis quadrilateralis     TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA AT-GGAGCCG GGCGCGT---
Gonospira sp.               TTCTCAAACT TTAAATGGGT AAGAAGTCCG GCTCGCTCGA AT-GGAGCCG GGCGTGT---
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mm-mmmmmmm mmmm------
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                                    2170       2180       2190       2200       2210       2220
Achatina fulica             -NTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Achatina achatina           -TTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Achatina stuhlmanni         -TTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Cochlitoma ustulata         -TTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Allopeas clavulinum         GTTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Bocageia sp.                --TCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Eutomopeas layardi          GTTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Leptinaria lamellata        GTTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Paropeas achatinaceum       GTTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Riebeckia sp.               -GTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Rumina decollata            -NTCGAATGC NTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Subulina octona             -TTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Subulina striatella         -TTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Subulina vitrea             TGTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Subulona sp.                TGTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Tortaxis erectus            GTACGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Xerocerastus sp.            -TTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Zootecus insularis          -TTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Coeliaxis blandii           --TCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Pyrgina umbilicata          GTTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Glessula ceylanica          GTCCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Cecilioides gokweanus       TGTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Ferussacia folliculus       -TTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Thyrophorella thomensis     GTTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Gibbulinella dewinteri      -TTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Gonaxis quadrilateralis     -TTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
Gonospira sp.               -CTCGAATGC GTGTGCCAAG TGGGCCACTT TTGGTAAGCA GAACTGGCGC TGTGGGATGA
NUCLEOTIDES INCLUDED        ---mmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    2230       2240       2250       2260       2270       2280
Achatina fulica             ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Achatina achatina           ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Achatina stuhlmanni         ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Cochlitoma ustulata         ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Allopeas clavulinum         ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Bocageia sp.                ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Eutomopeas layardi          ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Leptinaria lamellata        ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Paropeas achatinaceum       ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Riebeckia sp.               ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Rumina decollata            ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Subulina octona             ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Subulina striatella         ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Subulina vitrea             ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Subulona sp.                ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Tortaxis erectus            ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Xerocerastus sp.            ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Zootecus insularis          ACCAAACGCT CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Coeliaxis blandii           ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Pyrgina umbilicata          ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Glessula ceylanica          ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Cecilioides gokweanus       ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Ferussacia folliculus       ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Thyrophorella thomensis     ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Gibbulinella dewinteri      ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Gonaxis quadrilateralis     ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
Gonospira sp.               ACCAAACGCC CGGTTAAGGT GCCAAACGCT GACGCTCATC AGACACCATA AAAGGTGTTG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    2290       2300       2310       2320       2330       2340
Achatina fulica             GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Achatina achatina           GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Achatina stuhlmanni         GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Cochlitoma ustulata         GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Allopeas clavulinum         GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Bocageia sp.                GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Eutomopeas layardi          GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Leptinaria lamellata        GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Paropeas achatinaceum       GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Riebeckia sp.               GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Rumina decollata            GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Subulina octona             GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Subulina striatella         GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Subulina vitrea             GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Subulona sp.                GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Tortaxis erectus            GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Xerocerastus sp.            GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Zootecus insularis          GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGtgtaaC
Coeliaxis blandii           GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Pyrgina umbilicata          GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Glessula ceylanica          GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGtGGGAC
Cecilioides gokweanus       GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Ferussacia folliculus       GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Thyrophorella thomensis     GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGcTAAGG AGTGTGTAAC
Gibbulinella dewinteri      GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
Gonaxis quadrilateralis     GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGCGTAAC
Gonospira sp.               GTTGATATAG ACAGCAGGAC GGTGGCCATG GAAGTCGGAA CCCGCTAAGG AGTGTGTAAC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    2350       2360       2370       2380       2390       2400
Achatina fulica             AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Achatina achatina           AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Achatina stuhlmanni         AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Cochlitoma ustulata         AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Allopeas clavulinum         AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Bocageia sp.                AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Eutomopeas layardi          AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Leptinaria lamellata        AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Paropeas achatinaceum       AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Riebeckia sp.               AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Rumina decollata            AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Subulina octona             AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Subulina striatella         AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Subulina vitrea             AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Subulona sp.                AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Tortaxis erectus            AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Xerocerastus sp.            AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Zootecus insularis          AACTCACCTG CCGAATCAAC CAGCCCTGAA ACTGGATGGG GCTAGAGCGT CGGACCCATA
Coeliaxis blandii           AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Pyrgina umbilicata          AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Glessula ceylanica          AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Cecilioides gokweanus       AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Ferussacia folliculus       AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Thyrophorella thomensis     AACTCACCTG CCGAATCAAC CAGCCTGGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Gibbulinella dewinteri      AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Gonaxis quadrilateralis     AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
Gonospira sp.               AACTCACCTG CCGAATCAAC CAGCCCTGAA AATGGATGGC GCTAGAGCGT CGGACCCATA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    2410       2420       2430       2440       2450       2460
Achatina fulica             CCGGGCCGTC TCGGCAATGG GCCCTTCCAT GGGG-CCGGA AGCGAGGCCG AGACGAGTAG
Achatina achatina           CCGGGCCGTC TCGGCAATAG GCC---TTCT TCCG-CCGGA AGCGAGGCCG AGACGAGTAG
Achatina stuhlmanni         CCGGGCCGTC TCGGCAATGG GCCCTTTCAT GGGG-CCGGA AGCGAGGCCG AGACGAGTAG
Cochlitoma ustulata         CCGGGCCGTC TCGGCAATGG GCCC-TTCCA CGGG-CCGGA AGCGAGGCCG AGACGAGTAG
Allopeas clavulinum         CCGGGCCGTC TCGGCAATCG GAAACAA--- ---------G CGCGAGGCCG AGACGAGTAG
Bocageia sp.                CCGGGCCGTC TCGGCAATCA GAAAGCA--- ---------A ATCGAGGCCG AGACGAGTAG
Eutomopeas layardi          CCGGGCCGTC TCGGCAATCG GAAACAA--- ---------G CGCGAGGCCG AGACGAGTAG
Leptinaria lamellata        CCGGGCCGTC TCGGCAATCG TATGCAA--- ---------G CGCGAGGCCG AGACGAGTAG
Paropeas achatinaceum       CCGGGCCGTC TCGGCAATCG GAAACAA--- ---------G CGAGAGGCCG AGACGAGTAG
Riebeckia sp.               CCGGGCCGTC TCGGCAATCG AATAAAGCGG CA-------A AGCGAGGCCG AGACGAGTAG
Rumina decollata            CCGGGCCGTC TCGGCAGTGG CGATAGCCGC G--------A ATCGAGGCCG AGACGAGTAG
Subulina octona             CCGGGCCGTC TCGGCAATTG CCCCC----- ---------A AGCGAGGCCG AGACGAGTAG
Subulina striatella         CCGGGCCGTC TCGGCAATTG TTGCCTC--- ---------A AGCGAGGCCG AGACGAGTAG
Subulina vitrea             CCGGGCCGTC TCGGCAATCG GATCTAACCG AGAGA----G AGAGAGGCCG AGACGAGTAG
Subulona sp.                CCGGGCCGTC TCGGCAATGG TTG------- ---------C TGAGAGGCCG AGACGAGTAG
Tortaxis erectus            CCGGGCCGTC TCGGCAATGG CCTTTTACTC A--------A AGCGAGGCCG AGACGAGTAG
Xerocerastus sp.            CCGGGCCGTC TCGGCAGTGG CTTCGTTGCC GCG------A ATCGAGGCCG AGACGAGTAG
Zootecus insularis          CCGGGCCGTC TCGGCAGTGC A--------- ---------A ATCGAGGCCG AGACGAGTAG
Coeliaxis blandii           CCGGGCCGTC TCGGCAATCG AAACTAAAAG GC-------A AGCGAGGCCG AGACGAGTAG
Pyrgina umbilicata          CCGGGCCGTC TCGGCAATCG GAAACAA--- ---------A CGCGAGGCCG AGACGAGTAG
Glessula ceylanica          CCGGGCCGTC TCGGCAATGG TCACGCCATT ---------A AGCGAGGCCG AGACGAGTAG
Cecilioides gokweanus       CCGGGCCGTC TCGGCAATCG ATCTTCGGTA ---------A CGCGAGGCCG AGACGAGTAG
Ferussacia folliculus       CCGGGCCGTC TCGGCAATAC GTGCA----- ---------A AAAAAGGCCG AGACGAGTAG
Thyrophorella thomensis     CCGGGCCGTC TCGGCAATCG GAAACAA--- ---------A CGCGAGGCCG AGACGAGTAG
Gibbulinella dewinteri      CCGGGCCGTC TCGGCAATCG CGCGGCCGA- ---------A GGCAAGGCCG AGACGAGTAG
Gonaxis quadrilateralis     CCGGGCCGTC TCGGCAATCT GGCCGA---- ---------A GGCAAGGCCG AGACGAGTAG
Gonospira sp.               CCGGGCCGTC TCGGCAATCG GTGCCGCA-- ---------A GGCGAGGCCG AGACGAGTAG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmm-- ---------- ---------m mmmmmmmmmm mmmmmmmmmm


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                                    2470       2480       2490       2500       2510       2520
Achatina fulica             GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Achatina achatina           GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Achatina stuhlmanni         GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Cochlitoma ustulata         GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Allopeas clavulinum         GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Bocageia sp.                GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Eutomopeas layardi          GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Leptinaria lamellata        GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Paropeas achatinaceum       GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Riebeckia sp.               GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Rumina decollata            GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Subulina octona             GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Subulina striatella         GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Subulina vitrea             GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Subulona sp.                GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Tortaxis erectus            GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Xerocerastus sp.            GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Zootecus insularis          GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Coeliaxis blandii           GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Pyrgina umbilicata          GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Glessula ceylanica          GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Cecilioides gokweanus       GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Ferussacia folliculus       GAGGGCCGTC GAGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCTCGGG
Thyrophorella thomensis     GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Gibbulinella dewinteri      GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Gonaxis quadrilateralis     GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
Gonospira sp.               GAGGGCCGTC GGGGTGAGCG TGGAAGCCTG GGGAGCGATC CTGGGTGGAG CCGCCCCGGG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                  2530       2540       2550       2560       2570       2580
Achatina fulica             TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Achatina achatina           TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Achatina stuhlmanni         TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Cochlitoma ustulata         TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Allopeas clavulinum         TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Bocageia sp.                TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Eutomopeas layardi          TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Leptinaria lamellata        TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Paropeas achatinaceum       TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Riebeckia sp.               TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Rumina decollata            TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Subulina octona             TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Subulina striatella         TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Subulina vitrea             TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Subulona sp.                TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Tortaxis erectus            TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Xerocerastus sp.            TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Zootecus insularis          TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Coeliaxis blandii           TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Pyrgina umbilicata          TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Glessula ceylanica          TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Cecilioides gokweanus       TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Ferussacia folliculus       TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Thyrophorella thomensis     TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Gibbulinella dewinteri      TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Gonaxis quadrilateralis     TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
Gonospira sp.               TGCAGATCTT GGTGGTAGTA GCAAATATTC AAACGAGAAC TTTGAAGACT GAAGTGGAGA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                  2590       2600       2610       2620       2630       2640
Achatina fulica             AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Achatina achatina           AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Achatina stuhlmanni         AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Cochlitoma ustulata         AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Allopeas clavulinum         AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Bocageia sp.                AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Eutomopeas layardi          AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Leptinaria lamellata        AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Paropeas achatinaceum       AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Riebeckia sp.               AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Rumina decollata            AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Subulina octona             AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Subulina striatella         AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Subulina vitrea             AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Subulona sp.                AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Tortaxis erectus            AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Xerocerastus sp.            AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Zootecus insularis          AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Coeliaxis blandii           AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Pyrgina umbilicata          AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Glessula ceylanica          AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Cecilioides gokweanus       AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Ferussacia folliculus       AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Thyrophorella thomensis     AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Gibbulinella dewinteri      AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Gonaxis quadrilateralis     AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
Gonospira sp.               AGGGTTCCAT GTGAACAGCA GTTGAACATG GGTCAGTCGG TCCTAAGAGA TAGGAAAACT
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    2650       2660       2670       2680       2690       2700
Achatina fulica             CCGTTCTGAC CCCGGGGC-A TTCTTTCTTT CTTTCT---- ---------- ----AGAAGA
Achatina achatina           CCGTTCTGAC CCCGGGGC-A TTCTTTGTCA GCAGT----- ---------- -------CAA
Achatina stuhlmanni         CCGTTCTGAC CCCGGGGC-A TTCTTTATAA ---TTCGTTA TT-------- -------AGA
Cochlitoma ustulata         CCGTTCTGAC CCCGGGGC-A TTCTTTCGTG ---------- ---------- ----ATTAAA
Allopeas clavulinum         CCGTTCTGAC CCCGGGGC-A TTCTTTCTTT CTTTCTTCT- ------CGAA GCCAGAAGTA
Bocageia sp.                CCGTTCTGAC CCCGGGGC-A TTCTTTACTA ACA------- -------AAA AGGAAGAAAA
Eutomopeas layardi          CCGTTCTGAC CCCGGGGC-A TTCTTTCTTT CTTCTC---- ---------- --GAAGCAGA
Leptinaria lamellata        CCGTTCTGAC CCCGGGGC-A TTCTTTCTG- ---------- ---------- --AATGAGTA
Paropeas achatinaceum       CCGTTCTGAC CCCGGGGC-A TTCTTTCTTA CTTCTTCTTC T--CGCGAAC GAAGAGCAGA
Riebeckia sp.               CCGTTCTGAC CCCGGGGCAA TTCTTTCTTT CTTTCT---- -----CGAAC GAACGATCGA
Rumina decollata            CCGTTCTGAC CCCGGGGC-A ATCTTTCTCG AGCTA----- -------AGA AGAAAAAGAA
Subulina octona             CCGTTCTGAC CCCGGGGC-A ATCTTTTCTT C--------- ---------- ------AAGA
Subulina striatella         CCGTTCTGAC CCCGGGGC-A ATCTTCATTT TT-------- ---------- --------GA
Subulina vitrea             CCGTTCTGAC CCCGGGGC-A TTCTTTCTTT AATCTTTT-- ---------- -----GCAGA
Subulona sp.                CCGTTCTGAC CCCGGGGC-G TTTTTTTGTA ATAATCTT-- ---------- ---------A
Tortaxis erectus            CCGTTCTGAC CCCGGGGC-A TTCTTTCTC- ---------- ---------- --AGCGAATA
Xerocerastus sp.            CCGTTCTGAC CCCGGGGC-A CTCTTT---- ---------- ---CTTGACG ATTCAATTGA
Zootecus insularis          CCGTTCTGAC CCCGGGGC-A ATCTTTCTTT CTTTCTC--- ---------G AGAAGAAGAA
Coeliaxis blandii           CCGTTCTGAC CCCGGGGCAA TTCTTT---- ---------- ---------- ----CGTTGA
Pyrgina umbilicata          CCGTTCTGAC CCCGGGGC-A TTCTTTCTTT CACT------ -------CGA AGAAGCAAGA
Glessula ceylanica          CCGTTCTGAC CCCGGGGC-A TTCTTTCAG- ---------- ---------- ------AAAA
Cecilioides gokweanus       CCGTTCTGAC CCCGGGGCAA TTCTTTCTTT CTGTTT---- ---------- --------GA
Ferussacia folliculus       CCGTTCTGAC CCCGGGGC-A CTCTTT---- ---------- ------ACGT CGGTAAACGA
Thyrophorella thomensis     CCGTTCTGAC CCCGGGGC-A TTCTTTCTT- ---------- ---------- ACTCGAAGCA
Gibbulinella dewinteri      CCGTTCTGAC CCCGGGGC-G CTCTTTACG- ---------- ---------C AACGTTTCGA
Gonaxis quadrilateralis     CCGTTCTGAC CCCGGGGC-G CTCTTTTTT- ---------- ---------- -GTTGATCGA
Gonospira sp.               CCGTTCTGAC CCCGGGGC-G ATCTTTACA- ------CAAC AACACGCGAG TTGTCGTCGA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmm-- ---------- ---------- ---------- ---------m


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                                    2710       2720       2730       2740       2750       2760
Achatina fulica             G-TCTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Achatina achatina           G-TCTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Achatina stuhlmanni         G-TCTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Cochlitoma ustulata         G-TCTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Allopeas clavulinum         G-TCTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Bocageia sp.                GTTTTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Eutomopeas layardi          G-TCTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Leptinaria lamellata        G-TCTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Paropeas achatinaceum       G-TCTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Riebeckia sp.               G-TCTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Rumina decollata            G-TCTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Subulina octona             GTTTTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Subulina striatella         GTTTTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Subulina vitrea             G-TTTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Subulona sp.                ACACTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Tortaxis erectus            G-TCTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Xerocerastus sp.            G-TCTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Zootecus insularis          G-TAAGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Coeliaxis blandii           G-TCTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Pyrgina umbilicata          G-TCTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Glessula ceylanica          G-TCTGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Cecilioides gokweanus       A-TCAGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Ferussacia folliculus       GCTCGGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Thyrophorella thomensis     GNGTCGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Gibbulinella dewinteri      G-TACGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Gonaxis quadrilateralis     G-CACGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
Gonospira sp.               G-CACGCCCG CAGCCTATCG AAAGGGAATC GGGTTAATAT TCCCGAACCT GGACACGGAG
NUCLEOTIDES INCLUDED        m-mmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    2770       2780       2790       2800       2810       2820
Achatina fulica             ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Achatina achatina           ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Achatina stuhlmanni         ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Cochlitoma ustulata         ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Allopeas clavulinum         ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Bocageia sp.                ATTGGTCCTC TGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGAGAGCC
Eutomopeas layardi          ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Leptinaria lamellata        ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Paropeas achatinaceum       ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Riebeckia sp.               ACTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Rumina decollata            ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Subulina octona             ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Subulina striatella         ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Subulina vitrea             ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Subulona sp.                ATTGGTCCTC TGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Tortaxis erectus            ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGAAGCC
Xerocerastus sp.            ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Zootecus insularis          ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Coeliaxis blandii           ACTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Pyrgina umbilicata          ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Glessula ceylanica          ATTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGAAGCC
Cecilioides gokweanus       ATTGGTCCTC TGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Ferussacia folliculus       ACTGGTCCTC AGGGACCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Thyrophorella thomensis     ATTGGTCCTT TGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Gibbulinella dewinteri      ACTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCT
Gonaxis quadrilateralis     ACTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
Gonospira sp.               ACTGGTCCTC AGGGGCCACG TGCGGCAACG CAAACGAAGT GGGGGACGTC GGCGGGAGCC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    2830       2840       2850       2860       2870       2880
Achatina fulica             CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Achatina achatina           CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Achatina stuhlmanni         CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Cochlitoma ustulata         CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Allopeas clavulinum         CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Bocageia sp.                CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Eutomopeas layardi          CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Leptinaria lamellata        CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Paropeas achatinaceum       CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Riebeckia sp.               CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Rumina decollata            CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Subulina octona             CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Subulina striatella         CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Subulina vitrea             CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Subulona sp.                CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Tortaxis erectus            CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Xerocerastus sp.            CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Zootecus insularis          CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Coeliaxis blandii           CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Pyrgina umbilicata          CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Glessula ceylanica          CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Cecilioides gokweanus       CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Ferussacia folliculus       CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCATATCCC TGGAATCGGC TTGCCCGGAG
Thyrophorella thomensis     CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Gibbulinella dewinteri      CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Gonaxis quadrilateralis     CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
Gonospira sp.               CCGGGAAGAG TTCTCTTTTC TTTGTAAGGA GCCACATCCC TGGAATCGGC TTGCCCGGAG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    2890       2900       2910       2920       2930       2940
Achatina fulica             ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Achatina achatina           ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Achatina stuhlmanni         ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Cochlitoma ustulata         ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Allopeas clavulinum         ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Bocageia sp.                ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Eutomopeas layardi          ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Leptinaria lamellata        ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Paropeas achatinaceum       ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Riebeckia sp.               ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Rumina decollata            ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Subulina octona             ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Subulina striatella         ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Subulina vitrea             ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Subulona sp.                ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Tortaxis erectus            ATAGGGACCG CGGCTCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Xerocerastus sp.            ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Zootecus insularis          ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Coeliaxis blandii           ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Pyrgina umbilicata          ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Glessula ceylanica          ATAGGGACCA CGGCTCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Cecilioides gokweanus       ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Ferussacia folliculus       ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Thyrophorella thomensis     ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Gibbulinella dewinteri      ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Gonaxis quadrilateralis     ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
Gonospira sp.               ATAGGGACCG CGGCCCCGTA AAGCACCGCG GCTCTTGCGG TGTCCGGTGC GCTCCCGTCG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    2950       2960       2970       2980       2990       3000
Achatina fulica             GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Achatina achatina           GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Achatina stuhlmanni         GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Cochlitoma ustulata         GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Allopeas clavulinum         GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Bocageia sp.                GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Eutomopeas layardi          GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Leptinaria lamellata        GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Paropeas achatinaceum       GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Riebeckia sp.               GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Rumina decollata            GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Subulina octona             GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Subulina striatella         GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Subulina vitrea             GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Subulona sp.                GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Tortaxis erectus            GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Xerocerastus sp.            GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Zootecus insularis          GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Coeliaxis blandii           GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Pyrgina umbilicata          GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Glessula ceylanica          GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Cecilioides gokweanus       GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Ferussacia folliculus       GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Thyrophorella thomensis     GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Gibbulinella dewinteri      GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Gonaxis quadrilateralis     GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
Gonospira sp.               GCCCTTGAAA ACCCCACGGA GACGGTGTGA ATTTCGTGCC AGGCCGTACC CATATCCGCA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   3010       3020       3030       3040       3050       3060
Achatina fulica             GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Achatina achatina           GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Achatina stuhlmanni         GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Cochlitoma ustulata         GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Allopeas clavulinum         GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Bocageia sp.                GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Eutomopeas layardi          GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Leptinaria lamellata        GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Paropeas achatinaceum       GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Riebeckia sp.               GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Rumina decollata            GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Subulina octona             GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Subulina striatella         GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Subulina vitrea             GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Subulona sp.                GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Tortaxis erectus            GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Xerocerastus sp.            GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Zootecus insularis          GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Coeliaxis blandii           GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Pyrgina umbilicata          GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Glessula ceylanica          GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Cecilioides gokweanus       GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Ferussacia folliculus       GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Thyrophorella thomensis     GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Gibbulinella dewinteri      GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Gonaxis quadrilateralis     GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
Gonospira sp.               GCAGGTCTCC GAGGTGCACA GCCTCTAGTC GATAGAACAA TGTAGGTAAG GGAAGTCGGC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                   3070       3080       3090       3100       3110       3120
Achatina fulica             AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Achatina achatina           AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Achatina stuhlmanni         AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Cochlitoma ustulata         AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Allopeas clavulinum         AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Bocageia sp.                AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Eutomopeas layardi          AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Leptinaria lamellata        AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Paropeas achatinaceum       AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Riebeckia sp.               AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Rumina decollata            AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Subulina octona             AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Subulina striatella         AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Subulina vitrea             AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Subulona sp.                AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Tortaxis erectus            AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Xerocerastus sp.            AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Zootecus insularis          AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Coeliaxis blandii           AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Pyrgina umbilicata          AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Glessula ceylanica          AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Cecilioides gokweanus       AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Ferussacia folliculus       AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Thyrophorella thomensis     AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Gibbulinella dewinteri      AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Gonaxis quadrilateralis     AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
Gonospira sp.               AAATTGGATC CGTAACTTCG GGAAAAGGAT TGGCTCTGAG GGCTGGGTCA GTCGGGCCGG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    3130       3140       3150       3160       3170       3180
Achatina fulica             GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Achatina achatina           GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Achatina stuhlmanni         GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Cochlitoma ustulata         GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Allopeas clavulinum         GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Bocageia sp.                GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGTCGGCGG
Eutomopeas layardi          GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Leptinaria lamellata        GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Paropeas achatinaceum       GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Riebeckia sp.               GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Rumina decollata            GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGTCGGCGG
Subulina octona             GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Subulina striatella         GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Subulina vitrea             GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Subulona sp.                GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Tortaxis erectus            GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGTCGGCGG
Xerocerastus sp.            GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGTCGGCGG
Zootecus insularis          GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGTCGGCGG
Coeliaxis blandii           GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Pyrgina umbilicata          GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Glessula ceylanica          GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Cecilioides gokweanus       GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Ferussacia folliculus       GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TCGTCGGCGG
Thyrophorella thomensis     GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGCCGGCGG
Gibbulinella dewinteri      GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGTCGGCGG
Gonaxis quadrilateralis     GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGTCGGCGG
Gonospira sp.               GGTACGAAGC GGGACTGGGA TGGGCCCGGG CTGGGCGAGG CCGCCGCCGC TAGTCGGCGG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    3190       3200       3210       3220       3230       3240
Achatina fulica             GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Achatina achatina           GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Achatina stuhlmanni         GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Cochlitoma ustulata         GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Allopeas clavulinum         GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Bocageia sp.                GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Eutomopeas layardi          GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Leptinaria lamellata        GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Paropeas achatinaceum       GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Riebeckia sp.               GCCGGCCGAG CTCGGAACGT GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Rumina decollata            GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Subulina octona             GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Subulina striatella         GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Subulina vitrea             GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Subulona sp.                GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Tortaxis erectus            GCAGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Xerocerastus sp.            GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Zootecus insularis          GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Coeliaxis blandii           GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Pyrgina umbilicata          GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Glessula ceylanica          GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Cecilioides gokweanus       GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Ferussacia folliculus       GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGT
Thyrophorella thomensis     GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Gibbulinella dewinteri      GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Gonaxis quadrilateralis     GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
Gonospira sp.               GCCGGCCGAG CTCGGAACGC GGCTGCAACC TTCCCGTGGA CCGCCCCAGC TATGCGGCGG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    3250       3260       3270       3280       3290       3300
Achatina fulica             CGCCT----- -CCCCGGCGT CGTTCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Achatina achatina           CGCCT----- -CCCCGGCGT CGTTCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Achatina stuhlmanni         CGCCT----- -CCCCGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Cochlitoma ustulata         CGCCT----- -CCCCGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Allopeas clavulinum         CGCCT----- TCCCGGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Bocageia sp.                CGCCT----- -CCCCGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Eutomopeas layardi          CGCCT----- TCCCGGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Leptinaria lamellata        CGCCC----- TCCCGGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Paropeas achatinaceum       CGCCT----- TCCCGGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Riebeckia sp.               CGCCT----- -CCCCGGCGT CGTTCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Rumina decollata            CGCCT----- --CCCGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Subulina octona             CGCCT----- -CCCCGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Subulina striatella         CGCCT----- -CCCCGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Subulina vitrea             CGCCT----- TCCCGGGCGT CGTTCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Subulona sp.                CGCCT----- TCACGGGCGT CGTTCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Tortaxis erectus            CGCCT----- TCCCAGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Xerocerastus sp.            CGCCT----- -CCCCGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Zootecus insularis          CGCCT----- -CCCCGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Coeliaxis blandii           CGCCT----- -CCCCGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Pyrgina umbilicata          CGCCT----- TCCCGGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Glessula ceylanica          CACCG----- TCCCCGGTGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Cecilioides gokweanus       CGCCT----- TCCCGGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Ferussacia folliculus       CGCCTCCTCC CGCGGGGTGW CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Thyrophorella thomensis     CGCCT----- TCCCGGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Gibbulinella dewinteri      CGCCT----- --CCCGGCGT TGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Gonaxis quadrilateralis     CGCCT----- --CCCGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
Gonospira sp.               CGCCT----- --CCCGGCGT CGTCCGCGTC GGCTGGCATT CAACAGCCAA CTCAGAACTG
NUCLEOTIDES INCLUDED        mmmmm----- --mmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    3310       3320       3330       3340       3350       3360
Achatina fulica             GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Achatina achatina           GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Achatina stuhlmanni         GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Cochlitoma ustulata         GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Allopeas clavulinum         GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Bocageia sp.                GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Eutomopeas layardi          GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Leptinaria lamellata        GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Paropeas achatinaceum       GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Riebeckia sp.               GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Rumina decollata            GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Subulina octona             GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Subulina striatella         GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Subulina vitrea             GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Subulona sp.                GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Tortaxis erectus            GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Xerocerastus sp.            GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Zootecus insularis          GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Coeliaxis blandii           GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Pyrgina umbilicata          GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Glessula ceylanica          GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Cecilioides gokweanus       GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Ferussacia folliculus       GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Thyrophorella thomensis     GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Gibbulinella dewinteri      GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Gonaxis quadrilateralis     GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
Gonospira sp.               GTACGGACCA GGGGAATCCG ACTGTCTAAT TAAAACAAAG CATTGCGACG GCCGTCACCC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    3370       3380       3390       3400       3410       3420
Achatina fulica             GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Achatina achatina           GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Achatina stuhlmanni         GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Cochlitoma ustulata         GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Allopeas clavulinum         GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Bocageia sp.                GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Eutomopeas layardi          GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Leptinaria lamellata        GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Paropeas achatinaceum       GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Riebeckia sp.               GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Rumina decollata            GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Subulina octona             GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Subulina striatella         GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Subulina vitrea             GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Subulona sp.                GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Tortaxis erectus            GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Xerocerastus sp.            GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Zootecus insularis          GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Coeliaxis blandii           GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Pyrgina umbilicata          GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Glessula ceylanica          GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Cecilioides gokweanus       GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Ferussacia folliculus       GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Thyrophorella thomensis     GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Gibbulinella dewinteri      GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Gonaxis quadrilateralis     GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
Gonospira sp.               GGTGTTGACG CAATGTGATT TCTGCCCAGT GCTCTGAATG TCAAAGTGAA GAAATTCAAC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    3430       3440       3450       3460       3470       3480
Achatina fulica             CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Achatina achatina           CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Achatina stuhlmanni         CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Cochlitoma ustulata         CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Allopeas clavulinum         CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Bocageia sp.                CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Eutomopeas layardi          CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Leptinaria lamellata        CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Paropeas achatinaceum       CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Riebeckia sp.               CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Rumina decollata            CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Subulina octona             CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Subulina striatella         CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Subulina vitrea             CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Subulona sp.                CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Tortaxis erectus            CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Xerocerastus sp.            CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Zootecus insularis          CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Coeliaxis blandii           CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Pyrgina umbilicata          CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Glessula ceylanica          CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Cecilioides gokweanus       CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Ferussacia folliculus       CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Thyrophorella thomensis     CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Gibbulinella dewinteri      CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Gonaxis quadrilateralis     CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
Gonospira sp.               CAAGCGCGGG TAAACGGCGG GAGTAACTAT GACTCTCTTA AGGTAGCCAA ATGCCTCGTC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                   3490       3500       3510       3520       3530       3540
Achatina fulica             ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Achatina achatina           ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Achatina stuhlmanni         ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Cochlitoma ustulata         ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Allopeas clavulinum         ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Bocageia sp.                ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Eutomopeas layardi          ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Leptinaria lamellata        ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Paropeas achatinaceum       ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Riebeckia sp.               ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Rumina decollata            ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Subulina octona             ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Subulina striatella         ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Subulina vitrea             ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Subulona sp.                ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Tortaxis erectus            ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Xerocerastus sp.            ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Zootecus insularis          ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Coeliaxis blandii           ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Pyrgina umbilicata          ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Glessula ceylanica          ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Cecilioides gokweanus       ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Ferussacia folliculus       ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Thyrophorella thomensis     ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Gibbulinella dewinteri      ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Gonaxis quadrilateralis     ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
Gonospira sp.               ATCTAATTAG TGACGCGCAT GAATGGATTA ACGAGATTCC CACTGTCCCT ATCTACTATC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                   3550       3560       3570       3580       3590       3600
Achatina fulica             TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Achatina achatina           TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Achatina stuhlmanni         TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Cochlitoma ustulata         TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Allopeas clavulinum         TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Bocageia sp.                TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Eutomopeas layardi          TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Leptinaria lamellata        TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Paropeas achatinaceum       TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Riebeckia sp.               TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Rumina decollata            TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Subulina octona             TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Subulina striatella         TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Subulina vitrea             TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Subulona sp.                TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Tortaxis erectus            TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Xerocerastus sp.            TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Zootecus insularis          TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Coeliaxis blandii           TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Pyrgina umbilicata          TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Glessula ceylanica          TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Cecilioides gokweanus       TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Ferussacia folliculus       TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Thyrophorella thomensis     TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Gibbulinella dewinteri      TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Gonaxis quadrilateralis     TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
Gonospira sp.               TAGCGAAACC ACAGCCAAGG GAACGGGCTT GGTAGAATCA GCGGGGAAAG AAGACCCTGT
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                  3610       3620       3630       3640       3650       3660
Achatina fulica             TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Achatina achatina           TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Achatina stuhlmanni         TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Cochlitoma ustulata         TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Allopeas clavulinum         TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Bocageia sp.                TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Eutomopeas layardi          TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Leptinaria lamellata        TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Paropeas achatinaceum       TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Riebeckia sp.               TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Rumina decollata            TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Subulina octona             TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Subulina striatella         TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Subulina vitrea             TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Subulona sp.                TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Tortaxis erectus            TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Xerocerastus sp.            TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Zootecus insularis          TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Coeliaxis blandii           TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Pyrgina umbilicata          TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Glessula ceylanica          TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Cecilioides gokweanus       TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Ferussacia folliculus       TGAGCTTGAC TCTAKTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Thyrophorella thomensis     TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Gibbulinella dewinteri      TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Gonaxis quadrilateralis     TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
Gonospira sp.               TGAGCTTGAC TCTAGTCCGA CTTTGTGAAG ACACATGAAG GGTGTAGCAT AGGTGGGAGC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                  3670       3680       3690       3700       3710       3720
Achatina fulica             GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Achatina achatina           GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Achatina stuhlmanni         GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Cochlitoma ustulata         GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Allopeas clavulinum         GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Bocageia sp.                GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Eutomopeas layardi          GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Leptinaria lamellata        GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Paropeas achatinaceum       GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Riebeckia sp.               GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Rumina decollata            GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Subulina octona             GCGAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Subulina striatella         GCGAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Subulina vitrea             GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Subulona sp.                GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Tortaxis erectus            GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Xerocerastus sp.            GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Zootecus insularis          GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Coeliaxis blandii           GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Pyrgina umbilicata          GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Glessula ceylanica          GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Cecilioides gokweanus       GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Ferussacia folliculus       GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Thyrophorella thomensis     GCAAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Gibbulinella dewinteri      GCGAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Gonaxis quadrilateralis     GCGAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
Gonospira sp.               GCGAGCGCAA TTGAAATACC ACTACTTTTA TCGTTTCTTT ACTTATTCAG TCAAGCGGAG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                   3730      3740      3750      3760      3770      3780
Achatina fulica             AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Achatina achatina           AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Achatina stuhlmanni         AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Cochlitoma ustulata         AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA TCGGCGCTCG TCGTCGGCCG
Allopeas clavulinum         AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Bocageia sp.                AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Eutomopeas layardi          AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Leptinaria lamellata        AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Paropeas achatinaceum       AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Riebeckia sp.               AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Rumina decollata            AGCGGGGCGC AAGCCCCTCG CTTCTGGAAT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Subulina octona             AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Subulina striatella         AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Subulina vitrea             AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Subulona sp.                AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA TCGGCGCTCG TCGTCGGCCG
Tortaxis erectus            AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Xerocerastus sp.            AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCA- CCGGCGCTCG TCGTCGGCCG
Zootecus insularis          AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Coeliaxis blandii           AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Pyrgina umbilicata          AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Glessula ceylanica          AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCTCG TCGTCGGCCG
Cecilioides gokweanus       AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA TCGGCGCTCG TCGTCGGCCG
Ferussacia folliculus       AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAC TCGGCGCTCG TCGTCGGCCG
Thyrophorella thomensis     AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA CCGGCGCCCG TCGCCGGCCG
Gibbulinella dewinteri      AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA TCGGCGCTCG TCGTCGGCCG
Gonaxis quadrilateralis     AGCGGGGCGA AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA TCGGCGCTCG TCGTCGGCCG
Gonospira sp.               AGCGGGGCGC AAGCCCCTCG CTTCTGGAGT TAAGCGGCAA TCGGCGCTCG TCGTCGGCCG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                   3790      3800      3810      3820      3830      3840
Achatina fulica             CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Achatina achatina           CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Achatina stuhlmanni         CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Cochlitoma ustulata         CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Allopeas clavulinum         CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Bocageia sp.                CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Eutomopeas layardi          CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Leptinaria lamellata        CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Paropeas achatinaceum       CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Riebeckia sp.               CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Rumina decollata            CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Subulina octona             CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Subulina striatella         CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Subulina vitrea             CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Subulona sp.                CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Tortaxis erectus            CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Xerocerastus sp.            CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Zootecus insularis          CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Coeliaxis blandii           CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Pyrgina umbilicata          CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Glessula ceylanica          CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Cecilioides gokweanus       CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Ferussacia folliculus       CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Thyrophorella thomensis     CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Gibbulinella dewinteri      CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Gonaxis quadrilateralis     CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
Gonospira sp.               CGATCCGCTC TGAAGACAGT GTCAGGCGGG GAGTTTGACT GGGGCGGTAC ATCTGTCAAA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    3850       3860       3870       3880       3890       3900
Achatina fulica             AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Achatina achatina           AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Achatina stuhlmanni         AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Cochlitoma ustulata         AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Allopeas clavulinum         AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Bocageia sp.                AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Eutomopeas layardi          AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Leptinaria lamellata        AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Paropeas achatinaceum       AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Riebeckia sp.               AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Rumina decollata            AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Subulina octona             AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Subulina striatella         AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Subulina vitrea             AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Subulona sp.                AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Tortaxis erectus            AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Xerocerastus sp.            AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Zootecus insularis          AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Coeliaxis blandii           AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAAAGCAAAA
Pyrgina umbilicata          AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Glessula ceylanica          AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Cecilioides gokweanus       AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Ferussacia folliculus       AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Thyrophorella thomensis     AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Gibbulinella dewinteri      AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Gonaxis quadrilateralis     AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
Gonospira sp.               AGGTAACGCA GGTGTCCTAA GGCGAGCTCA GCGAGGACGG AAACCTCGCG TAGAGCAAAA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    3910       3920       3930       3940       3950       3960
Achatina fulica             GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Achatina achatina           GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Achatina stuhlmanni         GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Cochlitoma ustulata         GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Allopeas clavulinum         GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Bocageia sp.                GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Eutomopeas layardi          GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Leptinaria lamellata        GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Paropeas achatinaceum       GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Riebeckia sp.               GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Rumina decollata            GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Subulina octona             GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Subulina striatella         GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Subulina vitrea             GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Subulona sp.                GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Tortaxis erectus            GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Xerocerastus sp.            GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Zootecus insularis          GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Coeliaxis blandii           GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACAAATAC AGACCGTGAA AGCGTGGCCT
Pyrgina umbilicata          GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Glessula ceylanica          GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Cecilioides gokweanus       GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Ferussacia folliculus       GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Thyrophorella thomensis     GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Gibbulinella dewinteri      GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Gonaxis quadrilateralis     GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
Gonospira sp.               GGGCAAAAGC TCGCTTGATT TTGATTTTCA GTACGAATAC AGACCGTGAA AGCGTGGCCT
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    3970       3980       3990       4000       4010       4020
Achatina fulica             ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Achatina achatina           ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Achatina stuhlmanni         ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Cochlitoma ustulata         ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Allopeas clavulinum         ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Bocageia sp.                ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Eutomopeas layardi          ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Leptinaria lamellata        ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Paropeas achatinaceum       ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Riebeckia sp.               ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Rumina decollata            ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Subulina octona             ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Subulina striatella         ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Subulina vitrea             ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Subulona sp.                ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Tortaxis erectus            ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Xerocerastus sp.            ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Zootecus insularis          ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Coeliaxis blandii           ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Pyrgina umbilicata          ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Glessula ceylanica          ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Cecilioides gokweanus       ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Ferussacia folliculus       ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Thyrophorella thomensis     ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Gibbulinella dewinteri      ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Gonaxis quadrilateralis     ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
Gonospira sp.               ATCGATCCTT TTGACTTTAA GAGTTTTAAG CAAGAGGTGT CAGAAAAGTT ACCACAGGGA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    4030       4040       4050       4060       4070       4080
Achatina fulica             TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Achatina achatina           TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Achatina stuhlmanni         TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Cochlitoma ustulata         TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Allopeas clavulinum         TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Bocageia sp.                TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Eutomopeas layardi          TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Leptinaria lamellata        TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Paropeas achatinaceum       TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Riebeckia sp.               TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Rumina decollata            TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Subulina octona             TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Subulina striatella         TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Subulina vitrea             TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Subulona sp.                TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Tortaxis erectus            TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Xerocerastus sp.            TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Zootecus insularis          TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Coeliaxis blandii           TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Pyrgina umbilicata          TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Glessula ceylanica          TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Cecilioides gokweanus       TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Ferussacia folliculus       TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Thyrophorella thomensis     TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Gibbulinella dewinteri      TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Gonaxis quadrilateralis     TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
Gonospira sp.               TAACTGGCTT GTGGCAGCCA AGCGTTCATA GCGACGTTGC TTTTTGATCC TTCGATGTCG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    4090       4100       4110       4120       4130       4140
Achatina fulica             GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Achatina achatina           GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Achatina stuhlmanni         GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Cochlitoma ustulata         GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Allopeas clavulinum         GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Bocageia sp.                GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Eutomopeas layardi          GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Leptinaria lamellata        GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Paropeas achatinaceum       GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Riebeckia sp.               GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Rumina decollata            GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Subulina octona             GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Subulina striatella         GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Subulina vitrea             GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Subulona sp.                GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Tortaxis erectus            GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Xerocerastus sp.            GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Zootecus insularis          GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Coeliaxis blandii           GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Pyrgina umbilicata          GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Glessula ceylanica          GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Cecilioides gokweanus       GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Ferussacia folliculus       GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Thyrophorella thomensis     GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Gibbulinella dewinteri      GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Gonaxis quadrilateralis     GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
Gonospira sp.               GCTCTTCCTA TCATTGCGAA GCAGAATTCG CCAAGCGTTG GATTGTTCAC CCACTAATAG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    4150       4160       4170       4180       4190       4200
Achatina fulica             GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Achatina achatina           GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Achatina stuhlmanni         GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Cochlitoma ustulata         GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Allopeas clavulinum         GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Bocageia sp.                GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Eutomopeas layardi          GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Leptinaria lamellata        GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Paropeas achatinaceum       GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Riebeckia sp.               GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Rumina decollata            GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAA
Subulina octona             GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Subulina striatella         GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Subulina vitrea             GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Subulona sp.                GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Tortaxis erectus            GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Xerocerastus sp.            GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAA
Zootecus insularis          GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAA
Coeliaxis blandii           GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Pyrgina umbilicata          GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Glessula ceylanica          GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Cecilioides gokweanus       GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Ferussacia folliculus       GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAA
Thyrophorella thomensis     GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Gibbulinella dewinteri      GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAA
Gonaxis quadrilateralis     GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
Gonospira sp.               GGAACGTGAG CTGGGTTTAG ACCGTCGTGA GACAGGTTAG TTTTACCCTA CTGATGACAG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    4210       4220       4230       4240       4250       4260
Achatina fulica             GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Achatina achatina           GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Achatina stuhlmanni         GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Cochlitoma ustulata         GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Allopeas clavulinum         GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Bocageia sp.                GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Eutomopeas layardi          GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Leptinaria lamellata        GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Paropeas achatinaceum       GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Riebeckia sp.               GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Rumina decollata            GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Subulina octona             GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Subulina striatella         GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Subulina vitrea             GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Subulona sp.                GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Tortaxis erectus            GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Xerocerastus sp.            GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Zootecus insularis          GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Coeliaxis blandii           GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Pyrgina umbilicata          GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Glessula ceylanica          GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Cecilioides gokweanus       GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Ferussacia folliculus       GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Thyrophorella thomensis     GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Gibbulinella dewinteri      GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Gonaxis quadrilateralis     GTCGTTGCTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
Gonospira sp.               GTCGTTGTTA CGGTAATCCT GCTCAGTACG AGAGGAACCG CAGGTTCAGA CATTTGGTTC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    4270       4280       4290       4300       4310
Achatina fulica             ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Achatina achatina           ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Achatina stuhlmanni         ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Cochlitoma ustulata         ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Allopeas clavulinum         ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Bocageia sp.                ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Eutomopeas layardi          ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Leptinaria lamellata        ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Paropeas achatinaceum       ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Riebeckia sp.               ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Rumina decollata            ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Subulina octona             ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Subulina striatella         ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Subulina vitrea             ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Subulona sp.                ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Tortaxis erectus            ACGTGCTTGG CTGATAAGCC ACTGGTGCGA GGCTACCATC TGAGGGATTA TGG
Xerocerastus sp.            ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Zootecus insularis          ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Coeliaxis blandii           ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Pyrgina umbilicata          ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Glessula ceylanica          ACGTGCTTGG CTGATAAGCC ACTGGTGCGA GGCTACCATC TGAGGGATTA TGG
Cecilioides gokweanus       ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Ferussacia folliculus       ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Thyrophorella thomensis     ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Gibbulinella dewinteri      ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Gonaxis quadrilateralis     ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
Gonospira sp.               ACGTGCTTGG CTGATAAGCC AATGGTGCGA GGCTACCATC TGAGGGATTA TGG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmm
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Appendix 3.2: Alignment of the actin gene for the Achatinoidea and three streptaxid outgroup taxa.

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                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    10         20         30         40         50         60
Achatina achatina          TCCAAGAGAG GTATYCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Achatina fulica            TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Achatina stuhlmanni        TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Cochlitoma ustulata        TCCAAGAGAG GCATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Allopeas clavulinum        TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGAATTGT CACCAACTGG
Bocageia sp.               TCCAAGAGAG GTATCCTCAC ACTCAAGTAY CCCATTGARC ATGGTATTGT CACCAACTGG
Eutomopeas layardi         TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGAATTGT CACCAACTGG
Leptinaria lamellata       TCCAAGAGAG GTATCCTAAC TCTCAAGTAT CCCATCGAGC ATGGCATTGT CACCAACTGG
Paropeas achatinaceum      TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGAATTGT CACCAACTGG
Riebeckia sp.              TCYAAGAGAA GKATCCTCAC CYTCAAGTAC CCCATTGAGC ATGGTATTGT CACCAACTGG
Rumina decollata           TCYAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACYAACTGG
Subulina octona            TCTAAGAGAG GTATACTTAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACAAACTGG
Subulina striatella        TCTAAGAGAG GTATCCTCAC TCTCAAGTAC CCCATTGAGC AYGGTATTGT CACAAACTGG
Subulina vitrea            TCCAAGAGAG GTATCCTCAC TCTCAAGTAY CCCATTGAGC ATGGTATTGT CACCAACTGG
Subulona sp.               TCCAAGAGAG GTATCCTCAC TCTAAAGTAC CCCATTGAGC ATGGTATTGT CACCAACTGG
Tortaxis erectus           TCTAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGARC ATGGTATTGT CACCAACTGG
Xerocerastus sp.           TCCAAGAGAG GTATTCTCAC CCTCAAGTAT CCCATTGAGC ATGGTATTGT CACTAACTGG
Zootecus insularis         TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Coeliaxis blandii          TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Pyrgina umbilicata         TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGWATTGT CACCAACTGG
Glessula ceylanica         TCCAAGAGAG GTATCCTCAC TCTYAAGTAT CCCATTGAGC ATGGTRTTGT CACCAACTGG
Cecilioides gokweanus      TCCAAGAGAG GTATCCTCAC ACTCAAGTAT CCCATTGAGC ACGGYATTGT CACCAACTGG
Ferussacia folliculus      TCCAAGAGAG GTATCCTCAC TCTCAAGTAC CCCATTGAGC ATGGTATTGT CACCAACTGG
Thyrophorella thomensis    TCYAAGAGAG GTATCCTTAC TCTCAARTAT CCCATYGAGC ATGGTATTGT CACCAACTGG
Gibbulinella dewinteri     TCCAAGAGAG GTATCCTCAC TCTCAAGTAC CCTATTGAAC ATGGCATTGT CACCAACTGG
Gonaxis quadrilateralis    TCCAAGAGAG GCATCCTCAC TCTCAAGTAC CCCATTGAGC ACGGCATTGT CACCAACTGG
Gonospira sp.              TCCAAGAGAG GTATCCTCAC TCTCAAGTAC CCCATTGAGC ATGGCATTGT CACCAACTGG


                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    70         80         90        100        110        120
Achatina achatina          GATGATATGG AGAAGATCTG GCATCACACY TTCTACAATG AGTTGAGAGT TGCWCCAGAA
Achatina fulica            GATGATATGG AGAAGATCTG GCATCACACC TTCTACAATG AGCTSAGAGT TGCACCAGAA
Achatina stuhlmanni        GATGATATGG AGAAAATATG GCATCACACC TTCTACAATG AGCTGAGAGT TGCACCAGAA
Cochlitoma ustulata        GATGATATGG AGAAGATCTG GCACCACACC TTCTACAATG AGCTGAGAGT TGCACCAGAA
Allopeas clavulinum        GACGATATGG AGAAGATCTG GCATCACACT TTCTACAACG AGCTCAGAGT TGCTCCTGAA
Bocageia sp.               GAYGATATGG AGAAGATYTG GCAYCAYACY TTCTACAAYG ARCTKAGAGT TGCWCCTGAA
Eutomopeas layardi         GACGATATGG AGAAGATCTG GCATCACACT TTCTACAACG AGCTCAGAGT TGCTCCTGAA
Leptinaria lamellata       GACGATATGG AGAAGATCTG GCATCACACT TTCTACAACG AGCTCAGAGT TGCTCCTGAA
Paropeas achatinaceum      GATGATATGG AAAAGATCTG GCATCACACT TTCTACAACG AGCTCAGAGT TGCTCCTGAA
Riebeckia sp.              GAYGAYATGG AGAAGATCTG GCATCACACY TTCTACAACG AGCTGAGAGT TGCWCCTGAA
Rumina decollata           GAYGATATGG AGAAGATCTG GCATCACACY TTCTACAATG AGCTGAGAGT TGCWCCTGAA
Subulina octona            GATGATATGG AAAAGATCTG GCATCACACT TTCTACAATG AGCTGAGAGT TGCTCCTGAA
Subulina striatella        GATGATATGG AGAAGATCTG GCATCACACT TTCTACAATG ARCTGAGAGT TGCTCCTGAA
Subulina vitrea            GATGATATGG AGAAGATCTG GCATCACACY TTCTACAATG ARCTGAGAGT TGCCCCAGAA
Subulona sp.               GACGATATGG AGAAGATCTG GCACCATACT TTCTACAACG AGCTTAGAGT TGCTCCAGAA
Tortaxis erectus           GATGACATGG AGAAAATTTG GCATCACACT TTCTACAATG AGCTCAGAGT TGCACCTGAA
Xerocerastus sp.           GATGATATGG AGAAGATCTG GCATCATACC TTCTACAATG AGCTGAGAGT TGCCCCTGAG
Zootecus insularis         GATGATATGG AGAAGATCTG GCATCACACY TTCTACAATG AGCTGAGAGT TGCCCCTGAA
Coeliaxis blandii          GATGATATGG AGAAGATCTG GCATCACACC TTCTACAATG AGCTGAGAGT TGCCCCTGAA
Pyrgina umbilicata         GAYGAYATGG AGAAGATCTG GCATYAYACY TTCTACAACG AGCTSAGAGT TGCYCCTGAA
Glessula ceylanica         GATGACATGG AGAAGATCTG GCACCATACC TTCTACAATG AGCTCAGAGT TGCCCCTGAA
Cecilioides gokweanus      GATGATATGG AGAAGATCTG GCATCACACC TTCTACAACG AGCTGAGAGT TGCCCCAGAA
Ferussacia folliculus      GATGATATGG AGAAGATCTG GCATCACACC TTCTACAATG AGCTCAGAGT TGCCCCAGAG
Thyrophorella thomensis    GAYGAYATGG AGAAGATCTG GCATCAYACY TTCTACAACG AGCTSAGAGT TGCCCCTGAA
Gibbulinella dewinteri     GATGATATGG AGAAGATCTG GCATCACACC TTCTACAACG AGCTGAGAGT TGCCCCTGAG
Gonaxis quadrilateralis    GATGACATGG AGAAGATCTG GCATCACACC TTCTACAACG AGCTGAGAGT TGCCCCTGAG
Gonospira sp.              GATGATATGG AGAAGATCTG GCATCACACC TTCTACAACG AGTTGAGAGT TGCCCCTGAG
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                                   130        140        150        160        170        180
Achatina achatina          GAGCATCCAG TTCTRCTKAC AGAGGCTCCA CTCAATCCCA AGGCCAACAG AGAGAAGATG
Achatina fulica            GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Achatina stuhlmanni        GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Cochlitoma ustulata        GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Allopeas clavulinum        GAACATCCAG TTTTACTTAC AGAAGCTCCA CTCAACCCCA AGGCAAACCG AGAGAAGATG
Bocageia sp.               GARCAYCCAG TWYTKYTKAC AGAGGCTCCA CTCAAYCCMA AGGCCAACAG AGARAAGATG
Eutomopeas layardi         GAGCATCCAG TTTTACTCAC AGAAGCTCCA CTCAACCCCA AGGCAAATAG AGAGAAGATG
Leptinaria lamellata       GAGCATCCAG TTTTACTCAC AGAGGCTCCA CTGAATCCCA AGGCCAACAG AGAGAAGATG
Paropeas achatinaceum      GAGCATCCAG TTTTACTTAC AGAGGCTCCA CTCAACCCCA AGGCAAATCG AGAAAAGATG
Riebeckia sp.              GARCAYCCAG TAYTTCTGAC AGAGGCTCCM CTCAATCCCA AGGCCAACAG AGAGAAGATG
Rumina decollata           GAGCACCCAG TYYTSCTKAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Subulina octona            GAGCATCCAG TTTTGCTGAC AGAAGCACCA CTCAACCCCA AGGCCAATAG AGAGAAGATG
Subulina striatella        GAGCATCCAG TTTTGCTGAC AGAAGCACCA CTCAACCCCA AGGCYAACAG AGAGAARATG
Subulina vitrea            GAGCAYCCAG TTCTCCTTAC AGAGGCTCCA CTCAATCCCA AGGCYAACAG AGAGAAGATG
Subulona sp.               GAGCATCCAG TTCTCCTGAC AGAGGCCCCA CTTAACCCCA AGGCCAACAG AGAAAAGATG
Tortaxis erectus           GAACATCCAG TTCTCCTTAC AGAGGCYCCA CTCAATCCCA AAGCCAACAG AGAAAAGATG
Xerocerastus sp.           GAGCACCCAG TCCTCCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Zootecus insularis         GAGCACCCAG TCCTCCTGAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Coeliaxis blandii          GAGCACCCAG TACTTCTGAC AGAGGCTCCA CTCAATCCCA AGGCCAACAG AGAGAAGATG
Pyrgina umbilicata         GARCAYCCAG TWYTMCTCAC AGAGGCTCCW CTTAACCCCA AAGCCAAYAG AGARAAGATG
Glessula ceylanica         GAACAYCCAG TTYTTCTYAC AGAGGCYCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Cecilioides gokweanus      GAGCACCCAG TACTCCTTAC AGAGGCCCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Ferussacia folliculus      GAGCACCCAG TCCTCCTCAC TGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Thyrophorella thomensis    GAGCAYCCAG TWCTCCTCAC AGAGGCTCCA CTTAACCCCA AAGCTAAYAG AGAAAAGATG
Gibbulinella dewinteri     GAACACCCAG TCCTACTCAC GGAGGCTCCA CTCAACCCCA AAGCYAACAG AGAGAAGATG
Gonaxis quadrilateralis    GAACACCCRG TYCTACTCAC GGAGGCTCCW CTCAATCCCA AAGCCAACAG AGAGAAGATG
Gonospira sp.              GAACACCCAG TCCTACTCAC GGARGCTCCW CTCAATCCCA AAGCCAAYAG AGAGAAGATG


                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   190        200        210        220        230        240
Achatina achatina          ACCCAGATCA TGTTTGAGAC YTTCAAYWSY CCAGCYATGT ATGTYGCYAT TCAAGCNGTG
Achatina fulica            ACCCAGATCA TGTTTGAAAC YTTCAAYTCT CCAGCCATGT ATGTCGCCAT YCAAGCYGTG
Achatina stuhlmanni        ACCCAGATCA TGTTTGAAAC TTTCAACTCT CCAGCCATGT ATGTTGCCAT TCAAGCAGTC
Cochlitoma ustulata        ACCCAGATCA TGTTTGAGAC CTTCAACTCT CCAGCCATGT ATGTCGCCAT TCAAGCCGTG
Allopeas clavulinum        ACACAAATTA TGTTTGAAAC CTTCAATACT CCAGCCATGT ATGTCGCCAT CCAAGCCGTT
Bocageia sp.               ACCCAGATCA TGTTTGAGAC YTTCAAYACY CCAGCYATGT ACGTSKCYAT CCARGCTGTS
Eutomopeas layardi         ACACAGATTA TGTTTGAAAC CTTCAATACT CCAGCCATGT ATGTCGCCAT CCAAGCCGTT
Leptinaria lamellata       ACCCAGATTA TGTTTGAGAC CTTCAACACT CCAGCAATGT ACGTCGCCAT TCAAGCTGTG
Paropeas achatinaceum      ACACAGATTA TGTTTGAAAC CTTCAATACC CCAGCCATGT ATGTCGCCAT CCAAGCCGTT
Riebeckia sp.              ACCCAGATCA TGTTYGAGAC YTTCAACWCY CCAGCCATGT AYGTCGCYAT YCARGCWGTY
Rumina decollata           ACACAGATCA TGTTTGAGAC CTTCAAYACC CCAGCNATGT AYGTCGCYAT YCARGCCGTG
Subulina octona            ACACAGATCA TGTTTGAGAC ATTCAACACC CCAGCTATGT ATGTTGCTAT CCAGGCTGTA
Subulina striatella        ACACAGATCA TGTTTGAGAC ATTCAAYTCY CCAGCCATGT ATGTTGCTAT YCARGCTGTS
Subulina vitrea            ACCCAGATCA TGTTTGAGAC CTTCAACACA CCAGCCATGT ATGTTGCYAT CCAGGCCGTA
Subulona sp.               ACCCAGATCA TGTTTGAGAC CTTCAACTCT CCAGCCATGT ACGTTGCAAT TCAAGCCGTG
Tortaxis erectus           ACCCAGATAA TGTTTGAGAC CTTCAAYWCT CCAGCGATGT ATGTTGCMAT CCAGGCAGTT
Xerocerastus sp.           ACACAGATCA TGTTTGAAAC CTTCAACTCT CCAGCCATGT ATGTAGCAAT TCAAGCAGTG
Zootecus insularis         ACACAGATCA TGTTTGAAAC CTTCAATACC CCAGCAATGT ATGTMGCCAT CCAGGCNGTG
Coeliaxis blandii          ACCCAGATCA TGTTTGAGAC CTTCAACACC CCAGCCATGT ACGTCGCCAT CCAGGCCGTA
Pyrgina umbilicata         ACCCAGATTA TGTTYGAGAC CTTCAAYWCY CCAGCCATGT ACGTNGCCAT CCAAGCTGTY
Glessula ceylanica         ACCCAGATMA TGTTTGAGAC CTTCAACTCT CCAGCMATGT WTGTGCMCAT TCAAGCCGTA
Cecilioides gokweanus      ACCCAGATCA TGTTCGAGAC CTTCAACACT CCAGCCATGT ACGTTGCCAT CCAGGCCGTA
Ferussacia folliculus      ACACAGATCA TGTTTGAAAC CTTCAACTCC CCAGCAATGT ACGTCGCCAT TCAAGCCGTA
Thyrophorella thomensis    ACCCAGATTA TGTTYGAGAC YTTCAAYWCT CCAGCYATGT AYGTCGCTAT CCAAGCTGTC
Gibbulinella dewinteri     ACTCAGATCA TGTTTGAGAC ATTCAACACT CCAGCCATGT ATGTCGCCAT CCAGGCCGTA
Gonaxis quadrilateralis    ACCCAGATCA TGTTTGAAAC ATTCAACTCW CCAGCCATGT ATGTCGCYAT CCAGGCAGTY
Gonospira sp.              ACCCAGATCA TGTTTGAGAC ATTYAACWCT CCAGCCATGT ATGTYGCSAT YCAGGCNGTT
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                                   250        260        270        280        290        300
Achatina achatina          CTTTCYTTRT ATGCTTCAGG TCGTACAACT GGTATTGTKC TGGATTCTGG WGATGGTGTM
Achatina fulica            CTTTCTTTRT ATGCWTCAGG TCGTACAACT GGTATTGTKC TGGATTCTGG TGATGGTGTA
Achatina stuhlmanni        CTTTCTTTAT ATGCATCGGG TCGTACAACT GGTATTGTGC TGGATTCTGG TGATGGTGTA
Cochlitoma ustulata        CTTTCTTTAT ATGCATCAGG TCGTACAACT GGTATTGTTC TGGATTCTGG TGATGGTGTA
Allopeas clavulinum        CTCTCCCTGT ATGCCTCAGG TCGTACAACT GGTATTGTGC TTGATTCTGG AGATGGTGTC
Bocageia sp.               CTGTCCYTGT AYGCTTCWGG TCGKACNACY GGTRTWGTNC TKGATTCTGG WGATGGWGTY
Eutomopeas layardi         CTTTCCCTGT ATGCCTCTGG TCGTACTACT GGTATTGTGC TTGATTCTGG AGATGGTGTC
Leptinaria lamellata       CTGTCCCTGT ATGCCTCAGG TCGTACAACA GGTATTGTGC TAGATTCTGG AGATGGAGTC
Paropeas achatinaceum      CTCTCCCTGT ATGCCTCTGG TCGTACAACT GGCATTGTGC TCGATTCTGG AGATGGTGTC
Riebeckia sp.              CTGTCCYTGT AYGCYTCAGG TCGTACAACT GGGATTGTGC TAGATTCTGG WGATGGTGTC
Rumina decollata           CTKTCYYTGT ATGCCTCTGG TCGTACAACT GGTATTGTGC TAGATTCTGG WGATGGTGTT
Subulina octona            CTGTCTCTGT ATGCTTCTGG TCGTACGACT GGTATCGTCT TGGATTCAGG AGATGGTGTT
Subulina striatella        CTATCTYTGT ATGCYTCTGG TCGTACSACW GGCATTGTCT TRGAYTCWGG AGATGGKGTK
Subulina vitrea            CTTTCCTTGT ATGCTTCTGG TCGTACAACT GGTATTGTKC TAGATTCTGG AGATGGTGTY
Subulona sp.               CTGTCCTTGT ATGCTTCAGG TAGGACAACT GGTATCGTGC TGGATTCTGG GGATGGAGTC
Tortaxis erectus           CTCTCACTGT ATGCCTCAGG TCGTACAACA GGTATTGTGT TAGACTCTGG TGATGGTGTC
Xerocerastus sp.           CTTTCCCTGT ATGCCTCTGG TCGTACAACT GGTATTGTGC TAGATTCTGG TGATGGTGTT
Zootecus insularis         CTATCCCTGT ATGCCTCTGG TCGTACAACT GGTATTGTGC TAGATTCTGG TGATGGTGTT
Coeliaxis blandii          CTTTCCCTGT ATGCCTCAGG TCGTACAACT GGYATTGTKC TAGATTCTGG TGATGGTGTC
Pyrgina umbilicata         CTGTCCYTGT ATGCCTCAGG TCGTACAACT GGAATTGTGC TAGATTCTGG AGAYGGWGTC
Glessula ceylanica         CTATCGCTNT ATGCCTCAGG TCGTACAACC GGTATTGTCC TAGATTCTGG TGATGGTGTC
Cecilioides gokweanus      CTGTCCCTGT ATGCTTCAGG TCGTACAACT GGTATTGTGC TAGATTCTGG TGATGGTGTC
Ferussacia folliculus      CTTTCCCTGT ATGCCTCAGG TCGTACCACT GGTATTGTCC TGGATTCTGG TGATGGTGTG
Thyrophorella thomensis    CTCTCCYTGT ATGCCTCAGG TCGTACAACT GGAATTGTGC TAGATTCTGG MGAYGGWGTC
Gibbulinella dewinteri     CTTTCCTTGT ATGCCTCGGG TCGTACCACG GGTATTGTGC TCGACTCTGG TGATGGTGTC
Gonaxis quadrilateralis    CTGTCTTTGT ATGCYTCAGG TCGTACTACA GGYATTGTSC TGGATTCTGG TGATGGTGTC
Gonospira sp.              CTKTCTTTGT ATGCCTCAGG TCGWACCACA GGYATTGTGC TGGAYTCTGG KGATGGTGTC
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                                   310        320        330        340        350        360
Achatina achatina          ACYCAYACTG TNCCAATMTA TGARGGTTAT GCTCTTCCYC AYGCCATCAT GAGACTGGAY
Achatina fulica            ACCCACACTG TCCCAATTTA TGAAGGTTAT GCTCTACCTC ATGCCATCAT GAGACTGGAC
Achatina stuhlmanni        ACCCACACTG TCCCAATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAC
Cochlitoma ustulata        ACTCACACTG TCCCAATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAC
Allopeas clavulinum        ACTCACACTG TCCCTATCTA TGAAGGCTAT GCTCTACCAC ACGCCATCAT GAGATTAGAC
Bocageia sp.               WCYCAYACWG TSCCYATMTA TGAAGGTTAT GCCCTTCCTC ATGCCATCAT GAGRYTKGAC
Eutomopeas layardi         ACTCATACTG TCCCCATCTA TGAAGGCTAT GCTCTCCCAC ACGCCATCAT GAGATTAGAC
Leptinaria lamellata       ACTCACACAG TCCCTATATA TGAAGGTTAT GCCCTCCCTC ATGCTATTAT GAGACTGGAC
Paropeas achatinaceum      ACTCATACTG TCCCTATCTA TGAAGGCTAT GCTCTCCCAC ATGCCATCAT GAGATTAGAC
Riebeckia sp.              ACACACACTG TCCCCATCTA TGAAGGTTAT GCMCTTCCCC AYGCCATCAT GAGACTGGAT
Rumina decollata           ACCCAYACTG TCCCCATCTA TGAAGGTTAT GCCCTTCCTC ATGCCATCAT GAGAYTGGAC
Subulina octona            ACCCACACTG TTCCCATCTA TGAAGGTTAT GCTCTTCCTC ATGCCATTAT GAGACTGGAC
Subulina striatella        ACCCACACTG TWCCMATCTA TGAAGGCTAT GCTCTTCCTC ACGCCATCAT GAGACTGGAC
Subulina vitrea            ACTCACACTG TYCCCATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAT
Subulona sp.               ACCCATACTG TCCCCATCTA CGAAGGTTAT GCTCTCCCAC ATGCCATCAT GAGACTGGAC
Tortaxis erectus           ACCCACACTG TTCCCATCTA TGAAGGATAT GCCCTTCCTC ATGCCATCAT GAGACTGGAC
Xerocerastus sp.           ACCCATACTG TCCCCATATA TGAAGGTTAT GCCCTTCCCC ACGCCATCAT GAGACTGGAC
Zootecus insularis         ACCCACACTG TCCCYATCTA TGAAGGTTAT GCCCTTCCTC ATGCCATCAT GAGACTGGAY
Coeliaxis blandii          ACWCACACTG TCCCCATCTA TGAAGGTTAT GCCCTTCCTC ATGCCATCAT GAGACTGGAT
Pyrgina umbilicata         ACTCAYACWG TCCCYATCTA YGAAGGTTAT GCTCTTCCTC ACGCCATYAT GAGACTRGAT
Glessula ceylanica         ACCCACACTG TCCCTATYTW TGAAGGGTAT GCCCTTCCTC ATGCCATCAC GAGATTGGAC
Cecilioides gokweanus      ACTCACACTG TTCCCATCTA TGAAGGTTAT GCTCTTCCTC ATGCCATCAT GAGACTGGAC
Ferussacia folliculus      ACCCACACTG TCCCCATCTA TGAAGGTTAC GCTTTGCCCC ACGCCATCAT GAGACTGGAT
Thyrophorella thomensis    ACTCAYACWG TCCCYATMTA YGAAGGCTAT GCTCTTCCTC ACGCCATYAT GAGAYTGGAT
Gibbulinella dewinteri     ACCCACACGG TCCCCATCTA TGAAGGTTAT GCYCTTCCCC ACGCCATCAT GAGACTGGAT
Gonaxis quadrilateralis    ACCCACACAG TCCCYATCTA TGAAGGTTAT GCTCTYCCCC AYGCCATCAT GAGACTGGAY
Gonospira sp.              ACCCAYACAG TCCCYATCTA TGAAGGTTAT GCCCTTCCTC AYGCCATYAT GAGATTGGAT
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                                   370        380        390        400        410        420
Achatina achatina          TTGGCTGGTC GTGACCTCAC AGATTATCTC ATGAARATCC TCACAGAGAG AGGTTACAGC
Achatina fulica            TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Achatina stuhlmanni        TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Cochlitoma ustulata        TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Allopeas clavulinum        TTGGCTGGCC GTGACCTCAC CGACTACCTC ATGAAGATTC TGACTGAGCG AGGATACAGC
Bocageia sp.               YTGGCTGGYC GTGACCTTAC AGAYTACCTS ATGAAGATYC TSACWGAGAG AGGCTACAGC
Eutomopeas layardi         TTGGCTGGCC GTGACCTCAC TGACTACCTC ATGAAGATCC TCACTGAGCG AGGATACAGC
Leptinaria lamellata       TTGGCTGGTC GTGATCTCAC AGATTATTTG ATGAAGATTC TAACAGAGAG AGGCTACAGC
Paropeas achatinaceum      TTGGCTGGCC GTGACCTCAC TGACTACCTC ATGAAGATTC TCACTGAGCG AGGCTACAGC
Riebeckia sp.              CTGGCYGGCC GTGACCTCAC AGACTACCTC ATGAAGATCC TCACAGAGAG GGGCTACAGC
Rumina decollata           TTGGCTGGTC GTGACCTYAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Subulina octona            TTGGCTGGTC GCGACCTGAC AGATTATCTA ATGAAGATTC TCACGGAGAG AGGTTACAGC
Subulina striatella        TTGGCTGGTC GAGACCTGAC AGATTATCTG ATGAAGATTC TCACAGAGAG AGGTTACAGC
Subulina vitrea            CTGGCTGGCC GTGACCTCAC AGACTAYCTC ATGAAGATCC TGACAGAGAG AGGCYACAGC
Subulona sp.               TTGGCTGGTC GAGACCTCAC AGACTACCTC ATGAAGATCC TCACTGAGAG AGGTTACAGC
Tortaxis erectus           TTGGCTGGCC GTGACCTCAC AGATTACCTC ATGAARATCC TCACAGAGAG AGGTTACAGC
Xerocerastus sp.           TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAAATCC TCACAGAGAG AGGCTACAGC
Zootecus insularis         TTGGCTGGTC GTGACCTCAC AGATTAYCTC ATGAAGATCC TCACAGAGAG AGGCTAYAGY
Coeliaxis blandii          CTGGCTGGCC GTGACCTCAC AGACTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Pyrgina umbilicata         CTGGCTGGCC GTGACCTCAC AGAYTAYCTC ATGAAGATCC TMACAGAGMG AGGMTACAGC
Glessula ceylanica         CTGGCTGGAC GAGACCTCAC AGATTATCTC ATGAAGATTC TTMCAGAGAG AGGCTACCCC
Cecilioides gokweanus      TTGGCTGGCC GTGACCTTAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Ferussacia folliculus      CTGGCTGGTC GTGATCTCAC AGATTACCTC ATGAAGATCC TYACAGAGAG AGGCTACAGC
Thyrophorella thomensis    CTRGCTGGCC GTGAYCTCAC AGATTAYCTC ATGAAGATCC TCACAGAGAG AGGATACAGC
Gibbulinella dewinteri     CTGGCTGGCC GTGACCTTAC AGATTAYCTG ATGAAGATCC TCACAGAGAG AGGCTACAGT
Gonaxis quadrilateralis    TTGGCYGGGC GTGACCTTAC AGATTACCTG ATGAAGATCC TCACAGAGAG AGGCTACAGC
Gonospira sp.              TTGGCTGGAC GTGACCTKAC AGATTAYYTG ATGAAGATCC TCACAGAGAG AGGCTAYAGC


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                                   430        440        450        460        470        480
Achatina achatina          TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGAYATCA ARGAGAAGCT GTGCTATGTG
Achatina fulica            TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Achatina stuhlmanni        TTCACCACYA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAACT TTGCTATGTG
Cochlitoma ustulata        TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Allopeas clavulinum        TTCACTACAA CAGCCGAGAG AGAAATTGTA CGTGACATCA AGGAGAAACT TTGCTACGTT
Bocageia sp.               TTCACYACMA CWGCWGAGAG AGAAATTGTT CGAGAYATCA AGGAAAAACT TTSCTATGTY
Eutomopeas layardi         TTCACTACAA CAGCCGAGAG AGAAATTGTA CGCGACATCA AGGAGAAACT TTGCTACGTT
Leptinaria lamellata       TTCACAACAA CGGCTGAGAG AGAAATTGTA CGTGACATCA AGGAGAAACT TTGCTATGTT
Paropeas achatinaceum      TTCACAACAA CAGCCGAGAG AGAAATTGTA CGTGACATCA AAGAGAAACT TTGCTACGTT
Riebeckia sp.              TTCACCACYA CTGCYGAGAG AGAAATTGTT CGAGACATYA AAGARAAGCT TTSYTAYGTR
Rumina decollata           TTCACCACCA CTGCTGAGAG AGAAATTGTT CGAGACATCA AGGAGAAGCT GTSCTATGTT
Subulina octona            TTCACAACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AGGAGAAACT TTGCTACGTC
Subulina striatella        TTCACCACCA CAGCYGAGAG AGAAATTGTY CGAGACATCA AAGAGAAACT TTGCTACGTC
Subulina vitrea            TTCACCACCA CWGCTGAGAG AGAAATTGTT CGAGACATCA AGGAGAAACT CTGYTATGTT
Subulona sp.               TTCACCACAA CGGCCGAGAG AGAAATTGTT CGAGACATCA AGGAGAAACT CTGCTACGTC
Tortaxis erectus           TTCACYACYA CAGCYGAGAG AGAAATTGTT CGAGAYATCA AGGAGAAGCT KTSCTAYGTK
Xerocerastus sp.           TTCACCACCA CCGCTGAGAG AGAAATTGTT CGAGACATCA AGGAGAAGCT TTGCTATGTT
Zootecus insularis         TTCACCACCA CCGCTGAGAG AGAAATTGTT CGAGACATCA AGGARAAGCT TTSCTATGTT
Coeliaxis blandii          TTCACCACCA CTGCTGAGAG AGAAATYGTT MGAGACATCA ARGAGAAGCT TTSCTATGTT
Pyrgina umbilicata         TTYACTACCA CAGCYGAGAG AGAAATTGTT MGWGACATCA ARGAGAARCT KTGYTAYGTK
Glessula ceylanica         TTCACYACMA CAGCCGAGAG GRAAATYGTK CGAGACATGA AAGAGAAGCT TGCGTATGTT
Cecilioides gokweanus      TTCACCACCA CAGCCGAGAG GGAAATTGTC CGAGACATCA AGGAGAAGCT TTCATACGTT
Ferussacia folliculus      TTCACCACCA CTGCTGAGAG AGAAATTGTS AGGGAYATCA AGGAGAAGCT CTGTTATGTT
Thyrophorella thomensis    TTYACTACCA CAGCYGAGAG AGAAATTGTT MGRGAYATCA ARGAGAARCT NTSYTACGTK
Gibbulinella dewinteri     TTCACCACCA CTGCTGAGAG AGAGATTGTA CGAGACATCA AGGAGAAGCT CTGCTACGTT
Gonaxis quadrilateralis    TTCACCACCA CTGCTGAGAG AGAAATTGTA MGAGACATCA AGGAGAARCT CTGCTACGTT
Gonospira sp.              TTCACCACCA CTGCWGAGAG AGAGATYGTA CGAGACATMA ARGARAAGCT MTGYTATGTT
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                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                  490        500        510        520        530        540
Achatina achatina          GCYCTTGACT TTGAGCAAGA GATGTCRACA GCTTCCACAT CATCTTCATT AGAGAAGAGY
Achatina fulica            GCCCTTGACT TTGAGCAAGA RATGGCAACA GCTTCCACAT CATCTTCATT AGAGAAGAGT
Achatina stuhlmanni        GCCCTTGACT TTGAGCAAGA GATGGCAACA GCTGCCACAT CATCTTYATT AGAGAAGAGT
Cochlitoma ustulata        GCCCTTGACT TTGAGCAAGA GATGGCAACA GCTTCCACAT CATCTTCATT AGAGAAGAGT
Allopeas clavulinum        GCCCTAGATT TTGAGCAGGA GATGGGAACA GCTGCTACAT CGTCATCTTT GGAGAAGAGC
Bocageia sp.               GCTCTTGACT TTGAACAGGA AATGSACACA GCTGCCWCAT CATCTTCYCT RGAGAAGAGC
Eutomopeas layardi         GCTCTGGACT TTGAGCAGGA GATGGGAACA GCTGCTACAT CATCATCGTT GGAAAAGAGC
Leptinaria lamellata       GCTCTTGATT TTGAGCAGGA GATGGGTACA GCTGCAACGT CATCATCATT AGAGAAGAGC
Paropeas achatinaceum      GCCCTAGATT TCGAACAGGA GATGGGAACA GCTGCCACAT CATCATCTTT GGAGAAGAGC
Riebeckia sp.              GCTCTYGACT TTGAGCAAGA AAWGGSTACG GCTGCCACAT CWTCCTCAYT AGAGAAGAGT
Rumina decollata           GCTCTTGACT TTGAACAAGA AATGGCAACA GCTGCCACTT CATCTTCWCT GGAGAAAAGT
Subulina octona            GCCCTTGACT TTGAACAAGA AATGGGTACA GCTGCCACAT CGTCATCTTT AGAGAAGAGC
Subulina striatella        GCCCTTGACT TCGAACAAGA AATGGGTACA GCTGCCACAT CCTCATCTTT GGAGAAGAGT
Subulina vitrea            GCYCTTGACT TCGARCARGA AATGTCTACA GCTGCCACRT CWTCTTCACT RGAGAAGAGT
Subulona sp.               GCACTTGACT TTGAGCAGGA GATGCAGACA GCTGCTACAT CATCATCTTT GGAGAAAAGC
Tortaxis erectus           GCTCTAGACT TTGAGCAGGA GATGGCAACA GCTGCCACTT CATCTWCTCT AGAGAAAAGT
Xerocerastus sp.           GCTCTTGACT TTGAACAAGA AATGGCAACA GCTGCCACTT CATCTTCACT AGAGAAGAGT
Zootecus insularis         GCTCTTGAYT TTGAACAAGA AATGGCAACA GCTGCCACAT CATCTTCACT AGAGAAGAGT
Coeliaxis blandii          GCTCTTGACT TTGAGCAAGA AATGGCTACA GCTGCYACAT CATCCTCATT AGAGAAGAGT
Pyrgina umbilicata         GCTCTRGACT TTGARCAAGA RATGGCRACA GCWGCYWCTT CATCYWCYCT NGAGAAGAGC
Glessula ceylanica         GCTCTGGACT TTGAMCARGA GATGCAGWTA TCATCCAGYK CTTCAWCAAT TGAARAAAGT
Cecilioides gokweanus      GCWCTAGACT TTGAGCAAGA AATGGCAACA GCTGCAACTT CATCTTCACT RGAGAAGAGC
Ferussacia folliculus      GCTCTGGATT TTGAACAGGA GATGGCTACA GCTGCAACTT CCTCCTCCCT GGAGAAGAGC
Thyrophorella thomensis    GCTCTRGACT TTGAGCAAGA AATGGCAACA GCTGCYACTT CATCYTCYCT GGAGAAGAGY
Gibbulinella dewinteri     GCTCTGGACT TTGAGCAGGA GATGGCAACA GCTGCTACAT CATCATCACT TGAGAAGAGC
Gonaxis quadrilateralis    GCTCTGGACT TTGAGCARGA GATGGCMACA GCTGCTACAT CATCMTCCCT TGAGAAGAGY
Gonospira sp.              GCTCTGGACT TTGAACARGA GATGGSWACW GCWGCWWCAT CATCWTCCCT TGAGAAGAGC


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                                  550        560        570        580        590        600
Achatina achatina          TATGAATTGC CTGATGGACA RGTCATYACT ATTGGTAAYG AGCGYTTCAG RTGYCCAGAA
Achatina fulica            TATGAATTRC CTGATGGACA GGTCATCACC ATTGGTAAYG AGCGTTTCAG ATGTCCAGAA
Achatina stuhlmanni        TATGAATTGC CTGATGGACA GGTCATCACT ATTGGTAACG AGCGATTTAG GTGCCCAGAA
Cochlitoma ustulata        TATGAATTAC CTGATGGACA GGTCATAACT ATTGGTAATG AGCGCTTCAG GTGCCCAGAA
Allopeas clavulinum        TACGAACTTC CAGATGGACA GGTCATCACG ATTGGCAACG AGCGCTTTAG ATGCCCTGAG
Bocageia sp.               TAYGAACTTC CTGATGGACA GGTCATCACC ATTGGCAATG ARCGWTTCAG ATGTCCWGAR
Eutomopeas layardi         TACGAGCTTC CAGATGGACA GGTCATCACA ATCGGCAATG AGCGCTTTAG ATGCCCCGAG
Leptinaria lamellata       TATGAGCTGC CTGATGGGCA AGTCATTACC ATTGGAAATG AGCGCTTCAG ATGCCCCGAG
Paropeas achatinaceum      TACGAACTTC CAGATGGACA AGTTATCACA ATTGGCAATG AGCGCTTTAG ATGCCCCGAA
Riebeckia sp.              TAYGAATTGC CTGATGGACA AGTCATCACC ATTGGYAAYG ARCGKTTCMG GWGYCCAGAA
Rumina decollata           TATGAATTGC CTGAYGGACA GGTCATCACC ATCGGCAAYG AGCGTTTCAG ATGTCCAGAA
Subulina octona            TACGAACTTC CAGATGGGCA AGTGATTACC ATTGGCAATG AACGTTTCAG ATGCCCTGAG
Subulina striatella        TACGAACTTC CAGATGGGCA AGTTATTACC ATTGGCAATG AACGTTTYAG ATGCCCTGAG
Subulina vitrea            TACGAGYTGC CTGATGGACA GGTCATCACT ATTGGCAAYG AGCGTTTCAG ATGYCCWGAA
Subulona sp.               TACGAACTGC CAGATGGGCA AGTCATTACT ATTGGTAACG AGCGATTTAG ATGTCCCGAA
Tortaxis erectus           TATGAACTRC CTGATGGACA GGTCATCACY ATTGGCAAYG AAAGATTCAG RTGNCCAGAA
Xerocerastus sp.           TACGAACTGC CTGATGGACA GGTCATCACC ATTGGCAATG AGCGCTTCAG GTGCCCAGAA
Zootecus insularis         TATGAATTGC CTGAYGGACA GGTCATCACC ATTGGCAATG AGCGTTTCAG RTGTCCAGAA
Coeliaxis blandii          TATGAATTGC CTGATGGACA AGTCATCACY ATCGGTAAYG AGCGTTTCAG ATGCCCWGAA
Pyrgina umbilicata         TACGARYTKC CWGATGGACA GGTCATCACN ATTGGNAAYG AGCGYTTCAG RTGTCCWGAR
Glessula ceylanica         TACGARCTKC CGGATGGAMA SRTMATYACM ATWGGAAACG AGCGATTCAG RTGTCCCGAA
Cecilioides gokweanus      TACGAACTTC CCGATGGTCA AGTCATCACC ATTGGCAACG AGCGTTTCAG ATGTCCAGAA
Ferussacia folliculus      TACGAACTGC CTGACGGACA GGTCATCACT ATTGGCAACG AGCGATTCAG RGCTCCGGAA
Thyrophorella thomensis    TACGARYTNC CWGATGGACA GGTYATCACN ATTGGWAAYG AGCGTTTCAG ATGTCCAGAA
Gibbulinella dewinteri     TAYGAACTTC CAGACGGACA GGTCATCACC ATTGGCAATG ARCGATTCAG GTGCCCAGAA
Gonaxis quadrilateralis    TATGAACTRC CWGAYGGACA GGTCATYACY ATTGGMAACG ARCGWTTYAG RTGCCCAGAA
Gonospira sp.              TATGAAYTAC CTGAYGGACA GGTCATYACC ATTGGCAAYG ARMGWTTYAG GWSWCCTGAA
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                                  610        620        630        640        650        660
Achatina achatina          GCCATGTTCC AGCCATCTTT CCTTGGTATG GARWCTGCAG GTATTCATGA AACCACCTAC
Achatina fulica            GCCATGTTCC AGCCWTCTTT CCTTGGTATG GARWCCGCAG GTATTCATGA RACCACYTAC
Achatina stuhlmanni        GCAGAATTCC AGCCATCTTT CCTTGGTATG GAGTCTGCAG GTATTCACGA GACCACCTAC
Cochlitoma ustulata        GCAGAATTCC AGCCATCTTT CCTTGGTATG GAGTCTGCAG GTATTCATGA GACCACCTAC
Allopeas clavulinum        GCAATGTTCC AGCCATCCTT CCTTGGTATG GAGTCTGCTG GTACCCATGA AACAACGTAC
Bocageia sp.               GCAATGTTYC AGCCATCTTT CCTKGGAATG GAGTCTGCWG GTATTCATGA GACYAYCTAC
Eutomopeas layardi         GCAATGTTCC AGCCATCCTT CCTTGGTATG GAGTCTGCTG GTACCCATGA AACAACGTAC
Leptinaria lamellata       GCAATGTTCC AACCATCTTT TCTTGGCATG GAATCTGCTG GCACACATGA AACAACATAC
Paropeas achatinaceum      GCAATGTTCC AGCCATCATT CCTTGGTATG GAGTCTGCAG GTACCCATGA AACAACATAC
Riebeckia sp.              GCAATGTTCC AGCCATCCTT YCTTGGYATG GAGTCTGCTG GTATTCAYGA RACCACYTAC
Rumina decollata           GCAATGTTCC AGCCATCTTT CCTTGGTATG GAGTCTGCTG GTATTCATGA GACCACCTAC
Subulina octona            GCAATGTTTC AGCCATCTTT TCTGGGCATG GAATCTGCAG GTACTCATGA AACAACGTAC
Subulina striatella        GCAATGTTYC AGCCATCTTT TCTGGGCATG GAATCTGCAG GTACTCACGA AACAACATAC
Subulina vitrea            GCAATGTTCC AGCCATCTTT CCTTGGTATG GARTCWGCTG GTAYTCACGA GACCACYTAC
Subulona sp.               GCTGAGTTCC AACCATCTTT CTTGGGTATG GAGTCAGCTG GCATTCACGA AACTACCTAT
Tortaxis erectus           GCWATGTTNC ARCCATCTTT TCTTGGTATG GAATCTGCTG GWATCCATGA GACCACATAC
Xerocerastus sp.           GCAGAATTCC AACCATCCTT CCTTGGTATG GAGTCTGCTG GTATTCATGA GACCACCTAC
Zootecus insularis         GCAATGTTCC AGCCATCTTT CCTTGGTATG GAGTCTGCTG GTATYCATGA GACCACCTAC
Coeliaxis blandii          GCAATGTTCC AGCCATCCTT CCTTGGWATG GAATCTGCTG GTATTCACGA GACCACCTAC
Pyrgina umbilicata         GCAATRTTCC ARCCATCWTT CCTTGGYATG GARTCTGCYG GTATTCATGA AACCACCTAC
Glessula ceylanica         GCTTTGTTCC AGCCATCTTT TCTAGGTMTA GAGATCRSTG GTATTCACGA AACCACTTAC
Cecilioides gokweanus      GCAATGTTCC AGCCATCCTT CCTTGGTATG GAGTCTGCTG GTATTCACGA GACCACATAC
Ferussacia folliculus      GCAGAATTTC AGCCATCTTT CCTTGGCATG GAATCTGCCG GTATTCACGA AACAACCTAC
Thyrophorella thomensis    GCAATRTTCC ARCCATCNTT CCTTGGTATG GAGTCWGCTG GTATTCATGA AACCACCTAC
Gibbulinella dewinteri     GCAATGTTCC AACCATCTTT CCTTGGTATG GAGTCTGCTG GTATCCACGA GACCACGTAC
Gonaxis quadrilateralis    GCAATGTTYC AGCCATCWTT CYTTGGTATG GARTCTGCYG GYRTCCAYGA GACMACATAC
Gonospira sp.              GCAATGTTYC AGCCATCYTT CYTSGGYATG GAGTCTGCTG GTRTYCAYGA GACCACATAC


                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                  670        680        690        700        710        720
Achatina achatina          AACTCCATCA TGAAGTGTGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTA
Achatina fulica            AACTCCATCA TGAAGTGTGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Achatina stuhlmanni        AACTCCATCA TGAAGTGCGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTACTT
Cochlitoma ustulata        AACTCCATCA TGAAGTGCGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Allopeas clavulinum        AATTCCATCA TGAAGTGCGA TGTTGACATC AGAAAAGACC TCTATGCCAA CACTGTTCTG
Bocageia sp.               AAYTCYATCA TGAAGTGTGA TGTYGAYATC CGTAAAGAYY TGTAYGCCAA YAYTGTACTG
Eutomopeas layardi         AATTCCATCA TGAAATGCGA TGTTGATATC AGAAAAGACC TCTATGCCAA CACTGTTCTG
Leptinaria lamellata       AATTCAATTA TGAAGTGTGA TGTTGATATC AGAAAAGACC TCTATGCCAA CACTGTACTA
Paropeas achatinaceum      AATTCCATTA TGAAGTGCGA TGTTGATATC AGAAAAGACC TTTATGCTAA CACTGTATTG
Riebeckia sp.              AAYTCCWTYA TGAARTGTGA YGTYGACATY CGTAAAGACT TGTATGCCAA CWCCGTCTTG
Rumina decollata           AATTCCATCA TGAARTGTGA TGTYGACATC CGTAAAGACT TGTATGCCAA CACTGTCTTG
Subulina octona            AATTCAATCA TGAAGTGTGA CGTTGATATC CGAAAAGACC TTTATGCTAA CACTGTACTG
Subulina striatella        AATTCAATCA TGAAATGTGA CGTCGATATC CGAAAAGACC TATATGCTAA CACTGTACTG
Subulina vitrea            AACTCCATCA TGAAGTGTGA TGTYGACATC CGTAAAGACT TGTATGCCAA CACTGTAYTG
Subulona sp.               AACTCCATCA TGAAGTGTGA TGTTGACATC AGAAAAGACC TTTACGCCAA TACTGTGTTG
Tortaxis erectus           AACTCCATCA TGAARTGTGA TGTTGACATC CGTAAAGACT TGTATGCAAA YACAGTTCTG
Xerocerastus sp.           AACTCCATCA TGAAGTGTGA TGTTGACATT CGTAAAGACT TGTATGCCAA CACTGTGTTG
Zootecus insularis         AACTCCATCA TGAARTGCGA TGTTGACATY CGTAAAGACY TGTATGCCAA CACTGTATTG
Coeliaxis blandii          AACTCCATCA TGAAGTGTGA CGTAGACATY CGTAAAGACT TGTACKCCAA CAYCGTATTG
Pyrgina umbilicata         AACTCCATCA TGAAATGYGA YGTYGACATY CGTAAAGAYT TGTATGCCAA CACTGTATTG
Glessula ceylanica         AACTCCATMA TSAAATGTGA CGTCGACATC CGTAAAGACC TGTAYGCMAA CACWGTCYTR
Cecilioides gokweanus      AACTCCATCA TGAAGTGCGA CGTTGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Ferussacia folliculus      AACTCCATCA TGAAGTGTGA CGTCGACATC CGTAAAGACT TGTACGCCAA CACTGTCCTC
Thyrophorella thomensis    AAYTCYATCA TGAAATGCGA CGTYGAYATY CGWAAAGACY TGTATGCCAA CACTGTATTG
Gibbulinella dewinteri     AACTCCATCA TGAAGTGCGA CGTTGACATC CGTAAAGACT TGTACGCCAA CACCGTGCTG
Gonaxis quadrilateralis    AACTCCATCA TGAARTGCGA YGTTGATATC CGTAAAGAYT TGTACKCCAA CACYGTNTTG
Gonospira sp.              AACTCCATCA TGAARTGTGA TGTRGAYATC CGMAAAGACT TGTATTCCAA CACTGTTCTG
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                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   730        740        750        760        770        780
Achatina achatina          TCTGGTGGAW CTACCATGTA TCCTGGCATT GCTGACCGCA TGCAGAAGGA AATCACNAAY
Achatina fulica            TCTGGTGGAW CTACCATGTA TCCAGGCATT GCTGACCGCA TGCAGAAGGA AATYGYCAAC
Achatina stuhlmanni        TCTGGTGGCT CCACAATGTT TCCAGGCATC GCTGACCGCA TGCAGAAGGA AATCACCAGC
Cochlitoma ustulata        TCTGGTGGCT CCACAATGTT CCCTGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAGC
Allopeas clavulinum        TCTGGTGGTT CCACAATGTT CCCTGGCATT GCTGACCGCA TGCAGAAAGA GATAACCGCT
Bocageia sp.               TCTGGMGGTT CYACAATGTT YCCTGGMATY GCTGACCGCA TGCAGAARGA AATSACCTCW
Eutomopeas layardi         TCTGGTGGTT CCACAATGTT CCCTGGCATC GCTGACCGCA TGCAGAAAGA GATAACCGCG
Leptinaria lamellata       TCTGGTGGTT CCACTATGTT CCCTGGCATT GCTGATCGTA TGCAGAAAGA AATCACTGCT
Paropeas achatinaceum      TCTGGTGGGT CCACAATGTT CCCAGGCATA GCTGACCGCA TGCAGAAAGA GATAACTGCT
Riebeckia sp.              TCYGGWGGST CCACCATGTT CCCTGGSATC GCTGACCGCA TGCAGAAGGA AATCACYKCT
Rumina decollata           TCTGGTGGNT CAACAATGTT CCCAGGCATC GCTGACCGCA TGCAGAAAGA AATCACCAMT
Subulina octona            TCTGGCGGTT CTACAATGTT CCCTGGCATT GCCGATCGCA TGCAAAAGGA AATCACGGCT
Subulina striatella        TCTGGCGGTT CWACAATGTT CCCTGGCATT GCCGACCGCA TGCAGAAGGA AATCACAGCT
Subulina vitrea            TCTGGTGGTT CYACAATGTT YCCTGGCATY GCCGACCGCA TGCARAAGGA AATYRTCAAT
Subulona sp.               TCTGGAGGGT CCACGATGTT CCCAGGCATC GCTGACCGAA TGCAGAAGGA AATTACTTCT
Tortaxis erectus           TCTGGWGGTT CTACCATGTW CCCTGGARTT GCTGAYCGCA TGCAGAAGGA AATCACAGMT
Xerocerastus sp.           TCTGGTGGCT CAACAATGTT CCCAGGCATC GCTGACCGCA TGCAGAAAGA AATCACCAGC
Zootecus insularis         TCTGGTGGTT CAACAATGTT CCCTGGCATT GCTGACCGCA TGCAGAAAGA AATCACCAAT
Coeliaxis blandii          TCTGGTGGTW CCWCAATGTT CCCYGGTATY GCTGACCGCA TGCAGARGGA AATCGTGAAC
Pyrgina umbilicata         TCTGGWGGTT CCACAATGTT CCCTGGAATC GCTGACCGCA TGCAGAAAGA AATCACTKCY
Glessula ceylanica         TCTGGAGGAT CCACAATGTW TCCTGGAATT GCTGACCGCA TGCAGAAGGA AATCACMGCS
Cecilioides gokweanus      TCTGGTGGCT CCACCATGTT CCCCGGCATC GCTGACCGCA TGCAGAAAGA AATTACCTGC
Ferussacia folliculus      TCTGGAGGTT CAACAATGTT CCCTGGCATC GCTGACCGCA TGCAGAAAGA GATCACGTCT
Thyrophorella thomensis    TCTGGWGGTT CCACAATGTW CCCTGGAATC GCTGACCGCA TGCAGAAAGA AATCACTKCT
Gibbulinella dewinteri     TCTGGTGGGT CTACCATGTA CCCAGGCATC GCCGACCGTA TGCAGAAAGA AATTACTTCC
Gonaxis quadrilateralis    TCTGGTGGTT CCACCATGTA YCCCGGCATT GCTGACCGCA TGCAGAAGGA AATYACYTCC
Gonospira sp.              TCTGGAGGTT CTACMATGTT CCCWGGSATT GCWGAYCGCA TGCAAAARGA AATYACKKSY


                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   790        800        810        820        830        840
Achatina achatina          CTGGCTCCAS CCACAATGAA GATCAAGATC ATTGCTCCAC CAGAACGTAA ATACTCTGTC
Achatina fulica            CTGGCTCCTT CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA ATACTCTGTC
Achatina stuhlmanni        CTGGCTCCTG CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAACGTAA ATACTCTGTC
Cochlitoma ustulata        CTGGCTCCTG CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA ATACTCTGTC
Allopeas clavulinum        TTGGCTCCAC CAACAATGAA GATCAAGATC ATTGCCCCAC CAGAAAGGAA GTACTCAGTC
Bocageia sp.               CTTGCTCCAY CCACAATGAA GATCAAGATC ATTGCTCCTC CYGAGMGGAA ATACTCAGTC
Eutomopeas layardi         TTGGCTCCAC CAACGATGAA GATCAAGATC ATCGCTCCAC CAGAGAGGAA GTACTCGGTC
Leptinaria lamellata       CTCGCACCAC CAACAATGAA AATCAAAATC ATCGCTCCAC CTGAGAGAAA GTACTCCGTA
Paropeas achatinaceum      TTGGCTCCAC CAACAATGAA AATCAAGATC ATTGCCCCAC CAGAGAGAAA GTACTCAGTC
Riebeckia sp.              CTKGCTCCAM CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAAMGCAA ATACTCWGTC
Rumina decollata           CTGGCTCCAC CCACAATGAA GATCAAAATC ATTGCTCCTC CTGAGAGAAA ATACTCTGTC
Subulina octona            CTAGCTCCAC CCACAATGAA AATCAAGATA ATTGCGCCAC CTGAAAGGAA ATATTCAGTC
Subulina striatella        CTAGCTCCAC CCACAATGAA AATMAAAATA ATTGCACCAC CTGAACGGAA ATATTCGGTT
Subulina vitrea            CTTGCTCCAC CMACAATGAA GATCAAAATC ATCGCACCCC CAGAACGYAA ATACTCTGTG
Subulona sp.               CTTGCTCCAG CAACAATGAA GATCAAGATA ATAGCTCCCC CTGAGAGGAA GTACTCTGTT
Tortaxis erectus           TTRGCTCCAC CCACAATGAA GATCAAGATC ATAGCTCCTC CTGAACGCAA GTACTCTGTC
Xerocerastus sp.           CTGGCTCCAG CCACAATGAA GATCAAGATC ATTGCTCCTC CTGAGAGGAA ATACTCTGTC
Zootecus insularis         CTGGCYCCAC CCACGATGAA RATYAAAATC ATTGCTCCTC CTGAGAGAAA ATACTCTGTC
Coeliaxis blandii          CTTGCTCCAC CCACAATGAA GATCAAAATC ATTGCTCCCC CTGAACGTAA ATACTCAGTC
Pyrgina umbilicata         CTTGCTCCAA CAACRATGAA GATCAAGATC ATYGCTCCAC CWGARAGRAA GTACTCAGTC
Glessula ceylanica         CTGGCWCCAA SCACCATGAA AATCAAGATC ATTGCTCCCC CAGARCGGAA GTACTCTGTC
Cecilioides gokweanus      TTGGCTCCAC CCACAATGAA GATCAAGATC ATCGCTCCCC CAGAGAGGAA ATACTCAGTC
Ferussacia folliculus      TTAGCCCCTG CCACCATGAA AATCAAGATC ATCGCTCCAC CAGAACGTAA ATACTCCGTG
Thyrophorella thomensis    CTTGCTCCAG CAACAATGAA GATCAAGATC WTYGCTCCWC CTGAARRRAA GTACTCAGTC
Gibbulinella dewinteri     CTCGCTCCAC CCACAATGAA GATCAAGATC ATTGCTCCCC CCGAGCGTAA ATACTCTGTA
Gonaxis quadrilateralis    CTKGCTCCAM STACAATGAA GATCAAGATY ATTGCTCCYC CWGAGCGNAA ATACTCTGTA
Gonospira sp.              YTKGCTCCAC CCACTATGAA RATCAAGATC ATTGCTCCCC CWGAGCGWAA GTAYTCTGTC
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                           ....|....| ....|....| .
                                   850        860
Achatina achatina          TGGATTGGAG GTTCCATTCT G
Achatina fulica            TGGATTGGAG GATCCATCCT G
Achatina stuhlmanni        TGGATTGGAG GATCCATCCT G
Cochlitoma ustulata        TGGATTGGAG GATCCATCCT G
Allopeas clavulinum        TGGATTGGTG GCTCCATCTT G
Bocageia sp.               TGGATTGGAG GCTCCATCTT G
Eutomopeas layardi         TGGATCGGTG GCTCCATCTT G
Leptinaria lamellata       TGGATTGGTG GTTCAATCTT A
Paropeas achatinaceum      TGGATCGGTG GCTCCATCTT G
Riebeckia sp.              TGGATTGGAG GCTCCATCCT G
Rumina decollata           TGGATTGGAG GTTCCATCCT G
Subulina octona            TGGATTGGAG GCTCCATTTT G
Subulina striatella        TGGATTGGAG GCTCTATTTT G
Subulina vitrea            TGGATTGGAG GTTCCATCCT G
Subulona sp.               TGGATTGGTG GCTCCATCTT G
Tortaxis erectus           TGGATTGGAG GTTCCATCCT G
Xerocerastus sp.           TGGATTGGAG GTTCCATCCT G
Zootecus insularis         TGGATTGGAG GTTCCATCCT G
Coeliaxis blandii          TGGATTGGAG GTTCCATCCT G
Pyrgina umbilicata         TGGATCGGAG GTCCCATYTT G
Glessula ceylanica         TGGATTGGAG GTTCCATCCT G
Cecilioides gokweanus      TGGATCGGAG GCTCAATCCT G
Ferussacia folliculus      TGGATTGGTG GCTCCATCCT G
Thyrophorella thomensis    TGGATCGGAG GTTCCATCTT G
Gibbulinella dewinteri     TGGATCGGAG GCTCCATCTT G
Gonaxis quadrilateralis    TGGATCGGAG GCTCCATCTT G
Gonospira sp.              TGGATCGGAG GTTCCATTTT G
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Appendix 3.3: Alignment of the histone 3 gene for the Achatinoidea and three streptaxid outgroup taxa. Note that sequencing was usuccessful for the achatinoids *Cecilioides gokweanus*, *Paropeas achatinaceum*, *Riebeckia* sp. and *Subulina vitrea* and the streptaxids *Gonaxis quadrilateralis* and *Gonospira* sp.

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                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   10         20         30         40         50         60
Achatina achatina          TCGTAAATCC ACCGGAGGCA AGGCTCCCCG CAAGCARCTG GCCACCAAGG CKGCCAGRAA
Achatina fulica            TCGTAAATCC ACCGGAGGTA AGGCTCCCCG CAAACAGCTT GCCACCAAGG CGGCTAGAAA
Achatina stuhlmanni        TCGCAAATCC ACCGGAGGTA AGGCTCCTCG CAAACAGCTT GCCACCAAGG CGGCTAGAAA
Cochlitoma ustulata        TCGCAAATCC ACCGGAGGTA AGGCTCCCCG CAAACAGCTT GCCACCAAGG CGGCTAGGAA
Allopeas clavulinum        TCGTAAATCY ACCGGAGGCA ARGCTCCCCG CAARCARCTG GCCACCAARG CNGCCAGGAA
Bocageia sp.               TCGCAAGTCC ACCGGTGGTA AAGCACCCCG CAAACAGCTT GCCACAAAGG CCGCTAGAAA
Eutomopeas layardi         TCGCAAATCT ACCGGAGGCA AAGCACCCCG CAAGCAGCTT GCCACCAAGG CGGCTAGGAA
Leptinaria lamellata       CCGAAAATCT ACTGGTGGTA AAGCACCCCG CAAGCAACTT GCCACCAAGG CTGCTAGAAA
Rumina decollata           TCGCAAATCC ACAGGAGGAA AAGCTCCCCG CAAACAGCTT GCCACTAAGG CGGCTAGAAA
Subulina octona            CCGTAAATCA ACTGGAGGAA AGGCACCACG CAAACAACTG GCCACTAAGG CAGCCAGAAA
Subulina striatella        CCGTAAATCA ACTGGAGGCA AGGCCCCGCG CAAACAGCTG GCCACTAAGG CGGCCAGAAA
Subulona sp.               GCGAAAGTCT ACCGGTGGCA AAGCTCCCCG CAAGCAGCTA GCCACCAAGG CGGCTAGAAA
Tortaxis erectus           CCGCAAATCT ACCGGAGGAA AGGCCCCTCG TAAACAGCTT GCCACCAAGG CTGCTAGAAA
Xerocerastus sp.           TCGYAAATCY ACCGGAGGYA ARGCTCCCCG CAARCARCTK GCCACCAARG CRGCYAGRAA
Zootecus insularis         CCGCAAGTCC ACCGGAGGCA AGGCTCCACG TAAACAGCTT GCCACCAAGG CGGCTAGAAA
Coeliaxis blandii          TCGYAAATYY ACCGGAGGCA AGGCTCCYCG CAARCARCTK GCCACCAARG CGGCYAGRAA
Pyrgina umbilicata         TCGTAAATCT ACCGGAGGCA AAGCACCCCG AAAGCAGCTT GCCACCAARG CGGCTAGGAA
Glessula ceylanica         CAGGAAATCA ACCGGAGGCA AGGCTCCGCG TAAACAGCTT GCCACCAAAG CTGCCAGAAA
Ferussacia folliculus      TCGTAAGTCT ACTGGTGGTA AGGCGCCACG CAAACAGTTG GCCACCAAAG CAGCCAGGAA
Thyrophorella thomensis    TCGTAAATCT ACCGGAGGCA AAGCACCCCG AAAGCAGCTT GCCACAAAGG CGGCTAGGAA
Gibbulinella dewinteri     ACGTAAATCC ACCGGAGGCA AGGCTCCACG AAAGCAGCTG GCCACCAAGG CAGCAAGGAA


                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   70         80         90        100        110        120
Achatina achatina          RTCGGCCCCR GCCACMGGRG GTGTSAAGAA RCCCCATCGW TACAGGCCCG GCACNGTSGC
Achatina fulica            GTCGGCCCCG GCCACAGGAG GTGTCAAGAA ACCCCACAGA TACAGGCCCG GCACAGTCGC
Achatina stuhlmanni        GTCGGCCCCA GCCACAGGAG GTGTGAAGAA GCCCCACAGA TACAGGCCCG GCACAGTCGC
Cochlitoma ustulata        GTCGGCCCCA GCCACAGGAG GTGTGAAGAA ACCCCACAGA TACAGGCCCG GCACAGTCGC
Allopeas clavulinum        GTCGGCCCCR GCCACCGGWG GTGTSAAGAA ACCCCATCGT TACAGGCCCG GCACCGTGGC
Bocageia sp.               ATCGGCCCCA GCCACAGGAG GTGTGAAGAA ACCTCACCGA TACAGGCCCG GTACAGTGGC
Eutomopeas layardi         GTCGGCCCCA GCTACCGGAG GTGTCAAGAA ACCTCACAGA TACAGGCCCG GCACAGTCGC
Leptinaria lamellata       GTCAGCCCCG GCTACTGGGG GTGTGAAGAA GCCCCACAGA TACAGGCCCG GCACTGTCGC
Rumina decollata           GTCGGCCCCG GCCACAGGAG GCGTGAAGAA ACCCCAYCGA TACAGGCCTG GCACGGTCGC
Subulina octona            GTCTGCCCCA GCTACAGGAG GTGTCAAGAA RCCGCATCGT TACAGGCCCG GCACTGTCGC
Subulina striatella        GTCCGCCCCG GCCACAGGGG GTGTCAAGAA GCCCCATCGT TACAGGCCCG GCACTGTCGC
Subulona sp.               GTCGGCCCCA GCGACTGGAG GTGTGAAGAA ACCCCACAGA TACAGGCCAG GCACCGTGGC
Tortaxis erectus           GTCGGCTCCG GCCACAGGAG GTGTGAAGAA GCCCCACAGG TACAGGCCCG GTACAGTCGC
Xerocerastus sp.           RTCKGCCCCR GCCACCGGWG GTGTSAAGAA ACCCCAYCGW TACAGGCCCG GCACCGTSGC
Zootecus insularis         GTCGGCCCCG GCCACAGGAG GTGTGAAGAA ACCCCACCGA TACAGACCTG GCACGGTCGC
Coeliaxis blandii          GTCKGCCCCR GCCACCGGWG GTGTSAAGAA RCCYCAYMGA TACMGGCCSG GCACNGTSGC
Pyrgina umbilicata         ATCCGCCCCA GCCACCGGAG GTGTCAAGAA ACCTCACAGA TACAGGCCCG GCACTGTCGC
Glessula ceylanica         GTCGGCCCCG GCCACAGGAG GCGTGAAGAA ACCTCACAGR TACAGGCCCG GGACAGTCGC
Ferussacia folliculus      GTCCGCCCCA GCCACTGGTG GTGTGAAGAA ACCTCACCGT TACAGGCCTG GTACAGTTGC
Thyrophorella thomensis    ATCCGCCCCA GCCACCGGAG GTGTCAAGAA ACCTCACAGA TACAGGCCCG GCACTGTCGC
Gibbulinella dewinteri     ATCTGCCCCA GCAACCGGTG GTGTGAAGAA GCCCCATCGC TACAGGCCAG GCACTGTCGC
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   130        140        150        160        170        180
Achatina achatina           TCTKCGAGAR ATCCGTCGTT ACCAGAAGAG CACKGAGCTC CTCATCCGCA AGCTGCCCTT
Achatina fulica             ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACTGAGCTT CTCATCCGCA AACTGCCCTT
Achatina stuhlmanni         ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACGGAGCTT CTCATCCGCA AACTGCCATT
Cochlitoma ustulata         ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACGGAGCTT CTCATTCGCA AACTGCCCTT
Allopeas clavulinum         TCTGCGAGAR ATCCGTCGTT ACCAGAAGAG CACTGAGCTS CTCATCCGCA AGCTGCCCTT
Bocageia sp.                ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACAGAGCTC CTCATCCGTA AACTGCCTTT
Eutomopeas layardi          ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACGGAGCTC CTCATCCGCA AGCTGCCCTT
Leptinaria lamellata        ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACGGAACTT CTCATCCGCA AGCTGCCCTT
Rumina decollata            GCTTCGAGAG ATCCGACGTT ACCAGAAGAG CACAGAGCTT CTCATCCGCA AGCTGCCCTT
Subulina octona             ACTTCGAGAG ATCCGCCGTT ATCAGAAGAG CACGGAGCTT CTCATCCGCA AGCTGCCCTT
Subulina striatella         ACTTCGAGAG ATCCGCCGTT ACCAGAAGAG CACGGAGCTC CTCATCCGCA AGCTGCCCTT
Subulona sp.                ACTCCGAGAG ATCCGCCGTT ACCAGAAGAG CACCGAGCTT CTCATCCGCA AACTGCCCTT
Tortaxis erectus            ACTCAGAGAG ATCCGCCGTT ACCAGAAGAG CACAGAGCTG CTCATCCGCA AATTGCCCTT
Xerocerastus sp.            TCTGCGAGAG ATCCGTCGTT ACCAGAAGAG CACTGAGCTK CTCATCCGCA AGCTGCCCTT
Zootecus insularis          ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACAGAGCTT CTCATCCGCA AACTGCCCTT
Coeliaxis blandii           TCTKCGAGAG ATCCGTCGTT ACCAGAAGAG CACKGAGCTN CTCATCCGCA ARCTGCCCTT
Pyrgina umbilicata          ACTCCGAGAG ATCCGTCGTT ACCARAAGAG CACGGAGCTM CTCATCCGCA AGCTGCCCTT
Glessula ceylanica          ACTTCGAGAG ATCCGCCGTT ACCAGAAGAG CACGGAGCTG CTCATCCGAA AACTGCCCTT
Ferussacia folliculus       ACTCCGTGAG ATCCGTCGTT ACCAGAAGAG CACAGAGCTG CTCATCCGCA AACTGCCCTT
Thyrophorella thomensis     ACTCCGAGAG ATCCGTCGTT ACCAGAAGAG CACGGAGCTT CTCATCCGCA AGCTGCCCTT
Gibbulinella dewinteri      TCTTCGTGAG ATTCGTCGTT ATCAGAAAAG CACGGAACTT CTCATCCGCA AACTGCCCTT


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   190        200        210        220        230        240
Achatina achatina           CCAGCGCCTG GTCAGAGAAA TCGCCCAGGA CTTCAAGACY GACCTGCGCT TCCAGAGCTC
Achatina fulica             CCAGCGGCTG GTCAGAGAGA TCGCCCAGGA CTTTAAGACC GATCTGCGTT TCCAGAGCTC
Achatina stuhlmanni         CCAGCGGCTG GTCAGAGAGA TCGCACAGGA CTTCAAGACC GATCTGCGTT TCCAGAGCTC
Cochlitoma ustulata         CCAGCGGCTG GTCAGAGAGA TCGCCCAGGA CTTCAAGACC GATCTGCGTT TCCAGAGCTC
Allopeas clavulinum         CCAGCGCCTG GTSMGAGAAA TYGCYCAGGA CTTCAAGACY GACCTGCGYT TCCAGAGCTC
Bocageia sp.                CCAGCGCCTG GTCAGAGAAA TCGCCCAGGA TTTCAAAACC GACCTGCGTT TCCAGAGCTC
Eutomopeas layardi          CCAGCGTCTG GTCAGAGAGA TCGCCCAGGA CTTTAAGACA GATCTGCGTT TCCAGAGCTC
Leptinaria lamellata        CCAGCGCCTG GTCAGAGAAA TCGCTCAGGA CTTTAAAACA GATCTGCGTT TCCAAAGTTC
Rumina decollata            CCAGCGCCTT GTCAGAGAGA TCGCGCAGGA TTTCAAGACT GACCTGCGTT TTCAGAGCTC
Subulina octona             CCAGCGCCTG GTCAGAGAAA TCGCCCAGGA TTTCAAGACG GACCTGCGCT TCCAGAGCTC
Subulina striatella         CCAGCGACTG GTCAGAGAAA TCGCCCAGGA TTTCAAGACC GACCTGCGCT TCCAGAGCTC
Subulona sp.                CCAGCGACTG GTGAGAGAAA TCGCCCAGGA CTTCAAGACC GATCTTCGAT TCCAGAGCTC
Tortaxis erectus            CCAGCGCCTT GTCAGGGAGA TCGCACAGGA CTTTAAGACT GACCTGCGTT TCCAGAGCTC
Xerocerastus sp.            CCAGCGCCTG GTSMGAGARA TYGCYCAGGA YTTCAAGACY GAYCTGCGYT TCCAGAGCTC
Zootecus insularis          CCAGCGCCTG GTCAGAGAGA TCGCGCAGGA TTTCAAGACT GATCTGCGCT TCCAGAGCTC
Coeliaxis blandii           CCARCGCCTG GTSMGAGAAA TCGCYCAGGA YTTCAAGACY GAYCTGCGYT TCCAGAGCTC
Pyrgina umbilicata          CCAGCGCCTG GTCAGAGAAA TCGCTCAGGA CTTCAAGACC GATCTGCGCT TCCAGAGCTC
Glessula ceylanica          CCAGCGCCTG GTCAGAGAGA TTGCCCAGGA CTTCAAGACC GACCTGCGTT TCCAGAGCTC
Ferussacia folliculus       CCAGCGACTG GTCAGAGAAA TCGCACAGGA CTTCAAGACT GACCTGCGCT TCCAAAGCTC
Thyrophorella thomensis     CCAGCGCCTG GTCAGAGAAA TCGCTCAGGA CTTCAAGACC GATCTGCGCT TCCAAAGCTC
Gibbulinella dewinteri      CCAACGCTTG GTAAGAGAAA TTGCACAGGA CTTCAAGACA GATCTGCGCT TCCAGAGCTC


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   250        260        270        280        290        300
Achatina achatina           GGCYGTCATG GCCCTGCAAG AGGCYAGCGA RGCCTACCTG GTGGGTCTGT TYGAGGACAC
Achatina fulica             GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Achatina stuhlmanni         GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Cochlitoma ustulata         GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Allopeas clavulinum         SGCTGTCATG GCYCTGCARG AGGCCAGCGA RGCCTACCTG GTSGGYCTST TTGAGGACAC
Bocageia sp.                GGCTGTCATG GCTCTGCAAG AGGCTAGCGA GGCCTACCTG GTCGGTCTGT TTGAGGACAC
Eutomopeas layardi          GGCTGTCATG GCACTGCAGG AAGCCAGCGA GGCCTACCTC GTAGGTCTGT TTGAAGACAC
Leptinaria lamellata        AGCTGTCATG GCTCTGCAGG AGGCTAGCGA GGCCTACCTT GTGGGTCTGT TCGAAGACAC
Rumina decollata            RGCYGTCATG GCACTGCAGG AGGCTAGCGA GGCMTACYTR GTGGGCCTGT TTGAGGACAC
Subulina octona             GGCTGTCATG GCGCTGCAGG AGGCCAGCGA GGCCTACCTC GTAGGTCTGT TTGAGGACAC
Subulina striatella         GGCTGTCATG GCGCTGCAGG AGGCCAGCGA GGCCTACCTG GTAGGTCTGT TTGAGGACAC
Subulona sp.                TGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCTTACCTG GTCGGCCTGT TCGAGGACAC
Tortaxis erectus            GGCCGTCATG GCTCTGCAGG AAGCAAGCGA GGCCTATCTG GTGGGTCTGT TCGAGGACAC
Xerocerastus sp.            SGCTGTCATG GCYCTGCARG AGGCYAGCGA RGCCTACCTG GTSGGYCTST TTGAGGACAC
Zootecus insularis          GGCTGTCATG GCACTGCAGG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Coeliaxis blandii           SGCTGTCATG GCYCTGCAAG AGGCYAGCGA RGCCTACCTG GTSGGTCTST TTGAGGACAC
Pyrgina umbilicata          GGCTGTCATG GCACTGCAGG AAGCCAGCGA GGCCTACCTC GTAGGTCTGT TTGAAGACAC
Glessula ceylanica          AGCTGTCATG GCACTGCAGG AAGCCAGCGA AGCCTAYTTG GTGGGTTTGT TCGAGGACAC
Ferussacia folliculus       SGCCGTCATG GCCCTGCAAG AGGCAAGYGA GGCCTACCTT GTGGGTCTGT TTGAAGACAC
Thyrophorella thomensis     GGCTGTCATG GCACTGCAGG AAGCCAGCGA GGCCTACCTC GTAGGTCTGT TTGAAGACAC
Gibbulinella dewinteri      RGCCGTCATG GCATTGCAGG AGGCCAGCGA GGCTTACCTC GTGGGTCTCT TTGAGGACAC
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                           ....|....| ....|....| ....|...
                                  310        320
Achatina achatina          YAACYTGTGC GCYATCCACG CCAARCGT
Achatina fulica            CAACCTGTGC GCCATCCACG CCAAACGT
Achatina stuhlmanni        CAACCTGTGC GCCATYCACG CCAAACGT
Cochlitoma ustulata        CAACCTGTGC GCCATCCACG CCAAACGT
Allopeas clavulinum        CAACYTGTGC GCCATCCAYG CCAAGCGT
Bocageia sp.               CAACCTGTGC GCCATCCATG CCAAGCGG
Eutomopeas layardi         CAATCTGTGC GCAATTCACG CCAAGCGT
Leptinaria lamellata       CAACCTGTGC GCCATCCATG CCAAACGT
Rumina decollata           CAACCTGTGC GCCATCCACG CCAAACGT
Subulina octona            CAACCTGTGC GCCATCCACG CCAAGCGT
Subulina striatella        CAACCTGTGC GCCATCCACG CCAAACGT
Subulona sp.               CAACCTCTGC GCCATCCATG CCAAGCGC
Tortaxis erectus           AAACCTGTGC GCCATCCACG CCAAGCGA
Xerocerastus sp.           CAACTTGTGC GCCATCCAYG CCAARCGT
Zootecus insularis         CAACCTGTGC GCCATCCACG CCAAACGT
Coeliaxis blandii          CAACYTGTGC GCYATCCAYG CYAAGCGY
Pyrgina umbilicata         CAACCTGTGC GCCATCCATG CCAAGCGT
Glessula ceylanica         CAACCTGTGC GCCATCCACG CCAAACGT
Ferussacia folliculus      CAACCTGTGT GCCATCCACG CCAAGCGT
Thyrophorella thomensis    TAACCTGTGC GCCATCCATG CCAAGCGT
Gibbulinella dewinteri     CAACCTGTGC GCTATCCACG CCAAGCGT
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Appendix 3.4: Alignment of the CO1 gene for the Achatinoidea and three streptaxid outgroup taxa. Note that sequencing was usuccessful for *Cecilioides gokweanus* as well as the streptaxids *Gonaxis quadrilateralis* and *Gonospira* sp.

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                                    10         20         30         40         50         60
Achatina achatina          AGGTACAGGC CTATCATTGT TAATTCGATT AGAATTAGGG ACAGCTGGGG TTTTAACCGA
Achatina fulica            TGGCACAGGC TTGTCACTCT TAATTCGGTT AGAGCTTGGA ACAGTGGGAA CCTTAACTGA
Achatina stuhlmanni        TGGTACCGGC TTGTCTTTAC TTATCCGGCT AGAACTAGGG AGTATTGGAA CACTGACTGA
Cochlitoma ustulata        GGGCACAGGT CTATCTTTAT TGATCCGACT AGAGCTAGGA ACGACCTCTA CTTTAACTGA
Coeliaxis blandii          TGGGACTGGG TTATCTTTAC TTATTCGTTT AGAATTAGGT ACTGTTGGAG TTTTAACTGA
Pyrgina umbilicata         CGGGACTGGT CTATCTTTAT TAATCCGTTT AGAACTCGGA ATAGGGGGCG TGTTAATTGA
Glessula ceylanica         CGGTACAGGA TTATCATTAT TAATTCGGTT AGAATTAGGA ACAACTGGTG TATTGACGGA
Ferussacia folliculus      TGGAACTGGC TTATCTTTGC TTATTCGTTT AGAATTAGGT ACATCGGGCG TCTTAACAGA
Thyrophorella thomensis    TGGAACAGGT TTGTCATTAC TGATCCGTCT GGAGTTAGGA ACAGCCGGTG TACTAGTTGA
Allopeas clavulinum        TGGGACAGGA TTATCTCTTC TCATTCGTTT TGAGTTAGGT ACTAGTGGGG TGTTAACCGA
Bocageia sp.               AGGTACCGGC TTATCCTTAT TAATTCGTCT GGAATTAGGA ACCTCTGGTG TTTTGACTGA
Eutomopeas layardi         GGGGACAGGT TTATCATTAC TAATCCGTTT AGAATTAGGA ACTAGCGGAG TTTTAACTGA
Leptinaria lamellata       AGGTACAGGT TTATCGTTAT TAATTCGTTT AGAATTAGGG ACAATGGAAG TGTTAACAGA
Paropeas achatinaceum      TGGGACTGGT TTATCTTTAC TAATTCGTCT TGAGTTAGGA ACTAGGGGAG TGTTAACCGA
Riebeckia sp.              TGGGACTGGT TTATCTTTAT TAATTCGATT AGAGTTAGGT ACTTCAGGTG TATTAACTGA
Rumina decollata           TGGTACTGGT TTATCTCTTC TTATTCGTTT AGAACTAGGT ACAGCAGGAG TGTTAACAGA
Subulina octona            TGGGACTGGT TTATCATTAT TAATTCGTTT AGAGCTTGGG ACGGCTGGAG TGTTAACTGA
Subulina striatella        TGGGACGGGT TTGTCATTAT TAATTCGACT TGAGTTAGGT ACTGCTGGTG TTTTAACGGA
Subulina vitrea            TGGTACAGGG CTTTCCCTTT TAATTCGTAT TGAGCTTGGA ACTGCTGGGG TTCTTACTGA
Subulona sp.               AGGGACAGGA TTATCTTTAT TAATTAGTTT AGAATTAGGG ACTGTAAGGG TATTAGTAGA
Tortaxis erectus           TGGGACAGGG TTGTCTTTAT TGATTCGTCT TGAACTAGGT ACTTCTGGTG TATTAACAGA
Xerocerastus sp.           TGGTACTGGA CTATCTTTAT TAATTCGGCT TGAGTTAGGA ACAGCTGGTG TTTTAACTGA
Zootecus insularis         TGGGACAGGG TTGTCGTTAC TAATTCGGCT TGAATTAGGT ACCTCAGGTG TGTTAACAGA
Gibbulinella dewinteri     TGGGACCGGT TTGTCCTTAT TAATTCGGCT AGAATTAGGT ACAGCTGGGG TTCTTATTGA


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                                    70         80         90        100        110        120
Achatina achatina          TGATCATTTC TTTAATGTAG TGGTGACAGC CCATGCTTTT GTTATAATTT TTTTTATAGT
Achatina fulica            TGATCACTTT TTCAACGTGG TTGTAACTGC GCATGCTTTT GTCATAATTT TTTTTATGGT
Achatina stuhlmanni        CGATCATTTT TTTAATGTTG TAGTTACTGC TCATGCTTTT GTGATAATTT TTTTTATAGT
Cochlitoma ustulata        TGATCATTTC TTTAATGTTA TCGTGACAGC GCACGCTTTT GTAATAATTT TTTTCATAGT
Coeliaxis blandii          TGATCATTTT TTTAATGTGG TTGTAACTGC TCATGCTTTT GTAATAATTT TTTTTATAGT
Pyrgina umbilicata         TGACCACTTT TTCAATGTTG TTGTAACAGC TCATGCGTTT GTAATAATTT TTTTTATAGT
Glessula ceylanica         CGATCATTTT TTTAATGTAA TTGTTACCGC TCATGCTTTT GTTATAATTT TTTTTATAGT
Ferussacia folliculus      TGATCACTTT TTTAATGTTA TTGTTACTGC ACACGCTTTT GTTATGATTT TTTTTATGGT
Thyrophorella thomensis    TGATCACTTT TTTAATGTGG TCGTCACAGC CCACGCTTTT GTTATAATCT TTTTTATAGT
Allopeas clavulinum        TGACCATTTT TTTAATGTTG TAGTTACAGC TCATGCTTTC GTAATAATTT TTTTTATAGT
Bocageia sp.               CGATCACTTT TTTAACGTTG TAGTAACAGC TCATGCGTTT GTTATAATTT TCTTTATAGT
Eutomopeas layardi         TGATCACTTT TTTAATGTTG TAGTAACAGC TCACGCTTTC GTGATGATTT TTTTTATAGT
Leptinaria lamellata       TGATCATTTC TTTAACGTAG TGGTTACTGC TCACGCTTTT GTAATAATTT TTTTTATAGT
Paropeas achatinaceum      TGATCATTTT TTTAATGTTG TAGTAACTGC TCATGCATTT GTAATAATTT TTTTTATAGT
Riebeckia sp.              TGATCACTTT TTTAATGTAA TTGTAACCGC ACATGCTTTT GTTATAATTT TTTTTATAGT
Rumina decollata           TGACCATTTT TTTAATGTGG TAGTTACTGC CCATGCATTT GTGATAATTT TTTTTATAGT
Subulina octona            TGATCATTTT TTTAATGTTA TTGTAACTGC TCATGCATTT GTTATGATTT TTTTTATGGT
Subulina striatella        TGACCACTTT TTTAATGTAA TTGTGACAGC TCATGCTTTT GTTATAATTT TTTTTATAGT
Subulina vitrea            CGATCATTTT TTTAATGTAA TTGTGACTGC TCATGCTTTT GTTATAATTT TTTTTATAGT
Subulona sp.               CGATCATTTT TTTAACGTAA TTGTTACTGC TCATGCTTTT GTAATAATTT TCTTTATAGT
Tortaxis erectus           TGATCATTTT TTTAATGTTG TAGTTACAGC CCATGCTTTT GTTATGATTT TTTTTATAGT
Xerocerastus sp.           TGATCACTTT TATAATGTTG TTGTTACGGC TCATGCTTTT GTAATAATTT TTTTTATAGT
Zootecus insularis         CGACCATTTC TTTAATGTTA TTGTAACAGC TCATGCATTC GTAATAATTT TTTTTATAGT
Gibbulinella dewinteri     TGATCATTTT TTTAAWGTTA TTGTTACWGC TCACGCTTTT GTTATAATTT TTTTTATAGT
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                                   130        140        150        160        170        180
Achatina achatina          CATACCAATT ATGATTGGGG GTTTTGGTAA TTGAATAGTC CCACTATTAA TTGGGGCTCC
Achatina fulica            TATACCAATT ATAATTGGCG GATTTGGAAA CTGGATGGTC CCAATACTTA TTGGTGCTCC
Achatina stuhlmanni        GATACCAATT ATAATTGGTG GGTTTGGAAA CTGGATGGTC CCATTACTGA TTGGTGCTCC
Cochlitoma ustulata        AATACCCATT ATAATTGGGG GTTTTGGTAA TTGAATAACT CCCCTTTTAA TCGGGGCTCC
Coeliaxis blandii          TATACCTATT ATAATTGGGG GATTTGGAAA TTGAATGGTT CCATTATTAA TTGGAGCTCC
Pyrgina umbilicata         TATACCAATT ATGATTGGTG GGTTTGGGAA TTGAATAGTG CCGCTTTTAA TTGGTGCTCC
Glessula ceylanica         TATGCCTATT ATAATTGGAG GATTTGGTAA TTGGATAGTT CCGTTATTAA TTGGTGCTCC
Ferussacia folliculus      TATACCTATT ATAATTGGAG GGTTTGGAAA TTGAATGGTG CCCCTTTTGA TTGGTGCTCC
Thyrophorella thomensis    TATACCAATT ATAATTGGTG GGTTTGGTAA TTGAATAGTA CCACTTTTAA TTGGTGCTCC
Allopeas clavulinum        TATGCCTATT ATAATTGGTG GCTTTGGGAA CTGAATGGTC CCACTATTAA TTGGGGCTCC
Bocageia sp.               AATACCTATC ATAATTGGTG GGTTTGGGAA CTGAATAGTT CCACTATTAA TTGGAGCTCC
Eutomopeas layardi         TATACCAATC ATGATTGGGG GGTTTGGAAA CTGAATAGTC CCATTACTGA TTGGGGCCCC
Leptinaria lamellata       TATACCTATT ATAATTGGGG GATTTGGAAA TTGAATAGTG CCTTTACTAA TTGGTGCACC
Paropeas achatinaceum      TATACCAATT ATAATTGGAG GTTTTGGGAA TTGGATAGTC CCCTTATTAA TTGGTGCTCC
Riebeckia sp.              TATACCAATT ATAATTGGAG GATTTGGAAA TTGAATAGTC CCTTTACTAA TTGGGGCCCC
Rumina decollata           AATGCCTATT ATAATCGGTG GTTTTGGAAA TTGAATAGTG CCCCTATTAA TTGGGGCACC
Subulina octona            AATACCTATT ATAATTGGAG GATTTGGGAA TTGAATAGTT CCTTTGCTTA TTGGGGCTCC
Subulina striatella        CATACCTATT ATGATTGGAG GGTTTGGGAA TTGGATAGTT CCTTTACTGA TTGGTGCTCC
Subulina vitrea            TATACCTATT ATAATTGGGG GGTTTGGGAA TTGGATAGTA CCACTACTAA TTGGTGCGCC
Subulona sp.               AATACCTATT ATGATTGGGG GATTTGGAAA TTGAATAGTG CCTTTACTTA TTGGGGCTCC
Tortaxis erectus           AATGCCTATT ATAATTGGTG GTTTTGGTAA TTGAATAGTT CCACTTTTAA TTGGTGCTCC
Xerocerastus sp.           TATACCAATT ATAATTGGTG GATTTGGTAA TTGAATAGTT CCATTATTAA TTGGTGCTCC
Zootecus insularis         TATGCCCATC ATAATTGGCG GCTTCGGAAA TTGAATGGTC CCACTATTAA TTGGTGCTCC
Gibbulinella dewinteri     TATACCACTA ATAATTGGAG GTTTTGGAAA TTGAATAGTA CCTCTTCTTA TTGGGGCTCC


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                                   190        200        210        220        230        240
Achatina achatina          AGATATAAGA TTCCCTCGGA TGAATAATAT AAGGTTCTGA TTATTACCAC CTTCATTTAC
Achatina fulica            TGATATAAGA TTTCCACGAA TAAATAATAT AAGGTTTTGA CTTTTACCAC CTTCATTTAC
Achatina stuhlmanni        TGATATAAGG TTTCCGCGGA TAAATAACAT AAGATTTTGA CTACTTCCCC CATCATTTTC
Cochlitoma ustulata        TGATATAAGC TTTCCTCGTA TAAATAACAT GAGCTTTTGA TTGTTACCCC CTTCCTTTAC
Coeliaxis blandii          TGATATAAGA TTTCCCCGAA TAAATAATAT AAGATTTTGG CTTTTACCTC CATCTTTTAT
Pyrgina umbilicata         TGATATAAGT TTCCCACGAA TAAATAATAT AAGATTTTGA CTTTTACCTC CATCTTTTAT
Glessula ceylanica         AGATATAAGA TTCCCCCGAA TAAATAATAT AAGATTTTGG TTATTACCAC CATCTTTTGT
Ferussacia folliculus      TGATATAAGG TTTCCTCGTA TAAATAATAT GAGGTTTTGA CTTCTCCCGC CTTCTTTTAT
Thyrophorella thomensis    TGATATGAGT TTTCCCCGTA TAAACAACAT AAGCTTCTGG CTCCTTCCAC CATCATTTAT
Allopeas clavulinum        AGATATAAGG TTTCCTCGAA TAAATAATAT AAGTTTTTGG CTTCTTCCAC CATCTTTTAT
Bocageia sp.               GGACATAAGT TTTCCTCGTA TAAATAATAT AAGATTTTGA CTGCTTCCTC CGTCATTTAT
Eutomopeas layardi         GGATATGAGA TTTCCCCGGA TAAATAATAT AAGTTTCTGG TTACTTCCAC CATCTTTCGT
Leptinaria lamellata       AGATATAAGA TTTCCTCGAA TAAATAATAT AAGATTTTGG TTATTGCCGC CTTCTTTTAT
Paropeas achatinaceum      TGATATAAGA TTCCCTCGTA TAAATAATAT AAGTTTTTGA TTACTTCCGC CATCTTTTGT
Riebeckia sp.              AGATATAAGA TTTCCTCGAA TAAATAATAT AAGATTTTGA CTTTTACCTC CATCATTTAT
Rumina decollata           AGATATAAGG TTTCCTCGAA TAAATAATAT GAGATTTTGA CTACTTCCTC CTTCTTTTAT
Subulina octona            TGATATAAGA TTTCCGCGTA TGAATAATAT AAGGTTTTGG TTGTTACCTC CTTCATTTTT
Subulina striatella        TGACATAAGT TTTCCCCGTA TAAATAATAT AAGATTTTGG TTGCTACCAC CTTCTTTTAT
Subulina vitrea            TGACATAAGA TTTCCACGGA TAAATAATAT AAGATTTTGG CTTCTACCAC CCTCATTTAT
Subulona sp.               AGATATAAGT TTTCCACGAA TAAATAATAT AAGGTTTTGA TTATTGCCTC CTTCGTTTAT
Tortaxis erectus           TGATATAAGG TTTCCACGAA TAAATAATAT AAGATTTTGA TTATTACCTC CATCTTTTAT
Xerocerastus sp.           CGATATAAGA TTTCCTCGGA TAAATAACAT AAGATTTTGA TTGTTACCAC CATCATTTAT
Zootecus insularis         GGATATAAGT TTTCCTCGAA TAAATAATAT AAGATTTTGG CTTCTTCCGC CTTCTTTTAT
Gibbulinella dewinteri     AGATATAAGT TTTCCACGCA TAAATAATAT AAGATTTTGA TTATTACCCC CTTCCTTTGT
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                                   250        260        270        280        290        300
Achatina achatina          CTTACTTATT CTTTCTAGTA TAGTTGAGGG AGGAGCTGGT ACTGGGTGAA CAGTTTATCC
Achatina fulica            TTTGTTAATC TGTTCAAGTA TAGTGGAAGG AGGGGCTGGA ACTGGGTGGA CTGTGTACCC
Achatina stuhlmanni        TTTGCTAATT CTCTCAAGTA TAGTAGAAGG TGGGGCTGGG ACAGGATGGA CAGTTTACCC
Cochlitoma ustulata        ACTTCTTATC TTGTCAAGAA TAGTGGAGGG GGGTGCAGGT ACAGGTTGAA CTGTGTATCC
Coeliaxis blandii          TTTTTTAATT GTCTCGAGAA TGGTAGAAGG GGGAGCCGGG ACTGGGTGAA CTGTTTACCC
Pyrgina umbilicata         TTTCCTTATT ATGTCTAGTA TAATAGAGGG TGGAGCTGGT ACAGGTTGGA CAGTTTATCC
Glessula ceylanica         TCTTTTAATT GTATCTAGTA TAATTGAAGG TGGTGCTGGT ACAGGGTGAA CTGTTTATCC
Ferussacia folliculus      TCTTTTAATT ACATCTAGTT TGGTAGAAGG TGGTGCAGGG ACAGGATGGA CAGTTTACCC
Thyrophorella thomensis    TTTCTTGATC ACGTCAAGGT TAATAGAAGG CGGAGCTGGC ACAGGTTGGA CTGTATACCC
Allopeas clavulinum        TTTTTTAATT ATGTCAAGAA TAATAGAAGG AGGAGCAGGA ACAGGTTGAA CCGTTTATCC
Bocageia sp.               TTTTTTAATT ATGTCTAGAA TAGTTGAAGG TGGGGCTGGA ACTGGTTGAA CTGTGTACCC
Eutomopeas layardi         TTTTTTAATT ATGTCTAGTA TAATAGAGGG GGGGGCTGGT ACAGGCTGAA CTGTTTACCC
Leptinaria lamellata       ATTTTTAATT ATTTCTAGTT TAGTGGAAGG GGGTGCTGGA ACAGGTTGAA CAGTCTACCC
Paropeas achatinaceum      TTTTCTAATT GTTTCAAGGA TAATAGAGGG GGGAGCCGGA ACTGGTTGAA CTGTCTACCC
Riebeckia sp.              TCTACTTATT GTATCAAGTA TAGTAGAAGG AGGTGTAGGA ACAGGGTGAA CTGTTTACCC
Rumina decollata           TTTATTAATT ATATCTAGGA TAGTAGAAGG TGGGGCAGGA ACTGGTTGAA CAGTGTATCC
Subulina octona            ATTATTAATT TTATCTAGAA TAGTGGAAGG TGGTGCTGGT ACTGGTTGAA CAGTTTATCC
Subulina striatella        TTTATTAATT TTATCAAGCA TGGTARAAGG AGGTGCGGGG ACAGGTTGAA CCGTTTATCC
Subulina vitrea            TTTTTTAATT GTCTCTAGGA TAGTGGAAGG AGGGGCTGGA ACAGGGTGAA CAGTTTACCC
Subulona sp.               TTTTTTAATT ATTTCGAGGT TGATTGAAGG TGGAGCCGGA ACTGGTTGAA CTGTTTACCC
Tortaxis erectus           TTTATTAATT TTATCTAGAA TAGTTGAAGG TGGGGCTGGG ACTGGTTGGA CTGTTTACCC
Xerocerastus sp.           TTTATTAATT ATATCGAGGA TAGTTGAAGG GGGTGCTGGT ACTGGTTGAA CTGTTTACCC
Zootecus insularis         TTTACTAATT GTTTCAAGTT TAGTTGAGGG GGGTGCAGGG ACAGGCTGAA CCGTATATCC
Gibbulinella dewinteri     TTTTTTAATT ATTTCTAGAA TAGTAGAAGG TGGAGCTGGA ACAGGTTGAA CGGTATACCC


                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   310        320        330        340        350        360
Achatina achatina          ACCTTTAAGA TCTACTTTAG GTCATAGAGG TGCCTCGGTA GATTTAGCGA TTTTTTCATT
Achatina fulica            GCCCTTAAGT TCTTGCTTAG GACACAGAGG GGCTTCAGTT GATTTAGCTA TTTTTTCTTT
Achatina stuhlmanni        TCCTCTAAGT TCATTAATTG GCCATAGTGG AGCATCAGTG GACTTGGCAA TTTTTTCTCT
Cochlitoma ustulata        ACCTTTAAGG TCTATCATAG GTCATAGGGG AGCATCAGTG GATTTGGCTA TCTTCTCTCT
Coeliaxis blandii          GCCCTTAAGT GGTATTATTG GGCACAGCGG TGCCTCAGTT GATCTGGCTA TTTTTTCTTT
Pyrgina umbilicata         ACCCCTTAGC TCAATAATTG GCCACAGAGG TCCATCTGTT GATTTGGCAA TTTTCTCCCT
Glessula ceylanica         ACCATTAAGA AGTATTGTTG GACATAGCGG TGCGTCTGTT GACTTAGCTA TTTTTTCACT
Ferussacia folliculus      CCCTTTAAGC AGATTGGTAG GCCATAGAGG TGCTTCTGTA GATTTGGCGA TTTTCTCTCT
Thyrophorella thomensis    CCCCCTTAGA TCAATGATCG GTCATAGTGG TCCGTCTGTT GATTTAGCAA TCTTCTCTCT
Allopeas clavulinum        ACCATTAAGA TCAATATTAG GGCACGGAGG ACCTTCTGTA GACTTAGCTA TTTTTTCTCT
Bocageia sp.               TCCTTTAAGA AGTCTGATAG GTCATAGAGG TGCGTCCGTG GATTTGGCTA TTTTTTCACT
Eutomopeas layardi         ACCTTTAAGA TCAATATTAG GGCACGGTGG GCCCTCAGTA GATCTAGCTA TTTTTTCTCT
Leptinaria lamellata       ACCTTTAAGT GGGATTTTAG GTCATAGGGG CGCTTCTGTC GACTTAGCTA TTTTTTCTCT
Paropeas achatinaceum      ACCATTAAGG TCAATACTAG GTCATAGAGG CCCATCAGTA GACTTAGCTA TTTTTTCTCT
Riebeckia sp.              TCCTTTAAGA GGTATTTTAG GACATAGGGG AGCATCTGTT GATTTAGCTA TCTTTTCTCT
Rumina decollata           ACCCTTAAGC AGAATCATAG GACATAGTGG GGCATCTGTT GACTTAGCTA TTTTCTCTCT
Subulina octona            ACCTTTAAGC AGAATTATAG GTCATGCTGG GGCTTCAGTT GATCTTGCTA TTTTTTCTTT
Subulina striatella        CCCTCTTAGA GGAATTTTAG GACATGCTGG TGCGTCAGTG GATCTAGCTA TTTTTTCTTT
Subulina vitrea            CCCCCTAAGA GGGATCTTAG GCCATAGTGG CGCTTCTGTT GATTTAGCCA TTTTTTCTTT
Subulona sp.               TCCATTAAGT GGGATTAGAG GTCATGGTGG AGCTTCTGTT GACTTAGCAA TTTTTTCTTT
Tortaxis erectus           TCCTTTAAGT GGAATTATGG GCCATAGTGG TGCTTCAGTT GACTTAGCTA TTTTTTCATT
Xerocerastus sp.           CCCATTAAGT AGTATTATTG GACACAGTGG TGCTTCTGTA GATTTAGCTA TCTTCTCTCT
Zootecus insularis         ACCTCTAAGA AGAAGCTTGG GACATAGTGG AGCTTCTGTC GATCTGGCTA TTTTCTCACT
Gibbulinella dewinteri     ACCATTAAGT AGCCTATTAG GACATGGAGG AGCTTCTGTA GATTTAGTTA TTTTTTCTTT
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                                   370        380        390        400        410        420
Achatina achatina          ACATTTGGCT GGTATATCAT CTATCTTAGG GGCTATTAAC TTTATTACTA CAATTTTTAA
Achatina fulica            ACATTTGGCT GGTGTATCCT CAATTTTAGG GGCAATCAAT TTTATTACGA CGGTGTATAA
Achatina stuhlmanni        ACACTTAGCC GGAATATCCT CTATTCTCGG AGCTATCAAC TTTATTACTA CAATTTTTAA
Cochlitoma ustulata        ACACTTAGCT GGTATATCTT CTATTCTCGG GGCTATTAAC TTTATCACAA CTATCTTTAA
Coeliaxis blandii          ACATTTAGCT GGTATGTCTT CAATTTTAGG TGCTATTAAT TTTATTACAA CTATTTTTAA
Pyrgina umbilicata         CCATTTGGCA GGAATTTCTT CAATCTTAGG GGCAATTAAC TTTATTACCA CTATTTTTAA
Glessula ceylanica         TCACCTAGCA GGAATATCAT CAATTTTAGG TGCTATCAAT TTTATTACAA CTATTTTTAA
Ferussacia folliculus      ACATCTTGCT GGAATATCTT CAATTTTAGG GGCAATTAAT TTTATTACTA CTATCTTTAA
Thyrophorella thomensis    TCACTTAGCA GGGATATCCT CTATTTTGGG TGCAATTAAC TTTATTACAA CAATCTTTAA
Allopeas clavulinum        TCATTTAGCT GGGATGTCTT CTATTCTTGG TGCTATCAAT TTTATTACTA CGATTTTTAA
Bocageia sp.               TCATCTTGCG GGTATATCTT CAATCTTAGG TGCCATCAAT TTTATTACTA CTATTTTTAA
Eutomopeas layardi         TCACTTAGCG GGGATATCTT CAATTTTAGG GGCTATCAAT TTTATTACCA CAATTTTTAA
Leptinaria lamellata       CCATTTAGCT GGAATATCTT CAATTTTAGG TGCAATTAAT TTTATTACTA CAATTTTTAA
Paropeas achatinaceum      CCATTTGGCT GGGATATCCT CAATTTTAGG GGCTATTAAC TTTATTACAA CAATCTTTAA
Riebeckia sp.              TCATTTAGCA GGAATATCTT CAATTCTAGG GGCTATTAAT TTTATTACAA CTATTTTTAA
Rumina decollata           TCATTTAGCA GGGATATCTT CTATTTTAGG TGCAATTAAT TTTATTACTA CTATTTATAA
Subulina octona            GCATTTAGCA GGAATGTCTT CTATTTTAGG TGCAATTAAT TTTATTACTA CTGTATTTAA
Subulina striatella        ACATTTGGCT GGTATGTCTT CAATTTTAGG TGCAATTAAT TTTATTACGA CTGTTTTTAA
Subulina vitrea            ACATTTAGCA GGAATATCTT CTATTTTAGG GGCCATTAAT TTTATTACTA CAATTTATAA
Subulona sp.               ACATCTAGCT GGTATATCTT CCATTTTAGG TGCAATTAAC TTTATTACAA CTATTTATAA
Tortaxis erectus           ACATTTAGCT GGACTTTCTT CTATTTTAGG GGCTATTAAC TTTATTACAA CTATTTTTAA
Xerocerastus sp.           CCACTTAGCC GGGATGTCTT CTATCCTTGG GGCTATTAAT TTTATTACTA CCATTTTTAA
Zootecus insularis         TCACTTGGCC GGTATATCTT CAATTCTTGG AGCTATTAAT TTTATTACTA CTATCTTTAA
Gibbulinella dewinteri     ACATCTAGCA GGTATATCTT CTATTTTAGG GGCTATTAAT TTTATTACTA CTATCTTTAA
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                                   430        440        450        460        470        480
Achatina achatina          TATACGAGCA TCAGGGATAT CTATAGAACG GGTTAGACTG TTTGTATGAT CTATTTTAGT
Achatina fulica            TATACGAGCC TCTGGGCTAA CTATAGAACG GGTAAGCTTA TTCGTGTGGT CAATTTTAGT
Achatina stuhlmanni        CATACGAGTA TCTGGACTAT CTATGGAACG GGTGAGGTTA TTTGTATGAT CAATTCTTGT
Cochlitoma ustulata        TATACGAGCT CAAGGCTTAT CTATGGAGCG TATAAGATTA TTTGTATGGT CTATTTTAGT
Coeliaxis blandii          TATACGTGCT TCCGGATTAA CAATAGAACG TGTAAGTCTT TTTGTATGAT CTATTTTAAT
Pyrgina umbilicata         TATACGTTCG TCAGGAGTTA AATATGAACG GTTAAGCTTG TTTGTTTGAT CAATTTTAGT
Glessula ceylanica         CATACGAGCT CCTGGTCTTA CCATAGAACG AGTGAGGTTG TTTGTATGAT CTATTTTAGT
Ferussacia folliculus      TATACGATCC CCAGGTATAA CTATGGAACG GGTTAATTTA TTTGTGTGGT CTATTTTGGT
Thyrophorella thomensis    CATACGTTCA TCTGGAATAA GTTATGAGCG TCTAAGATTA TTTGTGTGAT CAATTTTAGT
Allopeas clavulinum        TATACGATCG TCAGGAATAA AGTACGAACG AATAAGGTTA TTTGTTTGAT CTATTTTGGT
Bocageia sp.               TATACGATCA CCTGGTATAA CAATAGAACG AACAAGATTA TTTGTATGGT CTATCTTAGT
Eutomopeas layardi         TATACGTTCA TCTGGGTTGA AATATGAGCG AATAAGATTA TTTGTTTGGT CTATTCTAGT
Leptinaria lamellata       TATACGGTCA CCTGGATTAA AAATAGAACG AGTAAGATTA TTTGTTTGAT CAATTTTAGT
Paropeas achatinaceum      TATACGCTCA TCAGGGATGA AGTATGAACG TATAAGTCTA TTTGTGTGGT CTATTTTAAT
Riebeckia sp.              CATACGTGCC TCAGGATTAA CATGAGAACG TACTAGTTTA TTTGTTTGAT CAATTTTAGT
Rumina decollata           TATACGGTCC CCAGGTCTTT CAATAGAACG GGTAAGCCTA TTTGTGTGAT CTATTTTAGT
Subulina octona            TATACGTTCT TCTGGTTTAT CAATAGAACG AGTTAGATTG TTTGTTTGGT CAATTTTAAT
Subulina striatella        TATACGATCT TCCGGTTTAA GTTTTGAGCG GGTGAGTTTA TTTGTATGGT CTATTTTAGT
Subulina vitrea            TATACGAGCC CCTGGTATAA CCCCAGAACG AATTAGGCTA TTTGTTTGAT CAATTTTAGT
Subulona sp.               CATACGAGCA CCAGGCTTAA CTCCAGAACG AACTAGACTA TTTGTTTGGT CTATTTTAGT
Tortaxis erectus           TATACGTTCT TCAGGAATAT CTATGGAACG GGTAAGTCTA TTTGTTTGAT CTATTTTAGT
Xerocerastus sp.           TATACGATCC TCTGGAATAA GTATGGAACG TGTCAGGTTG TTTGTATGAT CAATTCTGGT
Zootecus insularis         TATGCGCTCT CCCGGATTAA CTATGGAACG GGTGAGCTTA TTTGTATGAT CTATTTTGGT
Gibbulinella dewinteri     TATACGATCG CCTGGAATAA CAATAGAACG GGTGTCTTTA TTTGTTTGGT CTATTTTAGT
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                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   490        500        510        520        530        540
Achatina achatina          TACAGTATTT TTACTGCTTT TATCTCTCCC AGTATTAGCG GGTGCAATTA CTATACTTCT
Achatina fulica            TACAGTGTTT CTACTATTGT TATCATTGCC AGTTCTAGCG GGGGCAATTA CTATACTATT
Achatina stuhlmanni        TACTGTTTTC CTTTTACTTT TATCTCTACC AGTCTTAGCT GGGGCGATTA CTATACTATT
Cochlitoma ustulata        TACTGTTTTC CTACTGCTCT TATCTCTACC AGTACTAGCA GGGGCTATTA CAATACTCCT
Coeliaxis blandii          TACAGTATTT TTATTACTCC TATCTTTACC AGTCTTGGCA GGGGCAATTA CTATGTTATT
Pyrgina umbilicata         TACTGTATTT CTTCTCCTTC TTTCCCTTCC TGTATTAGCT GGTGCAATTA CCATATTATT
Glessula ceylanica         TACAGTTTTT TTACTTCTTC TTTCATTACC TGTGTTAGCT GGAGCTATTA CTATATTATT
Ferussacia folliculus      TACAGTTTTC CTCTTATTAT TATCACTCCC TGTACTTGCG GGGGCTATTA CTATATTATT
Thyrophorella thomensis    CACTGTTTTT CTTCTTCTCT TATCTCTTCC TGTTCTAGCT GGGGCTATTA CTATACTCTT
Allopeas clavulinum        GACAGTTTTT TTACTTCTTT TATCTCTTCC AGTTCTTGCC GGTGCTATCA CTATACTTTT
Bocageia sp.               CACAGTATTT CTATTACTTT TATCATTACC TGTTTTAGCT GGTGCTATTA CTATGCTTCT
Eutomopeas layardi         AACAGTTTTT TTGCTTTTAC TATCTCTTCC TGTTCTAGCT GGCGCGATTA CGATACTTTT
Leptinaria lamellata       AACTGTTTTT TTACTTCTCC TATCGCTTCC TGTTTTAGCT GGGGCAATTA CAATATTATT
Paropeas achatinaceum      CACAGTTTTC TTATTACTTC TTTCGTTACC TGTTCTTGCT GGTGCAATCA CTATACTTCT
Riebeckia sp.              AACAGTTTTT TTACTTCTTT TATCTCTTCC TGTTTTAGCT GGAGCAATTA CTATACTTTT
Rumina decollata           AACCGTTTTT CTATTGCTTT TATCCCTACC AGTACTAGCA GGAGCTATTA CAATACTACT
Subulina octona            TACTGTTTTT TTATTATTAC TATCATTGCC TGTATTGGCT GGTGCAATTA CAATATTATT
Subulina striatella        AACGGTGTTT TTACTATTAT TGTCTTTACC TGTATTGGCT GGGGCAATCA CTATGTTATT
Subulina vitrea            AACAGTATTT TTATTACTTT TATCTTTACC GGTTTTAGCT GGGGCTATCA CAATGTTATT
Subulona sp.               TACTGTGTTT TTATTATTGT TATCATTACC AGTACTAGCT GGCGCAATTA CTATACTACT
Tortaxis erectus           TACAGTTTTC TTGTTACTTC TTTCACTTCC TGTTTTAGCA GGTGCTATTA CTATGTTATT
Xerocerastus sp.           TACTGTATTC CTTTTATTAC TTTCACTCCC AGTATTAGCT GGTGCTATTA CTATATTATT
Zootecus insularis         TACTGTATTT CTATTACTGC TATCATTACC CGTTTTAGCG GGTGCAATTA CTATGCTATT
Gibbulinella dewinteri     TACTGTTTTC CTCTTACTTT TATCACTTCC AGTTCTTGCT GGAGCAATTA CTATATTGTT



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                                   550        560        570        580        590        600
Achatina achatina          GACCGATCGT AACTTTAATA CATCTTTTTT TGATCCAGCT GGAGGTGGTG ATCCAGTGCT
Achatina fulica            AACGGATCGT AACTTTAACA CATCTTTTTT TGACCCAGCT GGAGGGGGGG ACCCAGTCCT
Achatina stuhlmanni        AACTGATCGA AATTTTAATA CATCTTTTTT TGATCCGGCA GGGGGTGGTG ATCCAATCCT
Cochlitoma ustulata        TACTGATCGT AATTTTAACA CATCCTTTTT CGACCCGGCA GGGGGAGGAG ATCCTATCTT
Coeliaxis blandii          AACAGACCGG AACTTTAATA CGTCATTTTT TGACCCGGCC GGGGGCGGAG ATCCTGTTCT
Pyrgina umbilicata         AACTGATCGT AATTTTAATA CTTCTTTTTT TGATCCAGCT GGGGGTGGTG ATCCGGTGCT
Glessula ceylanica         GACAGATCGA AATTTTAATA CATCTTTTTT TGACCCAGCT GGAGGTGGTG ACCCAATTTT
Ferussacia folliculus      AACGGATCGT AATTTTAATA CGTCTTTTTT TGATCCAGCA GGAGGTGGAG ACCCAATTTT
Thyrophorella thomensis    AACTGATCGA AATTTTAATA CTTCTTTCTT TGACCCTGCG GGAGGGGGCG ATCCGGTGTT
Allopeas clavulinum        AACTGATCGG AATTTTAATA CATCTTTTTT TGATCCTGCT GGTGGAGGGG ACCCAGTCCT
Bocageia sp.               TACAGATCGT AATTTTAATA CATCCTTTTT TGATCCGGCT GGGGGAGGGG ATCCTATTTT
Eutomopeas layardi         AACTGATCGA AACTTTAACA CATCTTTTTT TGATCCGGCT GGAGGGGGGG ATCCTATCTT
Leptinaria lamellata       AACAGATCGA AATTTTAATA CATCATTCTT TGATCCAGCA GGTGGTGGAG ATCCAATTTT
Paropeas achatinaceum      TACAGACCGT AATTTTAATA CATCTTTTTT TGACCCCGCT GGTGGCGGTG ACCCTGTGTT
Riebeckia sp.              AACAGACCGA AATTTTAATA CATCATTTTT TGACCCAGCT GGAGGAGGTG ATCCTATTTT
Rumina decollata           AACTGACCGT AACTTTAACA CTTCATTCTT TGATCCTGCA GGGGGAGGTG ATCCAATTCT
Subulina octona            AACTGATCGT AATTTTAATA CATCTTTTTT TGATCCAGCT GGTGGGGGGG ACCCTATTCT
Subulina striatella        AACTGATCGT AATTTTAATA CATCTTTTTT TGACCCAGCA GGTGGAGGGG ACCCTATCTT
Subulina vitrea            AACCGATCGT AATTTTAACA CATCTTTCTT TGATCCGGCT GGAGGGGGAG ACCCTGTTTT
Subulona sp.               GACGGACCGT AATTTTAATA CATCATTTTT TGATCCTGCT GGGGGAGGAG ATCCAGTCTT
Tortaxis erectus           GACTGATCGA AATTTTAATA CATCATTCTT TGACCCAGCT GGTGGTGGTG ATCCAATTCT
Xerocerastus sp.           AACTGATCGT AATTTCAATA CTTCATTTTT TGATCCAGCA GGCGGAGGTG ACCCTGTACT
Zootecus insularis         GACTGATCGA AATTTTAACA CGTCGTTTTT TGATCCAGCT GGGGGTGGTG ATCCTATTTT
Gibbulinella dewinteri     AACTGATCGG AATTTTAATA CGTCTTTTTT TGATCCTGCT GGGGGTGGGG ATCCTATTTT
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Achatina achatina          TTACCAG
Achatina fulica            GTACCAG
Achatina stuhlmanni        ATACCAG
Cochlitoma ustulata        GTATCAG
Coeliaxis blandii          TTACCAA
Pyrgina umbilicata         ATATCAA
Glessula ceylanica         ATATCAG
Ferussacia folliculus      ATACCAA
Thyrophorella thomensis    ATATCAA
Allopeas clavulinum        ATATCAG
Bocageia sp.               ATATCAA
Eutomopeas layardi         ATACCAA
Leptinaria lamellata       ATATCAA
Paropeas achatinaceum      GTATCAA
Riebeckia sp.              GTATCAA
Rumina decollata           ATATCAG
Subulina octona            TTATCAG
Subulina striatella        ATATCAG
Subulina vitrea            ATACCAA
Subulona sp.               ATATCAA
Tortaxis erectus           TTATCAA
Xerocerastus sp.           TTATCAA
Zootecus insularis         GTACCAA
Gibbulinella dewinteri     ATATCAA
Gonaxis quadrilateralis    ATATCAA
Gonospira sp.              GTATCAA
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Appendix 3.5: Alignment of the 16S rRNA gene for the Achatinoidea and three streptaxid outgroup taxa. Positions included for the phylogeny analyses were marked by “`m`” within “NUCEOTIDES INCLUDED”.

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                                  10         20         30         40         50         60
Achatina fulica           TAGCTTAAAG A--------- ------GTGC GTAACACAGA TTTTAAGTAA CCCCTGCCCG
Achatina achatina         TAGCTTTAGG A--------- ---------- ----TTTAAA TCTTTAGTAC CTCCTGCCCA
Achatina stuhlmanni       TAGCTAATAG G--------- --------CT CTTTCCATAA TTATTAGTGG ACCCTGCCCG
Cochlitoma ustulata       TAGCCTGCTG T--------- ---------- ---AGATTTA TTACAGGTGA TCCCTGCCCG
Allopeas clavulinum       ---------- ---------- ---------- ----AATTAA TATAAGGTTA GACCTGCTCA
Bocageia sp.              ---------- ---------- ---------- ---------- ----AGATAT ATTCTGCCCA
Leptinaria lamellata      TTTCCTAAAG A--------- ---------- ----TTTTTA TTTTAGGTCC AGCCTGCCCA
Paropeas clavulinum       TAGCCTTAAG G--------- ---------- -----TATTA TTTAAGGTAA AGCCTGCTCA
Riebeckia sp.             ---------- ---------- ---------- --GATGGCTA TACTTAGCAT CCCCTGCCCA
Rumina decollata          ---------- ---------- ---------- ---------- -TTTAGGTAA CCCCTGCCCA
Subulina octona           TAGCTTGAAG A--------- ---------- ---AAATTGG TTTTAGGTTA TTTCTGCCCA
Subulina striatella       ---------- ---------- ---------- -----TACTA TTTTAAGTGA CTTCTGCCCG
Subulina vitrea           TAGCTTAAAG A--------- ---------- -GTATTTTTA TTTTAAGTAC CTTCTGCCCA
Subulona sp.              TKRCTTAACG G--------- ---------- ATATDGKGRA TGTTAAGCAT SSCCTGCCCA
Tortaxis erectus          ---------- ---------- ---------- ---------- CTTTATGTAA CTTCTGCCCG
Xerocerastus sp.          ---------- ---------- ---------- ---------- --TTAGGTGA TTTCTGCCCG
Zootecus insularis        ---------- -CATATTTTA TTAATTTGTA AGTTTATTTA TTTCAAGCTT CTCCTGCCCA
Coeliaxis blandii         ---------- ---------- ---------- ---------- TTATAGATTA ATCCTGCCCA
Pyrgina umbilicata        ---------- ---------- ---------- ---------- ---------- AGCCTGCTCA
Cecilioides gokweanus     TAACTTAAAG A--------- ---------- ----AATTTA TTTTAAGTAT ACCCTGCCCG
Ferussacia folliculus     ---------- ---------- ---------- ---------- ---------A CTCCTGCCCG
Thyrophorella thomensis   ---------- ---------- ---------- ---------- ---------- AGCCTGCTCA
Gibbulinella dewinteri    TAGCCTAGTG A--------- ---------- ----GTTTTA TATTAGGTTG CTTCTGCCCA
Gonaxis quadrilateralis   ---------- ---------- ---------- ---------- ----AGGTGA CTTCTGCCCA
Gonospira sp.             ---------- ---------- ---------- ---------- -----AGTGT TGTCTGCCCA
NUCLEOTIDES INCLUDED      ---------- ---------- ---------- ---------- ---------- mmmmmmmmmm


                          ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                  70         80         90        100        110        120
Achatina fulica           GTGAGTTATA GA---AACTT TAACGGCCGC AGTACCTTGA CTGTGCAAAG GTAGCATAAT
Achatina achatina         GTGATAGGTT AC---CTATT TAACGGCCGC AGTACCTTGA CTGTGCAAAG GTAGCATAAT
Achatina stuhlmanni       GTGAAGTTAA -----CCTTT TAACGGCCGC AGTACCCTGA CTGTGCTAAG GTAGCATAAT
Cochlitoma ustulata       GTGGGGCCTA TT---ACCCT AAACGGCCGC AGTACCTTGA CTGTGCAAAG GTAGCATAAT
Allopeas clavulinum       ATGAAAA--- -----TGTTT TAACAGCCGC AGTACCCTGA CTGTGCTAAG GTAGCATAAT
Bocageia sp.              ATGAACCCTA -----AGTTT TAATGGCCGC AGTACCTTGA CTGTGCAAAG GTAGCATAAT
Leptinaria lamellata      ATGATA---- -----TATTT TAATGGCCGC AGTACCCTGA CTGTGCTAAG GTAGCATAAT
Paropeas clavulinum       ATGAAT---- -----AATTT TAATAGCCGC AGTACCCTGA CTGTGCTAAG GTAGCATAAT
Riebeckia sp.             GTGAGATATA -----TTCTT AAATGGCCGC GGTACTTTGA CCGTGCTAAG GTAGCATAAT
Rumina decollata          GCGATATAT- -----AAGTT TAGCGGCCGC AGTACTTTGA CTGTGCTAAG GTAGCATAAT
Subulina octona           GTGACGGTAA A----AAGTT AAATGGCCGC AGTACATTGA CTGTGCTAAG GTAGCATAAT
Subulina striatella       GTGAATAG-- -----AAATT TAACGGCCGC AGTACATTGA CTGTGCTAAG GTAGCATAAT
Subulina vitrea           ATGAAATT-- -----AATTT TAATGGCCGC AGTACTTTGA CTGTGCAAAG GTAGCATAAT
Subulona sp.              AWGAATAATT T----ATTKT TAATGGCCGC AGTACCTTGA CTGTRCTAAG GTAGCATAAT
Tortaxis erectus          GTGATT---- -----TTTTT TAACGGCCGC AGTACCCTGA CTGTGCTAAG GTAGCATAAT
Xerocerastus sp.          GTGATA---- -----TATTT TAACGGCCGC AGTACCTTGA CTGTGCTAAG GTAGCGTAAT
Zootecus insularis        GTGATTTTT- -----ATATT TAACGGCCGC AGTACCCTGA CTGTGCTAAG GTAGCGTAAT
Coeliaxis blandii         GTGAATACTT GTGAAAATTT TAACGGCCGC GGTACCTTGA CCGTGCTAAG GTAGCATAAT
Pyrgina umbilicata        ATGAATAAAA A----ACTTT TAATAGCCGC AGTACCCTGA CTGTGCTAAG GTAGCATAAT
Cecilioides gokweanus     GTGAGTTATT T----TTCTT TAACGGCCGC AGTACCTTGA CTGTGCAAAG GTAGCATAAT
Ferussacia folliculus     GTGATGGT-- -----TTATT TAACGGCCGC AGTACCCTGA CTGTGCAAAG GTAGCGTAAT
Thyrophorella thomensis   ATGAA----- ------TATT TAATAGCCGC AGTACCCTGA CTGTGCTAAG GTAGCATAAT
Gibbulinella dewinteri    CTGATTAGTT AACT-AACTT TAACGGCCGC AGTACTCTGA CTGTGCTAAG GTAGCATAAT
Gonaxis quadrilateralis   GTGAA----- -----AATTT TAACGGCCGC AGTACCCTGA CTGTGCTAAG GTAGCATAAT
Gonospira sp.             GTGATGT--- -----TTATT CAACGGCCGC AGTACTTTGA CTGTGCTAAG GTAGCATAAT
NUCLEOTIDES INCLUDED      mmmmm----- -------mmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                          ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                  130        140        150        160        170        180
Achatina fulica           AATTTGTCCT CTAATTAAGG TCTGGAATGA AGGGGGACA- -CAGGGGAGA GCTGTCTCCA
Achatina achatina         AATTTGTCCC TTAATTAGGG TCTGGTATGA AAGGATTTT- -CGGGAGTTT ACTGTCTTAG
Achatina stuhlmanni       AATTTGTCCT TTAATTAAGG TCTTGCATGA ATGGGTGTT- -CGAGGAGTC GCTGTCTTTA
Cochlitoma ustulata       CACTTGTCCT TTAATTGAGG ACTGGAATGA AAGGGAAGAA ACGGGTATGA GCTGTCTCTA
Allopeas clavulinum       AATTTGTCTT TTAATTGGAG TCTGGAATGA ATGGATTAA- -TGGGGGATA ACTGTCTCTT
Bocageia sp.              AATTTGTCCT TTAATTAGGG TCTAGAATGA ATGAAAAATT TTGGAAAACC TCTGTCTCAT
Leptinaria lamellata      AATTAGTCCT TTAATTGAGG TCTGGAATAA ATGGTATAA- -CGGATAATA ACTGTCTCAT
Paropeas clavulinum       AATTTGTCTT TTAATTAAGG TCTAGAATGA ATGGTTTAT- -TGGGGAAAA GCTGTCTTAA
Riebeckia sp.             AATTTGTCCT TTAATTAAGG TCTAGAATGA ATGGGGTTA- -CTGGAAAGT ATTGTCTCTG
Rumina decollata          AACTTGTCCT TTAATTGAGG TCTTGAATGA ACGGGTTTA- -CGAAAAATT TCTGTCTCCT
Subulina octona           AATTTGTCCT TTAATTGGGG TCTAGAATGA ATGAATTTA- -TGGGGAATA GCTGTCTCAA
Subulina striatella       AAATTGTCTC TTAATTGGGG TCTAGAATTA ACGGAGTTA- -TGGGGATTA ACTGTCTCTA
Subulina vitrea           AATTTGTTCT TTAATTGGGG ACTAGAATGA ATGAAAAAA- -CGGAGGAAA GCTGTCTCTT
Subulona sp.              CACTTGTTCT TTAATTGAGG ACTAGAATGA ATGGGGGCA- -CGGGAACCR GCTGTCTGTA
Tortaxis erectus          AATTTGTCCT CTAATTAGGG TCTAGAATGA AAGAAGATT- -TAGGGATAA ACTGTCTCTG
Xerocerastus sp.          AATTTGGCTT TTAATTGAGG TCTTGAATGA AAGGGATAA- -CGTGGGGGA ATTGTCTCTT
Zootecus insularis        AATTTGTCCT TTAATTGGGG TCAGGTATGA ACGGAGATCA -CACATAGCC GCTGTCTCTT
Coeliaxis blandii         AATTTGTCCT TTAATTGAGG TCGGGAATGA ACGGATATT- -CTGAAATAA CCTGTCTTAA
Pyrgina umbilicata        AATTTGTCTT TTAATTGAGG TCTAGAATGA ATGGCACCT- -TGGGGTGAA GCTGTCTTAA
Cecilioides gokweanus     AATTTGTCTT TTAATTGGAG TCTTGAATAA ATGGGAATTT -GGGGAGG-G GCTGTCTCTT
Ferussacia folliculus     AATTTGTCCT TTAATTTGGG TCGAGAATGA AAGGAATTTT -GGGAAGA-A GGTGTCTCAT
Thyrophorella thomensis   AACTTGTCTC CTAATTAGGG TCTAGAATAA ACGGCATCTA -GAAGAGA-A TCTGTCTTGG
Gibbulinella dewinteri    AAATTGATTT TTAATTGGAG TCTAGAATGA AAGGGATTA- -TGGGGGGAT ACTGTCTCTA
Gonaxis quadrilateralis   AAATTGATTT TTAATTGAAG TCTAGAATGA ATGGAAATT- -TGGAAAAAA TCTGTCTTAA
Gonospira sp.             AAATTGTCTT ATAATTAAGG ACTAGAATCA AAGAATTTA- -TGGAGTTTA ACTGTCTTAA
NUCLEOTIDES INCLUDED      mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmm----- ---------- -mmmmmmmm-


                          ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                  190        200        210        220        230        240
Achatina fulica           ATAAGGTTAA TT--TAACTT TC-TTATCAG GTGAAAATTC CTGAGCCT-- --CCGATGAA
Achatina achatina         TGAGGTTAAT AT--GAATTT ACTCAATAAG GTGAAAATTC CTTAAAAT-- --TAGATAAA
Achatina stuhlmanni       TTAGGGTTTA ATT-AAATTT AC-TCAAGAG GTGAAAATTC CTCTAAATT- --AAGATAAA
Cochlitoma ustulata       GTTAGCTCTT TT--AAATTT AA-TTGTTAG GTGAAAATAC CTATACCT-- --TTAACAGA
Allopeas clavulinum       TAAGATTAAT TT--TAACTT GT-TTAAAAG GTGAAAAAAC CTTTGAAAA- --CAGAAAAA
Bocageia sp.              TTAGAAGTTT TG--TAAGTT TC-TAATAAG GTGAAAATTC CTTAGTGG-- --CCGAAGAA
Leptinaria lamellata      TGATTAATTT TAATTAACTT AC-TAATAAG GTGAAAATTC CTTAAAA--- --TTGAAAAA
Paropeas clavulinum       TTCAATTAAC TT--TAATTT AC-TTAGAAG GTGAAAAAAC CTTCAAAT-- --TAGAAAAA
Riebeckia sp.             CTTTATTACT T---GAAATT TC-TTATCAG GTGAAAATTC CTGAATT--- --TTGAAAAA
Rumina decollata          GTACAAATTT TACTGAACTT AC-TTAAGAG GTGAAAATTC CTTTAGTA-- --ATGAAAAA
Subulina octona           TAAGAATTTA TAT-GAATTT AT-TAATAAG GTGAAAATAC CTTAAGT--- --TTGAAAAA
Subulina striatella       TAGGGTTTAT AT--GAAGTT AA-TTATTAG GTGCAAAAGC CTAATTGT-- --TAGAAAAA
Subulina vitrea           GTAAGTTAAC TT--TAATTT AC-TTAAAAG GTGAAAATAC CTTTATTT-- --AACATGAA
Subulona sp.              TTATATTATC TA--TAATTT GC-TAAGGAG GTGAAAATTC CTCTAGC--- --TATAAGGT
Tortaxis erectus          TAGAGGTTAA TT--GAATTT CC-TTAAAAG GTGAAAATTC CTTTATAA-- --ATGAAGTT
Xerocerastus sp.          TAAAAGTTTG TA--GAATTT GT-TTATTAG GTGAAAATAC CTATATTT-- --AATATATT
Zootecus insularis        AGAAGTTTTT GT--GAAGTT AC-TTATAAG GTGAAAATTC CTTTGAGCT- --TAGATAAA
Coeliaxis blandii         TTTAATTAAA TT--TAAGTT CC-TAATAAG GTGCAAATTC CTTAATTTTG TTATGAAAAT
Pyrgina umbilicata        TTGGGGATTA TTT-TAACTT ACTTTATAGG GTGAAAATTC CCTTAAAT-- --ATTTATTT
Cecilioides gokweanus     ATAAATTTTT TT--TAACTT AC-TAAAGAG GTGAAAATTC CTCTGGTTA- --TTTTTAAA
Ferussacia folliculus     TTAAACTTTT TT--TAATTT TC-TTAGGGT GTGAAAATTC ACCTATTAAC T-TTTAAGAA
Thyrophorella thomensis   GTAGGTTAAT AC--TAACTT AC-TTAAAGG GTGAAAATTC CCTTGAAA-- --CTTTATTT
Gibbulinella dewinteri    GTTCGCATTT ATTTGAACTT AT-ATTTTAG GTGAAAATAC CTAAGAATT- --TTAATAAT
Gonaxis quadrilateralis   ATTAATTATT TT--TAAATT AC-TTATAAG GTGAAAATAC CTTAAATT-- --TTAATTAA
Gonospira sp.             TTTAATTGTT TT--GAATTT AC-TTAAAAG GTGAAAATTC CTTTATTA-- --AAAATAAT
NUCLEOTIDES INCLUDED      ---------- ----mmmmmm mm-mmmmmmm mmmmmmmmmm mmmm------ ----mmmmmm
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                          ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                 250        260        270        280        290        300
Achatina fulica           AGACGAGAAG ACCCTTAGAG TTTTTATTAT AACTTGATA- ---------- --------TA
Achatina achatina         AGACGAGAAG ACCCTTGGAG TTTTTATTAT ATAGATAGA- ---------- ----------
Achatina stuhlmanni       AGACGAGAAG ACCCTTAGAG TTTTAATGAA AAGTAAAC-- ---------- ----------
Cochlitoma ustulata       AGACGAGAAG ACCCTTAGAG TTTTTATGAT AAGCATTCT- ---------- ----------
Allopeas clavulinum       AGACGAGAAG ACCCTTAGAG TTTTTAATTA ATTGAATTT- ---------- ----------
Bocageia sp.              AGACGAGAAG ACCCTAAGAG TTTTTATAAA CTTCTACAT- ---------- ----------
Leptinaria lamellata      AGACGAGAAG ACCCTAAGAA TTTTTATGAA AAAG------ ---------- ----------
Paropeas clavulinum       AGACGAGAAG ACCCTTAGAG TTTTAATAAA ATGTTAATT- ---------- ----------
Riebeckia sp.             AGACGAGAAG ACCCTTAGAA TTTTTATAAT ACCTTAC--- ---------- ----------
Rumina decollata          AGACGAGAAG ACCCTTAGAA TTTTAATAAA AACTGTCAT- ---------- ----------
Subulina octona           AGACGAGAAG ACCCTAAGAG TTTTTATAAG TAGTAAAAA- ---------- ---------T
Subulina striatella       AGACGAGAAG ACCCTATGAA TTTTAATTAA AATATTTGA- ---------- ----------
Subulina vitrea           AGACGAGAAG ACCCTTAGAA TTTTTATAAA CATAATTTC- ---------- ----------
Subulona sp.              AGACGAGAAG ACCCTAAGAA TTTTACACCT GACCAGCGC- ---------- ----------
Tortaxis erectus          AGACGAGAAG ACCCTTAGAA TTTTTATAAT GTAACTCTT- ---------- ---TATAATA
Xerocerastus sp.          AGACGAGAAG ACCCTTAGAA TTTAAATTAT TG-------- ---------- ----------
Zootecus insularis        AGACGAGAAG ACCCTTAGAA TTTTTATAAT AGGTAAGAA- ---------- ----------
Coeliaxis blandii         AGACGAGAAG ACCCTTAGAA TTTTTATTTT ATTTAAATA- ---------- ----------
Pyrgina umbilicata        AGACGAGAAG ACCCTTAGAA CTTTTAATTA AAGAGG---- ---------- ----------
Cecilioides gokweanus     AGACGAGAAG ACCCTTAGAG TTTTAATAAA ATTTAATTTC ATATAATTTA AGTAAGAATT
Ferussacia folliculus     AGACGAGAAG ACCCTTAGAG TTTAATCGTG TGAGAGTAT- ---------- ----------
Thyrophorella thomensis   AGACGAGAAG ACCCTCAGAA CTTTAACTAA TGAAGG---- ---------- ----------
Gibbulinella dewinteri    AGACGAGAAG ACCCTTAGAA TTTTGAAAAT AAATAAAA-- ---------- ----------
Gonaxis quadrilateralis   AGACGAGAAG ACCCTTAGAG TTTTTATAAA AGG------- ---------- ----------
Gonospira sp.             AGACGAGAAG ACCCTATGAA TTTTTATAAT TGTTAGA--- ---------- ----------
NUCLEOTIDES INCLUDED      mmmmmmmmmm mmmmmmmmmm mmmmm----- ---------- ---------- ----------


                          ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                 310        320        330        340        350        360
Achatina fulica           TTAAGATTCT TGTTCTGTTT TTGTTGGGGC GACAGGGTTA CA-------- ---------A
Achatina achatina         --------TT CTATTCTTTT TCGCTGGGGC AGCGAGATTA CA-------- ----------
Achatina stuhlmanni       -------TTT ACTTAAGTTT TTGTTGGGGC AACAAGATGG CA--AAAATT AGTAATACTT
Cochlitoma ustulata       ---ACATATG CTGTCAGTTT TCGTTGGGGC AACGAGATTG CA-------- --------TG
Allopeas clavulinum       --TTTTAATG TTTATTTTTT TTGTTGGGGC GACATAGTAA CA-------- ----------
Bocageia sp.              CAACTTTAGA ATAGGCGTTT TCGTTGGGGC GACGAAATTA CA-------- ----ATAGTA
Leptinaria lamellata      ------TTAA ACTTAAGTTT TCGTTGGGGC GACGGGTTTT CA-------- ----------
Paropeas clavulinum       -------ATT TTCTTTTTTT TTGTTGGGGC GACAAAGTAA CA-------- ----------
Riebeckia sp.             ------TAAA GGGAAAGTTT TTGTTGGGGC GACAAAGTTA CA-------- --------AG
Rumina decollata          --TGCGTGAT TGTTTAGTTT TCGTTGGGGC GACGAGGTAG CA-------- --------AT
Subulina octona           TATTAGATTT ACATAAGTTT TCGTTGGGGC GACGGGATTA CA-------- ----------
Subulina striatella       -GAAGCAAAG TATTAGATTT TCGTTGGGGC GACGGAATTA CA-------- -TAAAGAGTT
Subulina vitrea           ---AACTTAT TATTGTATTT TCGTTGGGGC AACGGGCTGA CA-------- --------CG
Subulona sp.              -AACTCGTCT GWATAGGTTT TCGTTGGGGC GACGGATTAA CA-------- ------ACTC
Tortaxis erectus          TTATTGTAGG TTAATTTTTT TCGTTGGGGC GACGAAATTA CA-------- -AAAATTTAT
Xerocerastus sp.          --TTTAAAAG TATAACATTT TTGTTGGGGC GACAAAGTTA CA-------- ----------
Zootecus insularis        -----CTTTT ACTTTTGTTT TCGTTGGGGC GACGAGGTGA CATGTTGCTT TTAGGTGGAC
Coeliaxis blandii         ATTAATTTTA ATTAATGTTT TCGTTGGGGC GACGGGTTTA CA-------- ----------
Pyrgina umbilicata        ---TTACTCA CCTTTCTTTT TCATTGGGGC GATGAATTAA CA-------- ----------
Cecilioides gokweanus     ATTATATTTT AAATTAGTTT TCGTTGGGGC GACGTAGTTA CA-------- ----------
Ferussacia folliculus     ---GTCTCTT CTTGACGATT TTGTTGGGGC GACAAGTTTT CA-------- ----------
Thyrophorella thomensis   --TTATATAT CTTCTGTTTT TTGTTGGGGC GACAAGTTAA CA-------- ----------
Gibbulinella dewinteri    --ATTATTTT ATGAGTTTTT TTGTTGGGGT GACAAAATAA CA-------- ------GGTT
Gonaxis quadrilateralis   ----TAATTA ACTTTTTTTT TTGTTGGGGT GACAAAGTAR AA-------- ---------A
Gonospira sp.             ----TTTTTC TAATTATTTT TTGTTGGGGC AACAAGATAG CA-------- ----------
NUCLEOTIDES INCLUDED      ---------- -------mmm mmmmmmmmmm mmmmmmmmmm mm-------- ----------
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                          ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                 370        380        390        400        410        420
Achatina fulica           TAGATAACTT ACCCTACCAT ATTTTTATAT GGCGATCATT ATACTTT--- ----------
Achatina achatina         ----TCTTTA CTTTTAATTA ATCTTTACTT ATCTAAACAT TTGCCAAGTA TTTATCCTAA
Achatina stuhlmanni       AAACCCATCT AATTTTCTAA AGTGAATCAG TCAATTATTA TAAGAA---- ----------
Cochlitoma ustulata       AAATAAACCA ATCATACGTT AATAGTAGAT AAGTCAATCT TAATAGGTA- ----------
Allopeas clavulinum       AAATTAACTT ACTATATTAT TTTATTTTAC ACAACGCTTA AGCTATA--- ----------
Bocageia sp.              ACCATAACTA ATTAAGATTA ATCTTAAACA AATCAAAAGA ATTTTTAACT ----------
Leptinaria lamellata      --CATACTAT AACTTTACCT GATAATGATT ATTTTACTAA CCAAGACAAT TATTTATTA-
Paropeas clavulinum       ------TATT ACTTATAACT TACTTTTTTA TTAGTTTATC TGACATCTTT ATTGAG----
Riebeckia sp.             TTATATAATA ACTAACTATA AATAATTATT TTTGCCATAG TTTTATTGTG AT--------
Rumina decollata          CAAATAACCT ACCTATTAAT ATTTAATACA CCGAAATCTA TTAAACA--- ----------
Subulina octona           -TATAATTTA AACTTTTTAA TTATAGAATA GGGATATTTC AAATTTTGTT TAGAA-----
Subulina striatella       AAAGAATATA ACTTTGTTAA ACTTTTTTAA TTATTGAGTT TGTATATACC AGGTGATACC
Subulina vitrea           GATTAAATTC GGCCAAAAAG ATTTATATAT AAACCTATAT TTTCAAGAG- ----------
Subulona sp.              TACATAACTT AGCTGATATG AGTAAATTTA YTATATARAT CTTGTTTRTA AATGA-----
Tortaxis erectus          GAACTTATTG TTTTTAGTTT TT-------- -ATGTGCCGA ATCATATTAA GAA-------
Xerocerastus sp.          ------TTTA ACTTACTATA TTATTTAAGC TACTAGCCGA GTTAATTATG AG--------
Zootecus insularis        CCTGAAACTC ACCTTTAATT TTAA-AATTT TATAAGCCGA ATTTTATTAT GTA-------
Coeliaxis blandii         -TTCTGCATA AACTAATCTA TAAATTTTTC TTAATAAACC GAGGATTTTT ATCTT-----
Pyrgina umbilicata        -----TTTTT AGGTTTAACT TAATTTTTTT GTTTAGTACA AGACACTTTC TACAA-----
Cecilioides gokweanus     --TGATGTGA ACTAACTTAA TGAATTATTG TATTTTAATA AGTTTTATTT AATTAAATTT
Ferussacia folliculus     TAAATAACAA ACCTTTATGA AGTTTTTCAA GACGATTATA TTATGGT--- ----------
Thyrophorella thomensis   GCAATAACTT AACTTTAAGT TCATTTTACA AGGTATCGTC TTAGGA---- ----------
Gibbulinella dewinteri    AAATCAACTT ATTTTTGGTA TTAGTTTTAC AAGAAAGTTT TAATAACAGG AA--------
Gonaxis quadrilateralis   AAATTAACCT ACATTATAAT TCAAGCCGAG TTATACTATG AA-------- ----------
Gonospira sp.             TAAAAAATCT ATCTTAAAAT GATTTACTAC ATTTCAAAGT TTTTTATAA- ----------
NUCLEOTIDES INCLUDED      --------mm mmmm------ ---------- ---------- ---------- ----------
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                          ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                 430        440        450        460        470        480
Achatina fulica           ---------- --------TA ATTAAGCTAC CTAAGGGATA ACAGCGTAAT CTTTTTTTTT
Achatina achatina         GAA------- --------AA ACTAAACTAC CCAAGGGATA ACAGCATAAT TCCTT-AGGG
Achatina stuhlmanni       ---------- --------CA GAAAAACTAC CTAAGGGATA ACAGCGTAAT CTAAT-ATTA
Cochlitoma ustulata       ---------- --------TA ATTAAACTAC CTAAGGGATA ACAGCGTAAT CTTAT-TTAT
Allopeas clavulinum       ---------- --------AG AAGAAACTAC CTTAGGGATA ACAGCATAAT TTTTT-AAAA
Bocageia sp.              ---------- --------TG AATAAACTAC CTTAGGGATA ACAGCATAAT CTATT-TTTA
Leptinaria lamellata      ---------- --------AG ATTAAATTAC CTTAGGGATA ACAGCATAAT ATTTT-ATAA
Paropeas clavulinum       ---------- --------AA ATTAAACTAC CTTAGGGATA ACAGCATAAT TTTA--ATCA
Riebeckia sp.             ---------- --------TA AAAAAATTAC CTAAGGGATA ACAGCATAAT CTTAA-ATAA
Rumina decollata          ---------- --------TA ATTAAATTAC CTAAGGGATA ACAGCATAAT ACTAA-GTAG
Subulina octona           ---------- --------TA AGTAAACTAC CTTAGGGATA ACAGCATAAT ACTT--TTAG
Subulina striatella       TTTTA----- --------TA AGAAAATTAC CTTAGGGATA ACAGCATAAT ACTT--TTAG
Subulina vitrea           ---------- --------TA TTTAAATTAC CTAAGGGATA ACAGCATAAT TTTTT-AAAA
Subulona sp.              ---------- --------CA ATTAAATTAC CTTAGGGATA ACAGCATAAT CTTTW-ATAA
Tortaxis erectus          ---------- --------AA TTTAAATTAC CTAAGGGATA ACAGCATAAT ATTTT-TTTA
Xerocerastus sp.          ---------- --------TG ATAAAATTAC CTGAGGGATA ACAGCATAAT TTAT--TTTA
Zootecus insularis        ---------- --------AA ATTAAATTAC CTGAGGGATA ACAGCATAAT ATCCT-TTGA
Coeliaxis blandii         ---------- --------TA TATAAATTAC CTAAGGGATA ACAGCATAAT CTTAG-ATAA
Pyrgina umbilicata        ---------- --------AG GAGAAGTTAC CTGAGGGATA ACAGCATTAT TTATT-TTTA
Cecilioides gokweanus     AACGAGAAAT TTTAATTTTA ATTAAGCTAC CTTAGGGATA ACAGCATAAT ATTT--TTAA
Ferussacia folliculus     ---------- --------TG AGAAAACTAC CTAAGGGATA ACAGCATAAT TCTAT-AAAG
Thyrophorella thomensis   ---------- --------AG ATTAAGTTAC CTGAGGGATA ACAGCATTAT TTATT-AGTA
Gibbulinella dewinteri    ---------- --------AG ATTAAATTAC CTTAGGGATA ACAGCATAAT TCTTT-TACG
Gonaxis quadrilateralis   ---------- --------AG AAAAAACTAC CTTAGGGATA ACAGCATAAT TTTTT-TTAA
Gonospira sp.             ---------- --------AG GAGAAATTAC CTTAGGGATA ACAGCGTAAT TTCACTTTGA
NUCLEOTIDES INCLUDED      ---------- ---------- ---mmmmmmm mmmmmmmmmm mmmmmmmmmm mmm-----mm
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                          ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                  490        500        510        520        530        540
Achatina fulica           GGTTTGCGAC CTCGATGTTG GAC-TAGGGG CC---TACTG GTTAGTTACC ATTA-----T
Achatina achatina         AGATTGTGAC CTCGATGTTG GAC-TAGGGC TC---TATTG GTTAACTACC AAGA-----A
Achatina stuhlmanni       GGATTGCGAC CTCGATGTTG GAC-TAGGGA CC---TAATG ATGAGATATC AAGGTGACTA
Cochlitoma ustulata       GGATTGCGAC CTCGATGTTG GAC-TAGGGA CC---CAGTG GTGAGAAACC AGCT------
Allopeas clavulinum       AGATTGTGAC CTCGATGTTG GAC-TAGGGA CT---TTATG GTTAACCACC TTAA------
Bocageia sp.              GGATTGTGAC CTCGATGTTG GAC-TAGGGT CA---GAAAG GTAAGCAATC AAAA------
Leptinaria lamellata      AGATTGTGAC CTCGATGTTG GAC-TAGGGA CC---TATAG GTTAACCACC AATA------
Paropeas clavulinum       AGATTGTGAC CTCGATGTTG GAC-TAGGGA CT---TTATG GTTAACTACC TGAT------
Riebeckia sp.             GGTTTGTGAC CTCGATGTTG GAT-TAGGAA CA---TAATG ATTAACAATC AGCT------
Rumina decollata          TGTTTGTGAC CTCGATGTTG GAC-TAGGGA CT---AATTG GTTAACCACC AGGA------
Subulina octona           TGATTGTGAC CTCGATGTTG GAC-TAGGGA CAAATGAATG GTTAGATGCC TGTT------
Subulina striatella       TGTTTGTGAC CTCGATGTTG GAC-TAGGGA CA--TTAGTG GCGAGATGTC AAAT------
Subulina vitrea           AGATTGTGAC CTCGATGTTG GAT-TAGGAA CT---TAATG GTTAGCCACC AAGT------
Subulona sp.              GGATTRTGAC CTCGAWGTTG GAT-TAGGGA TT--AGATAG GTTAGCCATC TTTT-----T
Tortaxis erectus          TGATTGTGAC CTCGATGTTG GAC-TAGGGA CT---TAATG GTTAATAACT AAAA------
Xerocerastus sp.          AGTTTGTGAC CTCGATGTTG GAT-TAGGGA AA--ATAAAG GTTAGTAATT TTTA------
Zootecus insularis        TGATTGTGAC CTCGATGTTG GACTTAGGGC CC---AAATG GTTAGCCACC AAGC------
Coeliaxis blandii         TGATTGTGAC CTCGATGTTG GAT-TAGGGC CT---AAAAG GTAAGTAACC TAGT------
Pyrgina umbilicata        AGATTGTGAC CTCGATGTTG GAC-TAGGGC CC---TGAGG GTTAACCACC CAAA------
Cecilioides gokweanus     TGATTGTGAC CTCGATGTTG GAC-TAGGGA CT---TTCTG ATTAACCATC AAAC------
Ferussacia folliculus     AGATTATGAC CTCGATGTTG GAC-TAGGAA AC---TTATG GTTAGACACC AAAA------
Thyrophorella thomensis   AGATTGTGAC CTCGATGTTG GAC-TAGGGC CC--ATT-AG GTTAACCACC TTAA------
Gibbulinella dewinteri    AGTTTGTGAC CTCGATGTTG GAC-TAGGAA CC---TAATA ATAAGCAATT AAAT------
Gonaxis quadrilateralis   AGATTGTGAC CTCGATGTTG GAC-TAGGAA CT---TAATA ATTAGTAATT AAAA------
Gonospira sp.             AGATTGCGAC CTCGATGTTG GAC-TAGGAA CC---TTATG ACTAAAAGTC TAAA------
NUCLEOTIDES INCLUDED      mmmmmmmmmm mmmmmmmmmm mmm-mmmmmm mm---mm-mm mmmmmmmmmm mmmm------
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                          ....|....| ....|....| ....|....| ....
                                  550        560        570
Achatina fulica           GGG-GCGGTT CTGTTCGAAC TTTTCCTACC CTAC
Achatina achatina         TGT-AAGGTT CTGTTCGAAC TTT-TTATCC CTAC
Achatina stuhlmanni       TGG-ATTGTT CTGTTCGAAC AC--TAGACC CTAC
Cochlitoma ustulata       AGG-CAAGTT CTGTTCGAAC TTT-CCACCC CTAC
Allopeas clavulinum       TAGATTTGCT CTGTTCGAGC TT--TAACCC CTAC
Bocageia sp.              CTG-GATGTT CTGTTCGAAC ATT-TTACCC CTAC
Leptinaria lamellata      AGG-ATAGTT CTGTTCGAAC TC--TGTACC CTAC
Paropeas clavulinum       TAG-ATTGCT CTGTTCGAGC AC--TTGTTC CTAC
Riebeckia sp.             TTG-TAAGTT CTGTTCGAAC TTT-TACTTC CTAC
Rumina decollata          TAG-ATGATT CTGTTCGAAT CC--TTCACC CTAC
Subulina octona           TTG-CTGGTT CTGTTCGAAC TT--AAAACC CTAC
Subulina striatella       TTG-CAGGTT CTGTTCGAAC AT--ATAACC CTAC
Subulina vitrea           AAG-TTAGTT CTGTTCGAAC CC--TTCCTC CTAC
Subulona sp.              TAA-TGAAYT CTGTTCRAAY TWA-ATCNCC CTAC
Tortaxis erectus          AAG-ATTGTT CTGTTCGAAC ATA-ACAACC CTAC
Xerocerastus sp.          -TA-TAAGTT CTGTTCGAAC ATT-TTTACC CTAC
Zootecus insularis        TGG-ATGGTT CTGTTCGAAC CG--TTTACC CTAC
Coeliaxis blandii         TAG-ATAGTT CTGTTCGAAC TT--TTTACC CTAC
Pyrgina umbilicata        TGG-ACTGCT CTGTTCGAGC AT--TGTTCC CTAC
Cecilioides gokweanus     TAGATTTGTT CTGTTCGAAC TTT-TTTACC CTAC
Ferussacia folliculus     TGT-TATGTT CTGTTCGAAC ATT-AAACTC CTAC
Thyrophorella thomensis   CGG-ATAGCT CTGTTCGAGC TT--CTTACC CTAC
Gibbulinella dewinteri    TGG-AAAGTT CTGTTCGAAC AA--ATTATC CTAC
Gonaxis quadrilateralis   TTG-ATGGTT CTGTTCGAAC TT--ATTTTC CTAC
Gonospira sp.             AGG-AGTGTT CTGTTCGAAC AAT-TATTTC CTAC
NUCLEOTIDES INCLUDED      -mm----mmm mmmmmmmmmm --------mm mmmm
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Appendix 3.6: Log likelihood scores of the different models used for the Achatinoidea using (A) 3435 unambiguously aligned nucleotides from the rRNA gene cluster; (B) 861 unambiguously aligned nucleotides of actin; (B.1) 574 unambiguously aligned nucleotides of the 1^{st} and 2^{nd} codon positions of actin; (B.2) 287 unambiguously aligned nucleotides of the 3^{rd} codon position of actin; (C) 328 unambiguously aligned nucleotides of histone 3; (C.1) 218 unambiguously aligned nucleotides of the 1^{st} and 2^{nd} codon positions of histone 3; (D.2) 110 unambiguously aligned nucleotides of the 3^{rd} codon position of histone 3; (D) 607 unambiguously aligned nucleotides of CO1; (D.1) 404 unambiguously aligned nucleotides of the 1^{st} and 2^{nd} codon positions of CO1; (D.2) 203 unambiguously aligned nucleotides of the 3^{rd} codon position of CO1; and (E) 294 unambiguously aligned nucleotides of the 16S rRNA gene. Scores in **bold** belong to optimal models as determined by Likelihood Ratio Test. Note that the K2P and F81 models are non-nested and therefore cannot be compared for significant difference using the LRT.

	(A)	(B)	(B.1)	(B.2)	(C)	(C.1)	(C.2)	(D)	(D.1)	(D.2)	(E)
Model	**rRNA gene cluster**	**Actin-combined**	**Actin-1^{st}+2^{nd} codons**	**Actin 3^{rd} codons**	**Histone 3**	**Histone 3 1^{st}+2^{nd} codons**	**Histone 3 3^{rd} codons**	**CO1**	**CO1 1^{st}+2^{nd} codons**	**CO1 3^{rd} codons**	**16S rRNA**
JC69	8722.54544	7034.70607	1582.96160	4551.89700	2263.05590	387.26745	1519.62452	9562.61908	2707.77230	5655.47905	3720.10115
JC69+Γ	8166.65498	6318.61908	1457.51470	4364.19564	2055.16076	387.26745	1503.87233	8204.89347	2288.23519	5546.19261	3285.58073
F81	8696.59840	6997.51585	1577.09006	4404.85550	2259.84534	384.18591	1516.51436	9502.53463	2670.20603	5476.35282	3669.15845
F81+Γ	8139.63345	6263.18854	1452.88144	4302.40699	2050.07377	384.18591	1499.41097	8005.17426	2231.16774	5356.26679	3214.09399
K2P	8604.34705	6815.80245	1569.84105	4225.33326	2188.48052	385.69744	1444.53135	9484.47349	2553.77652	5631.30210	3670.91274
K2P+Γ	8038.52028	6058.78021	1439.71055	4120.55651	1977.17697	385.69744	1425.02655	8027.24407	2125.16439	5511.17394	3223.49673
HKY85	8577.13470	6776.05418	1567.69219	4205.14693	2183.03436	382.58884	1438.38403	9391.53749	2525.16880	5283.03501	3610.74395
HKY85+Γ	8000.79127	6026.10365	1439.81885	4092.36162	1969.91019	382.58884	1420.79835	7546.29497	2090.98831	4997.88304	3103.10529
TrN93	8524.93663	6730.23510	**1540.64290**	4201.59908	2172.17869	376.07479	1444.42135	9390.78281	2515.71421	5278.46766	3609.31276
TrN93+Γ	7970.59211	6024.01007	1420.57243	4092.24782	1965.63536	376.07479	1420.52557	7522.62965	2083.36045	4997.26819	3102.99238
GTR	8515.61458	6707.83141	1539.76409	4145.18258	2167.71615	**370.44371**	1411.10672	9096.60454	2506.42682	5222.31450	3536.04532
GTR+Γ	**7951.71731**	**5993.90425**	1420.05757	**4051.76435**	**1960.84472**	370.44371	**1408.67625**	**7507.55611**	**2069.51524**	**4993.80631**	**3089.76804**

Appendix 3.7: Summary of ambiguous sites for the actin gene for the Achatinoidea and the three streptaxid outgroup taxa

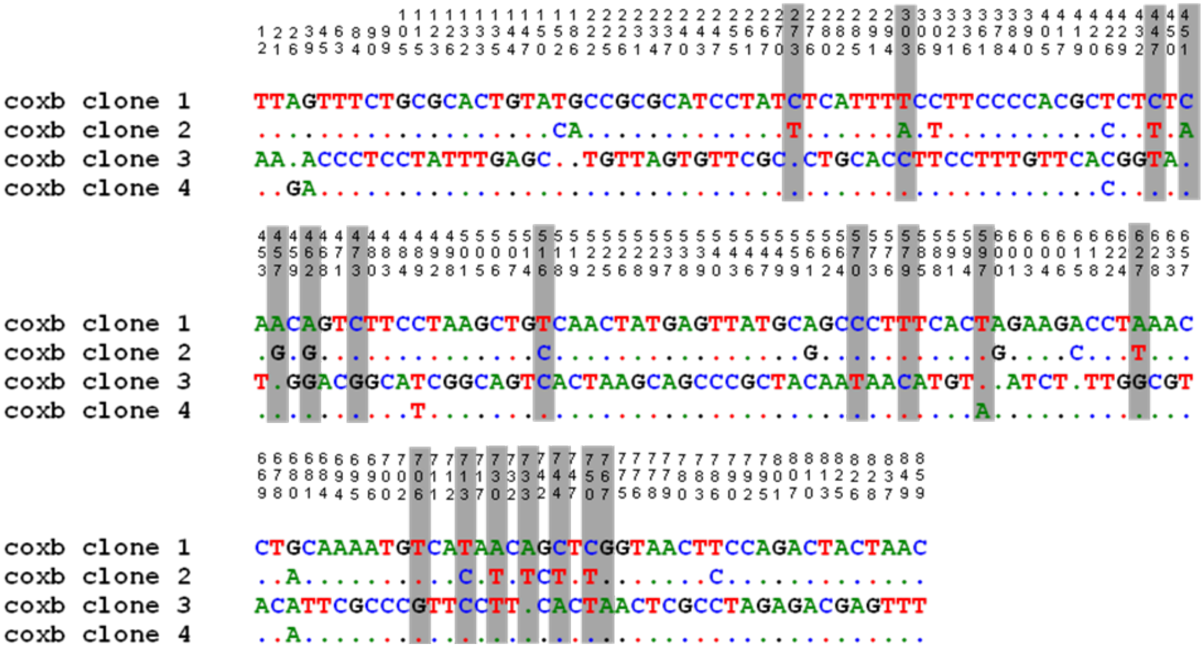
Species	Total ambiguous sites	% ambiguous sites (out of 873 total; 861 for subv)	Total ambiguous 3rd codon positions	% ambiguous 3rd codon positions relative to all ambiguous sites	Number of RY sites at ambiguous 3rd codon positions	% RY sites relative to all ambiguous 3rd codon positions	Number of ambiguous amino acids	% ambiguous amino acids (out of 291 total; 287 for subv)
ACHATINIDAE								
Achatina achatina	45	5.15	40	88.89	31	77.50	4	1.37
Achatina fulica	18	2.06	16	88.89	12	75.00	2	0.69
Achatina stuhlmanni	2	0.23	1	50.00	1	100.00	1	0.34
Cochlitoma ustulata	0	0	0	0	0	0	0	0
SUBULINIDAE								
Allopeas clavulinum	0	0	0	0	0	0	0	0
Bocageia sp.	101	11.57	85	84.16	51	60.00	14	4.81
Eutomopeas layardi	0	0	0	0	0	0	0	0
Leptinaria lamellata	0	0	0	0	0	0	0	0
Paropeas achatinaceum	1	0.11	0	0	0	0	1	0.34
Riebeckia sp.	76	8.71	59	77.63	44	74.58	15	5.15
Rumina decollata	29	3.32	24	82.76	16	66.67	3	1.03
Subulina octona	0	0	0	0	0	0	0	0
Subulina striatella	26	2.98	25	96.15	15	60.00	0	0
Subulina vitrea	37	4.30	32	86.49	26	81.25	4	1.39
Subulona sp.	0	0	0	0	0	0	0	0
Tortaxis erectus	32	3.67	26	81.25	20	76.92	7	2.41
Xerocerastus sp.	0	0	0	0	0	0	0	0
Zootecus insularis	20	2.29	18	90.00	16	88.89	1	0.34
COELIAXIDAE								
Coeliaxis blandii	21	2.41	13	61.90	9	69.23	7	2.41
Pyrgina umbilicata	88	10.08	78	88.64	55	70.51	7	2.41
THYROPHORELLIDAE								
Thyrophorella thomensis	62	7.10	51	82.26	37	72.55	7	2.41
GLESSULIDAE								
Glessula ceylanica	53	6.07	34	64.15	16	47.06	19	6.53
FERRUSSACIIDAE								
Cecilioides gokweanus	4	0.46	4	100.00	3	75.00	0	0
Ferussacia folliculus	4	0.46	4	100.00	4	100.00	0	0
STREPTAXIDAE (Outgroup)								
Gibbulinella dewinteri	6	0.69	6	100.00	4	66.67	0	0
Gonaxis quadrilateralis	55	6.30	49	89.09	34	69.39	4	1.37
Gonospira sp.	77	8.82	64	83.12	37	57.81	9	3.09

Appendix 3.8A: Summary of cloned actin sequences from three achatinoid species.

Species cloned	Total ambiguous sites	Total variable sites found in clones	Clone #	Sequence type*
Coeliaxis blandii	29	163	coxb clone 1	a
			coxb clone 2	b
			coxb clone 3	c
			coxb clone 4	d
Cochlitoma granulata	9	72	coig clone 1	e
			coig clone 2	f
			coig clone 3	g
			coig clone 4	h
			coig clone 5	i
			coig clone 6	j
			coig clone 7	k
Leptinaria lamellata	0	4	letl clone 1	l
			letl clone 2	m
			letl clone 3	l
			letl clone 4	n
			letl clone 5	l
			letl clone 6	o

* NOTE: Clones with the same letter have identical actin sequences.

Appendix 3.8B: Variable sites across the actin sequence for the different clones of **(1)** *Coeliaxis blandii*, **(2)** *Cochlitoma granulata* and **(3)** *Leptinaria lamellata*. The number shown directly above each site pertains to a variable site. Shaded positions refer to ambiguous sites found in the direct cycle sequences.



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                       111111111111222222222222222222223333333334444444444
              122346899012233344558222333444566777888990002367890112223455
              216953409553623547026256147037517036025143691618405790692701

coxb clone 1  TTAGTTTCTGCGCACTGTATGCCGCGCATCCTATCTCATTTTCCTTCCCCACGCTCTCTC
coxb clone 2  ...................CA.............T......A.T..........C..T.A
coxb clone 3  AA.ACCCTCCTATTTGAGC..TGTTAGTGTTCGC.CTGCACCTTCCTTTGTTCACGGTA.
coxb clone 4  ..GA..................................................C.....

              444444444444455555555555555555555555555555555556666666666666
              555667788889900001111222223334444456667777889990000011222235
              379281303492815674689256897890367991240369581470134658247837

coxb clone 1  AACAGTCTTCCTAAGCTGTCAACTATGAGTTATGCAGCCCTTTCACTAGAAGACCTAAAC
coxb clone 2  .G.G..............C................G...........G....C...T...
coxb clone 3  T.GGACGGCATCGGCAGTCACTAAGCAGCCCGCTACAATAACATGT..ATCT.TTGGCGT
coxb clone 4  ..........T...................................A.............

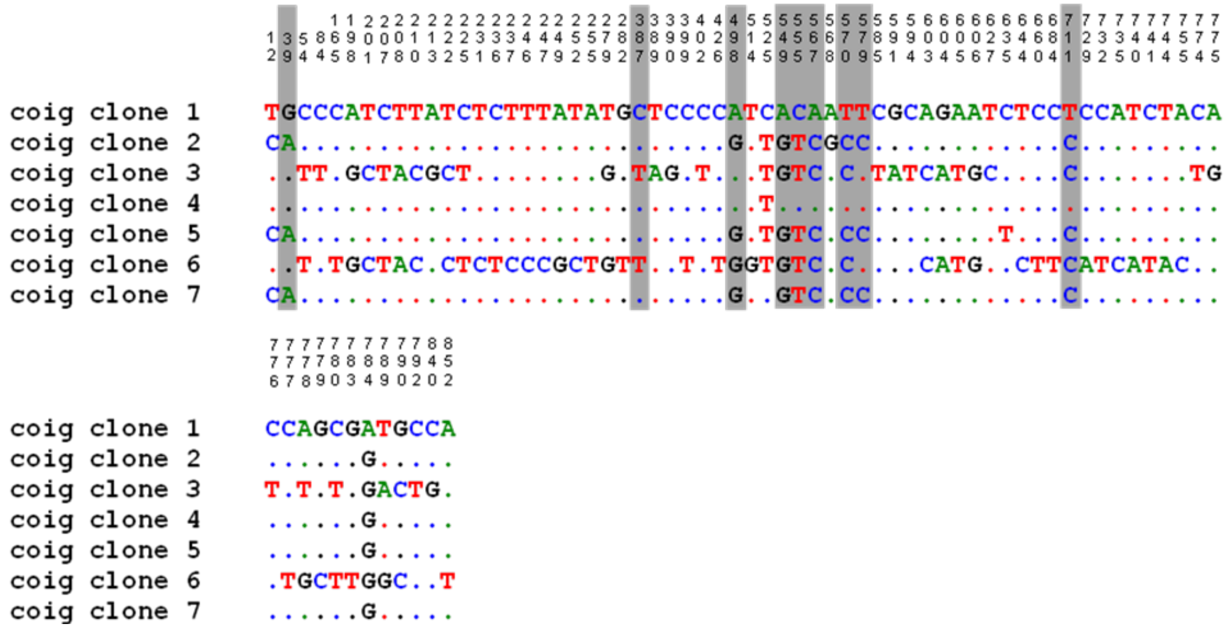
              6666666677777777777777777777777778888888888
              6788899900011113334445677778889990011222345
              9801445602612370232470756890360251703568799

coxb clone 1  CTGCAAAATGTCATAACAGCTCGGTAACTTCCAGACTACTAAC
coxb clone 2  ..A..........C.T.TCT.T.......C.............
coxb clone 3  ACATTCGCCCGTTCCTT.CACTAACTCGCCTAGAGACGAGTTT
coxb clone 4  ..A........................................
```

(1) *Coeliaxis blandii* (coxb)

NOTE: A total of 163 variable positions were detected from the four clones, with 132 positions alone attributable to Clone 3; these positions were not picked up as ambiguities in the direct sequence.

Appendix 3.8B (contd.)



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                    11222222222222222222233334445555555555566666666677777777777
                 135869000112233344455788899029124566778990000234681233444577
                 294458178032516767925927909268459578095143456754041925014545

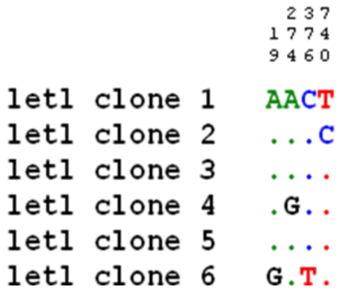
coig clone 1     TGCCCATCTTATCTCTTTATATGCTCCCCATCACAATTCGCAGAATCTCCTCCATCTACA
coig clone 2     CA...........................G.TGTCGCC............C.........
coig clone 3     ..TT.GCTACGCT........G.TAG.T...TGTC.C.TATCATGC....C.......TG
coig clone 4     ...............................T............................
coig clone 5     CA...........................G.TGTC.CC........T...C.........
coig clone 6     ..T.TGCTAC.CTCTCCCGCTGTT..T.TGGTGTC.C....CATG..CTTCATCATAC..
coig clone 7     CA...........................G..GTC.CC............C.........

                 777777777788
                 777788889945
                 678903490202

coig clone 1     CCAGCGATGCCA
coig clone 2     ......G.....
coig clone 3     T.T.T.GACTG.
coig clone 4     ......G.....
coig clone 5     ......G.....
coig clone 6     .TGCTTGGC..T
coig clone 7     ......G.....
```

(2) *Cochlitoma granulata* (coig)

NOTE: A total of 72 variable positions were found in the 7 clones, with 55 of these derived from Clones 3 and 6 and which were not picked up as ambiguities in the direct sequence.

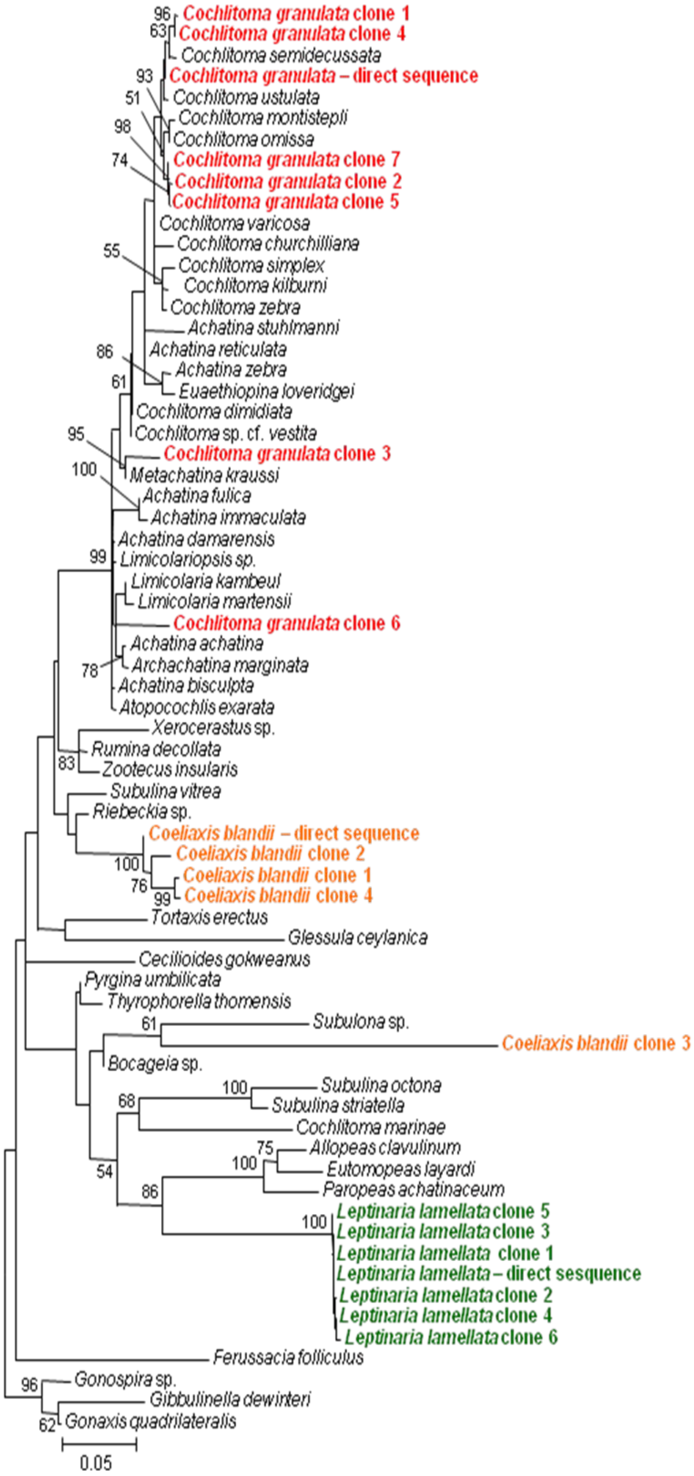


```
                  237
                 1774
                 9460

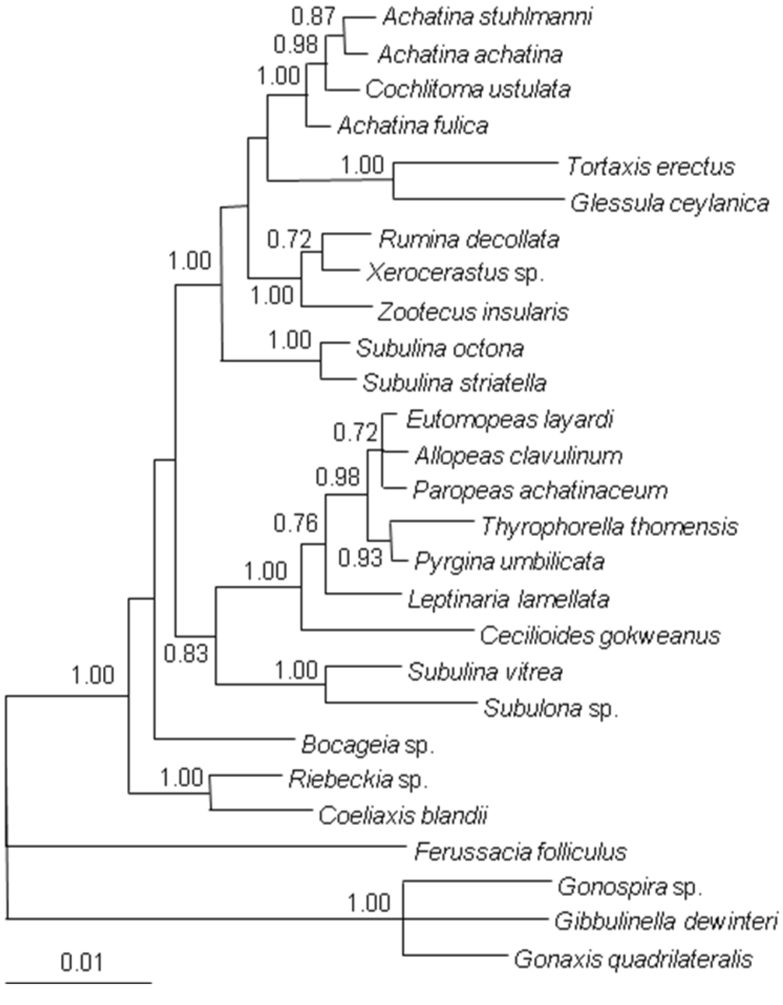
letl clone 1     AACT
letl clone 2     ...C
letl clone 3     ....
letl clone 4     .G..
letl clone 5     ....
letl clone 6     G.T.
```

(3) *Leptinaria lamellata* (letl)

NOTE: *Leptinaria lamellata* did not exhibit any ambiguous positions in the direct sequence. Nevertheless, this taxon was cloned to determine if the direct sequence missed any of the ambiguous sites. Six clones were obtained, three of which (clones 1, 3 and 5) were identical with the direct sequence.



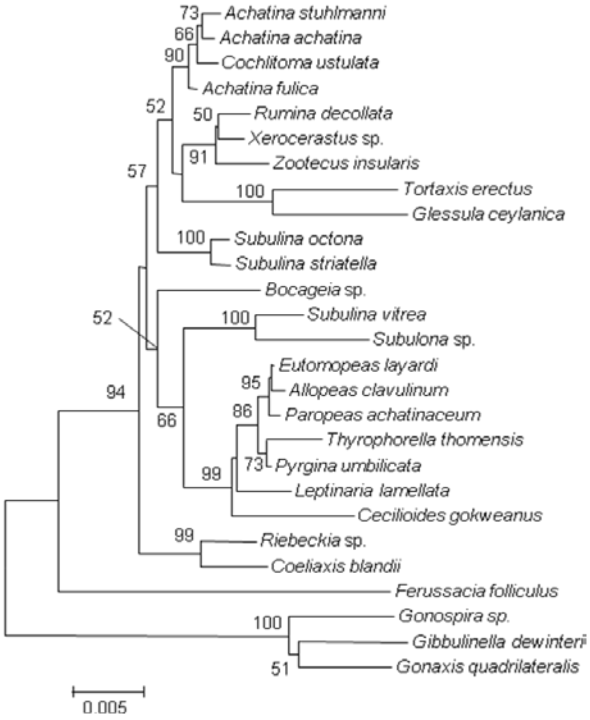
Appendix 3.9: Neighbor-joining phylogenetic tree of the Achatinoidea (including taxa from the Achatinidae) based on the actin and showing the clones of the three representative taxa (*Cochlitoma granulata*, *Coeliaxis blandii* and *Leptinaria lamellata*). The tree was constructed using 861 unambiguously aligned nucleotide sites and rooted on the streptaxids *Gibbulinella dewinteri*, *Gonaxis quadrilateralis* and *Gonospira* sp. using the GTR+Γ model of DNA sequence evolution. Bootstrap values lower than 50% are not shown. The scale bar represents 5 substitutional changes per 100 nucleotides.



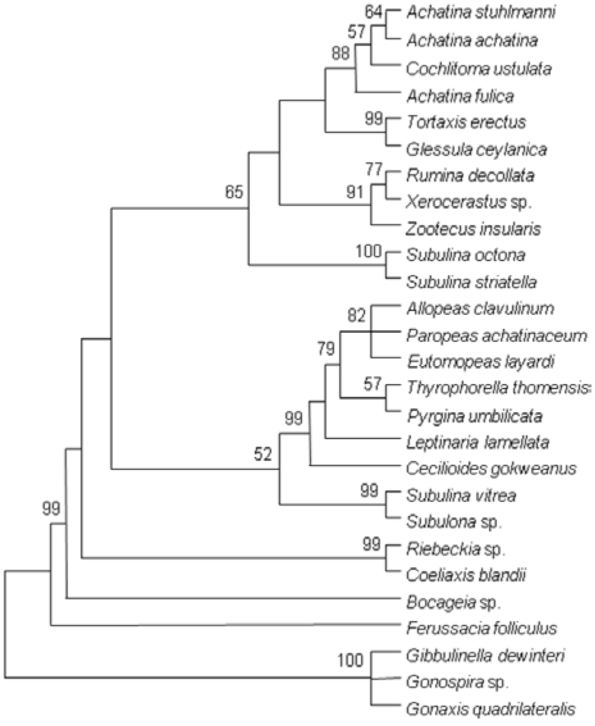
(A) BI (LSU rRNA)

Appendix 3.10: Phylogenetic trees of the Achatinoidea based on the large subunit rRNA gene using (**A**) Bayesian analysis, (**B**) neighbor-joining (p. 440) and (**C**) maximum parsimony based on two equally parsimonious trees (p. 440). The phylogenies were constructed from 3435 unambiguously aligned nucleotide sites and were rooted on the streptaxids *Gibbulinella dewinteri*, *Gonaxis quadrilateralis* and *Gonospira* sp. Bayesian posterior probabilities in (**A**) indicate support for individual branches in the Bayesian analysis based on the last 1000 trees. Posterior probabilities lower than 0.7 are not shown. Bootstrap values in (**B**) and (**C**) indicate the percentage support for individual branches based on 1000 replicates. Bootstrap values lower than 50% are not shown. The scale bar for (**A**) represents 1 substitutional change per 100 nucleotides and that of (**B**) represents 5 substitutional changes per 1000 nucleotides.

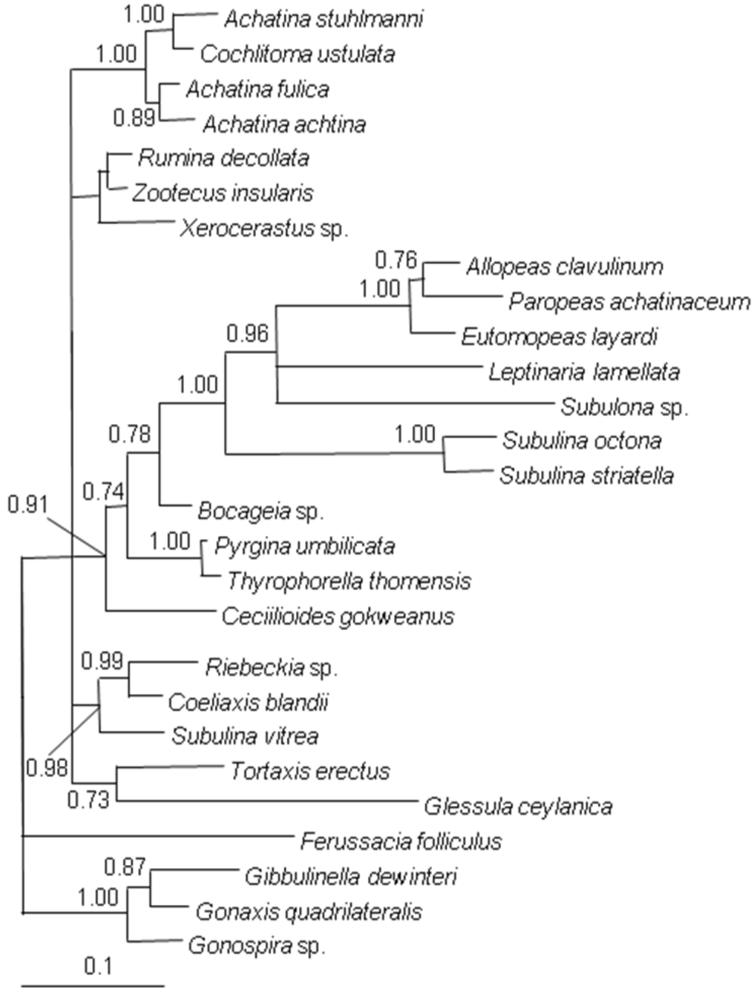
Appendix 3.10 (contd.)



(B) NJ (LSU rRNA)



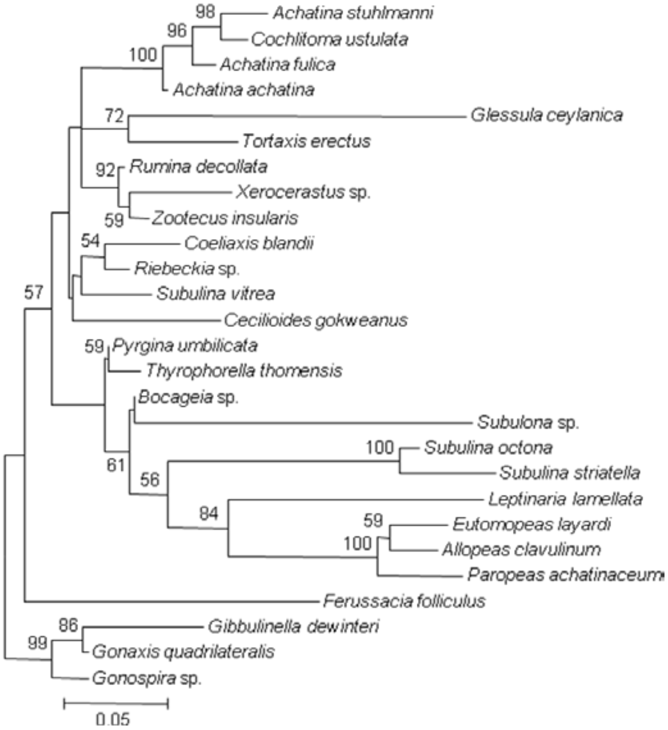
(C) MP (LSU rRNA)



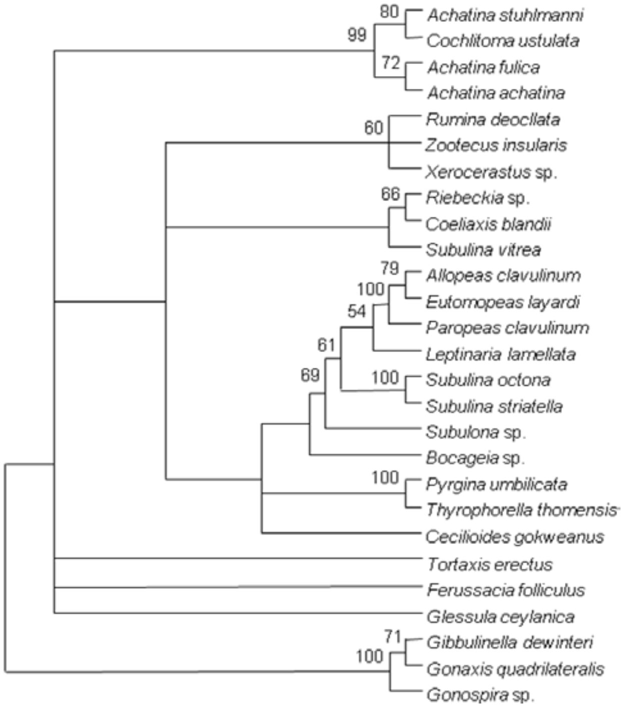
(A) BI (actin)

Appendix 3.11: Phylogenetic trees of the Achatinoidea based on the actin gene using (**A**) Bayesian analysis, (**B**) neighbor-joining (p. 442) and (**C**) maximum parsimony based on seven equally parsimonious trees (p. 442). The phylogenies were constructed from 861 unambiguously aligned nucleotide sites and were rooted on the streptaxids *Gibbulinella dewinteri*, *Gonaxis quadrilateralis* and *Gonospira* sp. Bayesian posterior probabilities in (**A**) indicate support for individual branches in the Bayesian analysis based on the last 1000 trees. Posterior probabilities lower than 0.7 are not shown. Bootstrap values in (**B**) and (**C**) indicate the percentage support for individual branches based on 1000 replicates. Bootstrap values lower than 50% are not shown. The scale bar for (**A**) represents 1 substitutional change per 10 nucleotides and that of (**B**) represents 5 substitutional changes per 100 nucleotides.

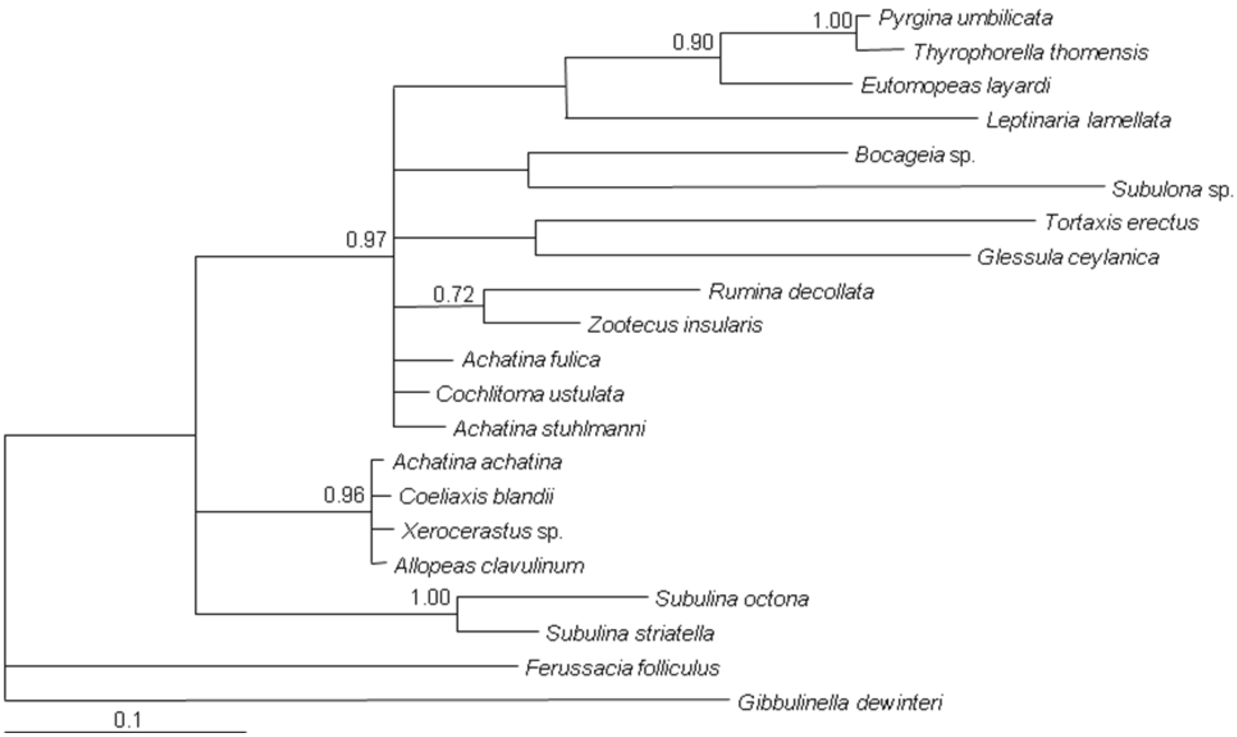
Appendix 3.11 (contd.)



(B) NJ (actin)



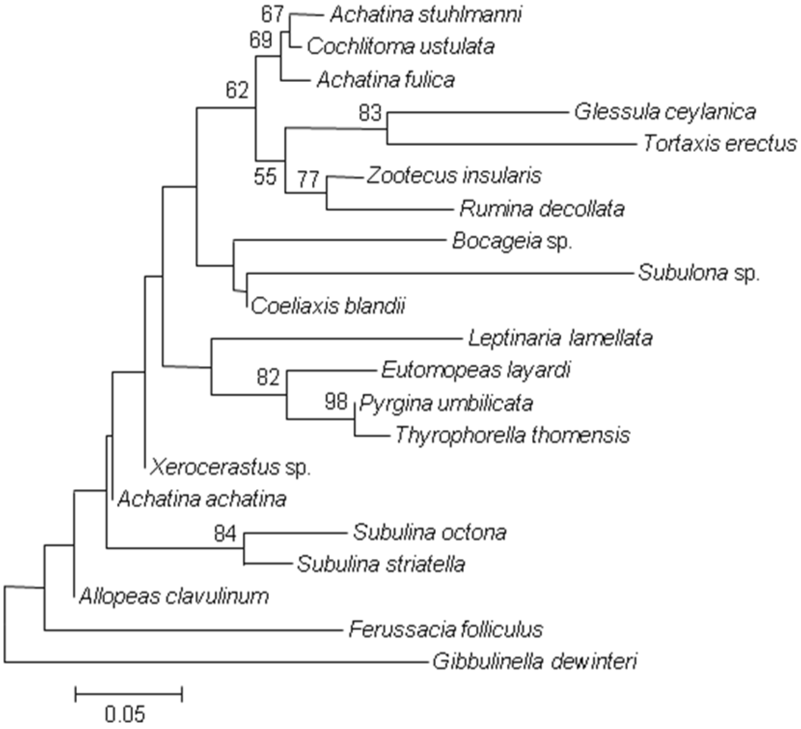
(C) MP (actin)



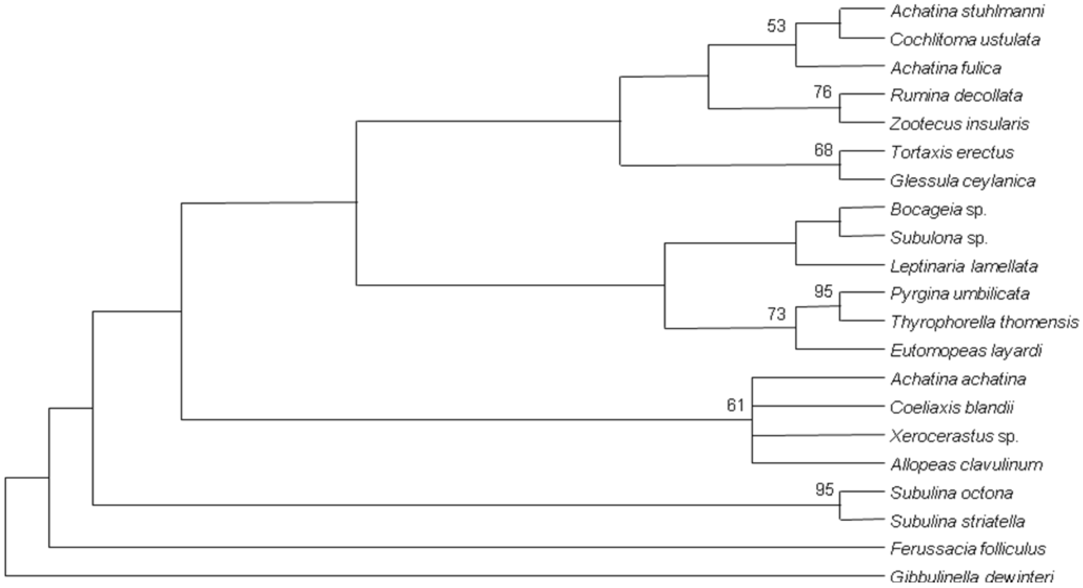
(A) BI (histone 3)

Appendix 3.12: Phylogenetic trees of the Achatinoidea based on the histone 3 gene using (**A**) Bayesian analysis, (**B**) neighbor-joining (p. 444) and (**C**) maximum parsimony based on five equally parsimonious trees (p. 444). The phylogenies were constructed from 328 unambiguously aligned nucleotide sites and were rooted on the streptaxid *Gibbulinella dewinteri*. Bayesian posterior probabilities in (**A**) indicate support for individual branches in the Bayesian analysis based on the last 1000 trees. Posterior probabilities lower than 0.7 are not shown. Bootstrap values in (**B**) and (**C**) indicate the percentage support for individual branches based on 1000 replicates. Bootstrap values lower than 50% are not shown. The scale bar for (**A**) represents 1 substitutional change per 10 nucleotides and that of (**B**) represents 5 substitutional changes per 100 nucleotides. Note that the achatinoids *Cecilioides gokweanus*, *Paropeas achatinaceum*, *Riebeckia* sp. and *Subulina vitrea* and the streptaxids *Gonaxis quadrilateralis* and *Gonospira* sp. were not included in the phylogenies as they were not successfully sequenced.

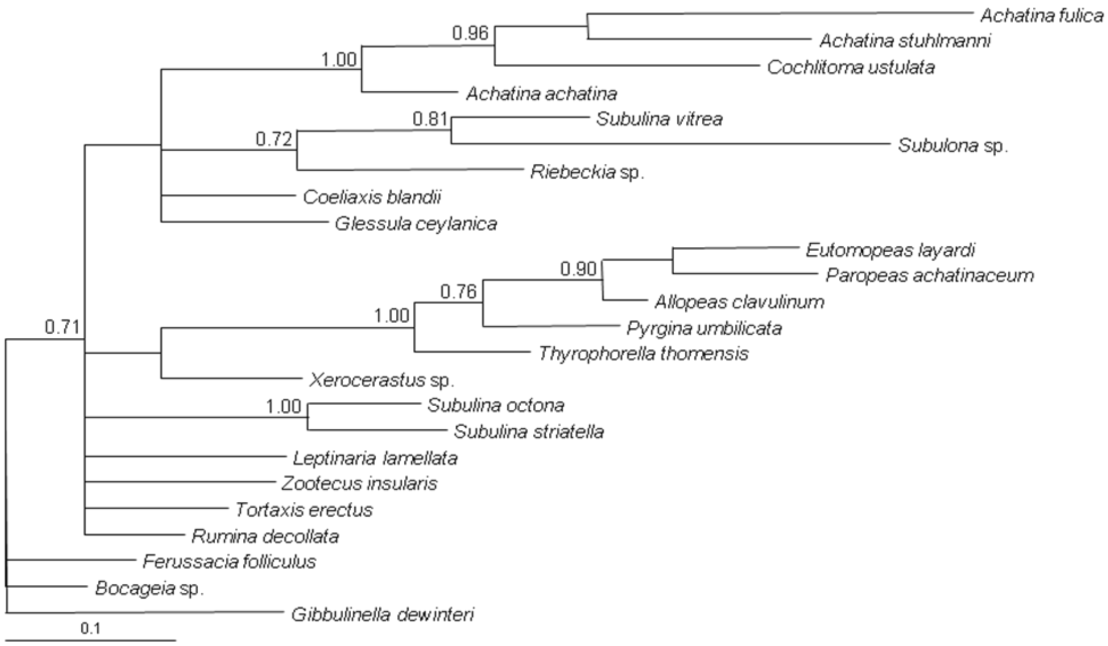
Appendix 3.12 (contd.)



(B) NJ (histone 3)



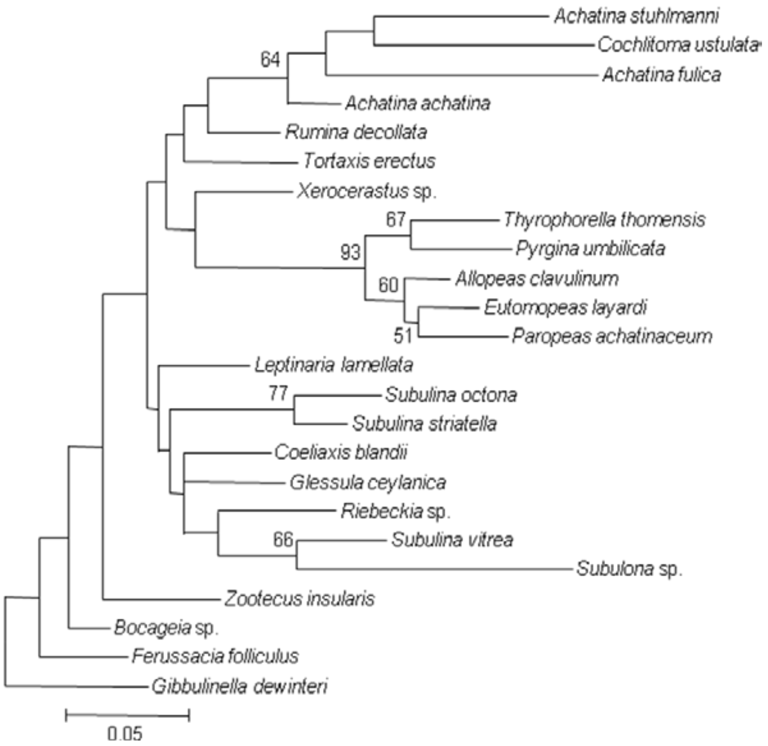
(C) MP (histone 3)



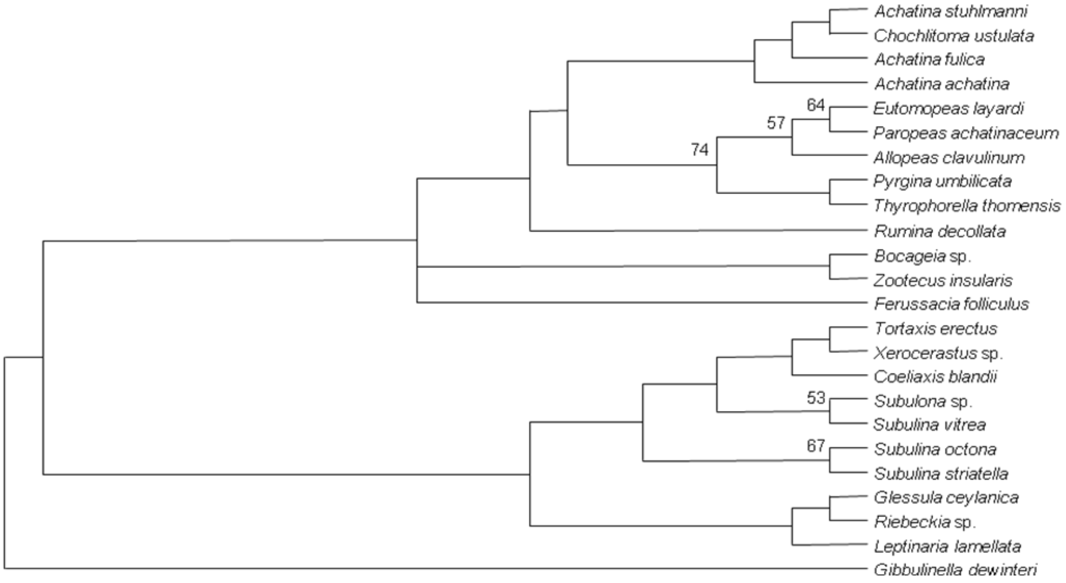
(A) BI (1st and 2nd codon positions of CO1)

Appendix 3.13: Phylogenetic trees of the Achatinoidea based on the 1st and 2nd codon positions of the CO1 gene using (**A**) Bayesian analysis, (**B**) neighbor-joining (p. 446) and (**C**) maximum parsimony based on two equally parsimonious trees (p. 446). The phylogenies were constructed from 404 unambiguously aligned nucleotide sites and were rooted on the streptaxids *Gibbulinella dewinteri*, *Gonaxis quadrilateralis* and *Gonospira* sp. Bayesian posterior probabilities in (**A**) indicate support for individual branches in the Bayesian analysis based on the last 1000 trees. Posterior probabilities lower than 0.7 are not shown. Bootstrap values in (**B**) and (**C**) indicate the percentage support for individual branches based on 1000 replicates. Bootstrap values lower than 50% are not shown. . The scale bar for (**A**) represents 1 substitutional change per 10 nucleotides and that of (**B**) represents 5 substitutional changes per 100 nucleotides. Note that *Ceceilioides gokweanus* and the streptaxids *Gonaxis quadrilateralis* and *Gonospira* sp. were excluded in the analyses as they were not successfully sequenced.

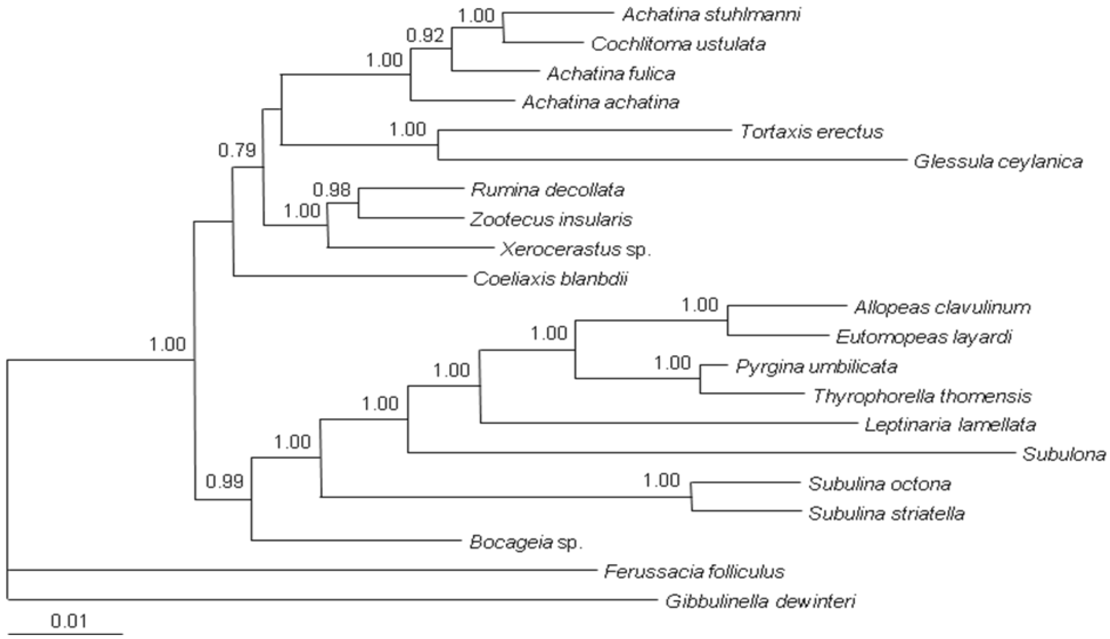
Appendix 3.13 (contd.)



(B) NJ (1st and 2nd codon positions of the CO1 gene)



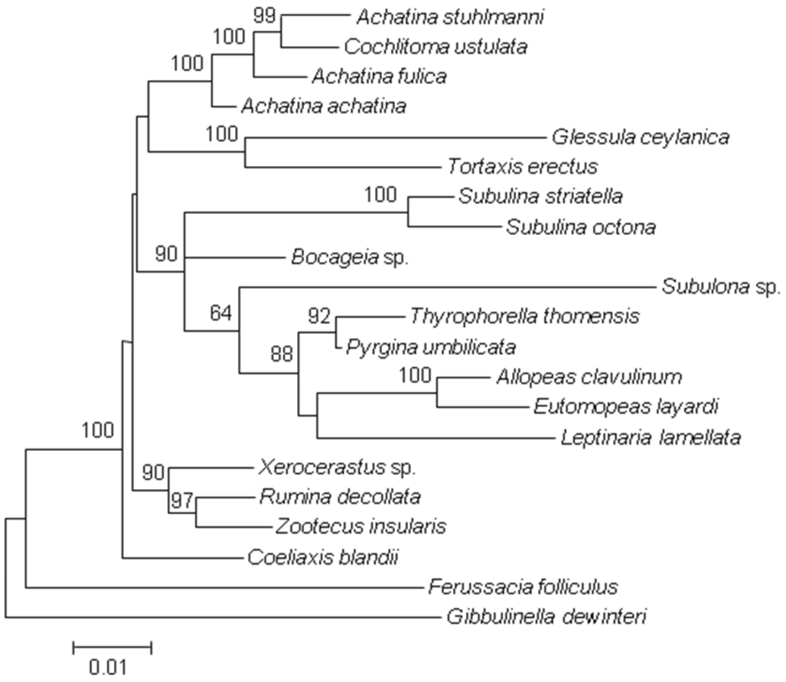
(C) MP (1st and 2nd codon positions of the CO1 gene)



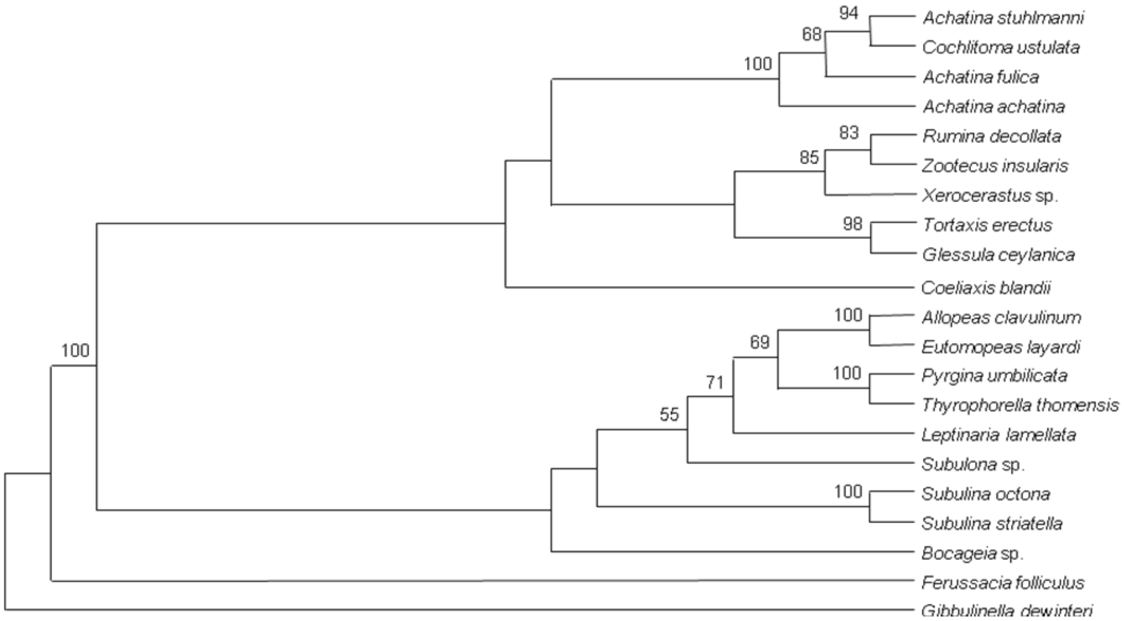
(A) BI (concatenated sequence – taxa with complete datasets only)

Appendix 3.14: Phylogenetic trees of the Achatinoidea (taxa with complete datasets only) based on the combined dataset of the LSU rRNA, actin and histone 3 genes and the 1st and 2nd codon positions of the CO1 gene using (**A**) Bayesian analysis, (**B**) neighbor-joining (p. 448) and (**C**) maximum parsimony based on one most parsimonious tree (p. 448). The phylogenies were constructed from a concatenated sequence of 5028 nucleotides and were rooted on the streptaxid *Gibbulinella dewinteri*. Bayesian posterior probabilities in (**A**) indicate support for individual branches in the Bayesian analysis based on the last 1000 trees. Posterior probabilities lower than 0.7 are not shown. Bootstrap values in (**B**) and (**C**) indicate the percentage support for individual branches based on 1000 replicates. Bootstrap values lower than 50% are not shown. The scale bars for (**A**) and **(B)** represent 1 substitutional change per 100 nucleotides. Note that the achatinoid *Cecilioides gokweanus*, *Paropeas achatinaceum*, *Riebeckia* sp. and *Subulina vitrea* and the streptaxids *Gonaxis quadrilateralis* and *Gonospira* sp. were not included in the phylogenies as they lack at least one of the genes used for the combined analyses.

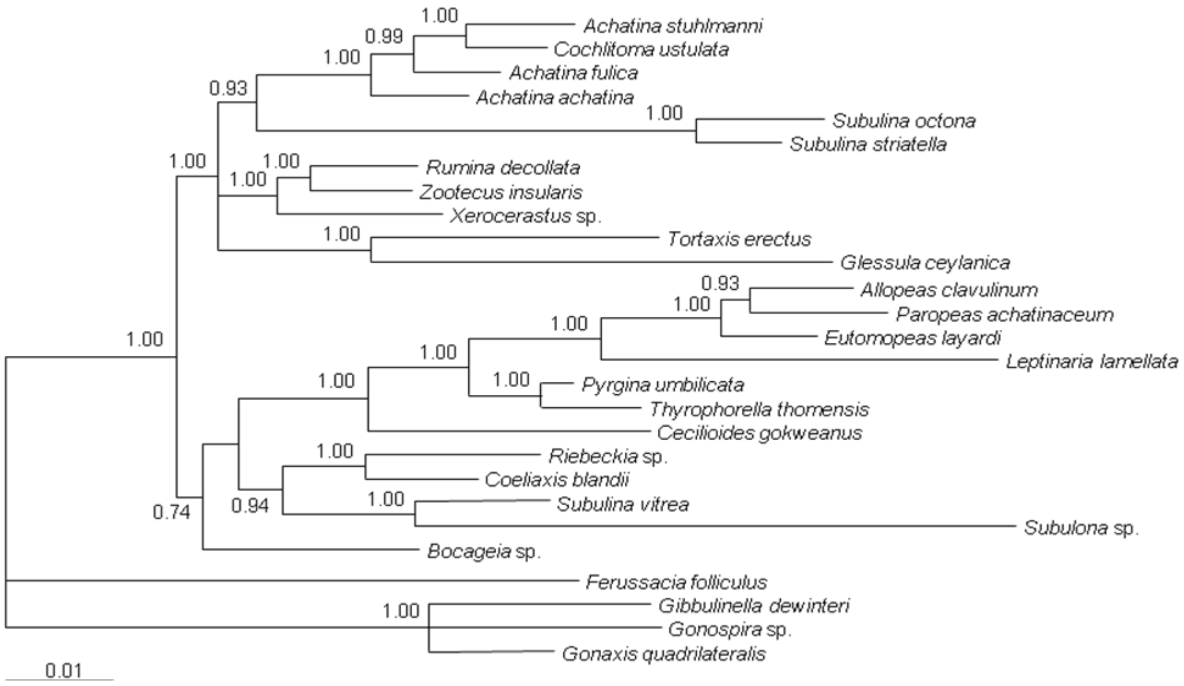
Appendix 3.14 (contd.)



(B) NJ (concatenated sequence – taxa with complete datasets only)



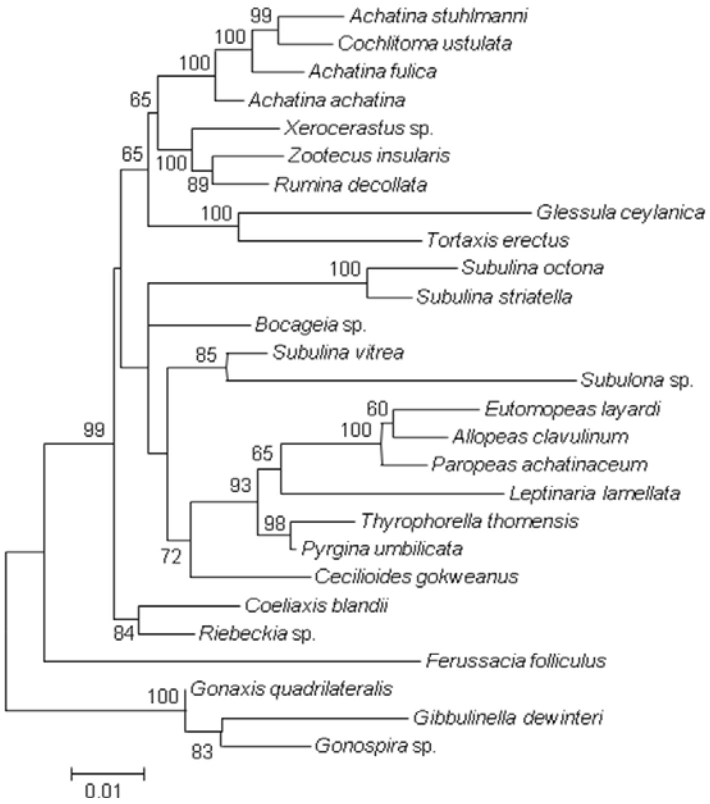
(C) MP (concatenated sequence – taxa with complete datasets only)



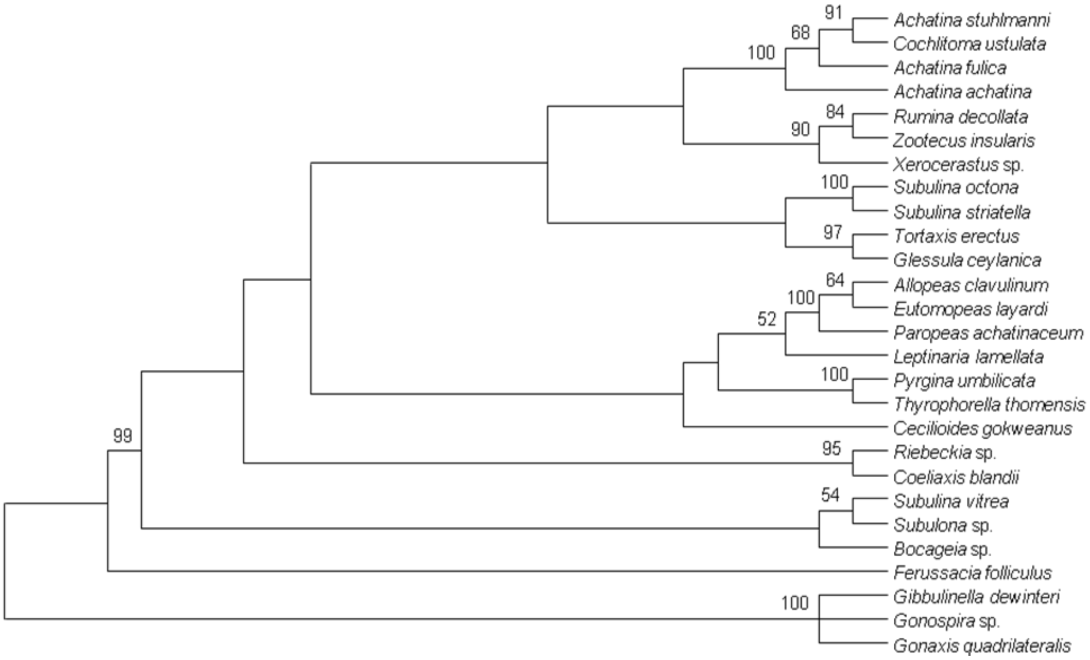
(A) BI (concatenated sequence – all taxa)

Appendix 3.15: Phylogenetic trees of the Achatinoidea (all taxa) based on the combined dataset of the LSU rRNA, actin and histone 3 genes and the 1st and 2nd codon positions of the CO1 gene using (**A**) Bayesian analysis, (**B**) neighbor-joining (p. 450) and (**C**) maximum parsimony based on two equally parsimonious trees (p. 450). The phylogenies were constructed from a concatenated sequence of 5028 nucleotides and were rooted on the streptaxid *Gibbulinella dewinteri*. Bayesian posterior probabilities in (**A**) indicate support for individual branches in the Bayesian analysis based on the last 1000 trees. Posterior probabilities lower than 0.7 are not shown. Bootstrap values in (**B**) and (**C**) indicate the percentage support for individual branches based on 1000 replicates. Bootstrap values lower than 50% are not shown. The scale bars for (**A**) and **(B)** represent 1 substitutional change per 100 nucleotides.

Appendix 3.15 (contd.)



(B) NJ (concatenated sequence – all taxa)



(C) MP (concatenated sequence – all taxa)

Appendix 4.1: Alignment of the LSU rRNA gene for the Achatinidae and the subulinid outgroup taxon *Rumina decollata*. Positions included for the phylogeny analyses were marked by “`m`” within “`NUCEOTIDES INCLUDED`”.

```
                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                     10         20         30         40         50         60
Achatina fulica             ---------- ---------A TTGCA-GAAC ACATTGAACA TCGACACCTT GAACGCACAT
Achtina immaculata          ---------- ---------- ---------- ------AACA TCGACACCTT GAACGCACAT
Achatina reticulata         ---------- ---------- ----A-GAAC ACATTGAACA TCGACACCTT GAACGCACAT
Achatina zanzibarica        ---------- ---------- ---------- ------AACA TCGACACCTT GAACGCATAT
Euaethiopina loveridgei     ---------- ---------A TTGCA-GAAA CCATTGAACA TCGAC-CCTT GAACGCACAT
Achatina achatina           -----AGAAT TAATGTGA-A TTGCA-GAAC ACATTGAACA TCGACACCTT GAACGCACAT
Archachatina marginata      ---------- ---------A TTGCA-GAAC ACATTGAACA TCGACACCTT GAACGCACAT
Achatina bisculpta          ---------- ---------- ----A-GAAC ACATTGAACA TCGACACCTT GAACGCATAT
Achatina damarensis         ---------- ---------- ---------- ------AACA TCGACACCTT GAACGCACAT
Achatina stuhlmanni         ---------- ---------- ----A-GAAC ACATTGAACA TCGACACCTT GAACGCACAT
Atopocochlis exarata        ---------- ---------A TTGCA-GAAC ACATTGAACA TCGACACCTT GAACGCACAT
Limicolaria kambeul         ---------- ---------A TTGCA-GAAC ACATTGAACA TCGACACCTT GAACGCACAT
Limicolaria martenssii      ---------- ---------A TTGCA-GAAC ACATTGAACA TCGACACCTT GAACGCACAT
Limicolariopsis sp.         ---------- ---------- ---------- ------AACA TCGACACCTT GAACGCATAT
Limicolariopsis ruwenzori   ---------- ---------- ----A-GAAC ACATTGAACA TCGACACCTT GAACGCACAT
Cochlitoma varicosa         TGCGAGGAAA TTATGAGA-A TTGCA-GAAC ACATTGAACA TCGACACCTT GAACGCACAT
Cochlitoma dimidiata        ---------- ---------- ------GAAC ACATTGAACA TCGACACCTT GAACGCACAT
Cochlitoma sp. cf. vestita  ---------- ---------A TTGCA-GAAC ACATTGAACA TCGACACCTT GAACGCATAT
Cochlitoma marinae          ---------- ---------- ----A-GAAC ACATTGAACA TCGACACCTT GAACGCACAT
Cochlitoma churchilliana    ---------- ---------- ---------- ------AACA TCGACACCTT GAACGCACAT
Cochlitoma granulata        ---------- ---------- ---------- ------AACA TCGACACCTT GAACGCACAT
Cochlitoma simplex          ---------- ---------- ---------- ------AACA TCGACACCTT GAACGCACAT
Cochlitoma kilburni         ---------- ---------- ---------- ---TTGAACA TCGACACCTT GAACGCACAT
Cochlitoma montistempli     ---------- ---------- ---------- ---TTGAACA TCGACACCTT GAACGCACAT
Cochlitoma omissa           ---------- ---------- ---------- ---TTGAACA TCGACACCTT GAACGCACAT
Cochlitoma semidecussata    ---------- ---------- ---------- ------AACA TCGACACCTT GAACGCACAT
Cochlitoma ustulata         ---------- ---------- -------AAC ACATTGAACA TCGACACCTT GAACGCACAT
Cochlitoma zebra            ---------- ---------- ---------- ---TTGAACA TCGACACCTT GAACGCACAT
Metachatina kraussi         ---------- ---------- ---------- ---TTGAACA TCGACACCTT GAACGCACAT
Rumina decollata            ---------- ---------A TTGCA-GAAC ACATTGAACA TCGACACCTT GAACGCACAT
NUCLEOTIDES INCLUDED        ---------- ---------- ---------- ------mmmm mmmmmmmmmm mmmmmmmmmm
```

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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                     70         80         90        100        110        120
Achatina fulica             GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Achtina immaculata          GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Achatina reticulata         GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Achatina zanzibarica        GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Euaethiopina loveridgei     GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Achatina achatina           GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Archachatina marginata      GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Achatina bisculpta          GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Achatina damarensis         GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Achatina stuhlmanni         GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Atopocochlis exarata        GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Limicolaria kambeul         GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Limicolaria martenssii      GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Limicolariopsis sp.         GGCGGCCTCG GGYCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Limicolariopsis ruwenzori   GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Cochlitoma varicosa         GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTYTGAGG GTCGGCGAGA GTACAAAGCC
Cochlitoma dimidiata        GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Cochlitoma sp. cf. vestita  GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Cochlitoma marinae          GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Cochlitoma churchilliana    GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Cochlitoma granulata        GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Cochlitoma simplex          GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Cochlitoma kilburni         GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Cochlitoma montistempli     GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Cochlitoma omissa           GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Cochlitoma semidecussata    GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Cochlitoma ustulata         GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Cochlitoma zebra            GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Metachatina kraussi         GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GTACAAAGCC
Rumina decollata            GGCGGCCTCG GGTCCATCCC GGGGCCACGC CCGTCTGAGG GTCGGCGAGA GT-CAAAGCC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mm-mmmmmmm
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                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   130        140        150        160        170        180
Achatina fulica            TTCGCTTCGT ATGAGG-CAG CAGGTCTCGC TC---AATTT ATTCCGAGAT CCGTCCAGCT
Achtina immaculata         TTCGCTTCGT ATGAGG-CAG CAGGTCTCGC TC---AATTT ATTCCTAGAT CCGTCCAGCT
Achatina reticulata        TTCGCTTCGT ATGAGG-CAG CAGGTCTCAC TC---AATTT CTTCCGAGAT CCGTCCAGCT
Achatina zanzibarica       TTCGCTTCGT ATGAGG-CAG CAGGTCTCGC TC---AATTT ATTCCGAGAT CCGTCCAGCT
Euaethiopina loveridgei    TTCGCTTCGT ATGAGG-CAG CAGGTCTCGC TC---AATTT ATTCCGAGAT CCGTCCAGCT
Achatina achatina          TTCGCTTCGC ATGTGG-CAG CAGGTCTTG- ------ATTT ATTCCGAGAT CCGTCTAAAA
Archachatina marginata     TTCGCTTCGC ATGTGGGCAG CAGGTCTCG- ------ATTT ATTCCGAGAT CCGTCTA-TA
Achatina bisculpta         TTCGCTTCGT ATGCGG-CAG CAGGTCTCTC TC--AAATTT CCGTCCAGAT CTTCCAC---
Achatina damarensis        TTCGCTTCGT ATGCGG-CAG CAGGTCTCTC TC--AAATTT CCGTCCAGAT CTTCCT----
Achatina stuhlmanni        TTCGCTTCGT ATGCGG-CAG CAGGTCTCGC TT--AAATTT CCGTCCAGAT CTTC------
Atopocochlis exarata       TTCGCTTCGT ATGCGG-CAG CAGGTCTCGC TCC--AGCTT CCTTCCAGCT CTTAATTC--
Limicolaria kambeul        TTCGCTTCGT ATGTGG-CAG CAGGTCTCGC TC--AAATTT CCGTCCAGCT CTTCTTCCTC
Limicolaria martenssii     TTCGCTTCGT ATGTGG-CAG CAGGTCTCGC TC--AAATTT CCGTCCAGCT CTTCTTCCTC
Limicolariopsis sp.        TTCGCTTCGT ATGTGG-CAG CAGGTCTCAC TC--AAATTT CCGTCCAGCG CTTCC-----
Limicolariopsis ruwenzori  TTCGCTTCGT ATGTGG-CAG CAGGTCTCGC TC--AAATTT CCGTCCAGCT CTTCTTCCTC
Cochlitoma varicosa        TTCGCTTCGT ATGTGG-CAG CAGGTCTCGC TC---AATTT ATTCCGAGAT CCGTCTAGCT
Cochlitoma dimidiata       TTCGCTTCGT ATGTGG-CAG CAGGTCTCGC TC---AATTT ATTCCGAGAT CCGTCTAGCT
Cochlitoma sp. cf. vestita TTCGCTTCGT ATGTGG-CAG CAGGTCTCGC TC---AATTT ATTCCAATAT CCGTCTAGCT
Cochlitoma marinae         CTCGCTTCGT ATGTGG-CAG CAGGTCTCGC TC---AGTTT ATTCCAAGAT CCGTCCAGCT
Cochlitoma churchilliana   TTCGCTTCGT ATGTGG-CAG CAGGTCTCGC TCCAAGATTT ATTCCAAGAT CCGTCCAGCT
Cochlitoma granulata       TTCGCTTCGT ATGTGG-CAG CAGGGCTCGC TCC---ATTT ATTCCCAGAA CCGGCTAGCT
Cochlitoma simplex         TTCGCTTCGT ATGTGG-CAG GAGGTCTCGC TC---AATTT ATTCC----- --GTCTAGCT
Cochlitoma kilburni        TTCGCTTCGT ATGTGG-CAG CAGGTCTCGC TC---AATTT ATTCCAGGAT CCGTCTAGCT
Cochlitoma montistempli    TTCGCTTCGT ATGTGG-CAG CAGGTCTCGC TC---AATTT ATTCCAAGAT CCGTCTAGCT
Cochlitoma omissa          TTCGCTTCGT ATGTGG-CAG CAGGTCTCGC TC---AATTT ATTCCAAGAT CCGTCTAGCT
Cochlitoma semidecussata   TTCGCTTCGT ATGTGG-CAG CAGGTCTCGC TC---AATTT ATTCCAAGAT CCGTCTAGCT
Cochlitoma ustulata        CTCGCTTCGT ATGTGG-CAG CAGGTCTCGC TC---AATTT ATTCCAAGAT CCGTCTAGCT
Cochlitoma zebra           TTCGCTTCGT ATGTGGGCAG CAGGTCTCGC TC---AATTT ATTCCAAGAT CCGTCTAGCT
Metachatina kraussi        TTCGCTTCGT ATGTGG-CAG CAGGTCTCGC TC--AATTTT ATTCCAAGAT CCGTCTAGCT
Rumina decollata           TTCGCTTCGC TTCTGG-CAG CTGGTCCGGT TC-------- ---------- ----------
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmm-mmm mmmmmmmmm- ---------- ---------- ----------


                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   190        200        210        220        230        240
Achatina fulica            CTTC-----C TCTATCC-AT CCGCGG-CTC GTGCGGA--- ------GGGG TTACAGAGAG
Achtina immaculata         CTTCTCTTCC TCTATCC-AT CCGCGG-CTC GTGCGGG--- ------GGGG G-ACAGAAAG
Achatina reticulata        CTTC--AACC TCTATCC-AT CCGCGG-CTC GTGCGGG--- ------GGG- TTACAGAGAG
Achatina zanzibarica       CTTC-----C TCTATCC-AC CCGCGG-CTC GTGCGGG--- ------GGGG TTACAGAGAT
Euaethiopina loveridgei    CTTC-----C TCTATCC-AT CCGCGG-CTC GCGCGGA--- ------GGGG TTACAGAGAG
Achatina achatina          CTTC---TTG CTCTGCCGTN CCGCTG-CTC GTGCTGG--- ---------G ACACGGAAAA
Archachatina marginata     CTTCNTGNTC TANTGNCGTC CCGCTG-CTC GTGCTGG--- ---------G ACACGGAAAA
Achatina bisculpta         ---------C TCTATCT--T CCGCGG-CTC GTGCGG---- ---------- GGACAGAAAG
Achatina damarensis        ---------C TAAATCT--T CCGCGG-CTC GTGCGG---- ---------- GGACAGAAAG
Achatina stuhlmanni        ---------C TCTATCT--T CCGCGG-CTC GTGCGG---- ---------- GGACAGAAAG
Atopocochlis exarata       ---------C TCTATCT--T CCGCGG-CTC GTGCGG---- ---------- GGACAGAAAG
Limicolaria kambeul        G--------C TCTATCT--T CCGCGG-CTC GTGCGG---- ---------- GGACAGAAAG
Limicolaria martenssii     G--------C TCTATCT--T CCGCGG-CTC GTGCGG---- ---------- GGACWGAAAG
Limicolariopsis sp.        ---------T CGAATCT--T CCGCGG-CTC GTGCGG---- ---------G GGACAGAAAG
Limicolariopsis ruwenzori  G--------C TCGATCT--T CCGCGG-CTC GTGCGG---- ---------- GGACAGAAAG
Cochlitoma varicosa        CTTC-----C TCTATCTTAT CCGCGG-CTC GTGCGGT--- -------GGA GGACAGAAAG
Cochlitoma dimidiata       CTTC-----C TCTATCT-AT CCGCGG-CTC GTGCGGT--- -------GGA GGACGGAAAG
Cochlitoma sp. cf. vestita CTTC-----C TCTATCT-AT CCGCGG-CTC GTGCGGT--- -------GGA GGACAGAAAG
Cochlitoma marinae         CTTC-----C TCTATCT-AT CCGCGG-CTC GTGCGGT--- -------GGA GGAAAGGAAG
Cochlitoma churchilliana   CTTC------ -----TTCCT CCGCGG-CTC GTGCGGT--- --------GG GGACACAAAG
Cochlitoma granulata       CTTC-----C TCTATCT-AT CCGCGGGCTC GGGGGGG--- -------GGA GGACAGAAAG
Cochlitoma simplex         CTTC-----C TCTATCT-AT CCGCGG-CTC GTGCGGT--- -------GGA GGACAGAAAG
Cochlitoma kilburni        CTTC-----C TCTATCT-AT CCGCGG-CTC GTGCGGT--- -------GGA GGACAGAAAG
Cochlitoma montistempli    CTTC-----C TCYATCT-AT CCGCGGGCTC GTGCGGTGGA GAAAGGAAGA AGACAGAAAG
Cochlitoma omissa          CTTC-----C TCTATCT-AT CCGCGGGCTC GTGCGGT--- -------GGA GGACAGAAAG
Cochlitoma semidecussata   CTTC-----C TCTATCT-AA CCGCGGGCTC GTGCGGT--- -------GGA GGACAGAGAG
Cochlitoma ustulata        CTTC-----C TCTATCT-AT CCGCGG-CTC GTGCGGT--- -------GGA GGACAGAAAG
Cochlitoma zebra           CTTC-----C ---------T CCGCGG-CTC GTGCGGT--- -------GGA GGACAGAAAG
Metachatina kraussi        CTTCCCT--C TCTATCTTAT CTGCGG-CTC GTGCGGT--- ----TT---- GGACAGAAAG
Rumina decollata           -TACCACGTC GTTTTTCACT CCGTG--CTC GTGCGA---- ---------- --GGGAGAAG
NUCLEOTIDES INCLUDED       ---------- ---------- -------mmm mmmm------ ---------- ----------
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                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   250        260        270        280        290        300
Achatina fulica            GAAGAAT-CG GG-CG----- --------GA GAAGGAAGAA GAAGAGACCG TCGAAGCGCT
Achtina immaculata         GAAGAAT-CG GG-CG----- --------GA GAAGGAAGAA GAAGAGACCG TCGAAGCGCT
Achatina reticulata        GAAGAAT-CG GG-CG----- --------GA GAAGGAAGAA GAAGAGACCG TCGAAGCGCT
Achatina zanzibarica       GAAGAAT-CG GG-CG----- --------GA GAAGGAAGAA GAAGAGACCG TCGAAGCGCT
Euaethiopina loveridgei    GAAGAAT-CG GG-CG----- --------GA GAAGGAAGAA GAAGAGACCG TCGAAGCGCT
Achatina achatina          GAAGAAT-TG GGGCG----- ------GATA AGGAAGGGGA AGAGAGACCG TCGAAGCGCT
Archachatina marginata     GAAGAAT-TG GA-CNN---- -------ATA NNGAAGGG-A AGAGAGGCCG TCGAAGCGCT
Achatina bisculpta         AAAGAAT-CT GG-CG----- ---------- -----GAGAA GCGGAGACCG TCGAAGCGCT
Achatina damarensis        AAAGAAT-CT GG-CG----- ---------- -----GAGAA GCGGAGACCG TCGAAGCGCT
Achatina stuhlmanni        AAAGAAT-CT GT-CG----- ---------- ----GAGAAG AAAGAGACCG TCGAAGCGCT
Atopocochlis exarata       GAAGAAT-CT GG-CG----- ---------- ------GAGA AGAGAGACCG TCGAAGCGCT
Limicolaria kambeul        GAAGAAT-CT GG-CG----- ---------- --------GA GAAGAGACCG TCGAAGCGCT
Limicolaria martenssii     GAAGAAT-CT GG-CG----- ---------- --------GA GAAGAGACCG TCGAAGCGCT
Limicolariopsis sp.        GAAGAAT-CT GG-CG----- ---------- --------GA GAAGAGACCG TCGAAGCGCT
Limicolariopsis ruwenzori  GAAGAAT-CT GG-CG----- ---------- --------GA GAAGAGGCCG TCGAAGCGCT
Cochlitoma varicosa        GCGGAGAA-- ---------- ---------- ------GGAA GAAGAGACCG TCGAAGCGCC
Cochlitoma dimidiata       GCGGAGAA-- ---------- -------GGA AGAAGAAGAA GAAGNGNCCG TCGAAGCGCT
Cochlitoma sp. cf. vestita GCGGAGAA-- ---------- ---------- ---GGAAGAA GAAGAGACCG TCGAAGCGCT
Cochlitoma marinae         GCG------- ---------G AGAAGGAAGA AGAAGAAGAA GAAGAGACCG TCGAAGCGCT
Cochlitoma churchilliana   GAAGAA-TCG GGCG------ --GAGAAGGG ACTAAGAAAG GAAGAGACCG TCGAAGCGCT
Cochlitoma granulata       GCG------- ---------- --------GA NAAAGAAGAA GAAGANACCG TCGAAGCGCT
Cochlitoma simplex         GCG------- ---------- --------GA GAAGGAAGAA GAAGAGACCG TCGAAGCGCT
Cochlitoma kilburni        GCG------- ---------- --------GA GAAGGAAGAA GAAGAGACCG TCGAAGCGCT
Cochlitoma montistempli    GCG------- ---------- -----GAGAA GGAAGAAGAA GAAGAGACCG TCGAAGCGCT
Cochlitoma omissa          GCG------- ---------- -----GAGAA GGAAGAAGAA GAAGAGACCG TCGAAGCGCT
Cochlitoma semidecussata   GCG------- ---------G AGAAGGAAGA AGAAGAAGAA GAAGAGACCG CCGAAGCGCT
Cochlitoma ustulata        GCG------- ---------- -----GCGAA GGAAGAAGAA GAAGAGACCG TCGAAGCGCT
Cochlitoma zebra           GCG------- ---------- --------GA GAAGGAAGAA GAAGAGACCG TCGAAGCGCT
Metachatina kraussi        GAAGAA-TCG GGCG--GAGA AGGAAGAAGA AGAAGAAGAA GCAGAGACCG TCGAAGCGCT
Rumina decollata           CTGCGTCGTG GATGA----- ---------- ---------- -TGAAGACCG TCGAAGCGCA
NUCLEOTIDES INCLUDED       ---------- ---------- ---------- ---------- ----mmmmmm mmmmmmmmmm


                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   310        320        330        340        350        360
Achatina fulica            GTGGGCCGTC GTGGGAGGAG GAAGAA---- GGGTTTT--- ---------T TTCCACCCTT
Achtina immaculata         GTGGGCCGTC GTGGGAGGAG GAGGAAGA-A GGGTTTTACC CCCCTTTTTT --ACACTCTT
Achatina reticulata        GTGGGCCGTC GTGGGCGGAG GAGGAAGA-A GGGTCTCACC CCCCTTTTTT CCCCACTCTT
Achatina zanzibarica       GTGGGCCGTC GTGGGAGGAG GAAGAA---- GGGTTTCACC CCCCTTTTTT CCC-ACTCTT
Euaethiopina loveridgei    GTGGGCCGTC GTGGGAGGAG GAAGAA---- GGGTTTCACC CCCCTTTTTT TTCCACTCTT
Achatina achatina          CTGGGCCGTC GTGGGAGAGA GG-AGGGA-- ---------- --TTGTTTTC TTTTTTTCTT
Archachatina marginata     CTGGGCCGTC GTGGGAGAGG AGGAGAGG-- ------GATT TTGGATTTTT CTTCTTTCTT
Achatina bisculpta         GTGGGCCGTC GTGGGATGAG GAAGAACT-- GGGTTTTTCC CAG---TTTT TT-CCCTCTT
Achatina damarensis        GTGGGCCGTC GTGGGATGAG GGTGAAGA-- -------ACC CAG---TTTT TTTTCCTCCT
Achatina stuhlmanni        GTGGGCCGTC GTGGGATGAG GAATAACT-- GGGTTTTTCC CAG-----TT TTTTTCTCTT
Atopocochlis exarata       GTGGGCCGTC GCGGGATGAG GAAGAACT-- GGGTTTTCCC CAG----TTT TTTTTCTCTT
Limicolaria kambeul        GTGGGCCGTC GTGGGATGAG GAAGAACT-- GGGTT----- ---------T TTCCCCTCTT
Limicolaria martenssii     GTGGGCCGTC GTGGGATGAG GAAGAACT-- GGGTT----- ---------- TTTCCCTCTT
Limicolariopsis sp.        GTGGGCCGTC GTGGGATGAG GAATTACT-- GGGTTT-ACC CAG-----TT TTTTTCTATT
Limicolariopsis ruwenzori  GTGGGCCGTC GTGGGATGAG GAAGAACT-- GGCTT----- --------TT TTCCCCTCTT
Cochlitoma varicosa        GTGGGCCGTC GTGGGAGGAG GAAGAAGT-- -GCTTTTTCT TTT------- --CCTCTCTT
Cochlitoma dimidiata       GTGGGCCGTN GTGGGAGGAG GAGGAAAA-- AGTTTTT--- ---------- --CCTCTCTT
Cochlitoma sp. cf. vestita GTGGGCCGTC GTGGGAGGAG GAAGAAGT-- -GCTTTTTTT TT-------- --CCTCTCTT
Cochlitoma marinae         GTGGGCCGTC GTGGGAGGAG GAAGAAGT-- -GCTTTTTTT T--------- --TCTCTCTT
Cochlitoma churchilliana   GTGGGCCGTC GTGGGAGGGA GGAAGAAG-- TGCTTTTTTT CCC------- --CCTGTCTT
Cochlitoma granulata       GTGGGCCGTN GNGGGANNAC GAAGAAGT-- -GNTNTTTTT TCT------- --NCTCTCTT
Cochlitoma simplex         GTGGGCCGTC GTGGGAGGAG GAGGAAGAAG TGCTCTTATG TTTTT----- CCCCCCTCTT
Cochlitoma kilburni        GTGGGCCGTC GTGGGAGGAG GAAGAAGT-- GCTTTTTTTT TCTTT----- --CCTCTCTT
Cochlitoma montistempli    GTGGGCCGTC GTGGGAGGAG GAAGAAGT-- GCTTTTTTTT ---------- CTCCTCTCTT
Cochlitoma omissa          GTGGGCCGTC GTGGGAGGAG GAAGAATT-- GCTTTTTTT- ---------- CTCCTCTCTT
Cochlitoma semidecussata   GTGGGCCGTC GTGGGAGGAG GAAGAAG--T GCTTTTTTTC T--------- --CCTCTCTT
Cochlitoma ustulata        GTGGGCCGTC GTGGGAGGAG GAAGAAGT-- GCTTTTTTTT ---------- --TCTCTCTT
Cochlitoma zebra           GTGGGCCGTC GTGGGAGGAG GAAGAAGT-- GCTTTTTTTT CC-------- --CCTCTCTT
Metachatina kraussi        GTGGGCCGTC GTGGGAGGAG GAAGAGTG-- CTTTTTTTTT ---------- --CCCCTCTT
Rumina decollata           CTGGGCTTTC G-AGGACGAG GAGGATCG-A GTTTTCTCT- ---------- -TTCCACCTT
NUCLEOTIDES INCLUDED       mmmmmmmmmm m-mmmm---- ---------- ---------- ---------- ----------
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    370        380        390        400        410        420
Achatina fulica             -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTCAGCGA CTCTTTCGCT
Achtina immaculata          -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTCAGCGA CTCTTTCGCT
Achatina reticulata         -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTCAGCGA CTCTTTCGCT
Achatina zanzibarica        -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTCAGCGA CTCTTTCGCT
Euaethiopina loveridgei     -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTCAGCGA CTCTTTCGCT
Achatina achatina           -CCCCCGTGG CCTCAAGTGC ACG-GTGCGC CGTCC-CGTC AGTTTAGCGA CTCTTTCGCT
Archachatina marginata      CCCCCCGTGG CCTCAAGTGC ACG-GTGCGC CGTCC-CGTC AGTTTAGCGA CTCTTTCGCT
Achatina bisculpta          -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTTAGCGA CTCTTTCGCT
Achatina damarensis         -TCCCCGTGG CCTCAAGTAC ACTCATGCGC CGTCGTCGTC ATTTCAGCGA CTCTTTCGCT
Achatina stuhlmanni         -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTTAGCGA CTCTTTCGCT
Atopocochlis exarata        -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTTAGCGA CTC----GCT
Limicolaria kambeul         -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTTGTC ATTT-AGCGA CTCTTTCGCT
Limicolaria martenssii      -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTTGTC ATTT-AGCGA CTCTTTCGCT
Limicolariopsis sp.         -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTTAGCGA CTCTTTCGCT
Limicolariopsis ruwenzori   -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTTGTC ATTT-AGCGA CTCTTTTGCT
Cochlitoma varicosa         -CCCCCGTGG CCTCAAGTAA ACGCATGCGC CGTCCTCGTC ATTTCAGCGA CTCTTTCGCT
Cochlitoma dimidiata        -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTCAGNGA CTCTTTTCGC
Cochlitoma sp. cf. vestita  -CCCCCGTGG TCTCAAGTAT ACGCATGCGC CGTCCTCGTC ATTTCAGCGA CTCCTTCGCT
Cochlitoma marinae          -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTCAGAGA CTCTTTCGCT
Cochlitoma churchilliana    TCCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTCAGCGA CTCTTTCGCT
Cochlitoma granulata        -CCCCCGTGN CCTCNAGTAC ACGCATGCNC CGNCCTNGTC NTTTCAGCGA CTCNTTCGCT
Cochlitoma simplex          -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTCAGCGA CTCTTTCGCT
Cochlitoma kilburni         -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTCAGCGA CTCTTTCGCT
Cochlitoma montistempli     -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTCAGCGA CTCTTTCGCT
Cochlitoma omissa           -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTCAGCGA CTCTTTCGCT
Cochlitoma semidecussata    -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTCAGCGA CTCTTTCGCT
Cochlitoma ustulata         -TCCCCGGGG CCTCCAGTAC ACCCATGCGC CGTCCTCGGC ATTTCAGCAA CTCCTTCGCT
Cochlitoma zebra            -CCCCCGTGG CCTCAAGTAC ACGCATGCGC CGTCCTCGTC ATTTCAGCGA CTCTTTCGCT
Metachatina kraussi         -CCCCCGTGG CCTCAAGTAC ACACATGCGC CGTCCTCGTC ATTTCAGCGA CTCTTTCGCT
Rumina decollata            -CCCTCGTAG CCTCAAGTAC ACGAATGCGC CGTCCCCGTC ATCTGAGCA- --------TC
NUCLEOTIDES INCLUDED        --mmmmmmmm mmmmmmmmmm mm---mmmmm mmmmm-mmmm m----mmm-- ----------


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                                    430        440        450        460        470        480
Achatina fulica             ---CGCCCGG AGCGCT-CAT CTTCGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Achtina immaculata          ---CGCCCGG AGCGCT-CAT CTTCGTCT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Achatina reticulata         ---CGCCCGG AGCGCT-CAT ATTCGTTT-G TTCGTTCGCC GTCCGTCCGG CAGGACTCGG
Achatina zanzibarica        ---CGCCCGG AGCGCT-CAT CTTCGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Euaethiopina loveridgei     ---CGCCCGG AGCGCT-CAT CTTCGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Achatina achatina           ---TGCCCCG AGCGCC-CGT CTTCGTTC-G TTCGC----C GTCCGTCCGG CAGGACTCGG
Archachatina marginata      ---TGCCCCG AGCGCC-CGT CTTCGTTC-G TTCGC----C GTCCGTCCGG CAGGACTCGG
Achatina bisculpta          ---CGCCAGG AGCGCTCCAT CTTCGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Achatina damarensis         ---CGCCCGG AGCNGCTCAT CTTCGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Achatina stuhlmanni         ---CGCCCGG AGCGCTCCAT CTTCGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Atopocochlis exarata        ---CGCCCGG AGCGCT-CAT CTTCGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Limicolaria kambeul         ---------- -------CNT GTTCG----- ----CTCGCC GTCCGTCCGG CAGGACTCGG
Limicolaria martenssii      ---------- -------CAT CTTCGCTT-G TTCGTTCGCC GTCCGTCCGG CAGGACTCGG
Limicolariopsis sp.         ---CGCCCGG AGCACT-CAT CTTCGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Limicolariopsis ruwenzori   ---------- -------CAT CTTCGCTT-G TTCGCTCGCC GTCCGTCCAG CAGGACTCGG
Cochlitoma varicosa         GCTCGCCCGG AGCGCT-CAT CTTCGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Cochlitoma dimidiata        GCTCNNCCGG ANNGNT-CAT NTTNNTTTTG TTCGCTTNCC GTCCNTCCGN CAGGACTCGG
Cochlitoma sp. cf. vestita  GCTCGCCCGG AGCGCT-CAT CTTCGTTTTG TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Cochlitoma marinae          GCTCGCCCGG AGCGCT-CAT CTTCGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Cochlitoma churchilliana    GCTCGCCCGG AGCGCT-CAT CTTCGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Cochlitoma granulata        GCTCGCCCGG AGCGCT-CAT CTTNGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGNCTCGN
Cochlitoma simplex          GCTCGCCCGG AGCGCT-CAT CTTCGTCT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Cochlitoma kilburni         GCTCGCCCGG AGCGCT-CAT CTTCGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Cochlitoma montistempli     GCTCGCCCGG AGCGCT-CAT CTTCGTTC-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Cochlitoma omissa           GCTCGCCCGG AGCGCT-CAT CTTCGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Cochlitoma semidecussata    GCTCGCCCGG AGCGCT-CAT CTTCGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Cochlitoma ustulata         GGTCGCCCGG AGCGGT-CAT CTTCGTTT-G TTCGCTCGCC GKCCGTCCGG CAGGACTCGG
Cochlitoma zebra            GCTCGCCCGG AGCGCT-CGT CTTCGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Metachatina kraussi         GCTCGCCCGG AGCGCT-CAT CTTCGTTT-G TTCGCTCGCC GTCCGTCCGG CAGGACTCGG
Rumina decollata            GCTCTCTCGA AGCGCT-CAT CTTCGTTC-G CTCGC----C GTCCGTCTGG CAGGACTCGG
NUCLEOTIDES INCLUDED        ---------- -------mmm mmmmm----- ---------- ---mmmmmmm mmmmmmmmmm
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                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                  490        500        510        520        530        540
Achatina fulica            CTCGCTTCTT T--------- AACAAATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Achtina immaculata         CTCGCTTCTT T--------G AAAAAATCGA GCCTGCCAGA C---CGTCCA AAGCGGCTAG
Achatina reticulata        CTCGCTTCTT T--------- AACAAATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Achatina zanzibarica       CTCGCTTTTT TTT------- AACAAATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Euaethiopina loveridgei    CTCGCTTCTT T--------- AACAAATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Achatina achatina          CTCGCTT--- ---------- ---TTATCGA GCCTGCCAGA CGACTGTCCG AAGCGGCTAG
Archachatina marginata     GTCGCTT--- ---------- ---TTATCGA GCCTGCCAGA C---TGTCCG AAGCGGCTAG
Achatina bisculpta         CTCGCTTTCT TTTT------ ----AATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Achatina damarensis        CTCGCTTCTT TTTT------ ----AATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Achatina stuhlmanni        CTCGCTTCTT TTTT------ ----AATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Atopocochlis exarata       CTCGCTTCTT TTTTT----- ----AATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Limicolaria kambeul        CTCGCTTCTT TTTT------ ----AATCGA GCCTGCCAGA C---CGTCCT AAGCGGCTAG
Limicolaria martenssii     CTCGCTTCTT TTTT------ ----AATCGA GCCTGCCAGA C---CGTCCT AAGCGGCTAG
Limicolariopsis sp.        CTCGCTTCTT TTT------- ----AATCGA GCCTGCCAGA C---CGTCCG AAGCGGCCAG
Limicolariopsis ruwenzori  CTCGCTTCTT TTTT------ ----AATCGA GCCTGCCAGA C---CGTCCT AAGCGGCTAG
Cochlitoma varicosa        CTCGCTTCTT TTTTTT---- ----AATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Cochlitoma dimidiata       CTCGNTTNTT TTTTT----- ----AATCGA GCCTGCCAGA C---CGTCCG AATCGGCTAG
Cochlitoma sp. cf. vestita CTCGCTTCTT TTTTTT---- ----AATCGA GCCTGCCAGA CC--CGTCCG AAGCGGCTAG
Cochlitoma marinae         CTCGCTTCTT TTTGTTT--- ----AATCGA GCCTGCCAGA CAC-CGTCCG AAGCGGCTAG
Cochlitoma churchilliana   CTCGCTTCTT TTTT------ ----AATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Cochlitoma granulata       CTCGCTTCTT TTTTTNTT-- ----ANTCGA GCCTGNCAGA C---CGTCCG AAGCGGCTAG
Cochlitoma simplex         CTCGCTTCTT TTTTTTNNNT TTTTAATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Cochlitoma kilburni        CTCGCTTCTT TTTTTT---- ----AATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Cochlitoma montistempli    CTCGCTTCAT TTTTATT--- ----AATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Cochlitoma omissa          CTCGCTTCAT TTTTATT--- ----AATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Cochlitoma semidecussata   CTCGCTTCTT TTT-ATT--- ----AATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Cochlitoma ustulata        CTCGCTTCTT TTTTTT---- ----AATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Cochlitoma zebra           CTCGCTTCTT TTTTTTTTT- ----AATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Metachatina kraussi        CTCGCTTCTT TTTAT----- ----AATCGA GCCTGCCAGA C---CGTCCG AAGCGGCTAG
Rumina decollata           CTCGCTGTG- ---------- AATAAAACGA GCCTGCC-GA C---CGTCCG AAGTGGCATG
NUCLEOTIDES INCLUDED       mmmmmm---- ---------- ---------m mmmmmmm-mm m---mmmmmm mmmmmmm--m


                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                  550        560        570        580        590        600
Achatina fulica            GG-ATTG-CG AAGTGGGG-- ---CGCGCAA GCGCATGGG- ---TCTGCTG CGGCGGCGCC
Achtina immaculata         GG-ATTG-CG AAGTGGGG-- ---CGCGCAA GCGCATGGG- ---TCTGCTG CGGCGGCGCC
Achatina reticulata        GG-ATTG-CG AAGTGGGG-- ---CGCGCAA GCGCATGGG- ---TCTGCTG CGGCGGCGCC
Achatina zanzibarica       GG-ATTG-CG AAGTGGGG-- ---CGCGCAA GCGCATGGGG ---TCTGCTG CGGCGGCGCC
Euaethiopina loveridgei    GG-ATTG-CG AAGTGGGG-- ---CGCGCAA GCGCATGGG- ---TCTGCTG CGGCGGCGCC
Achatina achatina          CG-GTTG-CG AAGCGGGT-- -GGCGCGTAA GCG-ATCGG- ---TCT---G CGGCGGCGCC
Archachatina marginata     CG-GTTG-CG AAGTGGGT-- -GGCGGGCAA GCG-ATCGG- ---TCT---G CGGCGGCGCC
Achatina bisculpta         CG-ATTG-CG AAGTGGAG-- ---------- ------GGG- ---TCTGCTG CGGCGGCGCC
Achatina damarensis        CG-ATTG-CG AAGTGGGG-C GCGTGAGCGC TGGCATGTTG GGGTCTGCTG CGGCGGCGCC
Achatina stuhlmanni        CG-ATTG-CG AAGTGGGG-- -CGCCCGCGA GCGGATTGGG GGGTCTGCTG TGGCGGCGCC
Atopocochlis exarata       CG-AATG-CG AAGTGGGG-- --CCCGGGAG CGGCATGGG- ---TCTGCTG CGGCGGCGCC
Limicolaria kambeul        CG-ATTGGCG AAGTG----- ---------- ---CATGGG- ---TCTGCTG AGGCGGCGCC
Limicolaria martenssii     CG-ATTGGCG AAGTG----- ---------- ---CATGGG- ---TCAGCTG AGGCGGCGCC
Limicolariopsis sp.        TG-ATTG-CG AAGTGGGT-- ---CGCGGGT GCGCATGGG- ---TCTGCTG CGGCGGCGCC
Limicolariopsis ruwenzori  CG-ATTGGCG AAGTG----- ---------- ---CATGGG- ---TCTGCTG CGGCGGCGCC
Cochlitoma varicosa        CGGATTG-CG AAGTGGGG-- CGCGCGAGCG CAGCATGGG- --GTCTGCTG CGGCGGCGCC
Cochlitoma dimidiata       CGGATTG-CG AAGTGGGG-- CGCGCGAGCG CAGCATGGGG GAGTCTGCTG CGGCGGCGCC
Cochlitoma sp. cf. vestita CGGATTG-CG AAGTGGGG-- CGCGCGAGCG CAGCATGGG- ---TCTGCTG CGGCGGCGCC
Cochlitoma marinae         CGGATTG-CG AAGTGGGG-- ---CGCGCGA GCGCATGGG- ---TCTGTTG CGGCGGCGCC
Cochlitoma churchilliana   CG-AGTG-CG AAGTGGGG-- -GGCGCGCGA GCGCATGGG- ---TCTGCTG CGGCGGCGCC
Cochlitoma granulata       CGGATTG-NG AAGNGGGG-- CGCGCGAGCG CAACATGGGG G--TCTGNTG CGGCGGCGCC
Cochlitoma simplex         CGGATTG-CG AAGTGGGGCG CACGCGAGCG CAGCATAGG- ---TCTGTTG CGGCGGCGCC
Cochlitoma kilburni        CGGATTG-CG AAGTGGGG-- CGCGCGAGCG CAGCATGGG- ---TCTGCTG CGGCGGCGCC
Cochlitoma montistempli    CGGATTG-CG AAGTGGGG-- CGCGCGAGCG CAACATGGGG GG-TCTGCTG CGGCGGCGCC
Cochlitoma omissa          CGGATTG-CG AAGTGGGG-- CGCGCGAGCG CAACATGGGG G--TCTGCTG CGGCGGCGCC
Cochlitoma semidecussata   CGGATTG-CG AAGTGGGG-- CGCGCGAGCG CAACATGGGG G--TCTGCTG CGGCGGCGCC
Cochlitoma ustulata        CGGATTG-CG AAGTGGGG-- CGCGCGAGCG CA---TGGG- ---TCTGTTG CGGCGGCGCC
Cochlitoma zebra           CGGATTG-CG AAGTGGGT-- CGCGCGAGCG CAGCATGGG- ---TCTGTTG CGGCGGCGCC
Metachatina kraussi        CG-ATTG-CG AAGTGGGG-- CGCGCGAGCG CA---TGGG- ---TCTGCTG CGGCGGCGCC
Rumina decollata           CG-GTTT-CG AAGTGTGA-- ---------- ------GAGG GCGATTGCCG CGGCGGCGCC
NUCLEOTIDES INCLUDED       mm------mm mmmmm----- ---------- ---------- ---------m mmmmmmmmmm
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   610        620        630        640        650        660
Achatina fulica             A--------- -----GTCTT TCT------- --AAAATCTT TCTTTA---- -TCCGACCTC
Achtina immaculata          A--------- -----GTCTT TCT------- --AAAATCTT TCTTTA---- -TCCGACCTC
Achatina reticulata         A--------- -----GTCTT TCT------- --AAAATCTT TCTTTA---- -TCCGACCTC
Achatina zanzibarica        A--------- -----GTCTT TCT------- --AAAATCTT TCTTTA---- -TCCGACCTC
Euaethiopina loveridgei     A--------- -----GTCTT TCT------- --AAAATCTT TCTTTA---- -TCCGACCTC
Achatina achatina           ACAACA---- -----GTCTT TATACGAACG AACGTTCGGT TCTTTA---- -TCCGACCTC
Archachatina marginata      AGCA------ -----GTCTC TATAACGACG ACGTTTNNTT TAAAATTTTT ATCCGACCTC
Achatina bisculpta          A--------- -----GTCTT TCT------- --AAAATATT TCTTTA---- -TCCGACCTC
Achatina damarensis         A--------- -----GTCTT TCT------- AAAAAATCTT TCTTTA---- -TCCGACCTC
Achatina stuhlmanni         A--------- -----GTCTT TCT------- --AAAATTTT TCTTTA---- -TCCGACCTC
Atopocochlis exarata        A--------- -----GTCTT TCT------A AAAAAATCTT TCTTTA---- -TCCGACCTC
Limicolaria kambeul         A--------- -----GTCTT TCT------- --AAAATTTT TCTTTA---- -TCCGACCTC
Limicolaria martenssii      A--------- -----GTCTT TCT------- --AAAATTTT TCTTTA---- -TCCGACCTC
Limicolariopsis sp.         A--------- -----GTCTT TCT------- --AAAATCTT TCTTTA---- -TCCGACCTC
Limicolariopsis ruwenzori   A--------- -----GTCTT TCT------- --AAAATTTT TCTTTA---- -TCCGACCTC
Cochlitoma varicosa         A--------- -----GTCTT TCT------- -----TTCAT TCTTTA---- -TCCGACCTC
Cochlitoma dimidiata        A--------- -----GTCTT TCT------- -----TTCAT TCGTTA---- -TCCGACCTC
Cochlitoma sp. cf. vestita  A--------- -----GTCTT TCT------- -----TTCAT TCTTTA---- -TCCGACCTC
Cochlitoma marinae          AA-------- -----GTCTT TCT------- -----TTCTT TCTTTA---- -TCCGACCTC
Cochlitoma churchilliana    A--------- -----GTCTT TCT------- -----TTCTT TCTTTA---- -TCCGACCTC
Cochlitoma granulata        A--------- -----GTCTT TCT------- ---------T TCTTTA---- -TCCGACCTC
Cochlitoma simplex          A--------- -----GTCTT TCT------- -TTCTTTCTT TCTTTA---- -TCCGACCTC
Cochlitoma kilburni         A--------- -----GTCTT TCT------- -----TTCAT TCTTTA---- -TCCGACCTC
Cochlitoma montistempli     A--------- -----GTCTT TCT------- -----TTCTT TCTTTA---- -TCCGACCTC
Cochlitoma omissa           A--------- -----GTCTT TCT------- -----TTCTT TCTTTA---- -TCCGACCTC
Cochlitoma semidecussata    A--------- -----GTCTT TCT------- -----TTCTT TCTTTA---- -TCCGACCTC
Cochlitoma ustulata         A--------- -----GTCTT TCT------- -----TTCTT TCTTTA---- -TCCGACCTC
Cochlitoma zebra            A--------- -----GTCTT TCT------- -----TTCAT TCTTTA---- -TCCGACCTC
Metachatina kraussi         A--------- -----GTCTT TCT------- -----TTCTT TCTTTA---- -TCCGACCTC
Rumina decollata            A----ATTTT TTTTTGTCCG TTCT------ --AAA----- ---------- -TCCGACCTC
NUCLEOTIDES INCLUDED        m--------- ---------- ---------- ---------- ---------- -mmmmmmmmm


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   670        680        690        700        710        720
Achatina fulica             AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Achtina immaculata          AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Achatina reticulata         AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Achatina zanzibarica        AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Euaethiopina loveridgei     AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Achatina achatina           AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Archachatina marginata      AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Achatina bisculpta          AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Achatina damarensis         AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Achatina stuhlmanni         AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Atopocochlis exarata        AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Limicolaria kambeul         AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Limicolaria martenssii      AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Limicolariopsis sp.         AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Limicolariopsis ruwenzori   AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Cochlitoma varicosa         AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Cochlitoma dimidiata        AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Cochlitoma sp. cf. vestita  AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Cochlitoma marinae          AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Cochlitoma churchilliana    AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Cochlitoma granulata        AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Cochlitoma simplex          AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Cochlitoma kilburni         AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Cochlitoma montistempli     AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Cochlitoma omissa           AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Cochlitoma semidecussata    AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Cochlitoma ustulata         AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Cochlitoma zebra            AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Metachatina kraussi         AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
Rumina decollata            AGATCGGACG AGATTACCCG CTGAATTTAA GCATATAACT AAGCGGAGGA AAAGAAACTA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    730        740        750        760        770        780
Achatina fulica             ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Achtina immaculata          ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Achatina reticulata         ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Achatina zanzibarica        ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Euaethiopina loveridgei     ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Achatina achatina           ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Archachatina marginata      ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Achatina bisculpta          ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Achatina damarensis         ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Achatina stuhlmanni         ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Atopocochlis exarata        ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Limicolaria kambeul         ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Limicolaria martenssii      ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Limicolariopsis sp.         ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Limicolariopsis ruwenzori   ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Cochlitoma varicosa         ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Cochlitoma dimidiata        ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Cochlitoma sp. cf. vestita  ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Cochlitoma marinae          ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Cochlitoma churchilliana    ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Cochlitoma granulata        ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Cochlitoma simplex          ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Cochlitoma kilburni         ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Cochlitoma montistempli     ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Cochlitoma omissa           ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Cochlitoma semidecussata    ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Cochlitoma ustulata         ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Cochlitoma zebra            ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Metachatina kraussi         ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAATAG CCCAGCACCG AATCCCTCAG
Rumina decollata            ACAAGGATTT CCCCAGTAAC GGCGAGTGAA GCGGGAAGAG CCCAGCACCG AATCCCCCAG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    790        800        810        820        830        840
Achatina fulica             TGTCACGCTG GCGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Achtina immaculata          TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Achatina reticulata         TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Achatina zanzibarica        TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Euaethiopina loveridgei     TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Achatina achatina           TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Archachatina marginata      TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Achatina bisculpta          TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Achatina damarensis         TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Achatina stuhlmanni         TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Atopocochlis exarata        TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Limicolaria kambeul         TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Limicolaria martenssii      TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Limicolariopsis sp.         TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Limicolariopsis ruwenzori   TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Cochlitoma varicosa         TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Cochlitoma dimidiata        TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Cochlitoma sp. cf. vestita  TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Cochlitoma marinae          TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Cochlitoma churchilliana    TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Cochlitoma granulata        TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Cochlitoma simplex          TGTCACGCTG GCGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Cochlitoma kilburni         TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Cochlitoma montistempli     TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Cochlitoma omissa           TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Cochlitoma semidecussata    TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Cochlitoma ustulata         TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Cochlitoma zebra            TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Metachatina kraussi         TGTCACGCTG ACGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
Rumina decollata            TGTCACGCTG GCGGGAACTG TGGTGTGTGG GACGCCACCA GTCGCATCAG AGGGCGTCGA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                  850        860        870        880        890        900
Achatina fulica            AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
Achtina immaculata         AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
Achatina reticulata        AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
Achatina zanzibarica       AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
Euaethiopina loveridgei    AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
Achatina achatina          AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
Archachatina marginata     AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
Achatina bisculpta         AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
Achatina damarensis        AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
Achatina stuhlmanni        AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
Atopocochlis exarata       AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
Limicolaria kambeul        AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
Limicolaria martenssii     AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
Limicolariopsis sp.        AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
Limicolariopsis ruwenzori  AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
Cochlitoma varicosa        AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
Cochlitoma dimidiata       AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCACTCTG
Cochlitoma sp. cf. vestita AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCACTCTG
Cochlitoma marinae         AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCACTCTG
Cochlitoma churchilliana   AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCACTCTG
Cochlitoma granulata       AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCACTCTG
Cochlitoma simplex         AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCACTCTG
Cochlitoma kilburni        AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCACTCTG
Cochlitoma montistempli    AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCACTCTG
Cochlitoma omissa          AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCACTCTG
Cochlitoma semidecussata   AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCACTCTG
Cochlitoma ustulata        AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCACTCTG
Cochlitoma zebra           AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCACTCTG
Metachatina kraussi        AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCACTCTG
Rumina decollata           AGTCCTCCTG ATCGGGGCTT CACCCAGAGC GGGTGTAAGG CCTTTGCAGG CGCCTCTCTG
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                  910        920        930        940        950        960
Achatina fulica            TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Achtina immaculata         TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Achatina reticulata        TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Achatina zanzibarica       TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Euaethiopina loveridgei    TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Achatina achatina          TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Archachatina marginata     TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Achatina bisculpta         TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Achatina damarensis        TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Achatina stuhlmanni        TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Atopocochlis exarata       TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Limicolaria kambeul        TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Limicolaria martenssii     TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Limicolariopsis sp.        TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Limicolariopsis ruwenzori  TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Cochlitoma varicosa        TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Cochlitoma dimidiata       TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Cochlitoma sp. cf. vestita TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Cochlitoma marinae         TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Cochlitoma churchilliana   TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Cochlitoma granulata       TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Cochlitoma simplex         TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Cochlitoma kilburni        TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Cochlitoma montistempli    TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Cochlitoma omissa          TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Cochlitoma semidecussata   TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Cochlitoma ustulata        TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Cochlitoma zebra           TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Metachatina kraussi        TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
Rumina decollata           TGCGGCCGCG AGCGTCTCAG GAGTCGGGTT GTTTGGGAAT GCAGCCCAAA GCGGGTGGTA
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    970        980        990        1000       1010       1020
Achatina fulica             AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Achtina immaculata          AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Achatina reticulata         AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Achatina zanzibarica        AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Euaethiopina loveridgei     AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Achatina achatina           AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Archachatina marginata      AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Achatina bisculpta          AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Achatina damarensis         AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Achatina stuhlmanni         AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Atopocochlis exarata        AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Limicolaria kambeul         AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Limicolaria martenssii      AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Limicolariopsis sp.         AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Limicolariopsis ruwenzori   AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Cochlitoma varicosa         AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Cochlitoma dimidiata        AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Cochlitoma sp. cf. vestita  AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Cochlitoma marinae          AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Cochlitoma churchilliana    AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Cochlitoma granulata        AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Cochlitoma simplex          AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Cochlitoma kilburni         AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Cochlitoma montistempli     AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Cochlitoma omissa           AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Cochlitoma semidecussata    AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Cochlitoma ustulata         AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Cochlitoma zebra            AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Metachatina kraussi         AACTCCATCT AAGGCTAAAT ACTGGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
Rumina decollata            AACTCCATCT AAGGCTAAAT ACTTGCACGA GTCCGATAGC GGACAAGTAC CGTGAGGGAA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    1030       1040       1050       1060       1070       1080
Achatina fulica             AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Achtina immaculata          AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Achatina reticulata         AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Achatina zanzibarica        AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Euaethiopina loveridgei     AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Achatina achatina           AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Archachatina marginata      AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Achatina bisculpta          AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Achatina damarensis         AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Achatina stuhlmanni         AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Atopocochlis exarata        AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Limicolaria kambeul         AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Limicolaria martenssii      AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Limicolariopsis sp.         AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Limicolariopsis ruwenzori   AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Cochlitoma varicosa         AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Cochlitoma dimidiata        AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Cochlitoma sp. cf. vestita  AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Cochlitoma marinae          AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Cochlitoma churchilliana    AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Cochlitoma granulata        AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Cochlitoma simplex          AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Cochlitoma kilburni         AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Cochlitoma montistempli     AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Cochlitoma omissa           AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Cochlitoma semidecussata    AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Cochlitoma ustulata         AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Cochlitoma zebra            AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Metachatina kraussi         AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
Rumina decollata            AGTTGAAAAG AACTTTGAAG AGAGAGTTCA AGAGTACGTG AAACCGCCCA GAGGTAAACG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                  1090       1100       1110       1120       1130       1140
Achatina fulica            GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Achtina immaculata         GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Achatina reticulata        GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Achatina zanzibarica       GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Euaethiopina loveridgei    GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Achatina achatina          GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Archachatina marginata     GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Achatina bisculpta         GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCT-G GGGCGATCGC
Achatina damarensis        GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCT-G GGGCGATCGC
Achatina stuhlmanni        GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCT-G GGGCGATCGC
Atopocochlis exarata       GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Limicolaria kambeul        GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCAGCCTCG GGGCTATCGC
Limicolaria martenssii     GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCAGCCTCG GGGCTATCGC
Limicolariopsis sp.        GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCTATCGC
Limicolariopsis ruwenzori  GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCAGCCTCG GGGCTATCGC
Cochlitoma varicosa        GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Cochlitoma dimidiata       GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Cochlitoma sp. cf. vestita GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Cochlitoma marinae         GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Cochlitoma churchilliana   GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Cochlitoma granulata       GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Cochlitoma simplex         GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Cochlitoma kilburni        GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Cochlitoma montistempli    GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Cochlitoma omissa          GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Cochlitoma semidecussata   GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Cochlitoma ustulata        GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Cochlitoma zebra           GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Metachatina kraussi        GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCTCG GGGCGATCGC
Rumina decollata           GGTGGATCCG CAAAGTCGGC CCGCGGAATT CAGCGCGGCG CGCGGCCT-G GGGCTATTGC
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmm-m mmmmmmmmmm


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                                  1150       1160       1170       1180       1190       1200
Achatina fulica            GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Achtina immaculata         GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Achatina reticulata        GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Achatina zanzibarica       GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Euaethiopina loveridgei    GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Achatina achatina          GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Archachatina marginata     GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Achatina bisculpta         GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Achatina damarensis        GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Achatina stuhlmanni        GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Atopocochlis exarata       GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Limicolaria kambeul        GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Limicolaria martenssii     GGCCGGGGAT CCYTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Limicolariopsis sp.        GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Limicolariopsis ruwenzori  GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Cochlitoma varicosa        GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Cochlitoma dimidiata       GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Cochlitoma sp. cf. vestita GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Cochlitoma marinae         GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Cochlitoma churchilliana   GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Cochlitoma granulata       GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Cochlitoma simplex         GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Cochlitoma kilburni        GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Cochlitoma montistempli    GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Cochlitoma omissa          GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Cochlitoma semidecussata   GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Cochlitoma ustulata        GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Cochlitoma zebra           GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Metachatina kraussi        GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
Rumina decollata           GGCCGGGGAT CCCTGGGACC CCGCCGCGGT GTCGATCCGG GCTCCGCCGC GTGCACTTTC
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    1210       1220       1230       1240       1250       1260
Achatina fulica             CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Achtina immaculata          CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Achatina reticulata         CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Achatina zanzibarica        CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGAC GGGTTGTCGG
Euaethiopina loveridgei     CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Achatina achatina           CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GAGTTGTCGG
Archachatina marginata      CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GAGTTGTCGG
Achatina bisculpta          CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Achatina damarensis         CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Achatina stuhlmanni         CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Atopocochlis exarata        CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Limicolaria kambeul         CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Limicolaria martenssii      CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Limicolariopsis sp.         CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Limicolariopsis ruwenzori   CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GTGTTGTCGG
Cochlitoma varicosa         CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Cochlitoma dimidiata        CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Cochlitoma sp. cf. vestita  CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Cochlitoma marinae          CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Cochlitoma churchilliana    CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Cochlitoma granulata        CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Cochlitoma simplex          CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Cochlitoma kilburni         CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Cochlitoma montistempli     CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Cochlitoma omissa           CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Cochlitoma semidecussata    CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Cochlitoma ustulata         CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Cochlitoma zebra            CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Metachatina kraussi         CGCGGGCAGA GTGCCACAAC CGGTTCCGCT GGAGCCGTCA GAGGCCGGGC GGGTTGTCGG
Rumina decollata            CGCGGGCAGA GTGCCACAAC CGGTTCCGCG GGAGCCGTCA GAGGTCGGAC GGGTTGTCGG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    1270       1280       1290       1300       1310       1320
Achatina fulica             TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Achtina immaculata          TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Achatina reticulata         TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Achatina zanzibarica        TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Euaethiopina loveridgei     TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Achatina achatina           TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGGACCG
Archachatina marginata      TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGGACCG
Achatina bisculpta          TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Achatina damarensis         TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Achatina stuhlmanni         TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACTG
Atopocochlis exarata        TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Limicolaria kambeul         TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Limicolaria martenssii      TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Limicolariopsis sp.         TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACTG
Limicolariopsis ruwenzori   TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Cochlitoma varicosa         TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Cochlitoma dimidiata        TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Cochlitoma sp. cf. vestita  TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Cochlitoma marinae          TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Cochlitoma churchilliana    TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Cochlitoma granulata        TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Cochlitoma simplex          TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Cochlitoma kilburni         TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Cochlitoma montistempli     TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Cochlitoma omissa           TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Cochlitoma semidecussata    TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Cochlitoma ustulata         TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Cochlitoma zebra            TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Metachatina kraussi         TGGGGGCGCT TGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGAACCG
Rumina decollata            TGGGGGCGCT CGCGTCCCTA CCAGCCCGCC CCGGCGGACG GCCTCGGGAC CGAGGGACCG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    1330       1340       1350       1360       1370       1380
Achatina fulica             CCGCGCGCTT CGAGGCTACC CGGCCCCTCT GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Achtina immaculata          CCGCGCGCTT CGAGGCTACC CGGCCCCTCT GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Achatina reticulata         CCGCGCGCTT CGAGGCTACC CGGCCCCTCT GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Achatina zanzibarica        CCGCGCGCTT CGAGGCTACC CGGCCCTTCT GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Euaethiopina loveridgei     CCGCGCGCTT CGAGGCTACC CAGCCCCTCT GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Achatina achatina           CCGCGCGCTT CGAGGCTACC CGACCCCTCC GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Archachatina marginata      CCGCGCGCTT CGAGGCTACC CGACCCCTCC GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Achatina bisculpta          CCGCGCGCTT CGAGGCTACC CGACCCCTCG GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Achatina damarensis         CCGCGCGCTT CGAGGCTACC CGACCCCTCG GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Achatina stuhlmanni         CCGCGCGCTT CGAGGCTACC CGACCCCTCG GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Atopocochlis exarata        CCGCGCGCTT CGAGGCTACC CGACCCCTCG GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Limicolaria kambeul         CCGCGCGCTT CGAGGCTACC CGACCCCTCG GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Limicolaria martenssii      CCGCGCGCTT CGAGGCTACC CGACCCCTCG GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Limicolariopsis sp.         CCGCGCGCTT CGAGGCTACC CGATCCCTCG GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Limicolariopsis ruwenzori   CCGCGCGCTT CGAGGCTACC CGACCCTTCG GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Cochlitoma varicosa         CCGCGCGCCT GGAGGCTACC CGACCCCTCC GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Cochlitoma dimidiata        CCGCGCGCTT GGAGGCTACC CGACCCCTCC GTGCGAGTCC GACTGGGAGA GACTGGGCAA
Cochlitoma sp. cf. vestita  CCGCGCGCCT GGAGGCTACC CGACCCCTCC GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Cochlitoma marinae          CCGCGCGCTT GGAGGCTACC CGACCCCTCC GTGCGAGTCC GACTGGGAGA GACTGGGCAA
Cochlitoma churchilliana    CCGCGCGCTT GGAGGCTACC CGACCCCTCC GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Cochlitoma granulata        CCGCGCGCTT GGAGGCTACC CGACCCCTCC GTGCGAGTCC GACTGGGAGA GACTGGGCAA
Cochlitoma simplex          CCGCGCGCCT GGAGGCTACC CGACCCCTCC GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Cochlitoma kilburni         CCGCGCGCCT GGAGGCTACC CGACCCCTCC GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Cochlitoma montistempli     CCGCGCGCTT GGAGGCTACC CGACCCCTCC GTGCGAGTCC GACTGGGAGA GACTGGGCAA
Cochlitoma omissa           CCGCGCGCTT GGAGGCTACC CGACCCCTCC GTGCGAGTCC GACTGGGAGA GACTGGGCAA
Cochlitoma semidecussata    CCGCGCGCTT GGAGGCTACC CGACCCCTCC GTGCGAGTCC GACTGGGAGA GACTGGGCAA
Cochlitoma ustulata         CCGCGCGCTT GGAGGCTACC CGACCCCTCC GTGCGAGTCC GACTGGGAGA GACTGGGCAA
Cochlitoma zebra            CCGCGCGCCT GGAGGCTACC CGACCCCTCC GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Metachatina kraussi         CCGCGCGCTT AGAGGCTACC CGACCCCTCC GCGCGAGTCC GACTGGGAGA GACTGGGCAA
Rumina decollata            CCGCACGCTT CGAGGCTACC T-GCTCCTCC GCGCGAGTCC GACTGGGAGA GACTGGGCAA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm m-mmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    1390       1400       1410       1420       1430       1440
Achatina fulica             CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Achtina immaculata          CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Achatina reticulata         CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Achatina zanzibarica        CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Euaethiopina loveridgei     CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Achatina achatina           CCGTGTCTCC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGC- GCGACTGAAA
Archachatina marginata      CCGTGTCTCC CGACCGCTCG CGTGCGACCG GGCCGGGCTA GCCGGGCGC- G--ACTGAAG
Achatina bisculpta          CCGTGTCTCC CGACCGCTCG CGCAAGACCG GGCCGGGCTA GCCGGGCGCC GCGACTGTAA
Achatina damarensis         CCGTGTCTCC CGACCGCTCG CGCAAGACCG GGCCGGGCTA GCCGGGCGCC GCGACTGTAA
Achatina stuhlmanni         CCGTGTCTCC CGACCGCTCG CGCAAGACCG GGCCGGGCTA GCCGGGCGCC GCGACTGTAA
Atopocochlis exarata        CCGTGTCTCC CGACCGCTCG CGCAAGACCG GGCCGGGCTA GCCGGGCGCC GCGACTGTAA
Limicolaria kambeul         CCGTGTCTCC CGACCGCTCG CGCAAGACCG GGCCGGGCTA GCCGGGCGCC GCGACTGTAA
Limicolaria martenssii      CCGTGTCTCC CGACCGCTCG CGCAAGACCG GGCCGGGCTA GCCGGGCGCC GCGACTGTAA
Limicolariopsis sp.         CCGTGTCTCC CGACCGCTCG CGCAAGACCG GGCCGGGCTA GCCGGGCGCC GCGACTGTAA
Limicolariopsis ruwenzori   CCGTGTCTCC CGACCGCTCG CGCAAGACCG GGCCGGGCTA GCCGGGCGCC GCGACTGTAA
Cochlitoma varicosa         CCGTGTCTTC CGACCGCTCG TGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Cochlitoma dimidiata        CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Cochlitoma sp. cf. vestita  CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Cochlitoma marinae          CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Cochlitoma churchilliana    CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Cochlitoma granulata        CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Cochlitoma simplex          CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Cochlitoma kilburni         CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Cochlitoma montistempli     CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Cochlitoma omissa           CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Cochlitoma semidecussata    CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Cochlitoma ustulata         CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Cochlitoma zebra            CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Metachatina kraussi         CCGTGTCTTC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGTC GCGACTGTAA
Rumina decollata            CCGTGTCTCC CGACCGCTCG CGCGCGACCG GGCCGGGCTA GCCGGGCGT- GC-AC---A-
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmm- m--mm-----
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                                 1450       1460       1470       1480       1490       1500
Achatina fulica            CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Achtina immaculata         CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Achatina reticulata        CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Achatina zanzibarica       CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Euaethiopina loveridgei    CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Achatina achatina          CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Archachatina marginata     CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Achatina bisculpta         CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAAca cggaCCAAGG
Achatina damarensis        CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Achatina stuhlmanni        CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Atopocochlis exarata       CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Limicolaria kambeul        CAGGGTTAGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Limicolaria martenssii     CAGGGTTAGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Limicolariopsis sp.        CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Limicolariopsis ruwenzori  CAGGGTTAGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Cochlitoma varicosa        CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Cochlitoma dimidiata       CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Cochlitoma sp. cf. vestita CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Cochlitoma marinae         CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Cochlitoma churchilliana   CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Cochlitoma granulata       CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Cochlitoma simplex         CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Cochlitoma kilburni        CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Cochlitoma montistempli    CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Cochlitoma omissa          CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Cochlitoma semidecussata   CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Cochlitoma ustulata        CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Cochlitoma zebra           CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Metachatina kraussi        CAGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAACA CGGACCAAGG
Rumina decollata           CGGGGTTGGT GGCGAGTCCG TCGGCATTCC ACCCGACCCG TCTTGAAAca cggaCCAAGG
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                 1510       1520       1530       1540       1550       1560
Achatina fulica            AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Achtina immaculata         AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Achatina reticulata        AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Achatina zanzibarica       AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Euaethiopina loveridgei    AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Achatina achatina          AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Archachatina marginata     AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Achatina bisculpta         AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Achatina damarensis        AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Achatina stuhlmanni        AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Atopocochlis exarata       AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Limicolaria kambeul        AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Limicolaria martenssii     AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Limicolariopsis sp.        AGTCTAACAT GCGCGCGAGT CATTGGGCTG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Limicolariopsis ruwenzori  AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Cochlitoma varicosa        AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Cochlitoma dimidiata       AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Cochlitoma sp. cf. vestita AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Cochlitoma marinae         AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Cochlitoma churchilliana   AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Cochlitoma granulata       AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Cochlitoma simplex         AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Cochlitoma kilburni        AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Cochlitoma montistempli    AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Cochlitoma omissa          AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Cochlitoma semidecussata   AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Cochlitoma ustulata        AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Cochlitoma zebra           AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Metachatina kraussi        AGTCTAACAT GCGCGCGAGT CATTGGGCGG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
Rumina decollata           AGTCTAACAT GCGCGCGAGT CATTGGGCWG TACGAAACCC AAAGGCGCAG TGAAAGCGAG
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                   1570       1580       1590       1600       1610       1620
Achatina fulica            GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Achtina immaculata         GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Achatina reticulata        GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCTTTC GCGGGAGCGG TGGCGCACCA
Achatina zanzibarica       GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGTTCCTTC GCGGGAGCGG TGGCGCACCA
Euaethiopina loveridgei    GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Achatina achatina          GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Archachatina marginata     GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Achatina bisculpta         GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Achatina damarensis        GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Achatina stuhlmanni        GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Atopocochlis exarata       GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Limicolaria kambeul        GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Limicolaria martenssii     GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Limicolariopsis sp.        GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Limicolariopsis ruwenzori  GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Cochlitoma varicosa        GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGTTCCTTC GCGGGAGCGG TGGCGCACCA
Cochlitoma dimidiata       GGTCGCCTCG CGCGACCCAG GTGGGATCCC CCGCTCCTTC GCGGGAGCGG AGGCGCACCA
Cochlitoma sp. cf. vestita GGTCGCCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Cochlitoma marinae         GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Cochlitoma churchilliana   GGTCGCCTCG CGCGACCCAG GTGGGATCCC CCACTCCTTT GCGGGAGCGG TGGCGCACCA
Cochlitoma granulata       GGTCGCCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Cochlitoma simplex         GGTCGCCTCG CGCGACCCAG GTGGGATCCC CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Cochlitoma kilburni        GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Cochlitoma montistempli    GGTCGCCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Cochlitoma omissa          GGTCGCCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Cochlitoma semidecussata   GGTCGCCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC ACGGGAGCGG TGGCGCACCA
Cochlitoma ustulata        GGTCGTCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Cochlitoma zebra           GGTCGCCTCG CGCGATCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Metachatina kraussi        GGTCGCCTCG CGCGACCCAG GTGGGATCCT CCGCTCCTTC GCGGGAGCGG TGGCGCACCA
Rumina decollata           GGTCGTCTCN CGCGACCCAG GTGGGATCCT CCACCCCTTC G-GGGGGCGG TGGCGCACCA
NUCLEOTIDES INCLUDED       mmmmmmmm-- -mmmmmmmmm mmmmmmmmmm ---------- --mmmmmmmm mmmmmmmmmm


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                                   1630       1640       1650       1660       1670       1680
Achatina fulica            CCGGCCCGTC CCGTCCGCGT CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Achtina immaculata         CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Achatina reticulata        CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Achatina zanzibarica       CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Euaethiopina loveridgei    CCGGCCCGTC CCGTCCGCGT CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Achatina achatina          CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Archachatina marginata     CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Achatina bisculpta         CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Achatina damarensis        CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Achatina stuhlmanni        CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Atopocochlis exarata       CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Limicolaria kambeul        CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Limicolaria martenssii     CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Limicolariopsis sp.        CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Limicolariopsis ruwenzori  CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Cochlitoma varicosa        CCGGCCCGTC CCGTCCGCGC TGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Cochlitoma dimidiata       CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Cochlitoma sp. cf. vestita CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Cochlitoma marinae         CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Cochlitoma churchilliana   CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Cochlitoma granulata       CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Cochlitoma simplex         CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Cochlitoma kilburni        CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Cochlitoma montistempli    CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Cochlitoma omissa          CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Cochlitoma semidecussata   CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Cochlitoma ustulata        CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Cochlitoma zebra           CCGGCCCGTC CCGTCCGCGC CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Metachatina kraussi        CCGGCCCGTC CCGTCCGCGT CGTCGGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
Rumina decollata           CCGGCCCGTC CCGTCYGCGY CGYCYGTGGG GCGGAGCAAG AGCGTGCACG CTGGGACCCG
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    1690       1700       1710       1720       1730       1740
Achatina fulica             AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Achtina immaculata          AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Achatina reticulata         AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Achatina zanzibarica        AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Euaethiopina loveridgei     AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Achatina achatina           AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Archachatina marginata      AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Achatina bisculpta          AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Achatina damarensis         AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Achatina stuhlmanni         AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Atopocochlis exarata        AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Limicolaria kambeul         AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Limicolaria martenssii      AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Limicolariopsis sp.         AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Limicolariopsis ruwenzori   AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Cochlitoma varicosa         AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Cochlitoma dimidiata        AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Cochlitoma sp. cf. vestita  AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Cochlitoma marinae          AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Cochlitoma churchilliana    AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Cochlitoma granulata        AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Cochlitoma simplex          AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Cochlitoma kilburni         AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Cochlitoma montistempli     AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Cochlitoma omissa           AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Cochlitoma semidecussata    AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Cochlitoma ustulata         AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Cochlitoma zebra            AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Metachatina kraussi         AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
Rumina decollata            AAAGATGGTG AACTATGCCT GAGTAGAACG AAGCCAGAGG AAACTCTGGT GGAGGTTCGT
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    1750       1760       1770       1780       1790       1800
Achatina fulica             AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Achtina immaculata          AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Achatina reticulata         AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Achatina zanzibarica        AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Euaethiopina loveridgei     AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Achatina achatina           AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Archachatina marginata      AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Achatina bisculpta          AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Achatina damarensis         AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Achatina stuhlmanni         AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Atopocochlis exarata        AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Limicolaria kambeul         AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Limicolaria martenssii      AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Limicolariopsis sp.         AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Limicolariopsis ruwenzori   AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Cochlitoma varicosa         AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Cochlitoma dimidiata        AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Cochlitoma sp. cf. vestita  AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Cochlitoma marinae          AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Cochlitoma churchilliana    AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Cochlitoma granulata        AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Cochlitoma simplex          AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Cochlitoma kilburni         AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Cochlitoma montistempli     AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Cochlitoma omissa           AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Cochlitoma semidecussata    AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Cochlitoma ustulata         AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Cochlitoma zebra            AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Metachatina kraussi         AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
Rumina decollata            AGCGATTCTG ACGTGCAAAT CGATCGTCAA ACTTGGGTAT AGGGGCGAAA GACTAATCGA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    1810       1820       1830       1840       1850       1860
Achatina fulica             ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Achtina immaculata          ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Achatina reticulata         ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Achatina zanzibarica        ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Euaethiopina loveridgei     ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Achatina achatina           ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Archachatina marginata      ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Achatina bisculpta          ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Achatina damarensis         ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Achatina stuhlmanni         ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Atopocochlis exarata        ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Limicolaria kambeul         ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Limicolaria martenssii      ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Limicolariopsis sp.         ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Limicolariopsis ruwenzori   ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Cochlitoma varicosa         ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Cochlitoma dimidiata        ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Cochlitoma sp. cf. vestita  ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Cochlitoma marinae          ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Cochlitoma churchilliana    ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Cochlitoma granulata        ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Cochlitoma simplex          ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Cochlitoma kilburni         ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Cochlitoma montistempli     ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Cochlitoma omissa           ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Cochlitoma semidecussata    ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Cochlitoma ustulata         ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Cochlitoma zebra            ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Metachatina kraussi         ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
Rumina decollata            ACCATCTAGT AGCTGGTTCC CTCCGAAGTT TCCCTCAGGA TAGCTGGCGC TCGATCGCAG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    1870       1880       1890       1900       1910       1920
Achatina fulica             TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Achtina immaculata          TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Achatina reticulata         TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Achatina zanzibarica        TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Euaethiopina loveridgei     TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Achatina achatina           TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Archachatina marginata      TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Achatina bisculpta          TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Achatina damarensis         TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Achatina stuhlmanni         TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Atopocochlis exarata        TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Limicolaria kambeul         TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Limicolaria martenssii      TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Limicolariopsis sp.         TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTTT
Limicolariopsis ruwenzori   TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Cochlitoma varicosa         TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Cochlitoma dimidiata        TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Cochlitoma sp. cf. vestita  TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Cochlitoma marinae          TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Cochlitoma churchilliana    TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Cochlitoma granulata        TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Cochlitoma simplex          TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Cochlitoma kilburni         TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Cochlitoma montistempli     TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Cochlitoma omissa           TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Cochlitoma semidecussata    TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Cochlitoma ustulata         TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Cochlitoma zebra            TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Metachatina kraussi         TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
Rumina decollata            TTTTATCCGG TAAAGCGAAT GATTAGAGGT CTTGGGGACG AAACGACCTC AACCTATTCT
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                  1930       1940       1950       1960       1970       1980
Achatina fulica            CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTNTCGAATG
Achtina immaculata         CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Achatina reticulata        CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Achatina zanzibarica       CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Euaethiopina loveridgei    CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Achatina achatina          CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Archachatina marginata     CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Achatina bisculpta         CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Achatina damarensis        CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Achatina stuhlmanni        CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Atopocochlis exarata       CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Limicolaria kambeul        CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Limicolaria martenssii     CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Limicolariopsis sp.        CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AACCGGGCGC GTTTTGAATG
Limicolariopsis ruwenzori  CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Cochlitoma varicosa        CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Cochlitoma dimidiata       CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Cochlitoma sp. cf. vestita CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Cochlitoma marinae         CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Cochlitoma churchilliana   CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Cochlitoma granulata       CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Cochlitoma simplex         CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Cochlitoma kilburni        CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Cochlitoma montistempli    CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Cochlitoma omissa          CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Cochlitoma semidecussata   CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Cochlitoma ustulata        CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Cochlitoma zebra           CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Metachatina kraussi        CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGATTGG AGCCGGGCGC GTTTCGAATG
Rumina decollata           CAAACTTTAA ATGGGTAAGA AGTCCGGCTC GCTCGAYTGG AGCCGGGCGC GTNTCGAATG
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                  1990       2000       2010       2020       2030       2040
Achatina fulica            CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Achtina immaculata         CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Achatina reticulata        CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Achatina zanzibarica       CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Euaethiopina loveridgei    CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Achatina achatina          CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Archachatina marginata     CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Achatina bisculpta         CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Achatina damarensis        CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Achatina stuhlmanni        CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Atopocochlis exarata       CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Limicolaria kambeul        CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Limicolaria martenssii     CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Limicolariopsis sp.        CGTGTGCCAA GTGGGCCCCT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Limicolariopsis ruwenzori  CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Cochlitoma varicosa        CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Cochlitoma dimidiata       CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Cochlitoma sp. cf. vestita CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Cochlitoma marinae         CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Cochlitoma churchilliana   CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Cochlitoma granulata       CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Cochlitoma simplex         CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Cochlitoma kilburni        CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Cochlitoma montistempli    CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Cochlitoma omissa          CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Cochlitoma semidecussata   CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Cochlitoma ustulata        CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Cochlitoma zebra           CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Metachatina kraussi        CGTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
Rumina decollata           CNTGTGCCAA GTGGGCCACT TTTGGTAAGC AGAACTGGCG CTGTGGGATG AACCAAACGC
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                  2050       2060       2070       2080       2090       2100
Achatina fulica            CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Achtina immaculata         CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Achatina reticulata        CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Achatina zanzibarica       CCGGTTAAGG TGCGAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Euaethiopina loveridgei    CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Achatina achatina          CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Archachatina marginata     CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Achatina bisculpta         CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Achatina damarensis        CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Achatina stuhlmanni        CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Atopocochlis exarata       CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Limicolaria kambeul        CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Limicolaria martenssii     CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Limicolariopsis sp.        CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Limicolariopsis ruwenzori  CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Cochlitoma varicosa        CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Cochlitoma dimidiata       CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Cochlitoma sp. cf. vestita CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Cochlitoma marinae         CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Cochlitoma churchilliana   CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Cochlitoma granulata       CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Cochlitoma simplex         CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Cochlitoma kilburni        CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Cochlitoma montistempli    CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Cochlitoma omissa          CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Cochlitoma semidecussata   CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Cochlitoma ustulata        CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Cochlitoma zebra           CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Metachatina kraussi        CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
Rumina decollata           CCGGTTAAGG TGCCAAACGC TGACGCTCAT CAGACACCAT AAAAGGTGTT GGTTGATATA
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                  2110       2120       2130       2140       2150       2160
Achatina fulica            GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Achtina immaculata         GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Achatina reticulata        GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Achatina zanzibarica       GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Euaethiopina loveridgei    GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Achatina achatina          GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Archachatina marginata     GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Achatina bisculpta         GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Achatina damarensis        GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Achatina stuhlmanni        GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Atopocochlis exarata       GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Limicolaria kambeul        GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Limicolaria martenssii     GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Limicolariopsis sp.        GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Limicolariopsis ruwenzori  GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Cochlitoma varicosa        GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Cochlitoma dimidiata       GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Cochlitoma sp. cf. vestita GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Cochlitoma marinae         GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Cochlitoma churchilliana   GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Cochlitoma granulata       GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Cochlitoma simplex         GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Cochlitoma kilburni        GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Cochlitoma montistempli    GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Cochlitoma omissa          GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Cochlitoma semidecussata   GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Cochlitoma ustulata        GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Cochlitoma zebra           GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Metachatina kraussi        GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
Rumina decollata           GACAGCAGGA CGGTGGCCAT GGAAGTCGGA ACCCGCTAAG GAGTGTGTAA CAACTCACCT
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   2170       2180       2190       2200       2210       2220
Achatina fulica             GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Achtina immaculata          GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Achatina reticulata         GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Achatina zanzibarica        GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Euaethiopina loveridgei     GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Achatina achatina           GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Archachatina marginata      GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Achatina bisculpta          GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Achatina damarensis         GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Achatina stuhlmanni         GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Atopocochlis exarata        GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Limicolaria kambeul         GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Limicolaria martenssii      GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Limicolariopsis sp.         GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Limicolariopsis ruwenzori   GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Cochlitoma varicosa         GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Cochlitoma dimidiata        GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Cochlitoma sp. cf. vestita  GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Cochlitoma marinae          GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Cochlitoma churchilliana    GCCGAATCAA CCAGCCCTGA AAATGGATGG CGSTAGAGCG TCGGACCCAT ACCGGGCCGT
Cochlitoma granulata        GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Cochlitoma simplex          GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Cochlitoma kilburni         GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Cochlitoma montistempli     GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Cochlitoma omissa           GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Cochlitoma semidecussata    GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Cochlitoma ustulata         GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Cochlitoma zebra            GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Metachatina kraussi         GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
Rumina decollata            GCCGAATCAA CCAGCCCTGA AAATGGATGG CGCTAGAGCG TCGGACCCAT ACCGGGCCGT
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                   2230       2240       2250       2260       2270       2280
Achatina fulica             CTCGGCAATG GGCCCTTCCA TGGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Achtina immaculata          CTCGGCAATG GGCCCTTCCA TGGGG-CCGG NAAGCGAGGC CGAGACGAGT AGGAGGGCCG
Achatina reticulata         CTCGGCAATG GGCCCTTCCA TGGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Achatina zanzibarica        CTCGGCAATG GGCCCTTCCA TGGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Euaethiopina loveridgei     CTCGGCAATG GGCCCTTCCA TGGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Achatina achatina           CTCGGCAATA GGCC------ TTCCG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Archachatina marginata      CTCGGCAATA GGCC---TTC TTCCG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Achatina bisculpta          CTCGGCAATG GGCTCTTTCA TGGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Achatina damarensis         CTCGGCAATG GGCCCTTTCA TGGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Achatina stuhlmanni         CTCGGCAATG GGCCCTTTCA TGGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Atopocochlis exarata        CTCGGCAATG GGCCCTTTCA TGGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Limicolaria kambeul         CTCGGCAATG GGCCCTTTCA TGGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Limicolaria martenssii      CTCGGCAATG GGCCCTTTCA TGGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Limicolariopsis sp.         CTCGGCAATG GGCCCTTTCA TGGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Limicolariopsis ruwenzori   CTCGGCAATG GGCCCTTTCA TGGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Cochlitoma varicosa         CTCGGCAATG GGCCCCTTCC ACGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Cochlitoma dimidiata        CTCGGCAATG GGCCCCTTCC ACGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Cochlitoma sp. cf. vestita  CTCGGCAATG GGCCCCTTCC ACGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Cochlitoma marinae          CTCGGCAATG GGCCC-TTCC ACGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Cochlitoma churchilliana    CTCGGCAATG GGCCC-TTCC ACGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Cochlitoma granulata        CTCGGCAATG GGCCCCTTCC ACGGGGCCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Cochlitoma simplex          CTCGGCAATG GGCCCCTTCC ACGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Cochlitoma kilburni         CTCGGCAATG GGCCCCTTCC ACGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Cochlitoma montistempli     CTCGGCAATG GGCCCCTTCC ACGGGGCCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Cochlitoma omissa           CTCGGCAATG GGCCCCTTCC ACGGGGCCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Cochlitoma semidecussata    CTCGGCAATG GGCCCCTTCC ACGGGGCCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Cochlitoma ustulata         CTCGGCAATG GGCCC-TTCC ACGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Cochlitoma zebra            CTCGGCAATG GGCCCCTTCC ACGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Metachatina kraussi         CTCGGCAATG GGCCC-TTCC ACGGG-CCGG -AAGCGAGGC CGAGACGAGT AGGAGGGCCG
Rumina decollata            CTCGGCAGTG GCGATAGCCG CG-------- -AATCGAGGC CGAGACGAGT AGGAGGGCCG
NUCLEOTIDES INCLUDED        mmmmmmmmmm m--------- ------mmmm -mmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    2290       2300       2310       2320       2330       2340
Achatina fulica             TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Achtina immaculata          TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Achatina reticulata         TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Achatina zanzibarica        TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Euaethiopina loveridgei     TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Achatina achatina           TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Archachatina marginata      TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Achatina bisculpta          TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Achatina damarensis         TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Achatina stuhlmanni         TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Atopocochlis exarata        TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Limicolaria kambeul         TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Limicolaria martenssii      TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Limicolariopsis sp.         TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Limicolariopsis ruwenzori   TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Cochlitoma varicosa         TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Cochlitoma dimidiata        TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Cochlitoma sp. cf. vestita  TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Cochlitoma marinae          TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Cochlitoma churchilliana    TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Cochlitoma granulata        TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Cochlitoma simplex          TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Cochlitoma kilburni         TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Cochlitoma montistempli     TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Cochlitoma omissa           TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Cochlitoma semidecussata    TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Cochlitoma ustulata         TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Cochlitoma zebra            TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Metachatina kraussi         TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
Rumina decollata            TCGGGGTGAG CGTGGAAGCC TGGGGAGCGA TCCTGGGTGG AGCCGCCCCG GGTGCAGATC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    2350       2360       2370       2380       2390       2400
Achatina fulica             TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Achtina immaculata          TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Achatina reticulata         TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Achatina zanzibarica        TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Euaethiopina loveridgei     TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Achatina achatina           TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Archachatina marginata      TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Achatina bisculpta          TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Achatina damarensis         TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Achatina stuhlmanni         TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Atopocochlis exarata        TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Limicolaria kambeul         TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Limicolaria martenssii      TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Limicolariopsis sp.         TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Limicolariopsis ruwenzori   TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Cochlitoma varicosa         TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Cochlitoma dimidiata        TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Cochlitoma sp. cf. vestita  TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Cochlitoma marinae          TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Cochlitoma churchilliana    TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Cochlitoma granulata        TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Cochlitoma simplex          TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Cochlitoma kilburni         TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Cochlitoma montistempli     TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Cochlitoma omissa           TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Cochlitoma semidecussata    TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Cochlitoma ustulata         TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Cochlitoma zebra            TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Metachatina kraussi         TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
Rumina decollata            TTGGTGGTAG TAGCAAATAT TCAAACGAGA ACTTTGAAGA CTGAAGTGGA GAAGGGTTCC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    2410       2420       2430       2440       2450       2460
Achatina fulica             ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Achtina immaculata          ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Achatina reticulata         ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Achatina zanzibarica        ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Euaethiopina loveridgei     ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Achatina achatina           ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Archachatina marginata      ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Achatina bisculpta          ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Achatina damarensis         ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Achatina stuhlmanni         ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Atopocochlis exarata        ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Limicolaria kambeul         ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Limicolaria martenssii      ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Limicolariopsis sp.         ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Limicolariopsis ruwenzori   ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Cochlitoma varicosa         ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Cochlitoma dimidiata        ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Cochlitoma sp. cf. vestita  ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Cochlitoma marinae          ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Cochlitoma churchilliana    ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Cochlitoma granulata        ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Cochlitoma simplex          ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Cochlitoma kilburni         ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Cochlitoma montistempli     ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Cochlitoma omissa           ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Cochlitoma semidecussata    ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Cochlitoma ustulata         ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Cochlitoma zebra            ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Metachatina kraussi         ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
Rumina decollata            ATGTGAACAG CAGTTGAACA TGGGTCAGTC GGTCCTAAGA GATAGGAAAA CTCCGTTCTG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    2470       2480       2490       2500       2510       2520
Achatina fulica             ACCCCGGGGC ATTCTTTCTT TCTTTCT--- ---------- ----AGAAGA GTCTGCCCGC
Achtina immaculata          ACCCCGGGGC ATTCTTTCTT TCTTTCT--- ---------- ----AGAAGA GTCTGCCCGC
Achatina reticulata         ACCCCGGGGC ATTCTTTCTT TCTTTCT--- ---------- ----AGAAGA GTCTGCCCGC
Achatina zanzibarica        ACCCCGGGGC ATTCTTTCTT TCTTTCT--- ---------- ----AGAAGA GTCTGCCCGC
Euaethiopina loveridgei     ACCCCGGGGC ATTCTTTCTT TCTTTCT--- ---------- ----AGAAGA GTCTGCCCGC
Achatina achatina           ACCCCGGGGC ATTCTTTCGT TTCTTTC--- ---------- -----AGCAA GTCTGCCCGC
Archachatina marginata      ACCCCGGGGC ATTCTTTGTC AGCAGT---- ---------- -------CAA GTCTGCCCGC
Achatina bisculpta          ACCCCGGGGC ATTCTTTATT A---TTCGTT ATTCGT---- -------AGA GTCTGCCCGC
Achatina damarensis         ACCCCGGGGC ATTCTTTATT ACTCTTCGTT ATT------- -------AGA GTCTGCCCGC
Achatina stuhlmanni         ACCCCGGGGC ATTCTTTATA A---TTCGTT ATT------- -------AGA GTCTGCCCGC
Atopocochlis exarata        ACCCCGGGGC ATTCTTTATT A---ATCGTT TAA------- -------AGA GTCTGCCCGC
Limicolaria kambeul         ACCCCGGGGC ATTCTTTATT A---TTCGTT ---------- -------AGA GTCTGCCCGC
Limicolaria martenssii      ACCCCGGGGC ATTCTTTATT A---TTCGTT ---------- -------AGA GTCTGCCCGC
Limicolariopsis sp.         ACCCCGGGGC ATTCTTTATT ATA-TTCGTT TT-------- -------AGA GTCTGCCCGC
Limicolariopsis ruwenzori   ACCCCGGGGC ATTCTTTATT A---TTCGTT ---------- -------AGA GTCTGCCCGC
Cochlitoma varicosa         ACCCCGGGGC ATTCTTTCTT T--CTTT--- ---------- CGTGATTAAA GTCTGCCCGC
Cochlitoma dimidiata        ACCCCGGGGC ATTCTTTCTT T--CTTT--- ---------- ---------A GTCTGCCCGC
Cochlitoma sp. cf. vestita  ACCCCGGGGC ATTCTTTCGT G--------- ---------- ----ATTAAA GTCTGCCCGC
Cochlitoma marinae          ACCCCGGGGC ATTCTTTCGT G--------- ---------- ----ATTAAA GTCTGCCCGC
Cochlitoma churchilliana    ACCCCGGGGC ATTCTTTCTT T--CTTTTCT T--------- ---GATTAAA GTCTGCCCGC
Cochlitoma granulata        ACCCCGGGGC ATTCTTTCTT TTTCTT---- ---------G ATTAATTAAA GTCTGCCCGC
Cochlitoma simplex          ACCCCGGGGC ATTCTTTCTT T--CTTT--- ---------- ---------A GTCTGCCCGC
Cochlitoma kilburni         ACCCCGGGGC ATTCTTTCTT T--CTTT--- ------ATTA ATTAAATAAA GTCTGCCCGC
Cochlitoma montistempli     ACCCCGGGGC ATTCTTTCTT TTTCTT---- ---------G ATTAATTAAA GTCTGCCCGC
Cochlitoma omissa           ACCCCGGGGC ATTCTTTCTT TTTCTT---- ---------G ATTAATTAAA GTCTGCCCGC
Cochlitoma semidecussata    ACCCCGGGGC ATTCTTTCTT TTTCTT---- ---------G ATTAATTAAA GTCTGCCCGC
Cochlitoma ustulata         ACCCCGGGGC ATTCTTTCGT G--------- ---------- ----ATTAAA GTCTGCCCGC
Cochlitoma zebra            ACCCCGGGGC ATTCTTTCGT G--------- ---------- ----ATTAAA GTCTGCCCGC
Metachatina kraussi         ACCCCGGGGC ATTCTTTCTT T--CTT---- ---------- -------AAA GTCTGCCCGC
Rumina decollata            ACCCCGGGGC AATCTTTCTC GAGCTA---- -------AGA AGAAAAAGAA GTCTGCCCGC
NUCLEOTIDES INCLUDED        mmmmmmmmmm ---------- ---------- ---------- ---------m mmmmmmmmmm
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    2530       2540       2550       2560       2570       2580
Achatina fulica             AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Achtina immaculata          AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Achatina reticulata         AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Achatina zanzibarica        AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Euaethiopina loveridgei     AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Achatina achatina           AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Archachatina marginata      AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Achatina bisculpta          AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Achatina damarensis         AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Achatina stuhlmanni         AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Atopocochlis exarata        AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Limicolaria kambeul         AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Limicolaria martenssii      AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Limicolariopsis sp.         AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Limicolariopsis ruwenzori   AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Cochlitoma varicosa         AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Cochlitoma dimidiata        AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Cochlitoma sp. cf. vestita  AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Cochlitoma marinae          AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Cochlitoma churchilliana    AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Cochlitoma granulata        AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Cochlitoma simplex          AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Cochlitoma kilburni         AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Cochlitoma montistempli     AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Cochlitoma omissa           AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Cochlitoma semidecussata    AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Cochlitoma ustulata         AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Cochlitoma zebra            AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Metachatina kraussi         AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
Rumina decollata            AGCCTATCGA AAGGGAATCG GGTTAATATT CCCGAACCTG GACACGGAGA TTGGTCCTCA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    2590       2600       2610       2620       2630       2640
Achatina fulica             GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Achtina immaculata          GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Achatina reticulata         GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Achatina zanzibarica        GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Euaethiopina loveridgei     GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Achatina achatina           GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Archachatina marginata      GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Achatina bisculpta          GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Achatina damarensis         GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Achatina stuhlmanni         GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Atopocochlis exarata        GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Limicolaria kambeul         GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Limicolaria martenssii      GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Limicolariopsis sp.         GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Limicolariopsis ruwenzori   GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Cochlitoma varicosa         GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Cochlitoma dimidiata        GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Cochlitoma sp. cf. vestita  GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Cochlitoma marinae          GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Cochlitoma churchilliana    GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Cochlitoma granulata        GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Cochlitoma simplex          GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Cochlitoma kilburni         GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Cochlitoma montistempli     GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Cochlitoma omissa           GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Cochlitoma semidecussata    GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Cochlitoma ustulata         GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Cochlitoma zebra            GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Metachatina kraussi         GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
Rumina decollata            GGGGCCACGT GCGGCAACGC AAACGAAGTG GGGGACGTCG GCGGGAGCCC CGGGAAGAGT
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   2650       2660       2670       2680       2690       2700
Achatina fulica            TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Achtina immaculata         TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Achatina reticulata        TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Achatina zanzibarica       TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Euaethiopina loveridgei    TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Achatina achatina          TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Archachatina marginata     TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Achatina bisculpta         TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Achatina damarensis        TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Achatina stuhlmanni        TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Atopocochlis exarata       TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Limicolaria kambeul        TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Limicolaria martenssii     TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Limicolariopsis sp.        TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Limicolariopsis ruwenzori  TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Cochlitoma varicosa        TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Cochlitoma dimidiata       TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Cochlitoma sp. cf. vestita TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Cochlitoma marinae         TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Cochlitoma churchilliana   TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Cochlitoma granulata       TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Cochlitoma simplex         TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Cochlitoma kilburni        TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Cochlitoma montistempli    TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Cochlitoma omissa          TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Cochlitoma semidecussata   TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Cochlitoma ustulata        TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Cochlitoma zebra           TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Metachatina kraussi        TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
Rumina decollata           TCTCTTTTCT TTGTAAGGAG CCACATCCCT GGAATCGGCT TGCCCGGAGA TAGGGACCGC
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                   2710       2720       2730       2740       2750       2760
Achatina fulica            GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Achtina immaculata         GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Achatina reticulata        GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Achatina zanzibarica       GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Euaethiopina loveridgei    GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Achatina achatina          GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Archachatina marginata     GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Achatina bisculpta         GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Achatina damarensis        GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Achatina stuhlmanni        GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Atopocochlis exarata       GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Limicolaria kambeul        GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Limicolaria martenssii     GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Limicolariopsis sp.        GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Limicolariopsis ruwenzori  GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Cochlitoma varicosa        GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Cochlitoma dimidiata       GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Cochlitoma sp. cf. vestita GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Cochlitoma marinae         GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Cochlitoma churchilliana   GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Cochlitoma granulata       GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Cochlitoma simplex         GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Cochlitoma kilburni        GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Cochlitoma montistempli    GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Cochlitoma omissa          GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Cochlitoma semidecussata   GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Cochlitoma ustulata        GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Cochlitoma zebra           GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Metachatina kraussi        GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
Rumina decollata           GGCCCCGTAA AGCACCGCGG CTCTTGCGGT GTCCGGTGCG CTCCCGTCGG CCCTTGAAAA
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                  2770       2780       2790       2800       2810       2820
Achatina fulica             CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Achtina immaculata          CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Achatina reticulata         CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Achatina zanzibarica        CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Euaethiopina loveridgei     CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Achatina achatina           CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Archachatina marginata      CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Achatina bisculpta          CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Achatina damarensis         CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Achatina stuhlmanni         CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Atopocochlis exarata        CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Limicolaria kambeul         CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Limicolaria martenssii      CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Limicolariopsis sp.         CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Limicolariopsis ruwenzori   CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Cochlitoma varicosa         CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Cochlitoma dimidiata        CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Cochlitoma sp. cf. vestita  CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Cochlitoma marinae          CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Cochlitoma churchilliana    CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Cochlitoma granulata        CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Cochlitoma simplex          CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Cochlitoma kilburni         CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Cochlitoma montistempli     CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Cochlitoma omissa           CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Cochlitoma semidecussata    CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Cochlitoma ustulata         CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Cochlitoma zebra            CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Metachatina kraussi         CCCCACGNAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
Rumina decollata            CCCCACGGAG ACGGTGTGAA TTTCGTGCCA GGCCGTACCC ATATCCGCAG CAGGTCTCCG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                  2830       2840       2850       2860       2870       2880
Achatina fulica             AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Achtina immaculata          AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Achatina reticulata         AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Achatina zanzibarica        AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Euaethiopina loveridgei     AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Achatina achatina           AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Archachatina marginata      AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Achatina bisculpta          AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Achatina damarensis         AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Achatina stuhlmanni         AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Atopocochlis exarata        AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Limicolaria kambeul         AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Limicolaria martenssii      AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Limicolariopsis sp.         AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Limicolariopsis ruwenzori   AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Cochlitoma varicosa         AGGTGCACAG TCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Cochlitoma dimidiata        AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Cochlitoma sp. cf. vestita  AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Cochlitoma marinae          AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Cochlitoma churchilliana    AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Cochlitoma granulata        AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Cochlitoma simplex          AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Cochlitoma kilburni         AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Cochlitoma montistempli     AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Cochlitoma omissa           AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Cochlitoma semidecussata    AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Cochlitoma ustulata         AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Cochlitoma zebra            AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Metachatina kraussi         AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
Rumina decollata            AGGTGCACAG CCTCTAGTCG ATAGAACAAT GTAGGTAAGG GAAGTCGGCA AATTGGATCC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                 2890       2900       2910       2920       2930       2940
Achatina fulica            GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Achtina immaculata         GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Achatina reticulata        GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Achatina zanzibarica       GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Euaethiopina loveridgei    GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Achatina achatina          GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Archachatina marginata     GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Achatina bisculpta         GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Achatina damarensis        GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Achatina stuhlmanni        GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Atopocochlis exarata       GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Limicolaria kambeul        GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Limicolaria martenssii     GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Limicolariopsis sp.        GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Limicolariopsis ruwenzori  GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Cochlitoma varicosa        GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Cochlitoma dimidiata       GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Cochlitoma sp. cf. vestita GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Cochlitoma marinae         GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Cochlitoma churchilliana   GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Cochlitoma granulata       GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Cochlitoma simplex         GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Cochlitoma kilburni        GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Cochlitoma montistempli    GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Cochlitoma omissa          GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Cochlitoma semidecussata   GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Cochlitoma ustulata        GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Cochlitoma zebra           GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Metachatina kraussi        GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
Rumina decollata           GTAACTTCGG GAAAAGGATT GGCTCTGAGG GCTGGGTCAG TCGGGCCGGG GTACGAAGCG
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                 2950       2960       2970       2980       2990       3000
Achatina fulica            GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Achtina immaculata         GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Achatina reticulata        GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Achatina zanzibarica       GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Euaethiopina loveridgei    GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Achatina achatina          GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Archachatina marginata     GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Achatina bisculpta         GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Achatina damarensis        GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Achatina stuhlmanni        GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Atopocochlis exarata       GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Limicolaria kambeul        GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Limicolaria martenssii     GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Limicolariopsis sp.        GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Limicolariopsis ruwenzori  GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Cochlitoma varicosa        GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Cochlitoma dimidiata       GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Cochlitoma sp. cf. vestita GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Cochlitoma marinae         GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Cochlitoma churchilliana   GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Cochlitoma granulata       GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Cochlitoma simplex         GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Cochlitoma kilburni        GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Cochlitoma montistempli    GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Cochlitoma omissa          GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Cochlitoma semidecussata   GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Cochlitoma ustulata        GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Cochlitoma zebra           GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Metachatina kraussi        GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGCCGGCGGG CCGGCCGAGC
Rumina decollata           GGACTGGGAT GGGCCCGGGC TGGGCGAGGC CGCCGCCGCT AGTCGGCGGG CCGGCCGAGC
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    3010       3020       3030       3040       3050       3060
Achatina fulica             TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Achtina immaculata          TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Achatina reticulata         TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Achatina zanzibarica        TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Euaethiopina loveridgei     TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Achatina achatina           TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Archachatina marginata      TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Achatina bisculpta          TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Achatina damarensis         TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Achatina stuhlmanni         TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Atopocochlis exarata        TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Limicolaria kambeul         TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Limicolaria martenssii      TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCGGG
Limicolariopsis sp.         TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Limicolariopsis ruwenzori   TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Cochlitoma varicosa         TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Cochlitoma dimidiata        TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Cochlitoma sp. cf. vestita  TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Cochlitoma marinae          TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Cochlitoma churchilliana    TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Cochlitoma granulata        TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Cochlitoma simplex          TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Cochlitoma kilburni         TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Cochlitoma montistempli     TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Cochlitoma omissa           TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Cochlitoma semidecussata    TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Cochlitoma ustulata         TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Cochlitoma zebra            TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Metachatina kraussi         TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCTCCCCGG
Rumina decollata            TCGGAACGCG GCTGCAACCT TCCCGTGGAC CGCCCCAGCT ATGCGGCGGC GCCT-CCCGG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmm-mmmmm


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                                    3070       3080       3090       3100       3110       3120
Achatina fulica             CGTCGTTCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Achtina immaculata          CGTCGTTCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Achatina reticulata         CGTCGTTCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Achatina zanzibarica        CGTCGTTCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Euaethiopina loveridgei     CGTCGTTCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Achatina achatina           CGTCGTTCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Archachatina marginata      CGTCGTTCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Achatina bisculpta          CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Achatina damarensis         CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Achatina stuhlmanni         CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Atopocochlis exarata        CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Limicolaria kambeul         CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Limicolaria martenssii      CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Limicolariopsis sp.         CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Limicolariopsis ruwenzori   CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Cochlitoma varicosa         CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Cochlitoma dimidiata        CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Cochlitoma sp. cf. vestita  CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Cochlitoma marinae          CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Cochlitoma churchilliana    CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Cochlitoma granulata        CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Cochlitoma simplex          CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Cochlitoma kilburni         CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Cochlitoma montistempli     CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Cochlitoma omissa           CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Cochlitoma semidecussata    CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Cochlitoma ustulata         CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Cochlitoma zebra            CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Metachatina kraussi         CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
Rumina decollata            CGTCGTCCGC GTCGGCTGGC ATTCAACAGC CAACTCAGAA CTGGTACGGA CCAGGGGAAT
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    3130       3140       3150       3160       3170       3180
Achatina fulica             CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Achtina immaculata          CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCTGTGTTG ACGCAATGTG
Achatina reticulata         CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Achatina zanzibarica        CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Euaethiopina loveridgei     CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Achatina achatina           CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Archachatina marginata      CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Achatina bisculpta          CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Achatina damarensis         CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Achatina stuhlmanni         CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Atopocochlis exarata        CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Limicolaria kambeul         CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Limicolaria martenssii      CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Limicolariopsis sp.         CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Limicolariopsis ruwenzori   CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Cochlitoma varicosa         CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Cochlitoma dimidiata        CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Cochlitoma sp. cf. vestita  CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Cochlitoma marinae          CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Cochlitoma churchilliana    CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Cochlitoma granulata        CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Cochlitoma simplex          CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Cochlitoma kilburni         CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Cochlitoma montistempli     CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Cochlitoma omissa           CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Cochlitoma semidecussata    CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Cochlitoma ustulata         CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Cochlitoma zebra            CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Metachatina kraussi         CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
Rumina decollata            CCGACTGTCT AATTAAAACA AAGCATTGCG ACGGCCGTCA CCCGGTGTTG ACGCAATGTG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    3190       3200       3210       3220       3230       3240
Achatina fulica             ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Achtina immaculata          ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Achatina reticulata         ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Achatina zanzibarica        ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Euaethiopina loveridgei     ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Achatina achatina           ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Archachatina marginata      ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Achatina bisculpta          ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Achatina damarensis         ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Achatina stuhlmanni         ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Atopocochlis exarata        ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Limicolaria kambeul         ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Limicolaria martenssii      ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Limicolariopsis sp.         ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Limicolariopsis ruwenzori   ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Cochlitoma varicosa         ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Cochlitoma dimidiata        ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Cochlitoma sp. cf. vestita  ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Cochlitoma marinae          ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Cochlitoma churchilliana    ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Cochlitoma granulata        ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Cochlitoma simplex          ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Cochlitoma kilburni         ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Cochlitoma montistempli     ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Cochlitoma omissa           ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Cochlitoma semidecussata    ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Cochlitoma ustulata         ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Cochlitoma zebra            ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Metachatina kraussi         ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
Rumina decollata            ATTTCTGCCC AGTGCTCTGA ATGTCAAAGT GAAGAAATTC AACCAAGCGC GGGTAAACGG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    3250       3260       3270       3280       3290       3300
Achatina fulica             CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Achtina immaculata          CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Achatina reticulata         CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Achatina zanzibarica        CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Euaethiopina loveridgei     CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Achatina achatina           CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Archachatina marginata      CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Achatina bisculpta          CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Achatina damarensis         CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Achatina stuhlmanni         CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Atopocochlis exarata        CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Limicolaria kambeul         CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Limicolaria martenssii      CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Limicolariopsis sp.         CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Limicolariopsis ruwenzori   CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Cochlitoma varicosa         CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Cochlitoma dimidiata        CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Cochlitoma sp. cf. vestita  CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Cochlitoma marinae          CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Cochlitoma churchilliana    CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Cochlitoma granulata        CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Cochlitoma simplex          CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Cochlitoma kilburni         CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Cochlitoma montistempli     CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Cochlitoma omissa           CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Cochlitoma semidecussata    CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Cochlitoma ustulata         CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Cochlitoma zebra            CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Metachatina kraussi         CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
Rumina decollata            CGGGAGTAAC TATGACTCTC TTAAGGTAGC CAAATGCCTC GTCATCTAAT TAGTGACGCG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    3310       3320       3330       3340       3350       3360
Achatina fulica             CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Achtina immaculata          CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Achatina reticulata         CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Achatina zanzibarica        CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Euaethiopina loveridgei     CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Achatina achatina           CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Archachatina marginata      CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Achatina bisculpta          CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Achatina damarensis         CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Achatina stuhlmanni         CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Atopocochlis exarata        CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Limicolaria kambeul         CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Limicolaria martenssii      CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Limicolariopsis sp.         CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Limicolariopsis ruwenzori   CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Cochlitoma varicosa         CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Cochlitoma dimidiata        CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Cochlitoma sp. cf. vestita  CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Cochlitoma marinae          CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Cochlitoma churchilliana    CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Cochlitoma granulata        CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Cochlitoma simplex          CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Cochlitoma kilburni         CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Cochlitoma montistempli     CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Cochlitoma omissa           CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Cochlitoma semidecussata    CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Cochlitoma ustulata         CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Cochlitoma zebra            CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Metachatina kraussi         CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
Rumina decollata            CATGAATGGA TTAACGAGAT TCCCACTGTC CCTATCTACT ATCTAGCGAA ACCACAGCCA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    3370       3380       3390       3400       3410       3420
Achatina fulica             AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Achtina immaculata          AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Achatina reticulata         AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Achatina zanzibarica        AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Euaethiopina loveridgei     AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Achatina achatina           AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Archachatina marginata      AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Achatina bisculpta          AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Achatina damarensis         AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Achatina stuhlmanni         AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Atopocochlis exarata        AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Limicolaria kambeul         AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Limicolaria martenssii      AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Limicolariopsis sp.         AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Limicolariopsis ruwenzori   AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Cochlitoma varicosa         AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Cochlitoma dimidiata        AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Cochlitoma sp. cf. vestita  AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Cochlitoma marinae          AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Cochlitoma churchilliana    AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Cochlitoma granulata        AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Cochlitoma simplex          AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Cochlitoma kilburni         AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Cochlitoma montistempli     AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Cochlitoma omissa           AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Cochlitoma semidecussata    AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Cochlitoma ustulata         AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Cochlitoma zebra            AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Metachatina kraussi         AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
Rumina decollata            AGGGAACGGG CTTGGTAGAA TCAGCGGGGA AAGAAGACCC TGTTGAGCTT GACTCTAGTC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    3430       3440       3450       3460       3470       3480
Achatina fulica             CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Achtina immaculata          CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Achatina reticulata         CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Achatina zanzibarica        CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Euaethiopina loveridgei     CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Achatina achatina           CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Archachatina marginata      CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Achatina bisculpta          CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Achatina damarensis         CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Achatina stuhlmanni         CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Atopocochlis exarata        CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Limicolaria kambeul         CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Limicolaria martenssii      CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Limicolariopsis sp.         CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Limicolariopsis ruwenzori   CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Cochlitoma varicosa         CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Cochlitoma dimidiata        CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Cochlitoma sp. cf. vestita  CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Cochlitoma marinae          CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Cochlitoma churchilliana    CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Cochlitoma granulata        CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Cochlitoma simplex          CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Cochlitoma kilburni         CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Cochlitoma montistempli     CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Cochlitoma omissa           CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Cochlitoma semidecussata    CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Cochlitoma ustulata         CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Cochlitoma zebra            CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Metachatina kraussi         CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
Rumina decollata            CGACTTTGTG AAGACACATG AAGGGTGTAG CATAGGTGGG AGCGCAAGCG CAATTGAAAT
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    3490       3500       3510       3520       3530       3540
Achatina fulica             ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Achtina immaculata          ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Achatina reticulata         ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Achatina zanzibarica        ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Euaethiopina loveridgei     ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Achatina achatina           ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Archachatina marginata      ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Achatina bisculpta          ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Achatina damarensis         ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Achatina stuhlmanni         ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Atopocochlis exarata        ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Limicolaria kambeul         ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Limicolaria martenssii      ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Limicolariopsis sp.         ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Limicolariopsis ruwenzori   ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Cochlitoma varicosa         ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Cochlitoma dimidiata        ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Cochlitoma sp. cf. vestita  ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Cochlitoma marinae          ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Cochlitoma churchilliana    ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Cochlitoma granulata        ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Cochlitoma simplex          ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Cochlitoma kilburni         ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Cochlitoma montistempli     ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Cochlitoma omissa           ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Cochlitoma semidecussata    ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Cochlitoma ustulata         ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Cochlitoma zebra            ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Metachatina kraussi         ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
Rumina decollata            ACCACTACTT TTATCGTTTC TTTACTTATT CAGTCAAGCG GAGAGCGGGG CGCAAGCCCC
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                    3550       3560       3570       3580       3590       3600
Achatina fulica             TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Achtina immaculata          TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Achatina reticulata         TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Achatina zanzibarica        TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Euaethiopina loveridgei     TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Achatina achatina           TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Archachatina marginata      TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Achatina bisculpta          TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Achatina damarensis         TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Achatina stuhlmanni         TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Atopocochlis exarata        TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Limicolaria kambeul         TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Limicolaria martenssii      TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Limicolariopsis sp.         TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Limicolariopsis ruwenzori   TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Cochlitoma varicosa         TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Cochlitoma dimidiata        TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCGC GGCCGCGATC CGCTCTGAAG
Cochlitoma sp. cf. vestita  TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Cochlitoma marinae          TCGCTTCTGG AATTAAGCGG CAACAGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Cochlitoma churchilliana    TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Cochlitoma granulata        TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Cochlitoma simplex          TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -TCCGCGATC CGCTCTGAAG
Cochlitoma kilburni         TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Cochlitoma montistempli     TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Cochlitoma omissa           TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Cochlitoma semidecussata    TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Cochlitoma ustulata         TCGCTTCTGG AGTTAAGCGG CAATCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Cochlitoma zebra            TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Metachatina kraussi         TCGCTTCTGG AGTTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
Rumina decollata            TCGCTTCTGG AATTAAGCGG CAACCGGCGC TCGTCGTCG- -GCCGCGATC CGCTCTGAAG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmm- -mmmmmmmmm mmmmmmmmmm
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                                    3610       3620       3630       3640       3650       3660
Achatina fulica             ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Achtina immaculata          ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Achatina reticulata         ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Achatina zanzibarica        ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Euaethiopina loveridgei     ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Achatina achatina           ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Archachatina marginata      ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Achatina bisculpta          ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Achatina damarensis         ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Achatina stuhlmanni         ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Atopocochlis exarata        ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Limicolaria kambeul         ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Limicolaria martenssii      ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Limicolariopsis sp.         ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Limicolariopsis ruwenzori   ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Cochlitoma varicosa         ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Cochlitoma dimidiata        ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Cochlitoma sp. cf. vestita  ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Cochlitoma marinae          ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Cochlitoma churchilliana    ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Cochlitoma granulata        ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Cochlitoma simplex          ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Cochlitoma kilburni         ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Cochlitoma montistempli     ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Cochlitoma omissa           ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Cochlitoma semidecussata    ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Cochlitoma ustulata         ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Cochlitoma zebra            ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Metachatina kraussi         ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
Rumina decollata            ACAGTGTCAG GCGGGGAGTT TGACTGGGGC GGTACATCTG TCAAAAGGTA ACGCAGGTGT
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    3670       3680       3690       3700       3710       3720
Achatina fulica             CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Achtina immaculata          CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Achatina reticulata         CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Achatina zanzibarica        CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Euaethiopina loveridgei     CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Achatina achatina           CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Archachatina marginata      CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Achatina bisculpta          CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Achatina damarensis         CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Achatina stuhlmanni         CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Atopocochlis exarata        CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Limicolaria kambeul         CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Limicolaria martenssii      CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Limicolariopsis sp.         CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Limicolariopsis ruwenzori   CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Cochlitoma varicosa         CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Cochlitoma dimidiata        CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Cochlitoma sp. cf. vestita  CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Cochlitoma marinae          CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Cochlitoma churchilliana    CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Cochlitoma granulata        CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Cochlitoma simplex          CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Cochlitoma kilburni         CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Cochlitoma montistempli     CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Cochlitoma omissa           CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Cochlitoma semidecussata    CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Cochlitoma ustulata         CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Cochlitoma zebra            CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Metachatina kraussi         CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
Rumina decollata            CCTAAGGCGA GCTCAGCGAG GACGGAAACC TCGCGTAGAG CAAAAGGGCA AAAGCTCGCT
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                   3730       3740       3750       3760       3770       3780
Achatina fulica            TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Achtina immaculata         TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Achatina reticulata        TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Achatina zanzibarica       TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Euaethiopina loveridgei    TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Achatina achatina          TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Archachatina marginata     TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Achatina bisculpta         TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Achatina damarensis        TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Achatina stuhlmanni        TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Atopocochlis exarata       TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Limicolaria kambeul        TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Limicolaria martenssii     TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Limicolariopsis sp.        TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Limicolariopsis ruwenzori  TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Cochlitoma varicosa        TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Cochlitoma dimidiata       TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Cochlitoma sp. cf. vestita TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Cochlitoma marinae         TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Cochlitoma churchilliana   TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Cochlitoma granulata       TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Cochlitoma simplex         TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Cochlitoma kilburni        TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Cochlitoma montistempli    TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Cochlitoma omissa          TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Cochlitoma semidecussata   TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Cochlitoma ustulata        TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Cochlitoma zebra           TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Metachatina kraussi        TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
Rumina decollata           TGATTTTGAT TTTCAGTACG AATACAGACC GTGAAAGCGT GGCCTATCGA TCCTTTTGAC
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                   3790       3800       3810       3820       3830       3840
Achatina fulica            TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Achtina immaculata         TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Achatina reticulata        TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Achatina zanzibarica       TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Euaethiopina loveridgei    TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Achatina achatina          TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Archachatina marginata     TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Achatina bisculpta         TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Achatina damarensis        TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Achatina stuhlmanni        TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Atopocochlis exarata       TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Limicolaria kambeul        TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Limicolaria martenssii     TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Limicolariopsis sp.        TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Limicolariopsis ruwenzori  TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Cochlitoma varicosa        TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Cochlitoma dimidiata       TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Cochlitoma sp. cf. vestita TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Cochlitoma marinae         TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Cochlitoma churchilliana   TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Cochlitoma granulata       TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Cochlitoma simplex         TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Cochlitoma kilburni        TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Cochlitoma montistempli    TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Cochlitoma omissa          TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Cochlitoma semidecussata   TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Cochlitoma ustulata        TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Cochlitoma zebra           TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Metachatina kraussi        TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
Rumina decollata           TTTAAGAGTT TTAAGCAAGA GGTGTCAGAA AAGTTACCAC AGGGATAACT GGCTTGTGGC
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                   3850       3860       3870       3880       3890       3900
Achatina fulica            AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Achtina immaculata         AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Achatina reticulata        AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Achatina zanzibarica       AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Euaethiopina loveridgei    AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Achatina achatina          AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Archachatina marginata     AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Achatina bisculpta         AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Achatina damarensis        AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Achatina stuhlmanni        AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Atopocochlis exarata       AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Limicolaria kambeul        AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Limicolaria martenssii     AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Limicolariopsis sp.        AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Limicolariopsis ruwenzori  AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Cochlitoma varicosa        AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Cochlitoma dimidiata       AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Cochlitoma sp. cf. vestita AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Cochlitoma marinae         AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Cochlitoma churchilliana   AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Cochlitoma granulata       AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Cochlitoma simplex         AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Cochlitoma kilburni        AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Cochlitoma montistempli    AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Cochlitoma omissa          AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Cochlitoma semidecussata   AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Cochlitoma ustulata        AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Cochlitoma zebra           AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Metachatina kraussi        AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
Rumina decollata           AGCCAAGCGT TCATAGCGAC GTTGCTTTTT GATCCTTCGA TGTCGGCTCT TCCTATCATT
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


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                                   3910       3920       3930       3940       3950       3960
Achatina fulica            GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Achtina immaculata         GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Achatina reticulata        GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Achatina zanzibarica       GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Euaethiopina loveridgei    GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Achatina achatina          GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Archachatina marginata     GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Achatina bisculpta         GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Achatina damarensis        GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Achatina stuhlmanni        GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Atopocochlis exarata       GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Limicolaria kambeul        GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Limicolaria martenssii     GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Limicolariopsis sp.        GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Limicolariopsis ruwenzori  GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Cochlitoma varicosa        GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Cochlitoma dimidiata       GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Cochlitoma sp. cf. vestita GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Cochlitoma marinae         GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Cochlitoma churchilliana   GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Cochlitoma granulata       GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Cochlitoma simplex         GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Cochlitoma kilburni        GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Cochlitoma montistempli    GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Cochlitoma omissa          GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Cochlitoma semidecussata   GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Cochlitoma ustulata        GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Cochlitoma zebra           GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Metachatina kraussi        GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
Rumina decollata           GCGAAGCAGA ATTCGCCAAG CGTTGGATTG TTCACCCACT AATAGGGAAC GTGAGCTGGG
NUCLEOTIDES INCLUDED       mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                    3970       3980       3990       4000       4010       4020
Achatina fulica             TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Achtina immaculata          TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Achatina reticulata         TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Achatina zanzibarica        TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Euaethiopina loveridgei     TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Achatina achatina           TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Archachatina marginata      TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Achatina bisculpta          TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Achatina damarensis         TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Achatina stuhlmanni         TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Atopocochlis exarata        TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Limicolaria kambeul         TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Limicolaria martenssii      TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Limicolariopsis sp.         TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Limicolariopsis ruwenzori   TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Cochlitoma varicosa         TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Cochlitoma dimidiata        TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Cochlitoma sp. cf. vestita  TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Cochlitoma marinae          TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Cochlitoma churchilliana    TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Cochlitoma granulata        TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Cochlitoma simplex          TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Cochlitoma kilburni         TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Cochlitoma montistempli     TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Cochlitoma omissa           TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Cochlitoma semidecussata    TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Cochlitoma ustulata         TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Cochlitoma zebra            TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Metachatina kraussi         TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAGGTCGT TGCTACGGTA
Rumina decollata            TTTAGACCGT CGTGAGACAG GTTAGTTTTA CCCTACTGAT GACAAGTCGT TGCTACGGTA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    4030       4040       4050       4060       4070       4080
Achatina fulica             ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Achtina immaculata          ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Achatina reticulata         ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Achatina zanzibarica        ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Euaethiopina loveridgei     ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Achatina achatina           ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Archachatina marginata      ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Achatina bisculpta          ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Achatina damarensis         ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Achatina stuhlmanni         ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Atopocochlis exarata        ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Limicolaria kambeul         ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Limicolaria martenssii      ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Limicolariopsis sp.         ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Limicolariopsis ruwenzori   ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Cochlitoma varicosa         ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Cochlitoma dimidiata        ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Cochlitoma sp. cf. vestita  ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Cochlitoma marinae          ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Cochlitoma churchilliana    ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Cochlitoma granulata        ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Cochlitoma simplex          ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Cochlitoma kilburni         ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Cochlitoma montistempli     ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Cochlitoma omissa           ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Cochlitoma semidecussata    ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Cochlitoma ustulata         ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Cochlitoma zebra            ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Metachatina kraussi         ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
Rumina decollata            ATCCTGCTCA GTACGAGAGG AACCGCAGGT TCAGACATTT GGTTCACGTG CTTGGCTGAT
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                            ....|....| ....|....| ....|....| ....|...
                                    4090       4100       4110
Achatina fulica             AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Achtina immaculata          AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Achatina reticulata         AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Achatina zanzibarica        AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Euaethiopina loveridgei     AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Achatina achatina           AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Archachatina marginata      AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Achatina bisculpta          AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Achatina damarensis         AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Achatina stuhlmanni         AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Atopocochlis exarata        AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Limicolaria kambeul         AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Limicolaria martenssii      AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Limicolariopsis sp.         AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Limicolariopsis ruwenzori   AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Cochlitoma varicosa         AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Cochlitoma dimidiata        AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Cochlitoma sp. cf. vestita  AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Cochlitoma marinae          AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Cochlitoma churchilliana    AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Cochlitoma granulata        AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Cochlitoma simplex          AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Cochlitoma kilburni         AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Cochlitoma montistempli     AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Cochlitoma omissa           AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Cochlitoma semidecussata    AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Cochlitoma ustulata         AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Cochlitoma zebra            AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Metachatina kraussi         AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
Rumina decollata            AAGCCAATGG TGCGAGGCTA CCATCTGAGG GATTATGG
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmm
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Appendix 4.2: Alignment of the actin gene for the Achatinidae and the subulinid outgroup *Rumina decollata*. Note that sequencing was unsuccessful for *Limicolariopsis ruwenzoriensis*.

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                                     10         20         30         40         50         60
Achatina fulica             TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Achatina immaculata         TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Achatina reticulata         TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Achatina zanzibarica        TCCAAGAGGG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Euaethiopina loveridgei     TCCAAGAGGG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Achatina achatina           TCCAAGAGAG GTATYCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Archachatina marginata      TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Achatina bisculpta          TCYAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Achatina damarensis         TYYAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Achatina stuhlmanni         TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Atopocochlis exarata        TCYAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Limicolaria kambeul         TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Limicolaria martenssii      TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Limicolariopsis sp.         TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGARC ATGGTATTGT YACCAACTGG
Cochlitoma varicosa         TCCAAGAGAG GYATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Cochlitoma dimidiata        TCCAAGAGAG GYATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Cochlitoma sp. cf. vestita  TCCAAGAGAG GYATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Cochlitoma marinae          TCTAAGAGGG GTATTCTCAC ACTCAAGTAC CCCATTGAAC ATGGTATTGT CACAAACTGG
Cochlitoma churchilliana    TCCAAGAGAG GCATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Cochlitoma granulata        TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGARC ATGGTATTGT CACCAACTGG
Cochlitoma simplex          TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACTAACTGG
Cpchlitoma kilburni         TCCAAGRGAG GCATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Cochlitoma montistempli     TCCAAGAGAG GCATCCTCAC TCTCAAGTAT CCTATTGAGC ATGGTATTGT CACCAACTGG
Cochlitoma omissa           TCCAAGAGAG GYATCCTCAC TCTCAAGTAT CCYATTGAGC ATGGTATTGT CACCAACTGG
Cochlitoma semidecussata    TCCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Cochlitoma ustulata         TCCAAGAGAG GCATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Cochlitoma zebra            TCCAAGAGAG GCATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACCAACTGG
Metachatina kraussi         TYCAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGARC ATGGTATTGT CACTAACTGG
Rumina decollata            TCYAAGAGAG GTATCCTCAC TCTCAAGTAT CCCATTGAGC ATGGTATTGT CACYAACTGG


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                     70         80         90        100        110        120
Achatina fulica             GATGATATGG AGAAGATCTG GCATCACACC TTCTACAATG AGCTSAGAGT TGCACCAGAA
Achatina immaculata         GATGATATGG AGAAGATCTG GCATCACACY TTCTACAATG AGCTGAGAGT TGCWCCAGAA
Achatina reticulata         GATGATATGG AGAAGATCTG GCATCACACC TTCTACAATG AGCTGAGAGT TGCACCRGAA
Achatina zanzibarica        GATGATATGG AGAAGATCTG GCATCACACC TTCTACAATG AGCTGAGAGT TGCACCAGAA
Euaethiopina loveridgei     GATGATATGG AGAAGATCTG GCATCACACC TTCTACAATG AGCTGAGAGT TGCACCAGAA
Achatina achatina           GATGATATGG AGAAGATCTG GCATCACACY TTCTACAATG AGTTGAGAGT TGCWCCAGAA
Archachatina marginata      GATGATATGG AGAAGATCTG GCATCACACC TTCTACAATG AGYTGAGAGT TGCACCAGAA
Achatina bisculpta          GATGATATGG AGAAGATCTG GCATCACACC TTCTACAATG AGCTGAGAGT TGCACCAGAA
Achatina damarensis         GATGATATGG AGAAGATCTG GCATCACACY TTCTACAATG AGCTGAGAGT TGCWCCAGAA
Achatina stuhlmanni         GATGATATGG AGAAAATATG GCATCACACC TTCTACAATG AGCTGAGAGT TGCACCAGAA
Atopocochlis exarata        GATGATATGG AGAAGATCTG GCATCACACC TTCTAYAATG ARCTGAGAGT TGCACCAGAA
Limicolaria kambeul         GATGAYATGG AGAAGATCTG GCATCACACC TTCTAYAATG AGCTGAGAGT TGCACCAGAA
Limicolaria martenssii      GATGATATGG AGAAGATCTG GCATCACACC TTCTATAATG AGCTGAGAGT TGCACCAGAA
Limicolariopsis sp.         GATGATATGG AGAAGATCTG GCATCACACC TTCTACAATG AGCTGAGAGT TGCACCAGAA
Cochlitoma varicosa         GATGATATGG AGAAGATCTG GCAYCACACY TTCTACAATG AGCTGAGAGT TGCACCAGAA
Cochlitoma dimidiata        GATGATATGG AGAAGATCTG GCAYCACACY TTCTACAATG AGCTGAGAGT TGCACCAGAA
Cochlitoma sp. cf. vestita  GATGATATGG AGAAGATCTG GCAYCACACC TTCTACAATG AGCTGAGAGT TGCACCAGAA
Cochlitoma marinae          GACGATATGG AGAAGATCTG GCATCACACT TTCTACARCG AGCTTAGAGT TGCCCCTGAA
Cochlitoma churchilliana    GATGATATGG AGAAGATCTG GCACCACACC TTCTACAATG AGCTGAGAGT TGCACCAGAA
Cochlitoma granulata        GATGATATGG AGAAGATCTG GCACCACACC TTCTACAATG AGCTGAGAGT TGCACCAGAA
Cochlitoma simplex          GATGATATGG AGAAGATCTG GCACCACACC TTCTACAATG AGCTGAGAGT TGCACCAGAA
Cpchlitoma kilburni         GATGATATGG AGAAGATCTG GCACCACACC TTCTACAATG AGCTGAGAGT TGCACCAGAA
Cochlitoma montistempli     GATGATATGG AGAAGATCTG GCACCATACT TTCTACAATG AGCTGAGAGT TGCACCAGAA
Cochlitoma omissa           GATGATATGG AGAAGATCTG GCACCATACT TTCTACAATG AGCTGAGAGT TGCACCAGAA
Cochlitoma semidecussata    GATGATATGG AGAAGATCTG GCACCATACT TTCTACAATG AGCTGAGAGT TGCACCAGAA
Cochlitoma ustulata         GATGATATGG AGAAGATCTG GCACCACACC TTCTACAATG AGCTGAGAGT TGCACCAGAA
Cochlitoma zebra            GATGATATGG AGAAGATCTG GCACCACACC TTCTACAATG AGCTGAGAGT TGCACCAGAA
Metachatina kraussi         GATGATATGG AGAARATCTG GCAYCACACC TTCTACAATG AGCTGAGAGT TGCWCCAGAA
Rumina decollata            GAYGATATGG AGAAGATCTG GCATCACACY TTCTACAATG AGCTGAGAGT TGCWCCTGAA
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                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   130        140        150        160        170        180
Achatina fulica            GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Achatina immaculata        GAGCATCCAG TTCTGCTTAC AGAAGCTCCA CTCAACCCCA AGGCCAAYAG AGAGAAGATG
Achatina reticulata        GARCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCYA AGGCCAACAG AGAGAAGATG
Achatina zanzibarica       GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Euaethiopina loveridgei    GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Achatina achatina          GAGCATCCAG TTCTRCTKAC AGAGGCTCCA CTCAATCCCA AGGCCAACAG AGAGAAGATG
Archachatina marginata     GAGCATCCAG TTCTRCTTAC AGAGGCTCCA CTCAATCCCA AGGCCAACAG AGAGAAGATG
Achatina bisculpta         GAGCATCCAG TTCTKCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Achatina damarensis        GARCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Achatina stuhlmanni        GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Atopocochlis exarata       GAGCATCCAG TTCTTCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Limicolaria kambeul        GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAAYCCCA AGGCCAACAG AGAGAAGATG
Limicolaria martenssii     GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Limicolariopsis sp.        GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAAYCCCA AGGCCAACAG AGAGAAGATG
Cochlitoma varicosa        GAGCATCCAG TTCTGCTTAC AGAGGCTCCD CTCAACCCCA AGGCCAAYAG AGAGAAGATG
Cochlitoma dimidiata       GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Cochlitoma sp. cf. vestita GAGCATCCWG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAAYAG AGAGAAGATG
Cochlitoma marinae         GAACATCCGG TTTTGCTGAC AGAGGCTCCT CTCAACCCAA AAGCCAACAG AGAGAAGATG
Cochlitoma churchilliana   GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Cochlitoma granulata       GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Cochlitoma simplex         GAGCATCCTG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAAATG
Cpchlitoma kilburni        GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAATAG AGAGAAGATG
Cochlitoma montistempli    GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Cochlitoma omissa          GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Cochlitoma semidecussata   GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Cochlitoma ustulata        GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG
Cochlitoma zebra           GAGCATCCAG TTCTGCTTAC AGAGGCTCCA CTCAACCCCA AGGCCAATAG AGAGAAGATG
Metachatina kraussi        GAGCATCCAG TTCTGCTTAC AGAGGCTCCM CTCAACCCCA AGGCCAACAG AGAGAAGATG
Rumina decollata           GAGCACCCAG TYYTSCTKAC AGAGGCTCCA CTCAACCCCA AGGCCAACAG AGAGAAGATG


                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   190        200        210        220        230        240
Achatina fulica            ACCCAGATCA TGTTTGAAAC YTTCAAYTCT CCAGCCATGT ATGTCGCCAT YCAAGCYGTG
Achatina immaculata        ACCCAGATCA TGTTTGAAAC TTTCAATTCT CCAGCCATGT ATGTYGCCAT TCAAGCYGTG
Achatina reticulata        ACCCAGATCA TGTTTGAAAC YTTCAAYTCT CCAGCCATGT AYGTYGCCAT TCAAGCTGTG
Achatina zanzibarica       ACCCAGATCA TGTTTGAAAC TTTCAATTCT CCAGCCATGT ATGTCGCCAT CCAAGCCGTG
Euaethiopina loveridgei    ACCCAGATCA TGTTTGAAAC TTTCAACTCT CCAGCCATGT ATGTCGCCAT CCAAGCCGTG
Achatina achatina          ACCCAGATCA TGTTTGAGAC YTTCAAYWSY CCAGCYATGT ATGTYGCYAT TCAAGCHGTG
Archachatina marginata     ACCCAGATCA TGTTTGAGAC CTTCAAYACC CCAGCYATGT ATGTTGCCAT CCAAGCYGTG
Achatina bisculpta         ACCCAGATCA TGTTTGARAC YTTCAAYWCC CCAGCYATGT ATGTTGCCAT YCAAGCCGTS
Achatina damarensis        ACCCAGATCA TGTTTGARAC YTTCAACWCY CCAGCYATGT ATGTTGCYAT TCAAGCYGTG
Achatina stuhlmanni        ACCCAGATCA TGTTTGAAAC TTTCAACTCT CCAGCCATGT ATGTTGCCAT TCAAGCAGTC
Atopocochlis exarata       ACCCAGATCA TGTTTGARAC YTTCAACTCY CCAGCCATGT AYGTTGCYAT TCAAGCTGTG
Limicolaria kambeul        ACCCAGATCA TGTTTGAGAC YTTCAAYWCY CCAGCYATGT AYGTTGCCAT YCAAGCYGTG
Limicolaria martenssii     ACCCAGATCA TGTTTGARAC CTTCAATACC CCAGCYATGT AYGTTGCCAT YCAAGCYGTG
Limicolariopsis sp.        ACCCAGATCA TGTTTGARAC YTTCAAYWCY CCAGCCATGT AYGTYGCCAT TCAAGCYGTG
Cochlitoma varicosa        ACCCAGATCA TGTTTGAGAC CTTCAAYWCY CCRGCCATGT ATGTCGCCAT TCAAGCTGTG
Cochlitoma dimidiata       ACCCAGATCA TGTTTGAGAC CTTCAAYWCY CCAGCCATGT AYGTYGCCAT YCAAGCTGTG
Cochlitoma sp. cf. vestita ACCCAGATCA TGTTTGAGAC CTTCAAYWCY CCRGCCATGT AYGTYGCYAT TCAAGCTGTG
Cochlitoma marinae         ACCCAGATCA TGTTTGAGAC CTTCAACACY CCAGCTATGT ATGTTGCTAT CCAGGCTGTG
Cochlitoma churchilliana   ACCCAGATCA TGTTTGAGAC CTTCAACTCT CCAGCCATGT ATGTCGCCAT TCAAGCTGTG
Cochlitoma granulata       ACCCAGATCA TGTTTGAAAC TTTCAACTCT CCAGCCATGT ATGTCGCCAT TCAAGCTGTG
Cochlitoma simplex         ACCCAGATCA TGTTTGAGAC CTTCAACTCT CCAGCCATGT ATGTCGCCAT TCAAGCTGTG
Cpchlitoma kilburni        ACCCAGATCA TGTTTGAGAC CTTCAACTCT CCAGCCATGT ATGTCGCCAT TCAAGCTGTG
Cochlitoma montistempli    ACCCAGATCA TGTTTGAGAC TTTCAACTCT CCAGCCATGT ATGTCGCCAT TCAAGCTGTG
Cochlitoma omissa          ACCCAGATCA TGTTTGAGAC TTTCAACTCT CCAGCCATGT ATGTCGCCAT TCAAGCTGTG
Cochlitoma semidecussata   ACCCAGATCA TGTTTGAGAC TTTCAACTCT CCAGCCATGT ATGTCGCCAT TCAAGCTGTG
Cochlitoma ustulata        ACCCAGATCA TGTTTGAGAC CTTCAACTCT CCAGCCATGT ATGTCGCCAT TCAAGCCGTG
Cochlitoma zebra           ACCCAGATCA TGTTTGAGAC CTTCAACTCT CCAGCCATGT ATGTCGCCAT TCAAGCTGTG
Metachatina kraussi        ACCCAGATCA TGTTTGAGAC CTTCAAYWCY CCAGCYATGT AYGTYGCYAT YCAAGCYGTG
Rumina decollata           ACACAGATCA TGTTTGAGAC CTTCAAYACC CCAGCHATGT AYGTCGCYAT YCARGCCGTG
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                                   250        260        270        280        290        300
Achatina fulica            CTTTCTTTRT ATGCWTCAGG TCGTACAACT GGTATTGTKC TGGATTCTGG TGATGGTGTA
Achatina immaculata        CTTTCTTTRT AYGCATCAGG TCGTACAACT GGTATTGTGY TGGATTCTGG TGATGGTGTA
Achatina reticulata        CTTTCYYTRT AYGCWTCAGG TCGTACAACT GGTATTGTRC TGGATTCTGG TGATGGTGTA
Achatina zanzibarica       CTTTCTTTAT ATGCATCAGG TCGTACAACT GGTATTGTAC TGGATTYTGG TGATGGTGTG
Euaethiopina loveridgei    CTTTCTTTAT ACGCATCAGG TCGTACAACT GGTATTGTGC TGGATTCTGG TGATGGTGTA
Achatina achatina          CTTTCYTTRT ATGCTTCAGG TCGTACAACT GGTATTGTKC TGGATTCTGG WGATGGTGTM
Archachatina marginata     CTTTCCTTGT ATGCTTCAGG TCGTACAACT GGTATTGTGC TGGATTCTGG TGATGGTGTM
Achatina bisculpta         CTTTCHYTGT AYGCWTCAGG TCGTACAACT GGTATTGTTC TGGATTCTGG TGATGGTGTR
Achatina damarensis        CTTTCYTTRT ATGCWTCAGG TCGTACAACT GGTATTGTGC TGGATTCTGG TGATGGTGTR
Achatina stuhlmanni        CTTTCTTTAT ATGCATCGGG TCGTACAACT GGTATTGTGC TGGATTCTGG TGATGGTGTA
Atopocochlis exarata       CTTTCYTTRT AYGCWTCAGG TCGTACAACT GGTATTGTGC TGGATTCTGG TGATGGTGTA
Limicolaria kambeul        CTTTCYYTRT ATGCWTCAGG TCGTACAACT GGTATYGTGC TGGATTCTGG TGATGGTGTA
Limicolaria martenssii     YTTTCYTTRT AYGCWTCAGG TCGTACAACT GGTATYGTGC TGGATTCTGG TGATGGTGTR
Limicolariopsis sp.        CTTTCYCTRT AYGCWTCAGG TCGTACAACT GGTATYGTGC TGGATTCTGG TGATGGTGTG
Cochlitoma varicosa        CTTTCTTTRT ATGCATCAGG TCGTACAACT GGTATTGTTC TGGATTCTGG WGATGGTGTA
Cochlitoma dimidiata       CTTTCTTTRT ATGCATCAGG TCGTACAACT GGTATTGTGC TGGATTCTGG WGATGGTGTM
Cochlitoma sp. cf. vestita CTTTCTTTRT ATGCATCAGG TCGTACAACT GGTATTGTGC TGGAYTCTGG WGATGGTGTM
Cochlitoma marinae         CTGTCACTGT ATGCTTCAGG TCGAACAACA GGCATTGTCC TTGACTCAGG AGATGGTGTC
Cochlitoma churchilliana   CTTTCTTTAT ATGCATCAGG TCGTACAACT GGTATTGTTC TGGATTCTGG TGATGGTGTA
Cochlitoma granulata       CTTTCTTTAT ATGCATCAGG TCGTACAACT GGTATTGTTC TGGATTCTGG TGATGGTGTA
Cochlitoma simplex         CTTTCTTTAT ATGCATCAGG TCGTACAACT GGTATTGTGC TGGATTCTGG TGATGGTGTA
Cpchlitoma kilburni        CTTTCTTTAT ATGCATCAGG TCGTACAACT GGTATTGTGC TGGATTCTGG TGATGGTGTA
Cochlitoma montistempli    CTTTCTTTAT ATGCATCAGG TCGTACAACT GGTATTGTTC TGGATTCTGG TGATGGTGTA
Cochlitoma omissa          CTTTCTTTAT ATGCATCAGG TCGTACAACT GGTATTGTTC TGGATTCTGG TGATGGTGTA
Cochlitoma semidecussata   CTTTCTTTAT ATGCATCAGG TCGTACAACT GGTATTGTTC TGGATTCTGG TGATGGTGTA
Cochlitoma ustulata        CTTTCTTTAT ATGCATCAGG TCGTACAACT GGTATTGTTC TGGATTCTGG TGATGGTGTA
Cochlitoma zebra           CTTTCTTTAT ATGCATCAGG TCGTACAACT GGTATTGTGC TGGATTCTGG TGATGGTGTA
Metachatina kraussi        CTTTCYTTRT ATGCWTCAGG TCGYACAACT GGTATTGTTC TGGATTCTGG WGATGGTGTV
Rumina decollata           CTKTCYYTGT ATGCCTCTGG TCGTACAACT GGTATTGTGC TAGATTCTGG WGATGGTGTT


                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   310        320        330        340        350        360
Achatina fulica            ACCCACACTG TCCCAATTTA TGAAGGTTAT GCTCTACCTC ATGCCATCAT GAGACTGGAC
Achatina immaculata        ACCCACACTG TCCCAATYTA TGAAGGTTAT GCTCTACCTC ATGCCATCAT GAGACTGGAC
Achatina reticulata        ACCCACACTG TCCCAATYTA TGAAGGTTAT GCTCTTCCCC AYGCCATCAT GAGACTGGAC
Achatina zanzibarica       ACCCACACTG TCCCAATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAC
Euaethiopina loveridgei    ACCCACACTG TCCCAATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAC
Achatina achatina          ACYCAYACTG THCCAATMTA TGARGGTTAT GCTCTTCCYC AYGCCATCAT GAGACTGGAY
Archachatina marginata     ACYCACACTG TCCCAATCTA YGARGGTTAT GCTCTTCCYC ATGCCATYMT GAGACTGGAC
Achatina bisculpta         ACCCACACTG TYCCAATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTRGAY
Achatina damarensis        ACCCACACTG TYCCAATCTA TGAAGGTTAT GCTCTTCCYC ATGCCATCAT GAGACTGGAY
Achatina stuhlmanni        ACCCACACTG TCCCAATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAC
Atopocochlis exarata       ACYCACACTG TCCCAATCTA TGAAGGTTAT GCTCTTCCYC ATGCCATCAT GAGACTGGAC
Limicolaria kambeul        ACYCACACTG TYCCAATCTA TGAAGGTTAT GCYCTTCCYC ATGCCATCAT GAGACTGGAC
Limicolaria martenssii     ACCCACACTG TYCCAATCTA YGAAGGTTAT GCYCTTCCYC ATGCCATCAT GAGACTKGAC
Limicolariopsis sp.        ACCCACACTG TYCCAATCTA YGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAC
Cochlitoma varicosa        ACCCACACTG TCCCAATCTA TGAAGGWTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAC
Cochlitoma dimidiata       ACYCACACTG TCCCAATCTA TGAAGGWTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAY
Cochlitoma sp. cf. vestita ACCCACACTG TCCCAATCTA TGAAGGWTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAY
Cochlitoma marinae         ACTCACACTG TGCCCATCTA TGAAGGTTAT GCCCTCCCTC ATGCCATCAT GAGACTGGAT
Cochlitoma churchilliana   ACCCACACTG TCCCAATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAC
Cochlitoma granulata       ACCCACACTG TCCCAATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAC
Cochlitoma simplex         ACCCACACTG TCCCAATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAC
Cpchlitoma kilburni        ACCCACACTG TCCCAATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAC
Cochlitoma montistempli    ACCCATACTG TCCCAATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAC
Cochlitoma omissa          ACCCAYACTG TCCCAATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAC
Cochlitoma semidecussata   ACCCACACTG TCCCAATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAC
Cochlitoma ustulata        ACTCACACTG TCCCAATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAC
Cochlitoma zebra           ACCCACACTG TCCCAATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCAT GAGACTGGAC
Metachatina kraussi        ACCCACACTG TCCCMATCTA TGAAGGTTAT GCTCTTCCCC ATGCCATCMW GAGACTGGAC
Rumina decollata           ACCCAYACTG TCCCCATCTA TGAAGGTTAT GCCCTTCCTC ATGCCATCAT GAGAYTGGAC
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                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                  370        380        390        400        410        420
Achatina fulica            TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Achatina immaculata        TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Achatina reticulata        TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Achatina zanzibarica       TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Euaethiopina loveridgei    TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAAATCC TTACAGAGAG AGGCTACAGC
Achatina achatina          TTGGCTGGTC GTGACCTCAC AGATTATCTC ATGAARATCC TCACAGAGAG AGGTTACAGC
Archachatina marginata     TTGGCTGGWC GTGACCTCAC AGATTAYCTC ATGAARATYC TCACAGAGAG AGGYTACAGY
Achatina bisculpta         TTGGCTGGTC GTGACCTYAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Achatina damarensis        TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Achatina stuhlmanni        TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Atopocochlis exarata       TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Limicolaria kambeul        TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGY
Limicolaria martenssii     TTGGSTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCY TCACAGAGAG AGGCYACAGY
Limicolariopsis sp.        TTGGCTGGTC GTGACCTCAC AGATTACCTY ATGAAGATCC TCACAGAGAG AGGCTACAGC
Cochlitoma varicosa        TTGGCTGGTC GTGACCTCAC AGATTATCTS ATGAAGATCC TCACAGAGAG AGGCTACAGC
Cochlitoma dimidiata       TTGGCTGGTC GTGACCTCAC AGATTATCTS ATGAAGATCC TYACAGAGAG AGGCTACAGC
Cochlitoma sp. cf. vestita TTGGCTGGTC GTGACCTCAC AGATTATCTS ATGAAGATCC TCACAGAGAG AGGCTACAGC
Cochlitoma marinae         CTGGCTGGTC GTGACCTTAC TGATTATTTG ATGAAGATCC TCACAGAGAG AGGCTACAGC
Cochlitoma churchilliana   TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Cochlitoma granulata       TTGGCTGGTC GTGACCTCAC AGATTAYCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Cochlitoma simplex         TTGGCTGGTC GTGACCTCAC AGATTATCTS ATGAAGATCC TCACAGAGAG AGGCTACAGC
Cpchlitoma kilburni        TTGGCTGGTC GTGACCTCAC AGATTATCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Cochlitoma montistempli    TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Cochlitoma omissa          TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Cochlitoma semidecussata   TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Cochlitoma ustulata        TTGGCTGGTC GTGACCTCAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Cochlitoma zebra           TTGGCTGGTC GTGACCTCAC AGATTATCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC
Metachatina kraussi        TTGGCTGGTC GTGACCTYAC AGATTAYCWS ATGAAGATCC TCACAGAGAG AGGCTACAGC
Rumina decollata           TTGGCTGGTC GTGACCTYAC AGATTACCTC ATGAAGATCC TCACAGAGAG AGGCTACAGC


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                                  430        440        450        460        470        480
Achatina fulica            TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Achatina immaculata        TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Achatina reticulata        TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAARCT TTGCTATGTG
Achatina zanzibarica       TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Euaethiopina loveridgei    TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Achatina achatina          TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGAYATCA ARGAGAAGCT GTGCTATGTG
Archachatina marginata     TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AGGAGAAGCT GTGCTATGTG
Achatina bisculpta         TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAACT TTGCTATGTG
Achatina damarensis        TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAACT TTGCTATGTG
Achatina stuhlmanni        TTCACCACYA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAACT TTGCTATGTG
Atopocochlis exarata       TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAACT TTGCTATGTG
Limicolaria kambeul        TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAACT TTGCTAYGTG
Limicolaria martenssii     TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAACT TTGCTAYGTG
Limicolariopsis sp.        TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAACT TTGCTAYGTG
Cochlitoma varicosa        TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Cochlitoma dimidiata       TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Cochlitoma sp. cf. vestita TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Cochlitoma marinae         TTCACCACTA CAGCCGAGAG AGAGATTGTA CGTGATATCA AGGAGAAGCT CTGCTATGTT
Cochlitoma churchilliana   TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Cochlitoma granulata       TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Cochlitoma simplex         TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Cpchlitoma kilburni        TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Cochlitoma montistempli    TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Cochlitoma omissa          TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Cochlitoma semidecussata   TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Cochlitoma ustulata        TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Cochlitoma zebra           TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGACATCA AAGAGAAGCT TTGCTATGTG
Metachatina kraussi        TTCACCACCA CAGCTGAGAG AGAAATTGTT CGAGAYATCA AAGAGAAGCT TTGCTATGTG
Rumina decollata           TTCACCACCA CTGCTGAGAG AGAAATTGTT CGAGACATCA AGGAGAAGCT GTSCTATGTT
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    490        500        510        520        530        540
Achatina fulica             GCCCTTGACT TTGAGCAAGA RATGGCAACA GCTTCCACAT CATCTTCATT AGAGAAGAGT
Achatina immaculata         GCCCTTGACT TTGAGCARGA GATGGCAACA GCTTCCACAT CATCTTCATT AGAGAAGAGT
Achatina reticulata         GCCCTTGACT TTGAGCAAGA GATGGCAACA GCTKCYACAT CATCTTCATT AGAGAAGAGT
Achatina zanzibarica        GCCCTTGACT TTGAGCAAGA GATGGCAACA GCTGCTACAT CATCCTCATT AGAGAAGAGT
Euaethiopina loveridgei     GCCCTTGACT TTGAGCAAGA GATGGCAACA GCTGCTACAT CATCTTCATT AGAGAAGAGT
Achatina achatina           GCYCTTGACT TTGAGCAAGA GATGTCRACA GCTTCCACAT CATCTTCATT AGAGAAGAGY
Archachatina marginata      GCYCTTGACT TTGAGCAAGA GATGGCAACA GCTKCCACAT CATCTTCATT AGAGAAGAGT
Achatina bisculpta          GCCCTTGACT TTGAGCAAGA GATGGCAACA GCTKCCACAT CATCTTCATT AGAGAAGAGT
Achatina damarensis         GCCCTTGACT TTGAGCAAGA GATGGCAACA GCTKCCACAT CATCTTCATT AGAGAAGAGT
Achatina stuhlmanni         GCCCTTGACT TTGAGCAAGA GATGGCAACA GCTGCCACAT CATCTTYATT AGAGAAGAGT
Atopocochlis exarata        GCYCTTGACT TTGAGCAAGA GATGGCAACA GCTKCCACAT CATCTTCATT AGAGAAGAGT
Limicolaria kambeul         GCCCTTGAYT TTGAGCAAGA GATGGCAACA GCTKCCACAT CATCTTCATT AGARAAGAGT
Limicolaria martenssii      GCCCTTGACT TTGAGCAAGA GATGGCAACA GCTKCCACAT CATCTTCATT AGAGAAGAGT
Limicolariopsis sp.         GCCCTTGACT TTGAGCAAGA GATGGSWACA GCTKCCACGT CATCTTCATT AGAGAAGAGT
Cochlitoma varicosa         GCCCTTGACT TTGARCAAGA GATGGCAACA GCTTCCACAT CATCTTCATT AGAGAAGAGT
Cochlitoma dimidiata        GCCCTTGACT TTGARCAAGA GATGGCAACA GCTTCCACAT CATCTTCATT AGAGAAGAGT
Cochlitoma sp. cf. vestita  GCCCTTGACT TTGAGCAAGA GATGGCAACA GCTTCCACAT CATCTTCATT AGAGAAGAGT
Cochlitoma marinae          GCACTTGACT TTGAGCAAGA AATGGGTACA GCAGCAACAT CATCATCTTT GGAGAAGAGC
Cochlitoma churchilliana    GCCCTTGACT TTGAACAAGA GATGGCAACA GCTTCCACAT CATCTTCATT AGAGAAGAGT
Cochlitoma granulata        GCCCTTGACT TTGAGCARGA GATGGCAACA GCTTCCACAT CATCTTCATT AGAGAAGAGT
Cochlitoma simplex          GCCCTTGACT TTGAACAAGA GATGGCAACA GCTTCCACAT CATCTTCATT AGAGAAGAGT
Cpchlitoma kilburni         GCCCTTGACT TTGAACAAGA GATGGCAACA GCTTCAACAT CATCTTCATT AGAGAAGAGT
Cochlitoma montistempli     GCCCTTGACT TTGAGCAGGA GATGGCAACA GCTTCCACAT CATCTTCATT AGAGAAGAGT
Cochlitoma omissa           GCCCTTGACT TTGAGCARGA GATGGCAACA GCTTCCACAT CATCTTCATT AGAGAAGAGT
Cochlitoma semidecussata    GCCCTTGACT TTGAGCAAGA GATGGCCACA GCTTCCACAT CATCTTCATT AGAGAAGAGT
Cochlitoma ustulata         GCCCTTGACT TTGAGCAAGA GATGGCAACA GCTTCCACAT CATCTTCATT AGAGAAGAGT
Cochlitoma zebra            GCCCTTGACT TTGAACAAGA GATGGCAACA GCTTCCACAT CATCTTCATT AGAGAAGAGT
Metachatina kraussi         GCCCTTGACT TTGAGCAAGA GATGGCAACA GCTTCCACAT CATCTTCATT AGAGAAGAGT
Rumina decollata            GCTCTTGACT TTGAACAAGA AATGGCAACA GCTGCCACTT CATCTTCWCT GGAGAAAAGT


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                                    550        560        570        580        590        600
Achatina fulica             TATGAATTRC CTGATGGACA GGTCATCACC ATTGGTAAYG AGCGTTTCAG ATGTCCAGAA
Achatina immaculata         TATGAATTGC CTGATGGACA GGTCATCACC ATTGGTAATG AGCGTTTCAG ATGTCCAGAA
Achatina reticulata         TATGAAYTGC CTGATGGACA GGTCATCACC ATTGGTAAYG AGCGTTTCAG RTGYCCAGAA
Achatina zanzibarica        TATGAATTGC CTGATGGACA GGTCATCACC ATTGGCAACG AGCGTTTCAG GTGCCCAGAA
Euaethiopina loveridgei     TATGAACTGC CTGATGGACA GGTCATCACC ATTGGTAATG AGCGTTTCAG GTGCCCAGAA
Achatina achatina           TATGAATTGC CTGATGGACA RGTCATYACT ATTGGTAAYG AGCGYTTCAG RTGYCCAGAA
Archachatina marginata      TATGAATTGC CTGATGGACA GGTCATCACY ATTGGWAAYG AGCGCTTCAG RTGYCCAGAA
Achatina bisculpta          TATGAATTGC CTGATGGACA GGTCATCACY ATTGGTAAYG AGCGTTTCAG ATGTCCAGAA
Achatina damarensis         TATGAATTGC CTGATGGACA GGTCATCACY ATTGGTAACG AGCGTTTCAG ATGTCCAGAA
Achatina stuhlmanni         TATGAATTGC CTGATGGACA GGTCATCACT ATTGGTAACG AGCGATTTAG GTGCCCAGAA
Atopocochlis exarata        TATGAATTGC CTGATGGACA GGTCATCACY ATTGGTAACG AGCGTTTCAG RTGTCCAGAA
Limicolaria kambeul         TATGAATTRC CTGATGGACA GGTCATCACT ATTGGTAACG AGCGTTTCAG RTGYCCAGAA
Limicolaria martenssii      TATGAATTRC CTGATGGACA GGTCATCACT ATTGGTAACG AGCGTTTCAG ATGTCCAGAA
Limicolariopsis sp.         TATGAATTGC CTGATGGACA GGTCATCACY ATTGGTAACG AGCGTTTCAG ATGYCCAGAA
Cochlitoma varicosa         TATGAATTRC CTGATGGACA GGTCATCACC ATTGGTAAYG AGCGYTTCAG RTGYCCAGAA
Cochlitoma dimidiata        TATGAATTGC CTGAYGGACA GGTCATCACC ATTGGTAAYG AGCGYTTCAG RTGYCCAGAA
Cochlitoma sp. cf. vestita  TATGAATTGC CTGATGGACA GGTCATCACC ATTGGTAAYG AGCGYTTCAG RTGYCCAGAA
Cochlitoma marinae          TATGAACTAC CAGACGGCCA GGTCATTACC ATTGGTAATG AGCGTTTCAG GTGCCCTGAG
Cochlitoma churchilliana    TATGAATTGC CTGATGGACA GGTCATCACC ATTGGTAACG AGCGCTTCAG GTGCCCAGAA
Cochlitoma granulata        TATGAATTRC CTGAYGGACA GGTCATMACY ATTGGTAAYG AGCGCTTCAG GTGCCCAGAA
Cochlitoma simplex          TATGAATTGC CTGATGGACA GGTCATCACT ATTGGTAACG AGCGCTTCAG GTGCCCAGAA
Cpchlitoma kilburni         TATGAATTGC CTGATGGACA GGTCATCACC ATTGGTAACG AGCGCTTCAG GTGCCCAGAA
Cochlitoma montistempli     TATGAATTGC CTGATGGACA GGTCATCACC ATTGGTAACG AGCGCTTCAG GTGCCCAGAA
Cochlitoma omissa           TATGAATTRC CTGATGGACA GGTCATCACC ATTGGTAACG AGCGCTTCAG GTGCCCAGAA
Cochlitoma semidecussata    TATGAATTAC CTGACGGACA GGTCATAACT ATTGGTAATG AGCGCTTCAG GTGCCCAGAA
Cochlitoma ustulata         TATGAATTAC CTGATGGACA GGTCATAACT ATTGGTAATG AGCGCTTCAG GTGCCCAGAA
Cochlitoma zebra            TATGAATTGC CTGATGGACA GGTCATCACC ATTGGTAATG AGCGCTTCAG GTGCCCAGAA
Metachatina kraussi         TATGAATTGC CTGATGGACA GGTCATCACM ATTGGTAAYG AGCGTTTYAG ATGTCCAGAA
Rumina decollata            TATGAATTGC CTGAYGGACA GGTCATCACC ATCGGCAAYG AGCGTTTCAG ATGTCCAGAA
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                                   610        620        630        640        650        660
Achatina fulica            GCCATGTTCC AGCCWTCTTT CCTTGGTATG GARWCCGCAG GTATTCATGA RACCACYTAC
Achatina immaculata        GCCATGTTCC AGCCATCTTT CCTTGGTATG GAAWCCGCAG GTATTCATGA AACCACCTAC
Achatina reticulata        GCMRWRTTTC AGCCATCTTT CCTTGGTATG GAGTCTGCAG GYATTCATGA AACCACCTAC
Achatina zanzibarica       GCAGAATTTC AGCCATCTTT CCTTGGTATG GAGTCTGCAG GCATTCATGA GACCACCTAC
Euaethiopina loveridgei    GCAGAATTTC AGCCCTCTTT CCTTGGTATG GAGTCTGCAG GCATTCATGA AACCACCTAC
Achatina achatina          GCCATGTTCC AGCCATCTTT CCTTGGTATG GARWCTGCAG GTATTCATGA AACCACCTAC
Archachatina marginata     GCCATGTTCC AGCCATCCTT CCTTGGTATG GARTCTGCAG GTATTCATGA GACCACCTAC
Achatina bisculpta         GCCATGTTCC AGCCATCTTT CCTTGGYATG GAGTCTGCAG GTATTCATGA GACCACSTAC
Achatina damarensis        GCCATGTTCC AGCCATCTTT YCTTGGTATG GARWCYGCAG GTATTCATGA GACCACCTAC
Achatina stuhlmanni        GCAGAATTCC AGCCATCTTT CCTTGGTATG GAGTCTGCAG GTATTCACGA GACCACCTAC
Atopocochlis exarata       GCMATGTTCC AGCCATCTTT CCTTGGTATG GAGTCYGCAG GTATTCATGA GACCACCTAC
Limicolaria kambeul        GCCATGTTCC AGCCATCTTT CCTTGGTATG GAGTCTGCAG GTATTCAYGA GACCACCTAY
Limicolaria martenssii     GCCATGTTCC AGCCMTCTTT YCTTGGTATG GAGTCHGCAG GTATTCAYGA GACCACCTAC
Limicolariopsis sp.        GCCATGTTCC AGCCATCTTT YCTTGGTATG GARWCWGCAG GTATTCAYGA GACCACCTAC
Cochlitoma varicosa        GCMRWRTTCC AGCCATCTTT CCTTGGTATG GAGTCTGCAG GTATTCATGA GACCACCTAC
Cochlitoma dimidiata       GCMRWRTTCC AGCCWTCTTT CCTTGGTATG GAGTCTGCAG GTATTCATGA GACCACCTAC
Cochlitoma sp. cf. vestita GCMRWRTTCC AGCCATCTTT CCTTGGYATG GAGTCTGCAG GTATTCATGA GACCACCTAC
Cochlitoma marinae         GCAATGTTCC AGCCATCTTT CTTGGGTATG GAGTCTGCTG GTAYTCATGA AACAACATAC
Cochlitoma churchilliana   GCAGAATTCC AGCCATCTTT CCTTGGTATG GAGTCTGCAG GTATTCATGA GACCACCTAC
Cochlitoma granulata       GCAGAATTCC AGCCATCTTT CCTTGGTATG GAGTCTGCAG GTATTCATGA GACCACCTAC
Cochlitoma simplex         GCAGAATTCC AGCCTTCTTT CCTTGGTATG GAGTCTGCAG GTATTCATGA GACCACCTAC
Cpchlitoma kilburni        GCAGAATTCC AGCCATCTTT CCTTGGTATG GAGTCTGCAG GTATTCATGA GACCACCTAC
Cochlitoma montistempli    GCAGAATTCC AGCCATCTTT CCTTGGTATG GAGTCTGCAG GTATTCATGA GACCACCTAC
Cochlitoma omissa          GCAGAATTCC AGCCATCTTT CCTTGGTATG GAGTCTGCAG GTATTCATGA GACCACCTAC
Cochlitoma semidecussata   GCAGAATTCC AGCCATCTTT CCTTGGTATG GAGTCTGCAG GTATTCATGA GACCACCTAC
Cochlitoma ustulata        GCAGAATTCC AGCCATCTTT CCTTGGTATG GAGTCTGCAG GTATTCATGA GACCACCTAC
Cochlitoma zebra           GCAGAATTCC AGCCATCTTT CCTTGGTATG GAGTCTGCAG GTATTCATGA GACCACCTAC
Metachatina kraussi        GCCATGTTCC AGCCATCTTT YCTTGGTATG GARWCYGCWG GTATTCATGA RACCACCTAC
Rumina decollata           GCAATGTTCC AGCCATCTTT CCTTGGTATG GAGTCTGCTG GTATTCATGA GACCACCTAC


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                                   670        680        690        700        710        720
Achatina fulica            AACTCCATCA TGAAGTGTGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Achatina immaculata        AACTCCATCA TGAAGTGYGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Achatina reticulata        AACTCCATCA TGAAGTGYGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Achatina zanzibarica       AACTCCATCA TGAAGTGCGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Euaethiopina loveridgei    AACTCCATCA TGAAGTGCGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Achatina achatina          AACTCCATCA TGAAGTGTGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTA
Archachatina marginata     AACTCCATCA TGAAGTGTGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTA
Achatina bisculpta         AACTCCATCA TGAAGTGCGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTACTG
Achatina damarensis        AACTCCATCA TGAAGTGYGA YGTYGACATC CGTAAAGACT TGTATGCCAA CACTGTAYTG
Achatina stuhlmanni        AACTCCATCA TGAAGTGCGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTACTT
Atopocochlis exarata       AACTCCATCA TGAAGTGYGA CGTCGACATC CGTAAAGACY TGTATGCCAA CACTGTACTG
Limicolaria kambeul        AACTCCATCA TGAARTGCGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Limicolaria martenssii     AACTCCATCA TGAARTGCGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTR
Limicolariopsis sp.        AACTCCATCA TGAAGTGYGA CGTCGACATC CGTAAAGACT TRTATKCCAA CACTGTMTTG
Cochlitoma varicosa        AACTCCATCA TGAAGTGYGA CGTYGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Cochlitoma dimidiata       AACTCCATCA TGAAGTGCGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Cochlitoma sp. cf. vestita AACTCCATCA TGAAGTGCGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Cochlitoma marinae         AACTCCATCA TGAAGTGCGA TGTTGATATC CGTAAAGACC TGTATGCCAA CACTGTCTTA
Cochlitoma churchilliana   AACTCCATCA TGAAGTGTGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Cochlitoma granulata       AACTCCATCA TGAAGTGCGA CGTCGACATC CGTAAAGACT TGTATGCCAA YACTGTATTG
Cochlitoma simplex         AACTCCATCA TGAAGTGCGA TGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Cpchlitoma kilburni        AACTCCATCA TGAAGTGCGA CGTTGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Cochlitoma montistempli    AACTCCATCA TGAAGTGCGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Cochlitoma omissa          AACTCCATCA TGAAGTGCGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Cochlitoma semidecussata   AACTCCATCA TGAAGTGCGA CGTTGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Cochlitoma ustulata        AACTCCATCA TGAAGTGCGA CGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Cochlitoma zebra           AACTCCATCA TGAAGTGCGA TGTCGACATC CGTAAAGACT TGTATGCCAA CACTGTATTG
Metachatina kraussi        AACTCCATCA TGAARTGCGA YGTCGACATC CGTAAAGACT TGTATGCCAA CWCTGTATTG
Rumina decollata           AATTCCATCA TGAARTGTGA TGTYGACATC CGTAAAGACT TGTATGCCAA CACTGTCTTG
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    730        740        750        760        770        780
Achatina fulica             TCTGGTGGAW CTACCATGTA TCCAGGCATT GCTGACCGCA TGCAGAAGGA AATYGYCAAC
Achatina immaculata         TCTGGTGGAA CTACCATGTA TCCAGGCATT GCTGACCGCA TGCAGAAGGA AATYGYCAAC
Achatina reticulata         TCTGGTGGAW CYACMATGTW YCCTGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAGC
Achatina zanzibarica        TCTGGTGGAT CCACAATGTT CCCTGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAGC
Euaethiopina loveridgei     TCTGGTGGAT CCACAATGTT CCCTGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAGC
Achatina achatina           TCTGGTGGAW CTACCATGTA TCCTGGCATT GCTGACCGCA TGCAGAAGGA AATCACHAAY
Archachatina marginata      TCTGGTGGAW CYACCATGTA CCCTGGCATT GCTGACCGCA TGCAGAAGGA AATCACYAAY
Achatina bisculpta          TCTGGTGGMT CYACMATGTW YCCCGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAAC
Achatina damarensis         TCTGGTGGAT CYACCATGTW TCCAGGCATT GCTGACCGCA TGCAGAAGGA AATCACYAAY
Achatina stuhlmanni         TCTGGTGGCT CCACAATGTT TCCAGGCATC GCTGACCGCA TGCAGAAGGA AATCACCAGC
Atopocochlis exarata        TCTGGTGGAT CCACCATGTW CCMYGGCATT GCTGACCGCA TGCAGAAGGA AATCACYAAY
Limicolaria kambeul         TCTGGTGGAT CYACCATGTA TCCAGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAAC
Limicolaria martenssii      TCTGGTGGAT CTACYATGTA TCCAGGCMTT GCTGACCGCA TGCAGAAGGA AATCACCAAC
Limicolariopsis sp.         TCTGGTGGAT CTACCATGTW TCCAGGCATT GCTGACCGCA TGCAGAAGGA AATCRYYAAC
Cochlitoma varicosa         TCTGGTGGCT CCACAATGTT CCCTGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAGY
Cochlitoma dimidiata        TCTGGTGGMT CCACAATGTT CCCTGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAGY
Cochlitoma sp. cf. vestita  TCTGGTGGCT CCACAATGTT CCCTGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAGY
Cochlitoma marinae          TCTGGTGGTT CCACAATGTT CCCAGGCATC GCTGACCGCA TGCAAAAGGA AATCACTGCT
Cochlitoma churchilliana    TCTGGTGGCT CCACAATGTT CCCTGGCATT GCTGACCGCA TGCAGAAAGA AATCACCAGC
Cochlitoma granulata        TCTGGTGGCT CCACAATGTT CCCTGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAGC
Cochlitoma simplex          TCTGGTGGCT CSACAATGTT CCCTGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAGC
Cpchlitoma kilburni         TCTGGTGGCT CCACAATGTT CCCTGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAGC
Cochlitoma montistempli     TCTGGTGGCT CCACAATGTT CCCTGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAGC
Cochlitoma omissa           TCTGGTGGCT CCACAATGTT CCCKGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAGC
Cochlitoma semidecussata    TCTGGTGGCT CCACAATGTT CCCGGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAGC
Cochlitoma ustulata         TCTGGTGGCT CCACAATGTT CCCTGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAGC
Cochlitoma zebra            TCTGGTGGCT CCACAATGTT CCCTGGCATT GCTGACCGCA TGCAGAAGGA AATCACCAGC
Metachatina kraussi         TCTGGTGGAW CYACCATGTT CCCTGGCATT GCTGACCGYA TGCAGAAGGA AATYRYCTSY
Rumina decollata            TCTGGTGGHT CAACAATGTT CCCAGGCATC GCTGACCGCA TGCAGAAAGA AATCACCAMT


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    790        800        810        820        830        840
Achatina fulica             CTGGCTCCTT CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA ATACTCTGTC
Achatina immaculata         CTGGCTCCAT CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA GTACTCTGTC
Achatina reticulata         CTGGCTCCTG CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA ATACTCTGTC
Achatina zanzibarica        CTGGCTCCTG CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA ATACTCTGTC
Euaethiopina loveridgei     CTGGCTCCTG CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA ATACTCTGTC
Achatina achatina           CTGGCTCCAS CCACAATGAA GATCAAGATC ATTGCTCCAC CAGAACGTAA ATACTCTGTC
Archachatina marginata      CTGGCTCCAC CCACAATGAA GATCAAGATC ATTGCTCCAC CAGAACGTAA ATACTCTGTC
Achatina bisculpta          YTGGCTCCWS CSACAATGAA GATCAAGATC ATTGCTCCAC CTGAACGTAA ATACTCTGTC
Achatina damarensis         CTGGCTCCTC CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAACGTAA ATWCTCTGTC
Achatina stuhlmanni         CTGGCTCCTG CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAACGTAA ATACTCTGTC
Atopocochlis exarata        CTGGCTCCTC CCACAATGAA GATCAAGATC ATTGCTCCMC CTGAACGTAA ATACTCTGTC
Limicolaria kambeul         CTRGCTCCAC CCACMATGAA GATCAAGATC ATTGCTCCAC CTGAACGTAA ATACTCTGTC
Limicolaria martenssii      CTRGCTCCAC CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAACGTAA ATACTCTGTC
Limicolariopsis sp.         CTRGCTCCAC CCACAATGAA GATCAAGATH ATTGCTCCAC CTGAACGTAA ATACTCTGTC
Cochlitoma varicosa         CTGGCTCCTG CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA ATACTCTGTS
Cochlitoma dimidiata        CTGGCTCCTS CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA ATACTCTGTG
Cochlitoma sp. cf. vestita  CTGGCTCCTS CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA ATACTCTGTG
Cochlitoma marinae          CTTGCTCCAC CCACAATGAA AATCAAGATT ATTGCTCCAC CAGAAAGAAA ATACTCTGTT
Cochlitoma churchilliana    CTGGCTCCTG CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA ATACTCTGTG
Cochlitoma granulata        CTGGCTCCTG CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA ATACTCTGTC
Cochlitoma simplex          CTGGCTCCTG CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA ATACTCTGTC
Cpchlitoma kilburni         CTGGCTCCTG CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA ATACTCTGTC
Cochlitoma montistempli     CTGGCTCCTG CCACAATGAA GATCAAGATT ATTGCTCCAC CTGAACGTAA ATACTCTGTC
Cochlitoma omissa           CTGGCTCCTG CCACAATGAA GATCAAGATT ATTGCTCCAC CTGAGCGTAA ATACTCTGTC
Cochlitoma semidecussata    CTGGCTCCTG CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA ATACTCTGTC
Cochlitoma ustulata         CTGGCTCCTG CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA ATACTCTGTC
Cochlitoma zebra            CTGGCTCCTG CCACAATGAA GATCAAGATC ATTGCTCCAC CTGAGCGTAA ATACTCTGTC
Metachatina kraussi         CTGGCTCCAC CCACAATGAA GATCAAGATC ATTGCTCCWC CTGAGMGTAA ATACTCTGTG
Rumina decollata            CTGGCTCCAC CCACAATGAA GATCAAAATC ATTGCTCCTC CTGAGAGAAA ATACTCTGTC
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                           ....|....| ....|....| ....|....| ...
                                   850        860        870
Achatina fulica            TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Achatina immaculata        TGGATYGGAG GATCCATCCT GGCCTCTCTG TCC
Achatina reticulata        TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Achatina zanzibarica       TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Euaethiopina loveridgei    TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Achatina achatina          TGGATTGGAG GTTCCATTCT GGCTTCTCTG TCC
Archachatina marginata     TGGATTGGAG GTTCCATTCT GGCTTCTCTG TCC
Achatina bisculpta         TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Achatina damarensis        TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Achatina stuhlmanni        TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Atopocochlis exarata       TGGATTGGAG GATCCATCCT WGCCTCTCTG TCC
Limicolaria kambeul        TGGATTGGAG GATCCATCCT GGCTTCTCTG TCC
Limicolaria martenssii     TGGATTGGAG GATCCATCCT GGCTTCTCTG TCC
Limicolariopsis sp.        TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Cochlitoma varicosa        TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Cochlitoma dimidiata       TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Cochlitoma sp. cf. vestita TGGATTGGAG GWTCCATCCT GGCCTCTCTG TCC
Cochlitoma marinae         TGGATTGGWG GCTCCATTTT GGCTTCTCTA TCC
Cochlitoma churchilliana   TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Cochlitoma granulata       TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Cochlitoma simplex         TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Cpchlitoma kilburni        TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Cochlitoma montistempli    TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Cochlitoma omissa          TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Cochlitoma semidecussata   TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Cochlitoma ustulata        TGGATTGGAG GATCCATCCT GGCTTCTCTG TCC
Cochlitoma zebra           TGGATTGGAG GATCCATCCT GGCCTCTCTG TCC
Metachatina kraussi        TGGATTGGAG GATCCATCCT GGCCTYTCTG TCC
Rumina decollata           TGGATTGGAG GTTCCATCCT GGCCTCTCTG TCC
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Appendix 4.3: Alignment of the histone 3 gene for the Achatinidae and the subulinid outgroup *Rumina decollata*. Note that sequencing was unsuccessful for *Euaethiopina loveridgei* and *Limicolariopsis ruwenzoriensis*.

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                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    10         20         30         40         50         60
Achatina fulica            TCGTAAATCC ACCGGAGGTA AGGCTCCCCG CAAACAGCTT GCCACCAAGG CGGCTAGAAA
Achatina immaculata        TCGCAAATCC ACCGGAGGTA AGGCTCCCCG CAAACAGCTT GCCACCAAGG CGGCTAGAAA
Achatina reticulata        TCGCAAATCC ACCGGAGGTA AGGCTCCCCG CAAACAGCTK GCCACCAAGG CKGCYAGAAA
Achatina zanzibarica       TCGCAAATCC ACCGGAGGTA AGGCTCCCCG CAAACAGCTT GCCACCAAGG CGGCTAGAAA
Achatina achatina          TCGTAAATCC ACCGGAGGCA AGGCTCCCCG CAAGCARCTG GCCACCAAGG CKGCCAGRAA
Archachatina marginata     TMGYAAATCN ACCGGAGGCA AGGCTCCCCG YMAGCAGCTG GCCCCCAAGG CAGCCAGRAA
Achatina bisculpta         TCGCAAATCC ACCGGAGGYA AGGCTCCYCG CAAACAGCTK GCCACCAAGG CGGCYAGAAA
Achatina damarensis        TCGCAAATCC ACCGGAGGTA AGGCTCCTCG CAAACAGCTT GCCACCAAGG CGGCTAGAAA
Achatina stuhlmanni        TCGCAAATCC ACCGGAGGTA AGGCTCCTCG CAAACAGCTT GCCACCAAGG CGGCTAGAAA
Atopocochlis exarata       TCGCAAATCC ACCGGAGGTA AGGCTCCTCG CAAACAGCTT GCCACCAAGG CGGCTAGAAA
Limicolaria kambeul        TCGCAAATCC ACCGGAGGCA AGGCTCCTCG CAAACAGCTT GCCACTAAGG CGGCTAGAAA
Limicolaria martenssii     TCGCAAATCC ACCGGAGGCA AGGCTCCTCG CAAACAGCTT GCCACYAAGG CGGCTAGAAA
Limicolariopsis sp.        TCGCAAATCC ACCGGAGGTA AGGCTCCTCG CAAACAGCTT GCCACCAAGG CGGCTAGAAA
Cochlitoma varicosa        TCGCAAATCC ACCGGAGGTA AGGCTCCCCG CAAACAGCTT GCCACMAAGG CGGCTAGGAA
Cochlitoma dimidiata       TCGCAAATCC ACCGGAGGYA AGGCTCCCCG CAARCARCTK GCCACCAAGG CRGCYAGGAA
Cochlitoma sp. cf. vestita TCGCAAATCC ACCGGAGGTA AGGCTCCCCG CMAACAGCTT GCCACCAAGG CGGCTAGGAA
Cochlitoma marinae         TCGCAAATCC ACCGGAGGTA AGGCTCCCCG CAAACAGCTT GCCACCAAGG CGGCTAGGAA
Cochlitoma churchilliana   TYGCAAATCC MCCGGAGGTA AGGCTCCCCG CAAACAGCTT GCCACCAAGG CGGCTAGGAA
Cochlitoma granulata       TCGCAAATCC ACCGGAGGTA AGGCTCCCCG CAAACAGCTT GCCACCAAGG CGGCTAGAAA
Cochlitoma simplex         TCGCAAATCC ACCGGAGGTA AGGCTCCCCG CAAACAGCTT GCCACCAAGG CGGCTAGGAA
Cochlitoma kilburni        TCGCAAATCC ACCGGAGGTA AGGCTCCCCG CAAACAGCTT GCCACCAAGG CGGCTAGGAA
Cochlitoma montistempli    TCGCAAATCC ACCGGAGGTA AGGCTCCCCG CAAACAGCTT GCCACCAAGG CGGCTAGGAA
Cochlitoma omissa          TCGCAAATCC ACCGGAGGTA AGGCTCCCCG CAAACAGCTT GCCACCAAGG CGGCTAGGAA
Cochlitoma semidecussata   TCGCAAATCC ACCGGAGGTA AGGCTCCCCG CAAACAGCTT GCCACCAAGG CGGCTAGGAA
Cochlitoma ustulata        TCGCAAATCC ACCGGAGGTA AGGCTCCCCG CAAACAGCTT GCCACCAAGG CGGCTAGGAA
Cochlitoma zebra           TCGCAAATCC ACCGGAGGTA AGGCTCCCCG CAAACAGCTT GCCACCAAGG CGGCTAGGAA
Metachatina kraussi        TCGCAAATCC ACCGGAGGTA AGGCTCCCCG CAAGCAGCTT GCCACGAAGG CGGCTAGAAA
Rumina decollata           TCGCAAATCC ACAGGAGGAA AAGCTCCCCG CAAACAGCTT GCCACTAAGG CGGCTAGAAA
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                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    70         80         90        100        110        120
Achatina fulica            GTCGGCCCCG GCCACAGGAG GTGTCAAGAA ACCCCACAGA TACAGGCCCG GCACAGTCGC
Achatina immaculata        GTCGGCCCCA GCCACAGGAG GTGTCAAGAA ACCCCACAGA TACAGGCCCG GCACAGTCGC
Achatina reticulata        GTCGGCCCCA GCCACAGGRG GTGTCAAGAA ACCCCAYMGA TACAGGCCCG GCACAGTCGC
Achatina zanzibarica       GTCGGCCCCA GCCACAGGGG GTGTCAAGAA ACCCCACAGA TACAGGCCCG GCACAGTCGC
Achatina achatina          RTCGGCCCCR GCCACMGGRG GTGTSAAGAA RCCCCATCGW TACAGGCCCG GCACHGTSGC
Archachatina marginata     RTCKGCYCCR SCCCCCGGWG GTGTCAAGAA RCCCCAYSGY TACAGGCCSG SSACCGTGGC
Achatina bisculpta         GTCGGCCCCA GCCACMGGAG GTGTGAAGAA GCCCCAYMGA TACAGGCCCG GCACAGTCGC
Achatina damarensis        GTCGGCCCCA GCCACAGGAG GTGTGAAGAA GCCCCACAGA TACAGGCCCG GCACAGTCGC
Achatina stuhlmanni        GTCGGCCCCA GCCACAGGAG GTGTGAAGAA GCCCCACAGA TACAGGCCCG GCACAGTCGC
Atopocochlis exarata       GTCTGCCCCA GCCACAGGAG GTGTGAAGAA GCCCCACAGA TACAGGCCCG GCACAGTCGC
Limicolaria kambeul        GTCGGCCCCA GCCACAGGAG GTGTGAAGAA GCCCCACAGA TACAGGCCCG GCACAGTCGC
Limicolaria martenssii     GTCGGCCCCA GCCACAGGAG GTGTGAARAA GCCCCACAGA TACAGGCCCG GCACAGTCGC
Limicolariopsis sp.        ATCGGCCCCA GCTACAGGAG GTGTGAAGAA GCCCCACAGA TACAGGCCCG GCACAGTCGC
Cochlitoma varicosa        GTCGGCCCCA GCCACMGGAG GWGTGAAGAA ACCCCACMGA TACMGGCCCG GMACMGTCGC
Cochlitoma dimidiata       RTCGGCCCCA GCCACMGGWG GTGTGAAGAA ACCCCAYMGA TACAGGCCCG GCACMGTCGC
Cochlitoma sp. cf. vestita GTCGGCCCCA GCCACAGGAG GKGKGAAGAA ACCCCACAGA TMCAGACCCG GCMCAGTCGC
Cochlitoma marinae         GTCGGCCCCA GCCACAGGAG GTGTGAAGAA ACCCCACAGA TACAGGCCCG GCACAGTCGC
Cochlitoma churchilliana   GTCGGCCCCA GCCACAGGAG GTGTGAARAA ACCCCACARA TACAGGCCCG GCACAGTCGC
Cochlitoma granulata       GTCGGCGCCA GCCACAGGAG GTGTGAAGAA ACCCCACAGA TACAGGCCCG GCACAGTCGC
Cochlitoma simplex         GTCGGCCCCA GCCACAGGAG GTGTGAAGAA ACCCCACAGA TACAGGCCCG GCACAGTCGC
Cochlitoma kilburni        GTCGGCCCCA GCCACAGGAG GTGTGAAGAA ACCCCACAGA TACAGACCCG GCACAGTCGC
Cochlitoma montistempli    GTCGGCCCCA GCCACAGGAG GTGTGAAGAA ACCCCACAGA TACAGGCCCG GCACAGTCGC
Cochlitoma omissa          GTCGGCCCCA GCCACAGGAG GTGTGAAGAA ACCCCACAGA TACAGGCCCG GCACAGTCGC
Cochlitoma semidecussata   GTCGGCCCCA GCCACAGGAG GTGTGAAGAA ACCCCACAGA TACAGGCCCG GCACAGTCGC
Cochlitoma ustulata        GTCGGCCCCA GCCACAGGAG GTGTGAAGAA ACCCCACAGA TACAGGCCCG GCACAGTCGC
Cochlitoma zebra           GTCGGCCCCA GCCACAGGAG GTGTGAAGAA ACCCCACAGA TACAGGCCCG GCACAGTCGC
Metachatina kraussi        GTCGGCCCCA GCCACAGGAG GTGTGAAGAA ACCCCACAGA TACAGGCCCG GCACAGTCGC
Rumina decollata           GTCGGCCCCG GCCACAGGAG GCGTGAAGAA ACCCCAYCGA TACAGGCCTG GCACGGTCGC
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                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   130        140        150        160        170        180
Achatina fulica            ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACTGAGCTT CTCATCCGCA AACTGCCCTT
Achatina immaculata        ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACGGAGCTT CTCATCCGCA AACTGCCCTT
Achatina reticulata        WCTKMGAGAG ATCCGTCGKT ACCAGAAGAG CACKGAGCTK CTCATYCGCA ARCTGCCCTT
Achatina zanzibarica       ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACGGAGCTT CTCATCCGCA AACTGCCCTT
Achatina achatina          TCTKCGAGAR ATCCGTCGTT ACCAGAAGAG CACKGAGCTC CTCATCCGCA AGCTGCCCTT
Archachatina marginata     CCTSMGAGAR ATCCGYCGTT ACCAGAAGAG CASGGAGCTG CTCATYCGCA AGYTGCCCTT
Achatina bisculpta         WCTTCGAGAG ATCCGTCGTT ACCAGAAGAG YACGGAGCTT CTCATCCGCA ARCTGCCATT
Achatina damarensis        ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG TACGGAGCTT CTCATCCGCA AACTGCCATT
Achatina stuhlmanni        ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACGGAGCTT CTCATCCGCA AACTGCCATT
Atopocochlis exarata       ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACGGAGCTT CTCATCCGCA AACTGCCATT
Limicolaria kambeul        ACTTCGAGAG ATCCGTCGTT ACCAAAAAAG CACGGAGCTT CTCATCCGCA AACTGCCATT
Limicolaria martenssii     ACTTCGAGAG ATCCGTCGTT ACCARAARAG CACGGAGCTT CTCATCCGCA AACTGCCATT
Limicolariopsis sp.        ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACGGAGCTT CTCATCCGCA AACTGCCGTT
Cochlitoma varicosa        WCTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACAGAGCTT CTCATCCGCA ARCTGCCCTT
Cochlitoma dimidiata       WCTKCGAGAR ATCCGTCGTT ACCAGAAGAG CACWGAGCTT CTCATCCGCA ARCTGCCCTT
Cochlitoma sp. cf. vestita ACTTCGAGAG ATCCGTCGTT ACCARAARAG CACGGAGCTT CTCATCCGCA AACTGCCCTT
Cochlitoma marinae         ACTTCGAGAG ATCCGTCGTT ACCAGAAAAG CACGGAGCTT CTCATCCGCA AACTGCCCTT
Cochlitoma churchilliana   ACTTCGAGAG ATCCGTCGTT ACCARAARAG CACCGAGCTT YTCATCCGCA AACTGCCCTT
Cochlitoma granulata       ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACAGAGCTT CTCATCCGCA AACTGCCCTT
Cochlitoma simplex         ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACAGAGCTT CTCATCCGCA AACTGCCCTT
Cochlitoma kilburni        ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACGGAGCTT CTCATCCGCA AACTGCCCTT
Cochlitoma montistempli    ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACAGAGCTT CTCATCCGCA AACTGCCCTT
Cochlitoma omissa          ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACAGAGCTT CTCATCCGCA AACTGCCCTT
Cochlitoma semidecussata   ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACAGAGCTT CTCATCCGCA AACTGCCCTT
Cochlitoma ustulata        ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACGGAGCTT CTCATTCGCA AACTGCCCTT
Cochlitoma zebra           ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACGGAGCTT CTCATCCGCA AACTGCCCTT
Metachatina kraussi        ACTTCGAGAG ATCCGTCGTT ACCAGAAGAG CACGGAGCTT CTCATCCGCA AACTGCCCTT
Rumina decollata           GCTTCGAGAG ATCCGACGTT ACCAGAAGAG CACAGAGCTT CTCATCCGCA AGCTGCCCTT


                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   190        200        210        220        230        240
Achatina fulica            CCAGCGGCTG GTCAGAGAGA TCGCCCAGGA CTTTAAGACC GATCTGCGTT TCCAGAGCTC
Achatina immaculata        CCAGCGGCTG GTCAGAGAGA TCGCCCAGGA CTTTAAGACC GATCTGCGTT TCCAGAGCTC
Achatina reticulata        CCAGCGGCTG GTSAGAGAGA TYGCCCAGGA CTTYAAGACC GATCTGCGYT TCCAGAGCTC
Achatina zanzibarica       CCAGCGGCTG GTCAGAGAGA TCGCCCAGGA CTTTAAGACC GATCTGCGTT TCCAGAGCTC
Achatina achatina          CCAGCGCCTG GTCAGAGAAA TCGCCCAGGA CTTCAAGACY GACCTGCGCT TCCAGAGCTC
Archachatina marginata     CCAGCGCYTG GTGAGAGARA TCGCCCARGA CTTCAAGACH GAYCTGCGYT TCCAGAGCTC
Achatina bisculpta         CCAGCGGCTG GTCAGAGAGA TCGCMCAGGA CTTCAAGACY GATCTGCGYT TCCAGAGCTC
Achatina damarensis        CCAGCGGCTG GTCAGAGAGA TCGCACAGGA CTTCAAGACC GATCTGCGTT TCCAGAGCTC
Achatina stuhlmanni        CCAGCGGCTG GTCAGAGAGA TCGCACAGGA CTTCAAGACC GATCTGCGTT TCCAGAGCTC
Atopocochlis exarata       CCAGCGGCTG GTCAGAGAGA TCGCACAGGA CTTCAAGACC GATCTGCGTT TCCAGAGCTC
Limicolaria kambeul        CCAGCGGCTG GTCAGAGAGA TCGCACAGGA CTTCAAGACC GATCTGCGTT TCCAGAGCTC
Limicolaria martenssii     CCAGCGGCTG GTCAGAGAGA TCGCACAGGA CTTCAAGACC GATCTGCGTT TYCAGAGCTC
Limicolariopsis sp.        CCAGCGGCTG GTCAGAGAGA TCGCACAGGA CTTCAAGACC GATCTGCGTT TCCAGAGCTC
Cochlitoma varicosa        CCAGCGGYTG GTCAGAGAGA TCGCCCAGGA CTTCAAGACC GATCTGCGTT TCCAGAGCTC
Cochlitoma dimidiata       CCAGCGGCTG GTSMGAGARA TCGCYCAGGA CTTCAAGACC GATCTGCGYT TCCAGAGCTC
Cochlitoma sp. cf. vestita CCAGCGGCTG GTCARARARA TCGCCCAGGA CTTCAAGACT GATYTGCGTT TCCAGAGCTC
Cochlitoma marinae         CCAGCGGCTT GTCAGAGAGA TCGCCCAGGA CTTCAAGACC GATCTGCGTT TCCAGAGCTC
Cochlitoma churchilliana   CCAGCGGCTG GTCARAGAGA TCGCCCAGGA CTTCAARACC GATYTGCGTT TCCARAGCTC
Cochlitoma granulata       CCAGCGGCTG GTCAGAGAGA TCGCCCAGGA CTTCAAGACC GATCTGCGTT TCCAGAGCTC
Cochlitoma simplex         CCAGCGGCTG GTCAGAGAGA TCGCCCAGGA CTTCAAGACC GATCTGCGTT TCCAGAGCTC
Cochlitoma kilburni        CCAGCGGCTG GTCAGAGAGA TCGCCCAGGA CTTCAAGACT GATCTGCGTT TCCAGAGCTC
Cochlitoma montistempli    CCAGCGGCTG GTCAGAGAGA TCGCCCAGGA CTTCAAGACC GATCTGCGTT TCCAGAGCTC
Cochlitoma omissa          CCAGCGGCTG GTCAGAGAGA TCGCCCAGGA CTTCAAGACC GATCTGCGTT TCCAGAGCTC
Cochlitoma semidecussata   CCAGCGGCTG GTCAGAGAGA TCGCCCAGGA CTTCAAGACC GATCTGCGTT TCCAGAGCTC
Cochlitoma ustulata        CCAGCGGCTG GTCAGAGAGA TCGCCCAGGA CTTCAAGACC GATCTGCGTT TCCAGAGCTC
Cochlitoma zebra           CCAGCGGCTG GTCAGAGAGA TCGCCCAGGA CTTCAAGACT GATCTGCGTT TCCAGAGCTC
Metachatina kraussi        CCAACGGCTG GTCAGAGAGA TCGCCCAAGA CTTCAAGACC GATCTGCGTT TCCAGAGCTC
Rumina decollata           CCAGCGCCTT GTCAGAGAGA TCGCGCAGGA TTTCAAGACT GACCTGCGTT TTCAGAGCTC
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   250        260        270        280        290        300
Achatina fulica             GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Achatina immaculata         GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Achatina reticulata         VGCTGTCATG GCWCTGCAAG AGGCYAGCGA RGCMTACCTG GTGGGTCTGT TYGAGGACAC
Achatina zanzibarica        GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Achatina achatina           GGCYGTCATG GCCCTGCAAG AGGCYAGCGA RGCCTACCTG GTGGGTCTGT TYGAGGACAC
Archachatina marginata      GGCTGTCATG GCYCTGCARG AGGCYAGCGA GGCMTACCTG GTGGGCCTGT TYGAGGACAC
Achatina bisculpta          GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Achatina damarensis         GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Achatina stuhlmanni         GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Atopocochlis exarata        GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Limicolaria kambeul         AGCTGTCATG GCACTGCAAG AAGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Limicolaria martenssii      AGCTGTCATG GCACTGCAAG AAGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGARGACAC
Limicolariopsis sp.         GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Cochlitoma varicosa         GGCTGTCATG GCACTGCAAG AGGCYAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Cochlitoma dimidiata        GGCTGTCAWG GCACTGCAAG AGGCYAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Cochlitoma sp. cf. vestita  GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTYTGT TTGAGGACAC
Cochlitoma marinae          GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Cochlitoma churchilliana    GGCTGTCATG GCACTGCAAR AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Cochlitoma granulata        GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Cochlitoma simplex          GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Cochlitoma kilburni         GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Cochlitoma montistempli     GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Cochlitoma omissa           GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Cochlitoma semidecussata    GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Cochlitoma ustulata         GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Cochlitoma zebra            GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTG GTGGGTCTGT TTGAGGACAC
Metachatina kraussi         GGCTGTCATG GCACTGCAAG AGGCTAGCGA GGCCTACCTA GTGGGTCTGT TTGAGGACAC
Rumina decollata            RGCYGTCATG GCACTGCAGG AGGCTAGCGA GGCMTACYTR GTGGGCCTGT TTGAGGACAC


                            ....|....| ....|....| ....|...
                                   310        320
Achatina fulica             CAACCTGTGC GCCATCCACG CCAAACGT
Achatina immaculata         CAACCTGTGC GCCATCCACG CCAAACGT
Achatina reticulata         CAACCTGTGC GCCATCCAYG CCAARMGT
Achatina zanzibarica        CAACCTGTGC GCCATCCACG CCAAACGT
Achatina achatina           YAACYTGTGC GCYATCCACG CCAARCGT
Archachatina marginata      CMACCTKTGC GCCATCCAYG CCARVCGT
Achatina bisculpta          CAACCTGTGC GCCATCCACG CCAAACGT
Achatina damarensis         CAACCTGTGC GCCATCCACG CCAAACGT
Achatina stuhlmanni         CAACCTGTGC GCCATYCACG CCAAACGT
Atopocochlis exarata        CAACCTGTGC GCCATCCACG CCAAACGT
Limicolaria kambeul         CAACCTGTGC GCCATCCACG CCAAACGT
Limicolaria martenssii      CAACCTGTGC GCCATCCACG CCAAACGT
Limicolariopsis sp.         CAACCTGTGC GCCATCCACG CCAAACGT
Cochlitoma varicosa         CAACCTGTGC GCCATCCACG CCAAACGT
Cochlitoma dimidiata        CAACCTGTGC GCCATCCACG CCAAACGT
Cochlitoma sp. cf. vestita  CAACCTGTGC GCCATCCACG CCAAACGK
Cochlitoma marinae          CAACCTGTGC GCCATCCACG CCAAACGT
Cochlitoma churchilliana    CAACTTGTGC GCCATCCACG CCAAACGT
Cochlitoma granulata        CAACCTGTGC GCCATCCACG CCAAACGT
Cochlitoma simplex          CAACCTGTGC GCCATCCACG CCAAACGT
Cochlitoma kilburni         CAACCTGTGC GCCATCCACG CCAAACGT
Cochlitoma montistempli     CAACCTGTGC GCCATCCACG CCAAACGT
Cochlitoma omissa           CAACCTGTGC GCCATCCACG CCAAACGT
Cochlitoma semidecussata    CAACCTGTGC GCCATCCACG CCAAACGT
Cochlitoma ustulata         CAACCTGTGC GCCATCCACG CCAAACGT
Cochlitoma zebra            CAACCTGTGC GCCATCCACG CCAAACGT
Metachatina kraussi         CAACCTGTGC GCCATCCACG CCAAACGT
Rumina decollata            CAACCTGTGC GCCATCCACG CCAAACGT
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Appendix 4.4: Alignment of the CO1 gene for the Achatinidae and the subulinid outgroup *Rumina decollata*. Note that sequencing was unsuccessful for *Euaethiopina loveridgei* and *Limicolariopsis ruwenzoriensis*.

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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    10         20         30         40         50         60
Achatina fulica             TTTTTGGTGT ATGATGTGGG TTAGTTGGCA CAGGCTTGTC ACTCTTAATT CGGTTAGAGC
Achatina immaculata         TTTTGGGGRT TTGATGTGGC TTGGTAGGAA CCGGCCTTTC ATTATTAATT CGATTGGAGC
Achatina reticulata         TCCTCGGGGT ATGATGTGGT TTGGTTGGTA CTGGTTTATC ATTATTAATT CGTCTAGAGC
Achatina zanzibarica        TATTTGGTGT TTGGTGCGGC TTGGTGGGGA CAGGCTTATC ATTACTAATT CGACTAGAGT
Achatina achatina           TTTTTGGGGT TTGATGTGGC CTAGTAGGTA CAGGCCTATC ATTGTTAATT CGATTAGAAT
Archachatina marginata      TTTTTGGGGT GTGATGTGGC CTTGTTGGAA CAGGTCTATC TTTTTTAATT CGGTTAGAAT
Achatina bisculpta          TTTTTGGTGT TTGATGTGGT TTGGTAGGAA CTGGGCTATC TTTACTAATT CGGTTAGAGT
Achatina damarensis         TTTTTGGTGT GTGGTGTGGG TTAGTCGGGA CTGGGTTATC ATTACTAATT CGGTTAGAGT
Achatina stuhlmanni         TTTTTGGGGT CTGGTGTGGA TTAGTTGGTA CCGGCTTGTC TTTACTTATC CGGCTAGAAC
Atopocochlis exarata        TCTTTGGGGT TTGATGTGGG CTAGTGGGTA CTGGCTTATC TATTTTAATT CGATTAGAAC
Limicolaria kambeul         TTTTTGGAAT TTGATGTGGG TTGGTTGGGA CAGGCCTATC GTTTTTAATT CGTTTAGAAC
Limicolaria martenssii      TCTTTGGAGT ATGATGTGGT TTAGTGGGGA CAGGGTTATC ATTACTGATT CGTTTAGAGT
Limicolariopsis sp.         TCTTAGGGGT ATGATGTGGG TTAGTGGGAA CAGGCCTATC ATTATTAATT CGACTAGAAC
Cochlitoma varicosa         TTTTCGGGGT GTGATGTGGT TTAGTTGGGA CTGGGCTATC TTTACTTATT CGATTAGAGT
Cochlitoma dimidiata        TTTTTGGTGT TTGATGTGGT TTGGTTGGGA CCGGGCTATC TCTACTAATC CGTTTAGAGC
Cochlitoma sp. cf. vestita  TTTTTGGTGT GTGATGTGGT TTGGTTGGGA CTGGGCTATC CTTACTAATC CGTCTAGAGT
Cochlitoma marinae          TCTTCGGGAC CTGGTGTGGC TTGGTGGGCA CTGGGCTGTC TTTACTAATC CGTTTGGAGT
Cochlitoma churchilliana    TTTTCGGGGT CTGGTGTGGG TTAGTGGGGA CTGGTTTGTC CCTATTAATT CGATTAGAGC
Cochlitoma granulata        TCTTTGGATT CTGATGCGGG TTAGTTGGTA CTGGGTTATC GTTATTGATC CGGTTAGAAC
Cochlitoma simplex          TTTTTGGAGT TTGATGTGGA CTAGTGGGAA CTGGGTTATC CTTACTAATC CGACTAGAAC
Cochlitoma kilburni         TTTTTGGAGT GTGATGTGGC TTGGTTGGGA CAGGACTATC ACTGCTTATC CGTTTAGAGT
Cochlitoma montistempli     TTTTTGGGTT TTGGTGCGGA TTGGTTGGAA CAGGGCTATC ATTATTAATT CGATTAGAGC
Cochlitoma omissa           TTTTCGGGTT CTGATGCGGG TTAGTTGGTA CTGGGTTATC ATTATTGATC CGGTTAGAGC
Cochlitoma semidecussata    TTTTCGGGTT TTGGTGCGGG TTGGTTGGTA CAGGGCTCTC GTTATTAATT CGATTAGAGC
Cochlitoma ustulata         TTTTTGGGGT ATGGTGTGGT CTAGTGGGCA CAGGTCTATC TTTATTGATC CGACTAGAGC
Cochlitoma zebra            TTTTCGGAGT GTGATGTGGA CTGGTTGGGA CWGRTTTATC TTTAYTKATY CGGYTAGAGT
Metachatina kraussi         TTTTTGGGGT ATGATGTGGC TTAGTTGGCA CAGGCTTATC TCTTTTAATT CGACTAGAAC
Rumina decollata            TTTTTGGGGT CTGATGCGGT TTAGTTGGTA CTGGTTTATC TCTTCTTATT CGTTTAGAAC


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    70         80         90        100        110        120
Achatina fulica             TTGGAACAGT GGGAACCTTA ACTGATGATC ACTTTTTCAA CGTGGTTGTA ACTGCGCATG
Achatina immaculata         TAGGGTCAGT TGGGACTTTA ACAGATGATC ATTTTTTTAA TGTTGTAGTA ACTGCGCATG
Achatina reticulata         TCGGTTCGGT GGGGACGTTA ACTGACGATC ATTTTTTTAA TGTTGTAGTA ACCGCACATG
Achatina zanzibarica        TAGGGACTAC TGGTACCCTC ACAGATGACC ATTTCTTTAA TGTTGTAGTT ACTGCACATG
Achatina achatina           TAGGGACAGC TGGGGTTTTA ACCGATGATC ATTTCTTTAA TGTAGTGGTG ACAGCCCATG
Archachatina marginata      TAGGGACAGC AGGGGTATTA ACTGATGATC ACTTTTTTAA TGTGGTAGTA ACTGCTCATG
Achatina bisculpta          TAGGGAATGT TGGTACTTTG ATTGATGATC ACTTTTTCAA CGTGGTGGTC ACTGCTCATG
Achatina damarensis         TAGGAAGTAC TGGTACCTTA ACTGATGATC ATTTTTATAA TGTAGTAGTT ACTGCTCATG
Achatina stuhlmanni         TAGGGAGTAT TGGAACACTG ACTGACGATC ATTTTTTTAA TGTTGTAGTT ACTGCTCATG
Atopocochlis exarata        TAGGAAATGT AGGGACATTA ACTGATGACC ACTTTTACAA TGTAATTGTG ACTGCTCATG
Limicolaria kambeul         TAGGGAACAT TGGAACTTTA ATTGATGATC ATTTGTATAA TGTAGTAGTT ACCGCCCACG
Limicolaria martenssii      TAGGTAATGT GGGTACCTTG ATAGATGATC ATTTTTATAA TGTTATTGTA ACAGCTCACG
Limicolariopsis sp.         TTGGGAACAC AGGAACCTTA ACTGATGATC ATTTTTTTAA TGTAGTAGTA ACTGCTCATG
Cochlitoma varicosa         TAGGTACTAC CTCTACCTTA ACAGACGATC ATTTCTTTAA TGTTATTGTA ACAGCACATG
Cochlitoma dimidiata        TCGGGACAAC CTCTACATTA ACAGATGACC ATTTCTACAA TGTAATTGTA ACAGCACATG
Cochlitoma sp. cf. vestita  TAGGTACGAC CTCTACACTA ACTGATGATC ATTTTTTCAA TGTAATTGTC ACGGCGCACG
Cochlitoma marinae          TAGGTACCAC ATCCACACTT ACCGATGATC ATTTCTACAA TGTAATTGTG ACAGCACATG
Cochlitoma churchilliana    TAGGGACTGT GTCTACTTTG ACAGATGACC ATTTTTTTAA TGTCATTGTG ACTGCACATG
Cochlitoma granulata        TGGGGACTAC TTCGACTTTA ACAGATGATC ATTTTTTTAA TGTTATTGTT ACAGCTCATG
Cochlitoma simplex          TTGGGACTAC CACTACTCTA ACCGATGATC ATTTTTACAA CGTGATCGTT ACTGCACATG
Cochlitoma kilburni         TAGGTACGAC CTCTACACTA ACTGATGATC ATTTCTTCAA TGTTATTGTA ACGGCTCACG
Cochlitoma montistempli     TAGGGACAAC AACTACTCTA ACAGATGATC ATTTTTTTAA TGTTATTGTA ACGGCACACG
Cochlitoma omissa           TGGGGACTAC CTCGACTCTA ACAGATGATC ATTTTTTTAA TGTTATTGTT ACAGCTCATG
Cochlitoma semidecussata    TAGGGACAAC GTCTACACTA ACGGATGATC ATTTTTTTAA CGTTATTGTA ACGGCACACG
Cochlitoma ustulata         TAGGAACGAC CTCTACTTTA ACTGATGATC ATTTCTTTAA TGTTATCGTG ACAGCGCACG
Cochlitoma zebra            TAGGWACTAC CTCYACYTTA ACKGATGATC ATTTCTTTAA TGTTATTGTR ACAGCTCACG
Metachatina kraussi         TAGGGATAAC CTCTACTTTA ACAGATGATC ATTTTTTTAA TGTTGTAGTT ACTGCTCACG
Rumina decollata            TAGGTACAGC AGGAGTGTTA ACAGATGACC ATTTTTTTAA TGTGGTAGTT ACTGCCCATG
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                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   130        140        150        160        170        180
Achatina fulica            CTTTTGTCAT AATTTTTTTT ATGGTTATAC CAATTATAAT TGGCGGATTT GGAAACTGGA
Achatina immaculata        CGTTTGTTAT AATTTTCTTT ATGGTTATGC CAATTATGAT TGGGGGATTT GGTAATTGAA
Achatina reticulata        CTTTTGTTAT AATTTTTTTT ATAGTTATAC CAATTATAAT CGGAGGATTT GGGAACTGAA
Achatina zanzibarica       CATTTGTTAT AATTTTTTTT ATAGTGATAC CAATTATGAT TGGGGGGTTT GGGAACTGAA
Achatina achatina          CTTTTGTTAT AATTTTTTTT ATAGTCATAC CAATTATGAT TGGGGGTTTT GGTAATTGAA
Archachatina marginata     CATTTGTAAT AATTTTTTTT ATGGTTATGC CAATTATAAT TGGGGGTTTT GGAAACTGAA
Achatina bisculpta         CTTTTGTAAT GATTTTCTTT ATAGTAATGC CTATTATAAT TGGGGGGTTT GGTAATTGAA
Achatina damarensis        CTTTTGTAAT AATCTTTTTT ATAGTTATAC CTATTATAAT TGGAGGATTT GGTAACTGAA
Achatina stuhlmanni        CTTTTGTGAT AATTTTTTTT ATAGTGATAC CAATTATAAT TGGTGGGTTT GGAAACTGGA
Atopocochlis exarata       CTTTCGTAAT AATTTTCTTT ATAGTTATAC CAATCATAAT TGGCGGGTTT GGGAACTGAA
Limicolaria kambeul        CTTTTGTAAT AATCTTCTTC ATAGTTATAC CTATTATAAT TGGAGGTTTC GGAAATTGGA
Limicolaria martenssii     CTTTTGTTAT AATTTTCTTT ATAGTTATAC CCATTATAAT TGGAGGATTT GGAAATTGAA
Limicolariopsis sp.        CCTTCGTAAT AATTTTTTTT ATAGTTATAC CTATTATAAT TGGTGGATTT GGTAATTGAA
Cochlitoma varicosa        CATTTGTAAT AATTTTTTTT ATAGTGATAC CCATTATAAT TGGTGGTTTT GGGAACTGGA
Cochlitoma dimidiata       CTTTCGTTAT AATTTTTTTC ATAGTAATAC CCATTATAAT TGGGGGTTTT GGGAACTGAA
Cochlitoma sp. cf. vestita CATTCGTTAT AATTTTTTTT ATGGTAATAC CAATTATAAT TGGGGGTTTT GGTAATTGAA
Cochlitoma marinae         CATTTGTGAT GATTTTTTTC ATAGTAATAC CAATTATGAT TGGGGGTTTT GGGAACTGGA
Cochlitoma churchilliana   CGTTTGTCAT GATCTTCTTC ATGGTAATGC CTATTATAAT TGGTGGTTTT GGAAATTGAA
Cochlitoma granulata       CATTCGTTAT AATTTTTTTC ATAGTAATAC CAATTATAAT TGGGGGTTTT GGTAACTGAA
Cochlitoma simplex         CTTTTGTTAT GATTTTTTTC ATGGTGATGC CCATTATAAT CGGGGGCTTT GGAAATTGGA
Cochlitoma kilburni        CATTCGTTAT AATTTTCTTT ATAGTAATAC CTATTATAAT TGGGGGTTTT GGCAACTGGA
Cochlitoma montistempli    CGTTTGTTAT AATTTTCTTT ATAGTAATAC CTATTATAAT TGGGGGTTTT GGGAACTGGA
Cochlitoma omissa          CATTCGTTAT AATTTTTTTT ATAGTAATAC CTATTATAAT CGGGGGTTTT GGTAACTGAA
Cochlitoma semidecussata   CATTTGTTAT AATTTTTTTT ATAGTAATAC CTATTATAAT TGGGGGTTTT GGGAATTGAA
Cochlitoma ustulata        CTTTTGTAAT AATTTTTTTC ATAGTAATAC CCATTATAAT TGGGGGTTTT GGTAATTGAA
Cochlitoma zebra           CTTTTGTTAT AATCTTCTTC ATGGTAATAC CCATTATAAT TGGGGGATTC GGAAATTGRA
Metachatina kraussi        CATTTGTTAT GATTTTTTTT ATAGTTATGC CTATTATAAT TGGTGGATTT GGAAATTGGA
Rumina decollata           CATTTGTGAT AATTTTTTTT ATAGTAATGC CTATTATAAT CGGTGGTTTT GGAAATTGAA


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                                   190        200        210        220        230        240
Achatina fulica            TGGTCCCAAT ACTTATTGGT GCTCCTGATA TAAGATTTCC ACGAATAAAT AATATAAGGT
Achatina immaculata        TGGTTCCCCT TTTAATTGGG GCTCCTGATA TAAGTTTTCC CCGGATGAAT AATATGAGGT
Achatina reticulata        TGGTTCCCAT ACTTATTGGG GCTCCCGATA TAAGTTTTCC ACGTATAAAC AATATAAGAT
Achatina zanzibarica       TGGTACCACT ATTAATTGGA GCACCTGACA TAAGATTCCC ACGCATAAAT AATATAAGAT
Achatina achatina          TAGTCCCACT ATTAATTGGG GCTCCAGATA TAAGATTCCC TCGGATGAAT AATATAAGGT
Archachatina marginata     TAGTTCCTCT ATTAATTGGG GCTCCAGATA TAAGTTTTCC TCGGATAAAT AATATAAGGT
Achatina bisculpta         TGGTCCCACT TTTAATTGGT GCGCCAGATA TAAGATTTCC TCGAATAAAT AATATAAGAT
Achatina damarensis        TGGTGCCTCT TTTGATTGGT GCACCAGACA TAAGATTTCC TCGTATAAAC AACATAAGGT
Achatina stuhlmanni        TGGTCCCATT ACTGATTGGT GCTCCTGATA TAAGGTTTCC GCGGATAAAT AACATAAGAT
Atopocochlis exarata       TAGTTCCATT ATTAATTGGG GCCCCCGACA TAAGTTTCCC TCGAATAAAT AACATGAGAT
Limicolaria kambeul        TAGTTCCCTT ATTAATTGGT GCTCCTGATA TAAGATTCCC CCGAATGAAT AATATAAGAT
Limicolaria martenssii     TAGTACCATT ATTGATTGGT GCACCAGATA TAAGCTTTCC TCGCATGAAT AATATAAGAT
Limicolariopsis sp.        TAGTACCACT GTTAATTGGG GCACCTGACA TAAGATTTCC TCGTATAAAC AATATAAGGT
Cochlitoma varicosa        TAGTCCCCTT GCTAATTGGT GCCCCTGATA TAAGCTTTCC CCGAATGAAT AATATAAGTT
Cochlitoma dimidiata       TAGTTCCTTT ATTGATTGGG GCACCAGATA TGAGATTTCC TCGTATAAAC AATATAAGCT
Cochlitoma sp. cf. vestita TGGTCCCCTT ACTGATCGGG GCCCCCGATA TAAGGTTTCC CCGAATGAAT AATATAAGTT
Cochlitoma marinae         TAGTACCCTT ATTGGTTGGT GCCCCTGATA TAAGATTTCC TCGAATAAAT AATATAAGTT
Cochlitoma churchilliana   TGATTCCCCT ACTAATTGGG GCTCCTGATA TAAGTTTTCC GCGAATAAAC AACATAAGGT
Cochlitoma granulata       TAGTACCAAT GTTAATCGGG GCCCCAGATA TAAGGTTCCC TCGTATAAAT AATATAAGCT
Cochlitoma simplex         TAGTTCCCTT GCTAATTGGG GCACCTGACA TGAGATTTCC TCGTATAAAC AATATAAGCT
Cochlitoma kilburni        TGGTTCCTTT GTTGATTGGG GCTCCTGATA TAAGGTTTCC CCGAATGAAT AATATAAGCT
Cochlitoma montistempli    TAGTACCTAT GCTTATTGGG GCTCCGGACA TAAGATTCCC CCGTATGAAT AATATAAGCT
Cochlitoma omissa          TAGTACCATT GTTAATCGGG GCCCCAGATA TAAGGTTTCC TCGTATAAAT AATATAAGCT
Cochlitoma semidecussata   TAGTTCCCAT GTTAATTGGG GCCCCGGATA TAAGATTCCC TCGTATAAAT AATATAAGCT
Cochlitoma ustulata        TAACTCCCCT TTTAATCGGG GCTCCTGATA TAAGCTTTCC TCGTATAAAT AACATGAGCT
Cochlitoma zebra           TAATYCCCTT ACTTATTGGS GCTCCTGATA TAAGCTTTCC CCGGATAAAT AACATRAGYT
Metachatina kraussi        TAGTTCCACT ATTAATTGGG GCTCCTGATA TAAGCTTTCC ACGAATAAAT AATATAAGCT
Rumina decollata           TAGTGCCCCT ATTAATTGGG GCACCAGATA TAAGGTTTCC TCGAATAAAT AATATGAGAT
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    250        260        270        280        290        300
Achatina fulica             TTTGACTTTT ACCACCTTCA TTTACTTTGT TAATCTGTTC AAGTATAGTG GAAGGAGGGG
Achatina immaculata         TTTGGCTTCT CCCACCATCG TTTACTTTAT TAATTAGGTC AAGCCTGGTT GAAGGTGGTG
Achatina reticulata         TTTGACTTTT ACCCCCTGCG TTTACATTAT TAATCTGCTC AAGTATAGTC GAAGGTGGGG
Achatina zanzibarica        TTTGACTTCT ACCACCTTCT TTTTGTCTTT TAATTAGATC GAGAATGGTA GAGGGGGGGG
Achatina achatina           TCTGATTATT ACCACCTTCA TTTACCTTAC TTATTCTTTC TAGTATAGTT GAGGGAGGAG
Archachatina marginata      TTTGATTGCT TCCACCTTCA TTTGTTCTGC TAATTCTCTC GAGGATGGTC GAGGGTGGAG
Achatina bisculpta          TCTGACTTTT ACCCCCATCT TTTACTCTTT TAATCCTATC GAGTATAGTT GAAGGTGGAG
Achatina damarensis         TTTGACTTTT ACCACCGTCT TTTACTTTAC TAATTTTATC AAGTATGGTT GAAGGTGGAG
Achatina stuhlmanni         TTTGACTACT TCCCCCATCA TTTTCTTTGC TAATTCTCTC AAGTATAGTA GAAGGTGGGG
Atopocochlis exarata        TTTGGTTACT TCCACCATCA TTTACCCTTT TAATTTTATC TAGAATAGTA GAAGGAGGGG
Limicolaria kambeul         TTTGATTACT ACCACCTTCT TTTACTTTAC TAATCTTATC AAGCATAGTA GAGGGTGGGG
Limicolaria martenssii      TCTGGTTACT ACCCCCAGCT TTTACTTTAT TAATTCTCTC TAGGATAGTA GAAGGAGGCG
Limicolariopsis sp.         TCTGATTACT TCCTCCTGCA TTTACTTTAC TAATTTTATC AAGGATAGTA GAAGGAGGCG
Cochlitoma varicosa         TCTGACTATT ACCACCTTCG TTCTCCCTGT TAATTCTATC AAGGATAGTT GAGGGGGGTG
Cochlitoma dimidiata        TTTGATTGCT CCCACCTTCA TTTTCTCTTT TGATTTTATC AAGAATAGTG GAAGGGGGAG
Cochlitoma sp. cf. vestita  TTTGATTACT TCCACCTTCG TTTTCTCTAT TAATTTTATC AAGAATGGTA GAAGGTGGTG
Cochlitoma marinae          TCTGATTATT ACCACCCTCA TTCTCACTAC TAATCTTATC TAGTATAGTA GAAGGGGGAG
Cochlitoma churchilliana    TCTGATTACT TCCCCCCTCT TTTTCGTTAC TGATTTTATC TAGTATAGTG GAAAGTGGTG
Cochlitoma granulata        TTTGACTCCT ACCCCCCTCA TTCTCTCTTC TAATCTTATC AAGAATGGTT GAGGGTGGTG
Cochlitoma simplex          TCTGACTGCT TCCTCCCTCA TTTTCTCTTC TAATCTTATC AAGACTAGTG GAGGGTGGGG
Cochlitoma kilburni         TTTGATTACT CCCACCTTCG TTTTCACTTC TAATCTTATC AAGAATGGTA GAGGGTGGTG
Cochlitoma montistempli     TCTGGCTCCT ACCCCCTTCT TTTTCCCTCT TAATTTTATC AAGAATAGTA GAGGGCGGAG
Cochlitoma omissa           TTTGACTCCT GCCCCCCTCG TTCTCTCTTT TAATCTTATC TAGAATGGTT GAGGGTGGTG
Cochlitoma semidecussata    TCTGGCTCCT ACCCCCTTCG TTTTCCCTCT TAATTTTATC AAGAATAGTA GAGGGTGGGG
Cochlitoma ustulata         TTTGATTGTT ACCCCCTTCC TTTACACTTC TTATCTTGTC AAGAATAGTG GAGGGGGGTG
Cochlitoma zebra            TTTGATTRCT CCCMCCTTCG TTCTCTCTAC TAATTTTRTC AAGRATAGTA GAGGGAGGTG
Metachatina kraussi         TTTGGTTATT ACCGCCGTCT TTTACATTAT TGATTTTGTC AAGAATAGTA GAAGGAGGTG
Rumina decollata            TTTGACTACT TCCTCCTTCT TTTATTTTAT TAATTATATC TAGGATAGTA GAAGGTGGGG


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    310        320        330        340        350        360
Achatina fulica             CTGGAACTGG GTGGACTGTG TACCCGCCCT TAAGTTCTTG CTTAGGACAC AGAGGGGCTT
Achatina immaculata         CTGGGACTGG TTGAACTGTT TACCCGCCGT TAAGTTCTTA TATGGGTCAC AGGGGGGCCT
Achatina reticulata         CTGGCACAGG TTGAACTGTC TACCCACCTT TAAGCTCTTA TTTAGGGCAT AGTGGGGCAT
Achatina zanzibarica        CAGGTACAGG TTGGACTGTG TACCCACCAT TGAGCTCAAT TATTGGGCAT AGGGGCCCAT
Achatina achatina           CTGGTACTGG GTGAACAGTT TATCCACCTT TAAGATCTAC TTTAGGTCAT AGAGGTGCCT
Archachatina marginata      CAGGTACTGG GTGGACAGTT TACCCCCCCC TTAGGTCAGT CTTAGGACAT AGTGGAGCTT
Achatina bisculpta          CGGGAACTGG CTGAACAGTT TATCCACCAC TTAGTTCATT AATTGGACAT AGTGGAGCAT
Achatina damarensis         CAGGAACTGG TTGGACAGTT TACCCACCTC TTAGTTCTCT GATTGGTCAT AGGGGAGCAT
Achatina stuhlmanni         CTGGGACAGG ATGGACAGTT TACCCTCCTC TAAGTTCATT AATTGGCCAT AGTGGAGCAT
Atopocochlis exarata        CAGGGACTGG TTGAACGGTG TACCCCCCTC TTAGCTCTAT GCTTGGCCAC AGGGGTGCCT
Limicolaria kambeul         CTGGAACTGG TTGAACAGTT TACCCTCCTC TTAGAGCTAT TACAGGCCAT AGAGGTGCTT
Limicolaria martenssii      CGGGAACAGG GTGAACTGTT TATCCTCCTT TAAGATCCCT AGTGGGTCAT AGAGGGGCCA
Limicolariopsis sp.         CAGGAACTGG TTGAACTGTA TACCCCCCTC TAAGTTCTAT AATTGGACAT AGAGGAGCCT
Cochlitoma varicosa         CAGGGACTGG TTGAACAGTT TACCCCCCTC TGAGTTCTAT AATAGGACAT AGAGGAGCGT
Cochlitoma dimidiata        CAGGGACAGG CTGGACGGTA TACCCGCCTC TAAGTTCGAT TATAGGTCAC AGAGGGGCTT
Cochlitoma sp. cf. vestita  CAGGTACTGG GTGAACTGTG TACCCACCTC TCAGGTCTAT GTTAGGGCAT AGAGGTGCGT
Cochlitoma marinae          CAGGCACCGG TTGGACTGTG TACCCGCCTT TAAGCTCTAT TATTGGTCAT AGGGGCGCTT
Cochlitoma churchilliana    CTGGGACAGG GTGAACAGTA TACCCTCCCC TGAGGTCAAC TATTGGTCAT AGGGGCGCAT
Cochlitoma granulata        CAGGTACAGG TTGAACTGTT TACCCTCCTT TGAGTTCTGT AATAGGCCAT AGAGGTGCAT
Cochlitoma simplex          CAGGAACAGG CTGAACAGTA TACCCTCCCC TTAGTTCTAT TATTGGTCAC AGAGGAGCTT
Cochlitoma kilburni         CAGGTACTGG TTGAACTGTG TACCCACCTC TTAGATCTAT ATTAGGGCAT AGGGGTGCAT
Cochlitoma montistempli     CAGGTACTGG TTGAACAGTT TACCCCCCTT TAAGTTCAAT TATTGGCCAT AGAGGTGCAT
Cochlitoma omissa           CAGGTACTGG TTGAACAGTT TACCCCCCTT TGAGCTCTAT AATAGGTCAT AGAGGTGCAT
Cochlitoma semidecussata    CAGGTACTGG TTGAACGGTT TACCCTCCTT TAAGTTCAAT TATTGGCCAT AGAGGAGCAT
Cochlitoma ustulata         CAGGTACAGG TTGAACTGTG TATCCACCTT TAAGGTCTAT CATAGGTCAT AGGGGAGCAT
Cochlitoma zebra            CWGGTACWGG CTGRACAGTK TATCCCCCTT TAAGTTCCAT GCTWGGACAT AGRGGWGCAT
Metachatina kraussi         CCGGGACTGG TTGAACTGTG TACCCACCGT TAAGTTCTAT TCTTGGGCAT AGGGGAGCAT
Rumina decollata            CAGGAACTGG TTGAACAGTG TATCCACCCT TAAGCAGAAT CATAGGACAT AGTGGGGCAT
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                                   370        380        390        400        410        420
Achatina fulica            CAGTTGATTT AGCTATTTTT TCTTTACATT TGGCTGGTGT ATCCTCAATT TTAGGGGCAA
Achatina immaculata        CAGTTGATTT AGCAATTTTT TCCCTTCATC TTGCTGGTGT CTCATCGATT TTAGGGGCAA
Achatina reticulata        CAGTAGATTT AGCTATCTTC TCTCTCCACT TAGCTGGGGT ATCCTCAATC TTAGGGGCTA
Achatina zanzibarica       CTGTTGATTT AGCGATTTTT TCACTTCATT TGGCAGGAGT TTCGTCAATT TTAGGGGCAA
Achatina achatina          CGGTAGATTT AGCGATTTTT TCATTACATT TGGCTGGTAT ATCATCTATC TTAGGGGCTA
Archachatina marginata     CTGTGGACCT GGCTATTTTT TCTTTGCACT TAGCCGGTAT ATCTTCTATT CTTGGTGCAA
Achatina bisculpta         CAGTGGATTT AGCAATTTTT TCTTTACACT TAGCTGGTAT ATCCTCAATC CTTGGAGCCA
Achatina damarensis        CTGTAGATTT AGCAATTTTT TCTTTACATC TAGCTGGGAT ATCCTCAATC CTTGGTGCTA
Achatina stuhlmanni        CAGTGGACTT GGCAATTTTT TCTCTACACT TAGCCGGAAT ATCCTCTATT CTCGGAGCTA
Atopocochlis exarata       CGGTTGACTT AGCAATTTTC TCACTTCATC TAGCAGGTAT ATCCTCGATT CTTGGGGCTA
Limicolaria kambeul        CAGTAGACTT AGCAATCTTC TCTCTTCACC TTGCAGGAAT GTCTTCAATC CTAGGAGCAA
Limicolaria martenssii     GGGTTGACTT AGCTATTTTT TCCTTACACT TAGCTGGAAT ATCTTCCATT CTAGGGGCTA
Limicolariopsis sp.        CAGTAGATTT AGCTATTTTC TCATTACATC TAGCAGGTAT GTCATCCATT TTAGGGGCTA
Cochlitoma varicosa        CTGTAGATCT GGCTATCTTC TCTCTTCATC TTGCTGGGAT GTCCTCAATC TTAGGCGCCA
Cochlitoma dimidiata       CTGTTGATTT GGCCATTTTT TCCTTACATC TGGCAGGAAT ATCGTCAATT TTAGGTGCTA
Cochlitoma sp. cf. vestita CTGTCGATTT AGCTATCTTT TCACTACATC TTGCAGGGAT ATCTTCGATT TTAGGAGCCA
Cochlitoma marinae         CAGTGGATCT AGCTATTTTT TCTCTTCACC TAGCTGGAAT ATCTTCTATT TTAGGTGCTA
Cochlitoma churchilliana   CAGTGGATTT AGCAATTTTT TCCCTTCACT TGGCGGGGAT ATCTTCAATC CTAGGTGCTA
Cochlitoma granulata       CAGTAGATTT AGCTATTTTT TCCCTTCACC TCGCAGGTCT GTCCTCAATC TTGGGTGCTA
Cochlitoma simplex         CTGTAGATCT GGCTATTTTT TCCCTACATC TAGCAGGAAT GTCATCAATC TTAGGCGCTA
Cochlitoma kilburni        CTGTCGATTT AGCAATCTTC TCATTACATC TTGCAGGGAT ATCCTCAATT TTAGGAGCTA
Cochlitoma montistempli    CTGTAGATCT GGCTATTTTT TCGCTACATC TTGCGGGTAT ATCCTCAATT CTAGGTGCTA
Cochlitoma omissa          CTGTGGATTT AGCTATTTTT TCTCTTCACC TTGCGGGTCT GTCCTCAATC CTAGGTGCTA
Cochlitoma semidecussata   CGGTGGACCT TGCAATCTTC TCACTTCATC TTGCGGGTAT ATCCTCAATT CTTGGTGCTA
Cochlitoma ustulata        CAGTGGATTT GGCTATCTTC TCTCTACACT TAGCTGGTAT ATCTTCTATT CTCGGGGCTA
Cochlitoma zebra           CCGTSGATCT RGCTATCTTC TCTCTACATY TMGCTGGCAT ATCCTCTATT TTAGGKGCCA
Metachatina kraussi        CAGTTGACTT AGCTATTTTT TCTTTACATT TAGCTGGAAT ATCATCTATT TTAGGAGCTA
Rumina decollata           CTGTTGACTT AGCTATTTTC TCTCTTCATT TAGCAGGGAT ATCTTCTATT TTAGGTGCAA


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                                   430        440        450        460        470        480
Achatina fulica            TCAATTTTAT TACGACGGTG TATAATATAC GAGCCTCTGG GCTAACTATA GAACGGGTAA
Achatina immaculata        TTAACTTTAT TACAACAGTA TATAATATAC GTTCTTCAGG GTTAACCATA GAACGAGTAA
Achatina reticulata        TTAATTTTAT TACTACAGTT TACAATATAC GTGCTTCTGG GTTAACTATA GAACGAGTAA
Achatina zanzibarica       TTAACTTTAT TACCACAGTC TATAATATGC GGGCTTCGGG CTTAGAGATA GAACGGATGA
Achatina achatina          TTAACTTTAT TACTACAATT TTTAATATAC GAGCATCAGG GATATCTATA GAACGGGTTA
Archachatina marginata     TTAACTTTAT CACAACTATT TTCAACATGC GAGCTCCCGG TCTTACAATG GAGCGGGTAA
Achatina bisculpta         TTAATTTTAT TACTACTATC TTTAATATAC GGGTGTCTGG TTTGTCTATG GAACGGGTAA
Achatina damarensis        TTAATTTCAT TACTACTATC TTCAATATGC GGGTGTCAGG GCTAACTATA GAACGGGTAA
Achatina stuhlmanni        TCAACTTTAT TACTACAATT TTTAACATAC GAGTATCTGG ACTATCTATG GAACGGGTGA
Atopocochlis exarata       TCAATTTTAT TACCACAATT TATAATATAC GGGTTAGGGG ATTGACAATA GAACGAGTAA
Limicolaria kambeul        TTAATTTTAT TACTACAATT TTTAATATAC GAGCATCAGG GTTATCTTTA GAGCGTATAA
Limicolaria martenssii     TTAATTTCAT TACTACTATT TTTAATATAC GAGTAAAAGG CTTATCTATA GAACGTCTAA
Limicolariopsis sp.        TTAACTTTAT TACAACTGTA TTTAATATGC GAGCATCAGG GTTAACTATA GAACGAGTAA
Cochlitoma varicosa        TTAACTTCAT TACCACAGTA TTTAATATAC GAGCGCAGGG GTTATCTATG GAGCGAGTCA
Cochlitoma dimidiata       TTAACTTTAT TACAACAGTA TTTAATATAC GGGTGCAAGG ACTCTCAATG GAACGGGTAA
Cochlitoma sp. cf. vestita TTAACTTTAT TACTACAGTA TTTAATATAC GAGCACAAGG CTTATCAATA GAACGTGTCA
Cochlitoma marinae         TTAACTTTAT CACCACTATT TTTAATATAC GGGCGCAAGG TTTAACTATA GAACGAGTGA
Cochlitoma churchilliana   TTAATTTTAT TACCACAGTC TTTAATATAC GTACTCCTGG TTTAACTATA GAACGGGTAA
Cochlitoma granulata       TTAATTTTAT TACTACAGTG TTTAACATAC GGGCACAAGG ATTATCTATG GAACGGGTCA
Cochlitoma simplex         TTAACTTTAT TACCACAGTG TTCAATATGC GGGTGAAAGG CCTGTCAATA GAACGAGTGA
Cochlitoma kilburni        TTAACTTTAT TACTACAGTA TTCAATATAC GAGCACAAGG ACTATCAATA GAACGAGTCA
Cochlitoma montistempli    TTAACTTTAT TACTACAGTG TTTAATATAC GGGCCCAGGG ATTATCAATG GAACGAGTAA
Cochlitoma omissa          TTAATTTTAT TACAACAGTG TTTAATATAC GGGCACAAGG GTTAACTATG GAACGAGTCA
Cochlitoma semidecussata   TCAACTTCAT TACTACAGTG TTTAATATAC GGGCCCAGGG AATATCTATA GAACGAGTAA
Cochlitoma ustulata        TTAACTTTAT CACAACTATC TTTAATATAC GAGCTCAAGG CTTATCTATG GAGCGTATAA
Cochlitoma zebra           TTAACTTTAT YACTACTGTA TTTAATATAC GAGCACAGGG GTTGTCAATG GAACGAGTCA
Metachatina kraussi        TTAATTTTAT TACTACCGTC TTTAATATAC GAACCCCGGG GTTATCTATA GAGCGGGTAA
Rumina decollata           TTAATTTTAT TACTACTATT TATAATATAC GGTCCCCAGG TCTTTCAATA GAACGGGTAA
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                                   490        500        510        520        530        540
Achatina fulica            GCTTATTCGT GTGGTCAATT TTAGTTACAG TGTTTCTACT ATTGTTATCA TTGCCAGTTC
Achatina immaculata        GGCTATTTGT CTGGTCTATT TTAGTAACCG TTTTTTTATT ACTGCTATCC CTACCAGTTC
Achatina reticulata        GATTATTTGT GTGATCAATT TTGGTTACGG TGTTTCTTTT ACTACTATCA TTACCTGTAC
Achatina zanzibarica       GTTTATTTGT TTGATCAATT TTAGTCACCG TATTTTTACT ACTACTCTCA TTACCTGTAT
Achatina achatina          GACTGTTTGT ATGATCTATT TTAGTTACAG TATTTTTACT GCTTTTATCT CTCCCAGTAT
Archachatina marginata     GTCTTTTTGT GTGGTCTATT TTGGTGACAG TTTTTCTGTT GTTGTTGTCT TTACCAGTGT
Achatina bisculpta         GTTTATTTGT TTGATCTATT CTTGTAACTG TATTTCTTTT ACTTCTCTCA TTGCCAGTCC
Achatina damarensis        GTTTATTTGT TTGGTCAATT CTTGTGACAG TGTTTCTTTT ACTTCTTTCT TTGCCTGTCT
Achatina stuhlmanni        GGTTATTTGT ATGATCAATT CTTGTTACTG TTTTCCTTTT ACTTTTATCT CTACCAGTCT
Atopocochlis exarata       GGTTATTTGT GTGGTCAATT TTGGTTACAG TATTCCTTTT ACTCTTATCA TTACCAGTAT
Limicolaria kambeul        GCTTATTTGT TTGGTCTATT CTTGTTACAG TATTTTTACT TCTTCTCTCT CTCCCTGTTT
Limicolaria martenssii     GTCTGTTTGT ATGATCTATC TTAGTAACGG TCTTTTTATT ACTCCTATCT CTTCCAGTAC
Limicolariopsis sp.        GGTTATTTGT ATGATCTATT TTAATTACTG TATTTCTTTT ACTCTTATCT CTACCAGTCC
Cochlitoma varicosa        GCTTATTTGT GTGGTCAATC CTTGTCACTG TATTTTTACT TCTTTTATCG CTACCTGTTT
Cochlitoma dimidiata       GCCTATTTGT GTGGTCTATC TTAGTTACCG TGTTTTTACT ACTCCTCTCC CTTCCTGTCT
Cochlitoma sp. cf. vestita GGTTATTTGT GTGGTCAATT TTAGTAACTG TATTTTTACT ACTTCTCTCT CTCCCAGTTC
Cochlitoma marinae         GGTTGTTTGT GTGATCAATC CTAGTAACCG TGTTTTTACT ATTATTATCC TTACCAGTTT
Cochlitoma churchilliana   GTTTGTTTGT ATGGTCTGTT CTAGTGACAG TATTCTTACT ACTTTTGTCT TTACCTGTAT
Cochlitoma granulata       GTTTATTCGT TTGGTCTATT TTGATTACTG TTTTTTTACT CCTTCTCTCT CTTCCTGTTC
Cochlitoma simplex         GCCTCTTTGT GTGGTCAATC TTAGTCACCG TGTTTTTACT ACTTCTCTCC CTCCCTGTCT
Cochlitoma kilburni        GGTTATTTGT ATGGTCAATT TTAGTAACTG TATTTTTATT ACTTCTCTCT CTACCTGTTC
Cochlitoma montistempli    GCTTGTTTGT ATGGTCAATC TTGGTAACAG TATTTTTACT TCTTCTCTCC CTTCCGGTTT
Cochlitoma omissa          ATTTATTCGT ATGGTCTATT TTAGTTACTG TATTTTTACT CCTTCTCTCT CTTCCTGTTC
Cochlitoma semidecussata   GCTTATTTGT GTGGTCCATC TTGGTAACAG TTTTTTTACT TCTTCTCTCC CTTCCTGTTT
Cochlitoma ustulata        GATTATTTGT ATGGTCTATT TTAGTTACTG TTTTCCTACT GCTCTTATCT CTACCAGTAC
Cochlitoma zebra           GMCTATTCGT MTGRTCCATT YTAGTAACAG TTTTCTTACT SCTCTTATCA TTACCCGTCT
Metachatina kraussi        GATTATTTGT TTGATCTATT TTAGTGACCG TGTTCTTATT ACTTCTTTCT TTACCAGTTT
Rumina decollata           GCCTATTTGT GTGATCTATT TTAGTAACCG TTTTTCTATT GCTTTTATCC CTACCAGTAC


                           ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   550        560        570        580        590        600
Achatina fulica            TAGCGGGGGC AATTACTATA CTATTAACGG ATCGTAACTT TAACACATCT TTTTTTGACC
Achatina immaculata        TTGCCGGAGC TATTACTATA CTGCTAACAG ACCGTAATTT TAATACCTCA TTTTTTGACC
Achatina reticulata        TGGCTGGGGC TATTACTATA TTATTAACAG ACCGTAATTT TAATACATCT TTTTTTGATC
Achatina zanzibarica       TAGCAGGGGC AATTACTATA TTATTAACAG ACCGAAACTT TAACACATCA TTTTTTGACC
Achatina achatina          TAGCGGGTGC AATTACTATA CTTCTGACCG ATCGTAACTT TAATACATCT TTTTTTGATC
Archachatina marginata     TAGCTGGTGC TATTACTATA CTTTTAACTG ATCGAAATTT TAATACATCT TTTTTTGACC
Achatina bisculpta         TAGCTGGGGC AATTACAATA TTATTAACAG ATCGAAATTT TAATACATCA TTTTTTGATC
Achatina damarensis        TAGCTGGAGC AATTACAATG TTATTAACTG ATCGAAATTT TAATACATCG TTTTTTGACC
Achatina stuhlmanni        TAGCTGGGGC GATTACTATA CTATTAACTG ATCGAAATTT TAATACATCT TTTTTTGATC
Atopocochlis exarata       TAGCAGGGGC AATTACTATA CTATTAACAG ATCGAAATTT TAATACTTCA TTTTTTGACC
Limicolaria kambeul        TAGCTGGAGC TATTACTATA TTATTAACTG ATCGTAATTT TAATACATCT TTTTTTGACC
Limicolaria martenssii     TGGCAGGGGC TATTACTATA TTATTAACAG ATCGTAATTT TAATACCTCT TTTTTTGACC
Limicolariopsis sp.        TTGCAGGTGC AATCACTATA CTATTAACTG ATCGTAACTT TAATACGTCA TTTTTTGATC
Cochlitoma varicosa        TAGCAGGGGC TATCACTATA CTATTAACAG ATCGAAATTT TAACACTTCT TTTTTTGATC
Cochlitoma dimidiata       TAGCGGGGGC TATCACTATA CTACTTACGG ACCGAAATTT TAACACCTCA TTTTTTGACC
Cochlitoma sp. cf. vestita TAGCAGGGGC TATTACTATG CTTTTAACAG ATCGTAATTT TAATACTTCC TTTTTTGACC
Cochlitoma marinae         TAGCAGGTGC AATCACAATG CTCTTGACTG ATCGGAATTT TAATACTTCC TTTTTTGATC
Cochlitoma churchilliana   TGGCAGGGGC GATTACTATA CTGCTTACTG ACCGGAATTT TAATACCTCT TTTTTCGACC
Cochlitoma granulata       TAGCTGGGGC TATTACTATA CTTTTAACAG ATCGCAATTT TAACACCTCG TTCTTTGACC
Cochlitoma simplex         TGGCCGGGGC TATTACTATG CTTCTAACAG ACCGAAATTT TAATACTTCA TTCTTTGACC
Cochlitoma kilburni        TAGCAGGGGC TATTACCATA CTTCTGACAG ACCGTAATTT TAATACTTCT TTTTTTGATC
Cochlitoma montistempli    TGGCAGGAGC TATTACTATG CTTTTAACAG ATCGAAATTT TAACACTTCC TTCTTTGATC
Cochlitoma omissa          TAGCAGGGGC TATTACTATA CTTTTAACAG ACCGAAATTT TAACACCTCG TTCTTCGACC
Cochlitoma semidecussata   TAGCAGGGGC TATTACTATA CTTTTAACGG ATCGGAATTT CAACACTTCA TTTTTTGATC
Cochlitoma ustulata        TAGCAGGGGC TATTACAATA CTCCTTACTG ATCGTAATTT TAACACATCC TTTTTCGACC
Cochlitoma zebra           TAGCGGGGGC TATTACCATA TTATTAACAG ATCGAAATTT TAATACATCT TTTTTTGATC
Metachatina kraussi        TAGCTGGAGC TATTACTATA CTTCTTACTG ATCGAAATTT TAATACTTCT TTTTTTGACC
Rumina decollata           TAGCAGGAGC TATTACAATA CTACTAACTG ACCGTAACTT TAACACTTCA TTCTTTGATC
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                            ....|....| ....|....| ....|....| ....|....| .
                                    610        620        630        640
Achatina fulica             CAGCTGGAGG GGGGGACCCA GTCCTGTACC AGCACCTATT T
Achatina immaculata         CAGCAGGGGG TGGTGATCCA ATTTTATACC AACATTTATT T
Achatina reticulata         CTGCTGGAGG TGGGGATCCG GTCTTATATC AACACTTGTT T
Achatina zanzibarica        CAGCGGGAGG GGGAGACCCA ATTTTGTATC AGCACTTGTT T
Achatina achatina           CAGCTGGAGG TGGTGATCCA GTGCTTTACC AGCACCTATT C
Archachatina marginata      CGGCGGGAGG TGGGGACCCT ATTCTTTATC AGCATTTGTT T
Achatina bisculpta          CTGCTGGAGG GGGTGATCCT GTCTTGTATC AACACTTGTT T
Achatina damarensis         CTGCCGGTGG TGGTGACCCG ATTTTATATC AACATTTATT T
Achatina stuhlmanni         CGGCAGGGGG TGGTGATCCA ATCCTATACC AGCAYCTATT C
Atopocochlis exarata        CGGCAGGGGG TGGTGACCCT GTGCTATATC AACATTTGTT T
Limicolaria kambeul         CTGCAGGCGG CGGGGATCCT ATTTTGTATC AGCACTTATT C
Limicolaria martenssii      CAGCTGGAGG GGGGGATCCT ATTCTTTATC AGCATTTATT C
Limicolariopsis sp.         CTGCAGGAGG AGGGGATCCA GTCTTATATC AACATTTATT T
Cochlitoma varicosa         CGGCCGGGGG GGGTGACCCT ATTCTATATC AGCATCTATT C
Cochlitoma dimidiata        CAGCTGGAGG TGGGGACCCT ATCTTGTACC AGCACCTCTT C
Cochlitoma sp. cf. vestita  CGGCTGGGGG AGGCGATCCT ATTTTGTATC AACATCTCTT T
Cochlitoma marinae          CTGCAGGAGG TGGGGACCCT ATTTTATACC AGCATTTATT T
Cochlitoma churchilliana    CTGCAGGAGG GGGAGACCCG ATTTTGTACC AACACCTTTT C
Cochlitoma granulata        CAGCTGGTGG TGGGGACCCT ATTTTATATC AGCACCTTTT T
Cochlitoma simplex          CAGCTGGAGG TGGAGACCCT ATTCTATACC AGCACCTCTT T
Cochlitoma kilburni         CAGCTGGTGG TGGTGACCCT ATTTTATACC AACATCTCTT T
Cochlitoma montistempli     CGGCTGGTGG AGGTGATCCC ATTTTATATC AACATCTTTT T
Cochlitoma omissa           CAGCTGGTGG TGGGGACCCT ATTTTATATC AGCACCTTTT T
Cochlitoma semidecussata    CTGCTGGGGG TGGTGATCCT ATTTTATATC AACACCTTTT C
Cochlitoma ustulata         CGGCAGGGGG AGGAGATCCT ATCTTGTATC AGCATCTCTT C
Cochlitoma zebra            CGGCTGGAGG GGGWGAYCCA ATCTTATACC AACATCTATT T
Metachatina kraussi         CTGCAGGAGG CGGAGATCCT ATTTTATATC AGCATCTTTT T
Rumina decollata            CTGCAGGGGG AGGTGATCCA ATTCTATATC AGCATTTATT T
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Appendix 4.5: Alignment of the 16S rRNA gene for the Achatinidae and the subulinid outgroup *Rumina decollata*. Positions included for the phylogeny analyses were marked by "`m`" within "`NUCEOTIDES INCLUDED`". Note that sequencing was unsuccessful for *Limicolariopsis ruwenzoriensis*.

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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                     10         20         30         40         50         60
Achatina fulica             TAGCTTAAAG A-GTGCGTAA CACAGATTTT AAGTAACCCC TGCCCGGTGA GTTATAGA--
Achatina immaculata         TAGTTTAAAG AA----ATTA AAAAGATTTT AAGTGATCCC TGCCCGGTGA GTAAAA----
Achatina reticulata         TAGCTTAAAG CG----TWCC TAAAGATTTT AAGTAATCTC TGCCCGGKGA GTTAC-----
Achatina zanzibarica        TAGCTTAAAG GA------CC AAAMCATTTT AAGTAACCCC TGCCCGGTGG GCTGT-----
Euaethiopina loveridgei     CAGCTTGAAG TT-----TAA AAAAGATTTT AAGTGATCCC TGCCCGGTGA GATTTGTT--
Achatina achatina           TAGCTTTAGG A--------- TTTAAATCTT TAGTACCTCC TGCCCAGTGA TAGGTTAC--
Archachatina marginata      TAGCTCTAGG A--------- CTTAAATCTT GAGTACACCC TGCCCAGTGA CAATTT----
Achatina bisculpta          TRGKTARTAG T--------- TTATGATTAT TAGTGGATCC TGCCCAGTGG AATTTTAA--
Achatina damarensis         TAGCCAGTAG C------TAG CTAGGATTGC TGGTGGATCC TGCCCAGTGG AAAATTCTC-
Achatina stuhlmanni         TAGCTAATAG G---CTCTTT CCATAATTAT TAGTGGACCC TGCCCGGTGA AGTTAA----
Atopocochlis exarata        TAGCTAAAAG T--------- -AGAAATTTT TAGTGTGTCC TGCCCACTGG GTTCC-----
Limicolaria kambeul         TAGCTAATAG A--------- -ATAGATTAT TAGTATTCCC TGCCCAGTGA AAATATTTCA
Limicolaria martenssii      TAGCTAATAG C-----ATTT TATATATTGT TAGTGTGTCC TGCCCAGTGG AGAACAATA-
Limicolariopsis sp.         TAGYTGGAAC G-------TT AGARATTTTT CAGTATATTC TGCCCAGTGA GATAAT----
Cochlitoma varicosa         TAGCTTAAAG T--------- AATTTATCTT AAGTGGTCCC TGCCCGGTGA AAGTT-----
Cochlitoma dimidiata        TAGCTKGAAG A--------A GTTTGATTTT AAGTGACCCC TGCCCAGTGG TAAAATC---
Cochlitoma sp. cf. vestit   TAGCTTGAAG T--------- TTTTCCTTTT AAGTGGTCCC TGCCCGGTGG ATTAA-----
Cochlitoma marinae          TAGCTTAAGG G--------T ATTAGGTYTT AAGTAGTCCC TGCCCGGTGG TAATAA----
Cochlitoma churchilliana    TAGCTTAAAG T-----TCTA AGTCTATTTT AAGTAGTCCC TGCCCGGTGA GTAGAGAAA-
Cochlitoma granulata        TAGCTTGAGA G--------T ACTTTATTTC AAGTGTCCCC TGCCCAGTGA ACAATAA---
Cochlitoma simplex          TAGCTTGAAG C-------AC ATTTGATTTT AAGTGACCCC TGCCCGGTGG CGCAGTAGCT
Cochlitoma kilburni         TAGCTTGAAG T--------- TTTTCGTTTT AAGTGATCCC TGCCCGGTGG TGTAA-----
Cochlitoma montistempli     TAGCTTGAGA G--------T ATTTTATTTT AAGTGTCCCC TGCCCAGTGA TAATTA----
Cochlitoma omissa           TAGCTTGRGA G--------T ACTTCATTTC AAGTGTCCCC TGCCCAGTGA TCAATAA---
Cochlitoma semidecussata    TAGCCTAAGA G--------T GCTTTATTTT AGGTGTCCCC TGCCCAGTGA TAATTA----
Cochlitoma ustulata         TAGCCTGCTG T--------A GATTTATTAC AGGTGATCCC TGCCCGGTGG GGCCTATT--
Cochlitoma zebra            TAGCTTTAAG T--------- AATTCATTTT AAGTGGTCCC TGCCCGGTGA GAATC-----
Metachatina kraussi         TTGCTTGAAG T------AGT ATTTTATTTT AAGTAATCCC TGCCCGGTGG GATAATA---
Rumina decollata            ---------- ---------- -------TTT AGGTAACCCC TGCCCAGCGA TATAT-----
NUCLEOTIDES INCLUDED        ---------- ---------- -------mmm mmmmmmmmmm mmmmmmmmmm m---------


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                     70         80         90        100        110        120
Achatina fulica             ---AACTTTA ACGGCCGCAG TACCTTGACT GTGCAAAGGT AGCATAATAA TTTGTCCTCT
Achatina immaculata         ---TATTTTA ACGGCCGCAG TACCCTGACT GTGCAAAGGT AGCATAATAA TTTGTCCTTT
Achatina reticulata         ---TACTTTA ACGGCCGCAG TACCTTGACT GTGCAAAGGT AGCATAATAA TTTGTCCTTT
Achatina zanzibarica        ---GGCTTAA ACGGCTGCAG TACCCTGACT GTGCAAAGGT AGCATAATAA TTTGTCCTAT
Euaethiopina loveridgei     ---TTCTTTA ACGGCCGCAG TACCTTGACT GTGCTAAGGT AGCATAATAA TTTGTCCTTT
Achatina achatina           ---CTATTTA ACGGCCGCAG TACCTTGACT GTGCAAAGGT AGCATAATAA TTTGTCCCTT
Archachatina marginata      ---TGACTTA ACGGCCGCAG TACCTTGACT GTGCTAAGGT AGCATAATAA TTTGTCCTTT
Achatina bisculpta          ---ATTCTTA ACGGCCGCAG TACCCTGACT GTGCTAAGGT AGCATAATGA TTTGTCCTTT
Achatina damarensis         ---ATTCTTA ACGGCCGCAG TACCCTGACT GTGCTAAGGT AGCATAATAA TTTGTCCTTT
Achatina stuhlmanni         ---CCTTTTA ACGGCCGCAG TACCCTGACT GTGCTAAGGT AGCATAATAA TTTGTCCTTT
Atopocochlis exarata        ---CTCCTTA ACGGCCGCAG TACTTTGACT GTGCTAAGGT AGCATAATAA CTTGTCCTTT
Limicolaria kambeul         TAGATTTTTA ACGGCCGCAG TACCCTGACT GTGCAAAGGT AGCATAATAA TTTGTCCTTT
Limicolaria martenssii      ---TACCTAA ACGGCCGCAG TACCTTGACT GTGCAAAGGT AGCATAATCA TTTGTCCTTT
Limicolariopsis sp.         ---ATCTTTA ACGGCCGCRG TACCCTGACT GTGCTAAGGT AGCATAATAA TTTGTCCCTT
Cochlitoma varicosa         ---AGTTTTA ACGGCCGCAG TACCCTGACT GTGCAAAGGT AGCATAATAA CTTGTCCTTT
Cochlitoma dimidiata        ---ACCCTAA ACGGCCGCAG TACCTTGACT GTGMTAAGGT AGCATAATAA TTTGTCCTTT
Cochlitoma sp. cf. vestit   ---AACCTAA ACGGCCGCAG TACCTTGACT GTGCAAAGGT AGCATAATAA TTTGTCCTTT
Cochlitoma marinae          ---ACTCTAA ACGGCCGCAG TACCTTGACT GTGCAAAGGT AGCATAATAA CTTGTCCYTT
Cochlitoma churchilliana    ---TACTTCA ACGGCCGCAG TACCCTGACT GTGCAAAGGT AGCATAATAA TTTGTCCTTT
Cochlitoma granulata        ---ACCTTAA ACGGCCGCAG TACCTTGACT GTGCAAAGGT AGCATAATAA TTTGTCCTTT
Cochlitoma simplex          ---GCCCTAA ACGGCCGCAG TACCTTGACT GTGCTAAGGT AGCATAATAA CTTGTCCTTT
Cochlitoma kilburni         ---AACCTAA ACGGCCGCAG TACCTTGACT GTGCAAAGGT AGCATAATAA TTTGTCCTTT
Cochlitoma montistempli     ---ACCTTAA ACGGCCGCAG TACCTTGACT GTGCAAAGGT AGCATAATAA CTTGTCCTTT
Cochlitoma omissa           ---ACCTTAA ACGGCCGCAG TACCTTGACT GTGCAAAGGT AGCATAATAA TTTGTCCTTT
Cochlitoma semidecussata    ---ACCTTTA ACGGCCGCAG TACCTTGACT GTGCAAAGGT AGCATAATAA CTTGTCCTTT
Cochlitoma ustulata         ---ACCCTAA ACGGCCGCAG TACCTTGACT GTGCAAAGGT AGCATAATCA CTTGTCCTTT
Cochlitoma zebra            ---AGTTTTA ACGGCCGCAG TACCTTGACT GTGCAAAGGT AGCATAATAA CTTGTCCTTT
Metachatina kraussi         ---AACCTAA ACGGCCGCAG TACCTTGACT GTGCAAAGGT AGCATAATAA TTTGTCCTTT
Rumina decollata            ---AAGTTTA GCGGCCGCAG TACTTTGACT GTGCTAAGGT AGCATAATAA CTTGTCCTTT
NUCLEOTIDES INCLUDED        -----mmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    130        140        150        160        170        180
Achatina fulica             AATTAAGGTC TGGAATGAAG GGGGACA--C AGGGGAG-AG CTGTCTCCAA TAAGGTTAAT
Achatina immaculata         AATTGAGGTC TAGTATGAAT GGGTTCA--C AGGGGAA-AG CTGTCTCAAG GGAGATTAAT
Achatina reticulata         AATTTAGGTC TGGAATGAAT GAGAACA--C AGGGGAG-AG CTGTCTCTAG WARGGTTAAC
Achatina zanzibarica        AATTGAGGTC TGGTATGAAT GGGTTCA--C GGGGGAA-AC CTGTCTTTAT TAAGGTAACC
Euaethiopina loveridgei     AATTGAGGTC TGGTATGAAT GGGGGTA--C GGGCGGG-TG CTGTCTTTAC TAAAGGTTAC
Achatina achatina           AATTAGGGTC TGGTATGAAA GGATTTT--C GGGAGTT-TA CTGTCTTAGT GAGGTTAATA
Archachatina marginata      AATTGAGGTC TGGAATGAAT GGGCTAC--C GGGGGTT-GG CTGTCTGCTA -AAGGATAAT
Achatina bisculpta          AATTAAGGTC TTGTATGAAA GGGGGAA--C GGGGGGT-AA CTGTCTCTAA GGGGTTTCAG
Achatina damarensis         AATTAAGGTC TTGTATGAAA GGGAGAA--C GGGGGAT-AA CTGTCTCTTA TGGGGTTTAA
Achatina stuhlmanni         AATTAAGGTC TTGCATGAAT GGGTGTT--C GAGGAGT-CG CTGTCTTTAT TAGGGTTTAA
Atopocochlis exarata        GATTGGGGTC TAGAATGAAT GGATGAT--T GGGGGAA-AA CTGTTTCTTT CATGTTAATA
Limicolaria kambeul         AAATGAGGTC TTGTATGAAT GGGATAA--C GGGGGGT-AG CTGTCTTATT ATAGTTTCTT
Limicolaria martenssii      AAATGAGGTC TTGTATGAAA GGATTAA--C GGGGGAG-AG CTGTCTTATC TATAAAAAAC
Limicolariopsis sp.         AATTAGGGTC TAGAATGAAA GAACGCA--C GATATAA-AG CTGTCTCAAA ATGGGTTATT
Cochlitoma varicosa         AATTGGGGTC TAGTATGAAT GGGTTAA--C GGGTATT-AG CTGTCTCAGG GGGGTCTTAT
Cochlitoma dimidiata        AATTGAGGTC TGGAATGAAC GGGTTAGA-C GAATGTT-AG CTGTCTTATG TTAGGTCTTA
Cochlitoma sp. cf. vestit   AATTGAGGTC TGGAATGAAT GGGTTAAA-C GAGTATT-AG CTGTCTTATG TTGGTTAATG
Cochlitoma marinae          AATTGAGGTC TAGAATGAAT GGGAAAAG-C GGGTGAT-AG CTGTCTTAAG TCAGTTTTTA
Cochlitoma churchilliana    AATTAAGGTC TGGTATGAAT GGGTTAA--C GGGTGTT-GA CTGTCTCAGG GATTGATATT
Cochlitoma granulata        AATTGAGGTC TGGTATGAAT GGGTTAGA-C GGGTATA-AG CTGTCTTAAT TTGGTTATCT
Cochlitoma simplex          AATTGAGGTC TAGAATGAAT GGGTTAAAAC GGGTGTT-AG CTGTCTCGCG TTGGGTTTTT
Cochlitoma kilburni         AATTGAGGTC TGGAATGAAT GGGTTTAA-C GGGTGTT-AG CTGTCTCATG CTGGTTAATG
Cochlitoma montistempli     AATTGAGGTC TGGAATGAAT GGGTTAGA-C GGGTATA-AG CTGTCTTAAT TTGGTTATCT
Cochlitoma omissa           AATTGAGGTC TGGAATGAAT GGGTTAGA-C GGGTATG-AG CTGTCTTAAT TTGGTTATTT
Cochlitoma semidecussata    AATTGAGGTC TGGAATGAAT GGGTTAGA-C GGGTATA-AG CTGTCTTAAT TTGGTTATCC
Cochlitoma ustulata         AATTGAGGAC TGGAATGAAA GGGAAGAAAC GGGTATG-AG CTGTCTCTAG TTAGCTCTTT
Cochlitoma zebra            AATTGAGGTC TGGAATGAAT GGGTTTAA-C GGGTAAA-AG CTGTCTTAGG AAGGTCTTAT
Metachatina kraussi         AATTGAGGTC TGGAATGAAT GGGAAAA--C GGGTATA-AG CTGTCTCAAG CTATTTTTGT
Rumina decollata            AATTGAGGTC TTGAATGAAC GGGTTTA--C GAAAAATGTT CTGTCTCCTG TACAAATTTT
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmmmmmmmm mmm------m mmm------m mmmmmmmm-- ----------


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                                    190        200        210        220        230        240
Achatina fulica             T--TAACTTT C-TTATCAGG TGAAAATTCC TGAGCCT-CC GATGAAAGAC GAGAAGACCC
Achatina immaculata         C--TAATTTA C-TTATCAGG TGAAAATTCC TGAGGAT-AA AAGGAAAGAC GAGAAGACCC
Achatina reticulata         T--TAACTTC C-TTATCAGG TGAAAATTCC TGAGCTT-CT TTGGAAAGAC GAGAAGACCC
Achatina zanzibarica        T--AAATTTG C-TTATCAGG TGAAAATTCC TGAATTTATA AAGGAAAGAC GAGAAGACCC
Euaethiopina loveridgei     CT-AAACTTA C-TTATCAGG TGAAAATTCC TGAACTT-TT AAGGAAAGAC GAGAAGACCC
Achatina achatina           T--GAATTTA C-TCAATAAG GTGAAAATTC CTTAAAATTA GATAAAAGAC GAGAAGACCC
Archachatina marginata      TT-GAATTTG C-TTATAAGG TGAAAATTCC TTTAATTATA GATAAAAGAC GAGAAGACCC
Achatina bisculpta          T--GAATTTC C-TCAGGAGG TGAAAATTCC TCTGATATTT GACAAAAGAC GAGAAGACCC
Achatina damarensis         T--AAATTTA C-TTAAGAGG TGAAAATTCC TCTAATT-GT GACAAAAGAC GAGAAGACCC
Achatina stuhlmanni         TT-AAATTTA C-TCAAGAGG TGAAAATTCC TCTAAATTAA GATAAAAGAC GAGAAGACCC
Atopocochlis exarata        T--TAACTTA C-TTAAAAGG TGAAAATTCC TTTAGTT-AA GAAAAAAGAC GAGAAGACCC
Limicolaria kambeul         T--GAACTTA CTAAATTAGG TGAAAAATCC TACACTTATA TACAAAAGAC GAGAAGACCC
Limicolaria martenssii      ---GAAATTA CTTAATTAGG TGAAAACTCC TATAAAT-AA GAAAAAAGAC GAGAAGACCC
Limicolariopsis sp.         TT-TAATTTG C-TAAAGAGG TGAAAATTCC TTTAATTTTT TATAAAAGAC GAGAAGACCC
Cochlitoma varicosa         T--TAATTTA T-TTAGAAGG TGAAAATACC TTTAAATTTA TATAGTAGAC GAGAAGACCC
Cochlitoma dimidiata        T--TAACTTA A-TTAGAAGG TGAAAACTCC TTTATGTATT ATTAGAAGAC GAGAAGACCC
Cochlitoma sp. cf. vestit   C--TAACTTA A-TTAGAAGG TGAAAATGCC TTCATATTTT AATAGAAGAC GAGAAGACCC
Cochlitoma marinae          T--TAATTTA A-TTAGGGGG KGAAAATTCC CCTATTCCTA AACAGTAGAC GAGAAGACCC
Cochlitoma churchilliana    ATTGAATTTA A-TCATAAGG TGAAAATGCC TTTACTTATT AACAGAAGAC GAGAAGACCC
Cochlitoma granulata        T--AAATTTA A-TTAAAAGG TGAAAATTCC TTTAAAATAA GATAGAAGAC GAGAAGACCC
Cochlitoma simplex          T--TAACTTA ATCTAGAAGG TGAAAACTCC TTCAAGAATA GACAGAAGAC GAGAAGACCC
Cochlitoma kilburni         T--CAACTTA A-TTAGAAGG TGAAAATACC TTCATGTTTA AATAGAAGAC GAGAAGACCC
Cochlitoma montistempli     T--AAACTTA A-TTAGAAGG TGAAAATTCT TTTAATATAT TACAGAAGAC GAGAAGACCC
Cochlitoma omissa           T--AAATTTA A-TTAAAAGG TGAAAATTCC TTTAAAGTGA AATAGAAGAC GAGAAGACCC
Cochlitoma semidecussata    T--GAACTTA A-TGAAAAGG TGAAAATTCC TTTAAGT-GT TACAGAAGAC GAGAAGACCC
Cochlitoma ustulata         T--AAATTTA A-TTGTTAGG TGAAAATACC TATACCT-TT AACAGAAGAC GAGAAGACCC
Cochlitoma zebra            T--TAACTTA A-TTAGAAGG TGAAAATCCC TTTAAGTATA AAAAGTAGAC GAGAAGACCC
Metachatina kraussi         T--GAACTTA CTTTAGAAGG TGAAAATACC TTTGTTT-TA GTTAGAAGAC GAGAAGACCC
Rumina decollata            ACTGAACTTA C-TTAAGAGG TGAAAATTCC TTTAGTA-AT GAAAAAAGAC GAGAAGACCC
NUCLEOTIDES INCLUDED        ---mmmmmmm m-mmmmmmmm mmmmmmmmmm mmm------- mmmmmmmmmm mmmmmmmmmm
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                   250        260        270        280        290        300
Achatina fulica             TTAGAGTTTT TATTATAACT TGATA----- TATTAAGATT CTTGTTCTGT TTTTGTTGGG
Achatina immaculata         TTAGAGCTTT TATGAAAATT TGAGA----- AGTTACTAAT CTAATATCGT TTTTGTTGGG
Achatina reticulata         TTAGAGTTTT AATAATTATT TAGAT----- AAATAAAATT CTACTATTGT TTTTGTTGGG
Achatina zanzibarica        TTAGAGTTTT CATTAAAGCC TAGGA----- --GTAATAGC ATGGTTATGT TTTTGTTGGG
Euaethiopina loveridgei     TTAGAGTTTT TACTACAACT AGAAA----- -TGTCATATT CTAGTATTGT TTTTGTTGGG
Achatina achatina           TTGGAGTTTT TATTATATAG ATAGA----- ---------- TTCTATTCTT TTTCGCTGGG
Archachatina marginata      TTGGAATTTT AAGGAATTTG TAAGC----- ---------T TTACATAAAT TTTCGCTGGG
Achatina bisculpta          TTAGAGCTTT AATAAAAGGT AAATC----- ----ACTATT TTACTTAAGT TTTTGTTGGG
Achatina damarensis         TTAGAGCTTT TACAAAAAGT AGACAAGTAG TGTACTATTT CTACTTAAGT TTTTGTTGGG
Achatina stuhlmanni         TTAGAGTTTT AATGAAAAGT AAAC------ ---------T TTACTTAAGT TTTTGTTGGG
Atopocochlis exarata        TTAGAAATTT GTAGAAAATG CAAAT----- -----TCAAT TTGCTTACTT TTGTGTTGGG
Limicolaria kambeul         TATGAGTTTT TATGAATAAA TGAAA----T CATATTTTAT CATACTAAGT TTTTGTTGGG
Limicolaria martenssii      TAAGAGTTTT AATGAGAATA CTATT----- AGGTAATTAA ATAGAGAAGT TTTTGTTGGG
Limicolariopsis sp.         TAAGAGCTTT TAATAATCTA AATAT----- -AAAAATTTA TATTTAAAGT TTTTGTTGGG
Cochlitoma varicosa         TTAGAGTTTC CATGAAAGAG TATAA----- ---TCTTTAT ATATCTAAGT TTTCGTTGGG
Cochlitoma dimidiata        TTAGAGTTTT AATGAAACAA TATAT----- TTTACAATTG TATTTTTAGT TTTCGTTGGG
Cochlitoma sp. cf. vestit   TTAGAGTTTA AAATGAATAA ATATT----A ATCTTACGAT TATTTTGAGT TTTCGTTGGG
Cochlitoma marinae          TTAGAGTTTT TATGAAAGTA GTCTA--AGG TTATCTAGTA TACTACTAGT TTTCGTTGGG
Cochlitoma churchilliana    TTAGAGTTTT TATGAAGAAG TTATA--TAT ATATCAAATA AGCTTTAAGT TTTCGTTGGG
Cochlitoma granulata        TTAGAGTTTT TATAAATAAA TATAG---AA CAGATGAGTT ATATTTTAGT TTTTGTTGGG
Cochlitoma simplex          TTAGAGTTTT AATGAAATAA TATAG----- TTTAAAGTAG TGTTTTCAGT TTTCGTTGGG
Cochlitoma kilburni         TTAGAGTTTT AAATGAATAA ATACT----A ATATTATAAT TATTTTTAGT TTTCGTTGGG
Cochlitoma montistempli     TTAGAGTTTT TATAAATAAA TATAG----A ACAATAAGTT GTATTTCAGT TTTTGTTGGG
Cochlitoma omissa           TTAGAGTTTT TATAAACAAA TGTAG----A ACAATGAGTT ATATTTTAGT TTTTGTTGGG
Cochlitoma semidecussata    TTAGAGTTTT TATAAATAAA TGTAG----A ACAATGCGTT GTATTTTAGT TTTTGTTGGG
Cochlitoma ustulata         TTAGAGTTTT TATGATAAGC ATTCT----- -----ACATA TGCTGTCAGT TTTCGTTGGG
Cochlitoma zebra            TTAGAGTTTT TATAAGAATA TATAA----- ---CTTTTTT ATATTTTAGT TTTCGTTGGG
Metachatina kraussi         TTAGAGTTTT TATAAAAATA TATGG---TA ATTATTTAAA TATATTGAGT TTTCGTTGGG
Rumina decollata            TTAGAATTTT AATAAAAACT GTCAT----- ----TGCGTG ATTGTTTAGT TTTCGTTGGG
NUCLEOTIDES INCLUDED        mmmmmmmmmm m--------- ---------- ---------- -------mmm mmmmmmmmmm
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                                   310        320        330        340        350        360
Achatina fulica             GCGACAGGGT TACA------ ---------A TAGATAACTT ACCCTACCAT A--TTTTTAT
Achatina immaculata         GCGACAGGGT AGCA------ ---------- TATTAAACCT ACCTGATCTT T--AAAGTAT
Achatina reticulata         GCGACAGGGT AACA------ --------AT AGGTAAACTT ACCCATTCAT ATATTTTTAT
Achatina zanzibarica        GCGACGGGGT TACA------ ---------- GTTTGAACTC ACCTAGAATA C-TTCCTGTT
Euaethiopina loveridgei     GCGACAGGGT GACA------ ---------A TAATTAACTT ACCAACACAA TATTATATAT
Achatina achatina           GCAGCGAGAT TACA------ ---------- ----TCTTTA CTTTTAATTA ATCTTTACTT
Archachatina marginata      GCGGCGAGAC TACA------ -----AGGTT TCATTAACTA GTCTTACATT ATAATTTGGT
Achatina bisculpta          GCAACAAGAT GGCA------ -AATGAAAAT AAACCCATCT AATATTCCTA TTTTATTTGA
Achatina damarensis         GCAACAAGAT GGCA------ -----AAGTT TAACCCATCC A-TATTCTAT GTTAATTTGA
Achatina stuhlmanni         GCAACAAGAT GGCAAAAATT AGTAATACTT AAACCCATCT AATTTTCTAA AGTGAATCAG
Atopocochlis exarata        GCAACAGAAT GGCA------ ----AATATA TAACCCATTT AAAACTTAAG CTTAAATCTA
Limicolaria kambeul         GCAACAAGAT ATCA------ ---------- AGATTAATAT ATCTTTATTA TAGTAAATAA
Limicolaria martenssii      GCAACAGAAT TCCA------ ---------- GATTAAATGA ATTTATCTAT ATTATATTAT
Limicolariopsis sp.         GCAACAAGAT ATCA------ --------AA AAGTTAACAT ATCTGTTTTT CTTGAATACA
Cochlitoma varicosa         GCAACGGGGT CGTA------ ---------- AAGTTAACCG ACCTGTATAG ATGGTAAATG
Cochlitoma dimidiata        GCAACGGAAT CGCA------ ---------G TGTTTAACCG GTTTAA--AA GTAATACACA
Cochlitoma sp. cf. vestit   GCAACGGAGT CGCA------ ---------A TATTTAACCG GCTAACGAAA TAAACTAAGA
Cochlitoma marinae          GCAACGGATC TGCA------ --------AT TAGTTAAACA GATTAATTTG TTTAGGGTTT
Cochlitoma churchilliana    GCAACGGGGT AGCA------ ---------- ATATTAACCT ACTTGTTAGG GAAGTAATAA
Cochlitoma granulata        GCAACAGGTT CGCA------ ---------A GCATAAACCG AATTATTTAG TAACTAACAT
Cochlitoma simplex          GCAACGGAAC CGCA------ --------GA GCTTGAACCG GTTTAATAAA TAATGCATAT
Cochlitoma kilburni         GCAACGGAAT CGCA------ ---------A TACTTAACCT GTTAACGAAA TAAACTAATA
Cochlitoma montistempli     GCAACGGAAT CGCA------ ---------A ATACTAACCG ATTTATCAAA TAATTAATGA
Cochlitoma omissa           GCAACAGTTT CGCA------ ---------A GCATAAACCG AATTATTTAG TAACTAACAT
Cochlitoma semidecussata    GCAACAGAAT CGCA------ ---------A ATATTAACCG ATCTAT-TAA TACCTAGTGG
Cochlitoma ustulata         GCAACGAGAT TGCA------ --------TG AAATAAACCA ATCAT--ACG TTAATAGTAG
Cochlitoma zebra            GCAACGGGGT CGAA------ ---------- AAATTAACCG ATCAAAAAAT TTATTAATAA
Metachatina kraussi         GCAACGAGAT TTCA---TTA TTTTAATATA TCTGTATAAA ATTTTATC-- ----------
Rumina decollata            GCGACGAGGT AGCA------ --------AT CAAATAACCT ACCTATTAAT ATTTAATACA
NUCLEOTIDES INCLUDED        mmmmmmmmmm mmmm------ ---------- ---------- ---------- ----------
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                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    370        380        390        400        410        420
Achatina fulica             ATGGCGATCA TTATACTTT- ---------- ---TAATTAA GCTACCTAAG GGATAACAGC
Achatina immaculata         ATACCGATGG TAATATTAA- ---------- ---CACGAAA GCTACCTAAG GGATAACAGC
Achatina reticulata         GCGTCGATAG TTATACTAA- ---------- ---TAATTAA ACTACCTAAG GGATAACAGC
Achatina zanzibarica        TTGACGACTT TCTTACCTA- ---------- ---TAATAAA ACTACCTAAG GGATAACAGC
Euaethiopina loveridgei     CCAGCGATTA TTATACTAG- ---------- ---TAAATAA GCTACCTAAG GGATAACAGC
Achatina achatina           ATCTAAACAT TTGCCAAGTA TTTATCCTAA GAAAAACTAA ACTACCCAAG GGATAACAGC
Archachatina marginata      CAAGTTTATT AAGAA----- ---------- ---GAATTAA ATTACCCAAG GGATAACAGC
Achatina bisculpta          AGAGG-TTTC TAAGAG---- ---------- ---TAGTTAA GCTACCTAAG GGATAACAGC
Achatina damarensis         AGAGTTGTTT TAAGAG---- ---------- ---TAGATAA GCTACCTAAG GGATAACAGC
Achatina stuhlmanni         TCAATTATTA TAAGAA---- ---------- ---CAGAAAA ACTACCTAAG GGATAACAGC
Atopocochlis exarata        CTAGTTAATT TTAATAAGAA ---------- ---TGAAGAA TTTACCTAAG GGATAACAGC
Limicolaria kambeul         ATCGATTATG ATAATGG--- ---------- ---AAACTAA ACTACCTTAG GGATAACAGC
Limicolaria martenssii      AAGAAGAAAG GTAATAAGAA ---------- ---AAAATAA GCTACCTTAG GGATAACAGC
Limicolariopsis sp.         TACCGACTAG TTAGTATAAA ---------- ---TGATCAA GCTACCTTAG GGATAACAGC
Cochlitoma varicosa         TATATGCCAA TTTTTATAAG AA-------- ---TAATTAA ACTACCTAAG GGATAACAGC
Cochlitoma dimidiata        TATATGACCA TTTTTAAAAG AA-------- ---TAAGTAA ACTACCTAAG GGATAACAGC
Cochlitoma sp. cf. vestit   GATTTGCCAA TATTAATAAG AA-------- ---TAAGAAA ACTACCTAAG GGATAACAGC
Cochlitoma marinae          TATCTGCCAA TTTATTATAA GGG------- ---TAAATAA ACTACCTAAG GGATAACAGC
Cochlitoma churchilliana    ACA-TGCGTC AATATTTTAT TCGTT----- ---TAACAAA ACTACCTAAG GGATAACAGC
Cochlitoma granulata        ATA-TGACAA TTCCTATAAG AA-------- ---TAAGTAA ACTACCTAAG GGATAACAGC
Cochlitoma simplex          ATT-TGTCCA CTTTCAAAAG AA-------- ---TAAGTAA ACTACCTAAG GGATAACAGC
Cochlitoma kilburni         CATTTGCCAA TATTAATAAG AA-------- ---TAAGAAA ACTACCTAAG GGATAACAGC
Cochlitoma montistempli     ATA-TGACAA TTCGTATGAG AG-------- ---TAAATAA ACTACCTAAG GGATAACAGC
Cochlitoma omissa           ATA-TGACAA TTTATATAAG TA-------- ---TAAGTAA ACTACCTAAG GGATAACAGC
Cochlitoma semidecussata    ATA-AGACAA TTCGAATAAG AA-------- ---TAAGCAA ACTACCTAAG GGATAACAGC
Cochlitoma ustulata         ATA-AGTCAA TCTTAATAGG TA-------- ---TAATTAA ACTACCTAAG GGATAACAGC
Cochlitoma zebra            AATTTGATAA TCTTTATAAG AA-------- ---TAATTAA ACTACCTAAG GGATAACAGC
Metachatina kraussi         ----TGCCAA TTATTCTATA AA-------- ---CAAGTAA GCTACCTAAG GGATAACAGC
Rumina decollata            CCGAAATCTA TTAAACA--- ---------- ---TAATTAA ATTACCTAAG GGATAACAGC
NUCLEOTIDES INCLUDED        ---------- ---------- ---------- ---mmmmmmm mmmmmmmmmm mmmmmmmmmm


                            ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                    430        440        450        460        470        480
Achatina fulica             GTAATCTTTT T--TTTTGGT TTGCGACCTC GATGTTGGAC TAGGGGCCTA CTGGTTAGTT
Achatina immaculata         GTAATCTTTG ---TTATGGT TTGCGACCTC GATGTTGGAC TAGGAACCCT TTGGTTAGTT
Achatina reticulata         GTAATCTTTT T--TTTTGGT TTGCGACCTC GATGTTGGAC TAGGGGCCTA CTGGTTAGCA
Achatina zanzibarica        GTAATCTAAA ---AGTAGGT TTGCGACCTC GATGTTGGAC TAGGGTCCAC TTGGTTAGCC
Euaethiopina loveridgei     GTAATCTTTT ---TTAAGGC TTGCGACCTC GATGTTGGAC TAGGGACCTG TTGGTTAGTT
Achatina achatina           ATAATTCCTT ---AGGGAGA TTGTGACCTC GATGTTGGAC TAGGGCTCTA TTGGTTAACT
Archachatina marginata      ATAATTCCCA ---ATGGAGT TTGTGACCTC GATGTTGGAC TAGGGCCCTT ATGATTAACT
Achatina bisculpta          GTAATCTAAA ATGTTTAGGA TTGCGACCTC GATGTTGGAC TAGGGACCAA ATGATTAGAT
Achatina damarensis         GTAATCTAAT AG-TTTAGGA TTGCGACCTC GATGTTGGAC TAGGGACCAA ATGATTAGAT
Achatina stuhlmanni         GTAATCTAAT ---ATTAGGA TTGCGACCTC GATGTTGGAC TAGGGACCTA ATGATGAGAT
Atopocochlis exarata        GTAATCTAGC ---ATTAGGA TTACGACCTC GATGTTGGAC TAGGGACCAA ATGATAAGAT
Limicolaria kambeul         GTAATCTAAA ---TTTAGGT TTGCGACCTC GATGTTGGAC TAGGGCCCTA ATGATTAGTC
Limicolaria martenssii      GTAATCTATT A--GTTAGGT TTGCGACCTC GATGTTGGAC TAGGGACCGA ATGATTAAGC
Limicolariopsis sp.         GTAATCTATT ---AATAGGA TTGCGACCTC KATGTTGGAC TAGGGWCCAA ATGATTWGAT
Cochlitoma varicosa         GTAATCTTCT ---TTTAGGA TTGCGACCTC GATGTTGGAC TAGGGACCTA TTGGTTAKTA
Cochlitoma dimidiata        GTAATCTAYT T--TTTAGGY TTGCGACCTC GATGTTGGAC TAGGGACCTA TTGGTTAGCA
Cochlitoma sp. cf. vestit   GTAATTTATT ---TTTAAGA TTGCGACCTC GATGTTGGAC TAGGGACCTT TTGGTTAGTA
Cochlitoma marinae          GTAATCTTAC T--ATTGGGA TTGCGACCTC GATGTTGGAC TAGGGACCCA TTGGTTAGTA
Cochlitoma churchilliana    GTAATCTCTC ---TTTTGGA TTGCGACCTC GATGTTGGAC TAGGGACTGA ATGGTTAACA
Cochlitoma granulata        GTTATCTACT ---ATTAGGA TTGCGACCTC GATGTTGGAC TAGGGACTTA TCGGTAATCA
Cochlitoma simplex          GTGATCTATT ---CATAGGT TTGCGACCTC GATGTTGGAC TAGGGACCCA TTGGTTAACA
Cochlitoma kilburni         GTAATTTATT ---TTTAAGA TTGCGACCTC GATGTTGGAC TAGGGACCTT TTGGTTAGTA
Cochlitoma montistempli     GTAATTCACT A--TTTGGGA TTGCGACCTC GATGTTGGAC TAGGGACCTA TTGGTAAGCA
Cochlitoma omissa           GTTATCTACT ---ATTAGGA TTGCGACCTC GATGTTGGAC TAGGGACTTA TTGGTAAACA
Cochlitoma semidecussata    GTAATTCACT ---ATTGGGA TTGCGACCTC GATGTTGGAC TAGGGACCTA TTGGTAAGTA
Cochlitoma ustulata         GTAATCTTAT ---TTATGGA TTGCGACCTC GATGTTGGAC TAGGGACCCA GTGGTGAGAA
Cochlitoma zebra            GTAATCTTCT ---TTTTGGA TTGCGACCTC GATGTTGGAC TAGGGACCTA ATGGTTAGTA
Metachatina kraussi         GTAATCTTT- ---TGAAGGA TTGCGACCTC GATGTTGGAC TAGGGACCTA TCGGTTAGCA
Rumina decollata            ATAATACTAA ---GTAGTGT TTGTGACCTC GATGTTGGAC TAGGGACTAA TTGGTTAACC
NUCLEOTIDES INCLUDED        mmmmmmmm-- -----mmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
```

```
                            ....|....| ....|....| ....|....| ....|....| ....|..
                                   490        500        510        520
Achatina fulica             ACCATTA--- --TGGG-GCG GTTCTGTTCG AACTTTTCCT ACCCTAC
Achatina immaculata         ACCATTT--- --CTGG-ATA GTTCTGTTCG AACTT--TTT TTCCTAC
Achatina reticulata         ACCATCA--- --ATGG-AGG GTTCTGTTCG AACTT--AAT CCCCTAC
Achatina zanzibarica        ACCATTT--- --GTGG-GTG GTTCTGTTCG AACTT--ATC TCCCTAC
Euaethiopina loveridgei     ACCATCA--- --TGGG-GTG GTTCTGTTCG AACTT--TTT TCCCTAC
Achatina achatina           ACCAAGA--- --ATGT-AAG GTTCTGTTCG AACTTT-TTA TCCCTAC
Archachatina marginata      ATCAATT--- ---TGG-ACA GTTCTGTTCG AACTC--TCG CCCCTAC
Achatina bisculpta          ATCAAGA--T AACTGG-ATT GTTCTGTTCG AACAC--TGG ACCCTAC
Achatina damarensis         ATCAAGT--T TTCTGG-ATT GTTCTGTTCG AACAC--TTG ACCCTAC
Achatina stuhlmanni         ATCAAGGTGA CTATGG-ATT GTTCTGTTCG AACAC--TAG ACCCTAC
Atopocochlis exarata        ATTAAGA--T TCACGG-ATT GTTCTGTTCG AACACT-TAG ACCCTAC
Limicolaria kambeul         GTCAGGC--- ---TGG-ATT AAGTTCTGTT CGAACTTCGT ACCCTAC
Limicolaria martenssii      ATCAAGT--- ---TGGAAGT GTTCTGTTCG AACTT--AAT ACCCTAC
Limicolariopsis sp.         ATCATCT--- ---AGG-AYT GTTCTGTTCG AACAT--TAA MCCCTAM
Cochlitoma varicosa         ACCAGCT--- ---TGG-CAG GTTCTGTTCG AACCC--TTA CCCCTAC
Cochlitoma dimidiata        ACCAGAT--- ---TGTCCAG GATCTGTKCR MACMM--YKK AMYCTAC
Cochlitoma sp. cf. vestit   ACCAGGC--- ---TGG-CGG GTTCTGTTCG AACCT--TTT CCCCTAC
Cochlitoma marinae          ACCAGTA--- ---TAG-CGA GTTCTGTTCG AACTAA-TTT CCCCTAC
Cochlitoma churchilliana    ACCAGGC--- ---TAG-CAG GTTCTGTTCG AACTT--TTT ACCCTAC
Cochlitoma granulata        ACCAGAA--- ---TAGCCAG GTTCTGTTCG AACTATTTTT CCCCTAC
Cochlitoma simplex          ACCAGGA--- ---TGG-CAG GTTCTGTTCG AACCC--TCT CCCCTAC
Cochlitoma kilburni         ACCAGGC--- ---TGG-CGG GTTCTGTTCG AACCT--TTT CCCCTAC
Cochlitoma montistempli     ATCTAAA--- ---GGG-CTG GTTCTGTTCG AACCTC-TTA CCCCTAC
Cochlitoma omissa           ACCAGAA--- ---TAG-CAG GTTCTGTTCG AACTAT-TTT CCCCTAC
Cochlitoma semidecussata    ATCAGGA--- ---GGG-CTG GTTCTGTTCG AACCT--TTT CCCCTAC
Cochlitoma ustulata         ACCAGCT--- ---AGG-CAA GTTCTGTTCG AACTTT-CCA CCCCTAC
Cochlitoma zebra            ATCAGCT--- ---TGG-CAG GTTCTGTTCG AACCC--CTT CCCCTAC
Metachatina kraussi         ACCAGAT--- ---TGG-CGA GTTCTGTTCG AACTTC-TTA CCCCTAC
Rumina decollata            ACCAGGA--- ---TAG-ATG ATTCTGTTCG AATCC--TTC ACCCTAC
NUCLEOTIDES INCLUDED        mmmmmmm--- ----mm---- mmmmmmmmmm mmm------- -mmmmmm
```

Appendix 4.6: Log likelihood scores of the different models used for the Achatinidae using (A) 3648 unambiguously aligned nucleotides from the rRNA gene cluster; (B) 873 unambiguously aligned nucleotides of actin; (B.1) 582 unambiguously aligned nucleotides of the 1^{st} and 2^{nd} codon positions of actin; (B.2) 291 unambiguously aligned nucleotides of the 3^{rd} codon position of actin; (C) 328 unambiguously aligned nucleotides of histone 3; (C.1) 218 unambiguously aligned nucleotides of the 1^{st} and 2^{nd} codon positions of histone 3; (D.2) 110 unambiguously aligned nucleotides of the 3^{rd} codon position of histone 3; (D) 641 unambiguously aligned nucleotides of CO1; (D.1) 427 unambiguously aligned nucleotides of the 1^{st} and 2^{nd} codon positions of CO1; (D.2) 214 unambiguously aligned nucleotides of the 3^{rd} codon position of CO1; and (E) 310 unambiguously aligned nucleotides of the 16S rRNA gene. Scores in **bold** belong to optimal models as determined by Likelihood Ratio Test. Note that the K2P and F81 models are non-nested and therefore cannot be compared for significant difference using the LRT.

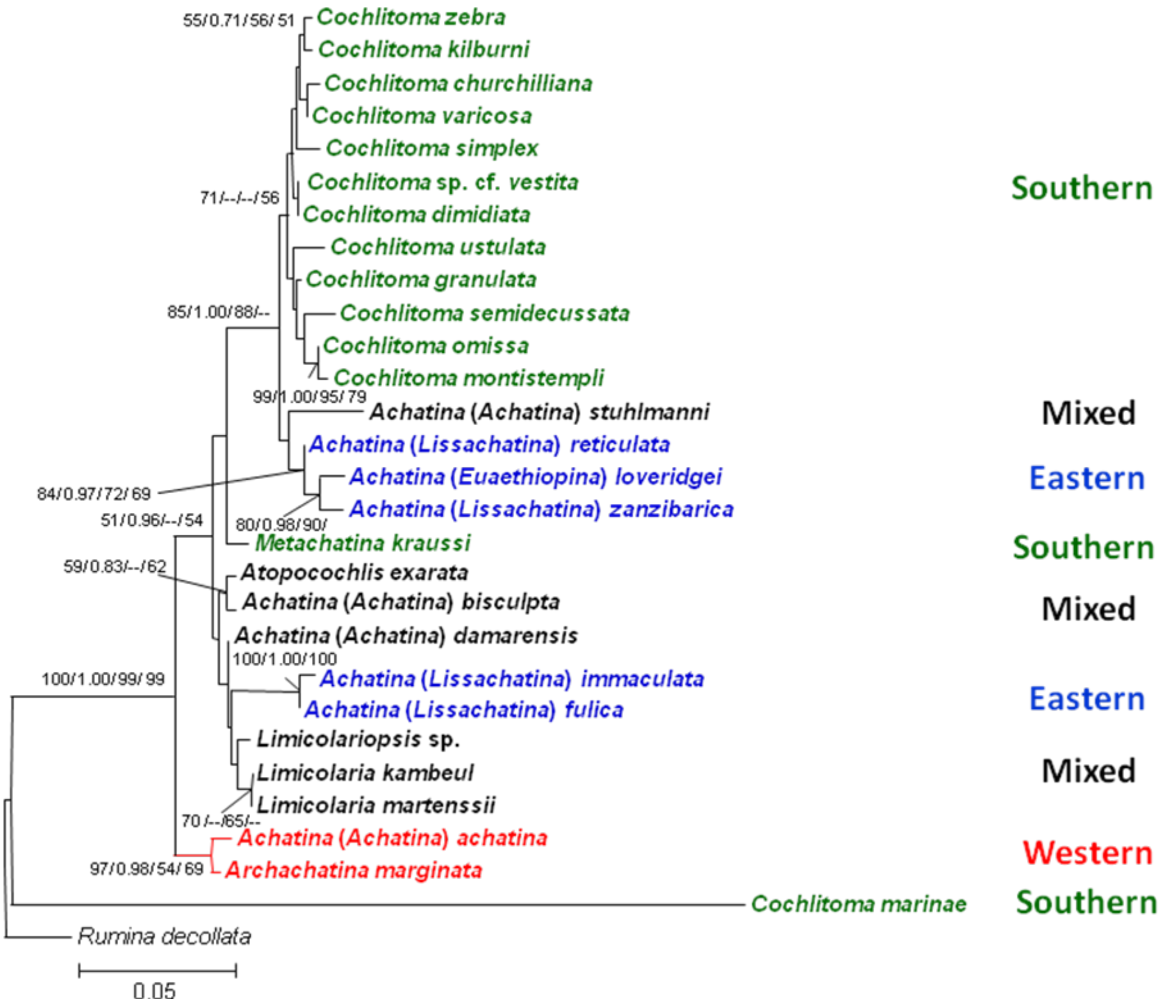
	(A)	(B)	(B.1)	(B.2)	(C)	(C.1)	(C.2)	(D)	(D.1)	(D.2)	(E)
Model	**rRNA gene cluster**	**Actin-combined**	**Actin- $1^{st}+2^{nd}$ codons**	**Actin 3^{rd} codons**	**Histone 3**	**Histone 3 $1^{st}+2^{nd}$ codons**	**Histone 3 3^{rd} codons**	**CO1**	**CO1 $1^{st}+2^{nd}$ codons**	**CO1 3^{rd} codons**	**16S rRNA**
JC69	6248.60194	3079.30195	1033.47821	1770.38462	961.35579	330.69952	547.08597	10577.13076	2639.75972	6467.22043	3410.68577
JC69+Γ	6274.56535	2941.42677	1019.80247	1748.03013	944.88406	330.69952	545.05987	9044.70208	2207.91549	6415.07916	3057.86503
F81	6187.62669	3067.34670	1028.44871	1747.01512	951.97785	325.87231	537.40127	10519.45591	2597.94022	6379.86740	3392.31335
F81+Γ	6213.92744	2928.60315	1015.11409	1722.19734	938.63868	325.87231	535.75438	8289.79099	2137.55284	6334.75953	3022.41771
K2P	6217.14469	2999.90791	1029.51509	1690.58148	942.44107	330.63592	520.04898	10305.12794	2494.32907	6291.12771	3332.43652
K2P+Γ	6233.51676	2856.89829	1018.80719	1657.31863	927.23046	330.63592	525.37382	8654.44378	2053.68656	6219.17666	2961.52886
HKY85	6155.43566	2987.60266	1024.45322	1677.30224	932.61470	**325.81310**	**514.06374**	10214.37634	2447.65021	6026.06510	3311.76468
HKY85+Γ	6173.49112	2847.31250	1013.84964	1646.32805	**909.37626**	325.81310	513.02241	8294.44610	2020.38852	5887.87774	2902.18513
TrN93	**6146.48364**	2976.74300	1019.97904	1677.26346	932.53700	324.88259	513.02953	10210.89277	2422.04372	6023.81427	3308.08745
TrN93+Γ	6164.98831	2837.76616	**1013.43024**	1644.81901	909.25171	324.88259	512.04887	8289.71414	2015.28913	5879.85256	2900.05462
GTR	6143.87015	2967.76023	1018.79267	1663.08220	931.83493	321.54407	512.77514	9954.78203	2405.51236	6018.45857	3243.11777
GTR+Γ	6157.24483	**2821.80122**	1011.67014	**1634.16756**	908.90524	321.54420	511.78485	**8289.46582**	**1995.68125**	**5878.05759**	**2876.32253**

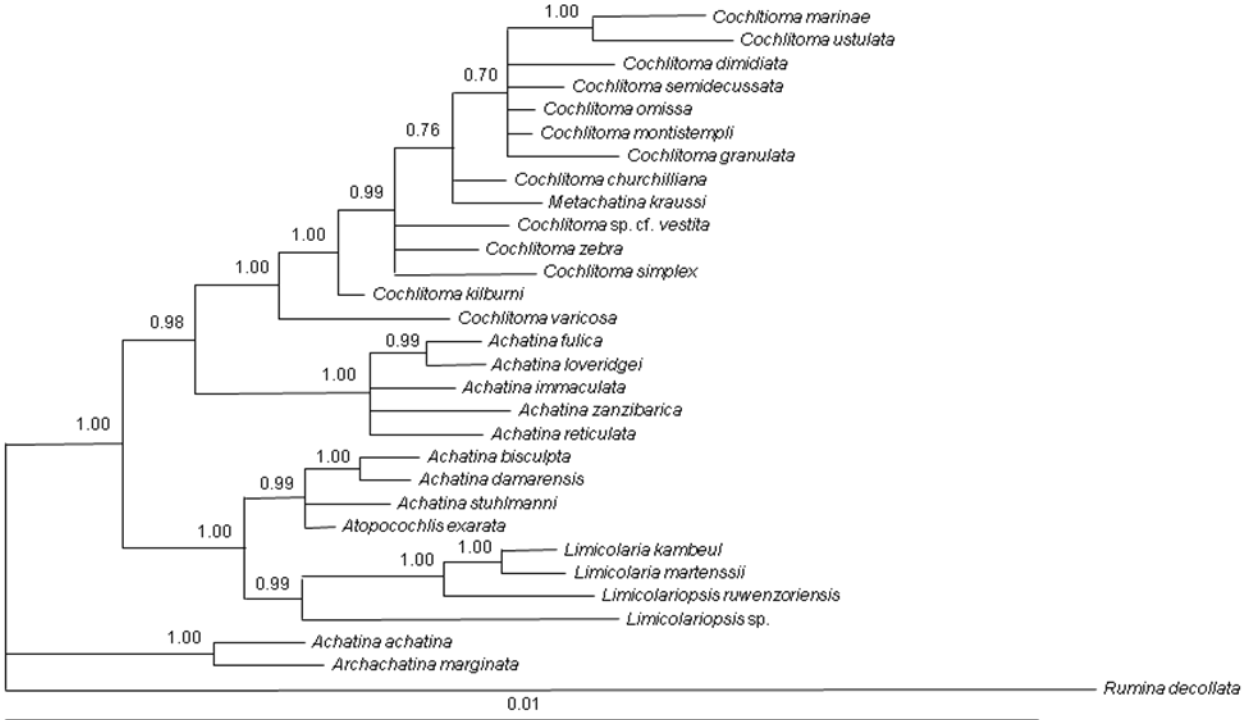
Appendix 4.7: Summary of ambiguous sites for the actin gene for the Achatinidae

Species	Total ambiguous sites	% ambiguous sites (out of 873 total)	Total ambiguous 3rd codon positions	% ambiguous 3rd codon positions relative to all ambiguous sites	Number of RY sites at ambiguous 3rd codon positions	% RY sites relative to all ambiguous 3rd codon positions	Number of ambiguous amino acids	% ambiguous amino acids (out of 291 total)
WEST AFRICAN								
acha	45	5.15	40	88.89	31	77.50	4	1.37
arcm	27	3.09	23	85.19	21	91.30	3	1.03
EAST AFRICAN								
achf	18	2.06	16	88.89	12	75.00	2	0.69
achi	15	1.72	12	80.00	11	91.67	1	0.34
achr	33	3.78	26	78.79	23	88.46	4	1.37
achz	1	0.11	0	0	0	0	1	0.34
euel	0	0	0	0	0	0	0	0
OTHERS								
achb	32	3.67	26	81.25	17	65.38	4	1.37
achd	34	3.89	27	79.41	25	92.59	6	2.06
achs	2	0.23	1	50.00	1	100.00	1	0.34
atcx2	29	3.32	25	86.21	21	84.00	3	1.03
lim	30	3.44	27	90.00	25	92.59	2	0.69
limm	33	3.78	27	81.82	23	85.19	7	2.41
lip	40	4.58	32	80.00	27	84.38	7	2.41
SOUTHERN AFRICAN								
achv	27	3.09	24	88.89	18	75.00	2	0.69
arcd	31	3.55	27	87.10	20	74.07	3	1.03
arcv	30	3.32	26	86.67	19	73.08	3	1.03
coia	4	0.46	2	50.00	1	50.00	2	0.69
coic	0	0	0	0	0	0	0	0
coik	1	0.11	0	0	0	0	0	0
coig	9	1.03	9	100.00	8	88.89	0	0
coii	2	0.23	2	100.00	0	0	0	0
coim	0	0	0	0	0	0	0	0
coio	6	0.69	6	100.00	5	83.33	0	0
cois	0	0	0	0	0	0	0	0
coiu	0	0	0	0	0	0	0	0
coiz	0	0	0	0	0	0	0	0
metk	52	5.96	38	73.08	29	76.32	9	3.09

NOTE: primers used: ActF1 and ActR

Appendix 4.8. Maximum likelihood phylogenetic tree of the Achatinidae based on 873 unambiguously aligned nucleotide sites of the actin gene. The phylogenies were rooted on the subulinid *Rumina decollata*. Values on the nodes represent bootstrap support (1000 replicates) for ML, posterior probabilities (based on the last 1000 trees) for BI, and bootstrap supports for NJ (1000 replicates) and MP (69 replicates only after the PAUP* version 4.0b10 was terminated after running for 135 hours). The scale bar represents 5 substitutional changes per 100 nucleotide positions.

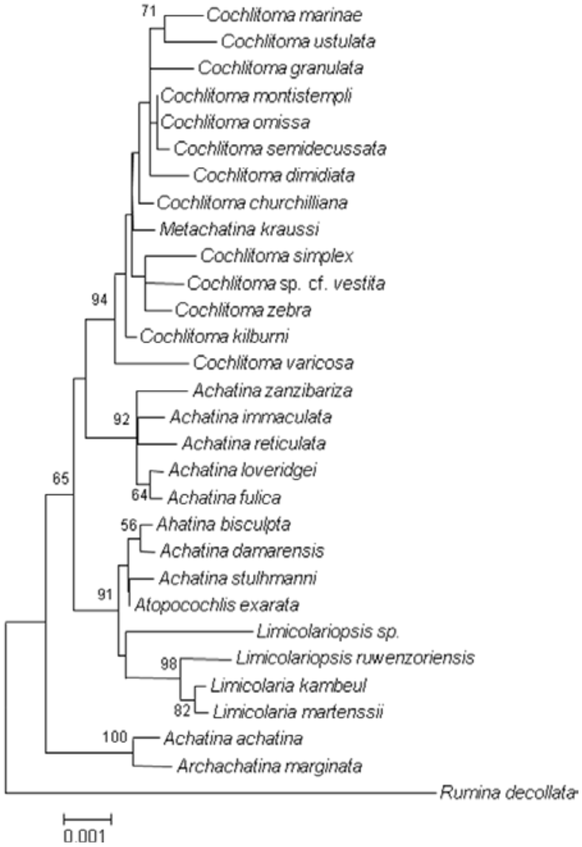




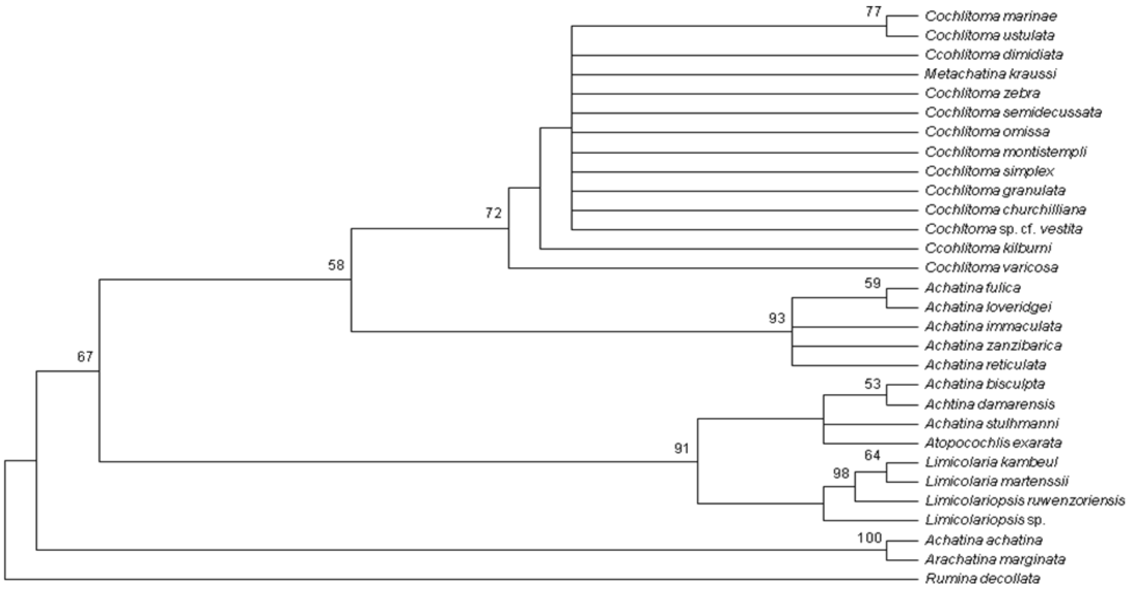
(A) BI (LSU rRNA)

Appendix 4.9: Phylogenetic trees of the Achatinidae based on the large subunit rRNA gene using (**A**) Bayesian analysis, (**B**) neighbor-joining (p. 512) and (**C**) maximum parsimony based on 25 equally parsimonious trees (p. 512). The phylogenies were constructed from 3648 unambiguously aligned nucleotide sites and were rooted on the subulinid *Rumina decollata*. Bayesian posterior probabilities in (**A**) indicate support for individual branches in the Bayesian analysis based on the last 1000 trees. Posterior probabilities lower than 0.7 are not shown. Bootstrap values in (**B**) and (**C**) indicate the percentage support for individual branches based on 1000 replicates. Bootstrap values lower than 50% are not shown. The scale bar for (**A**) represents 1 substitutional change per 100 nucleotides and that of (**B**) represents 1 substitutional change per 1000 nucleotides.

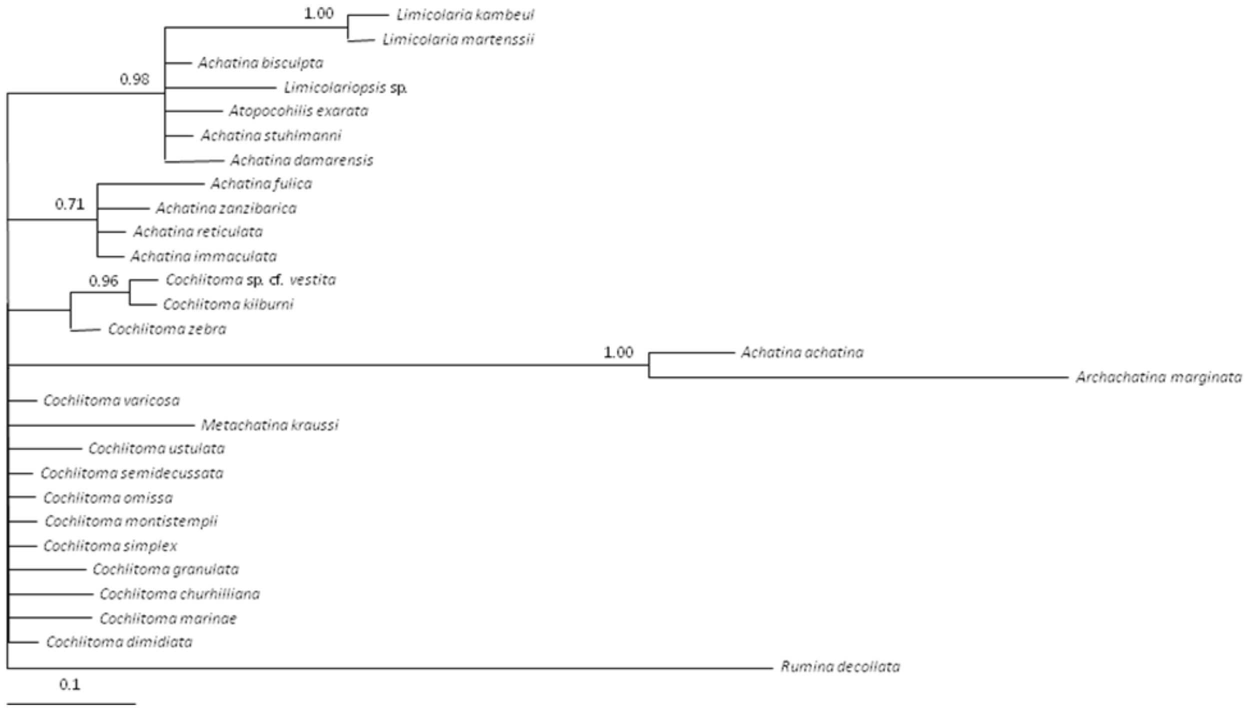
Appendix 4.9 (contd.)



(B) NJ (LSU rRNA)



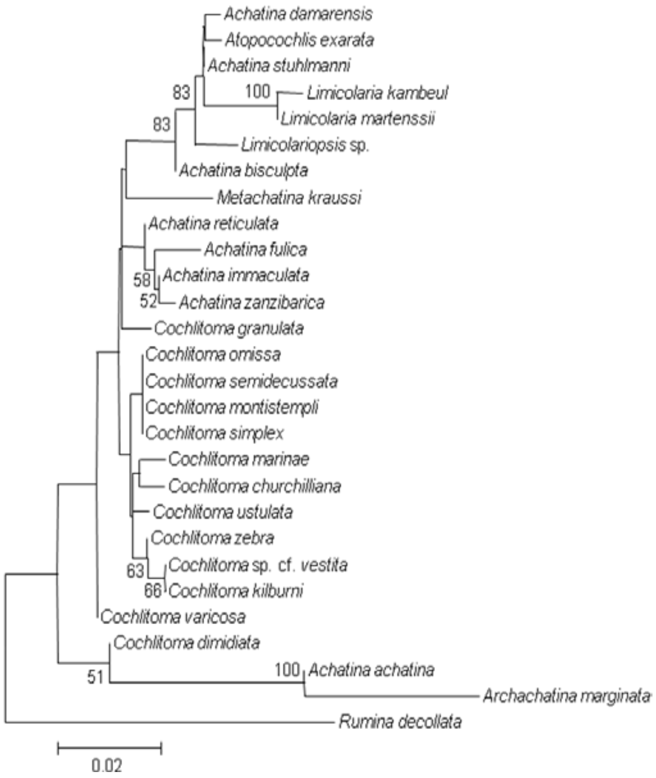
(C) MP (LSU rRNA)



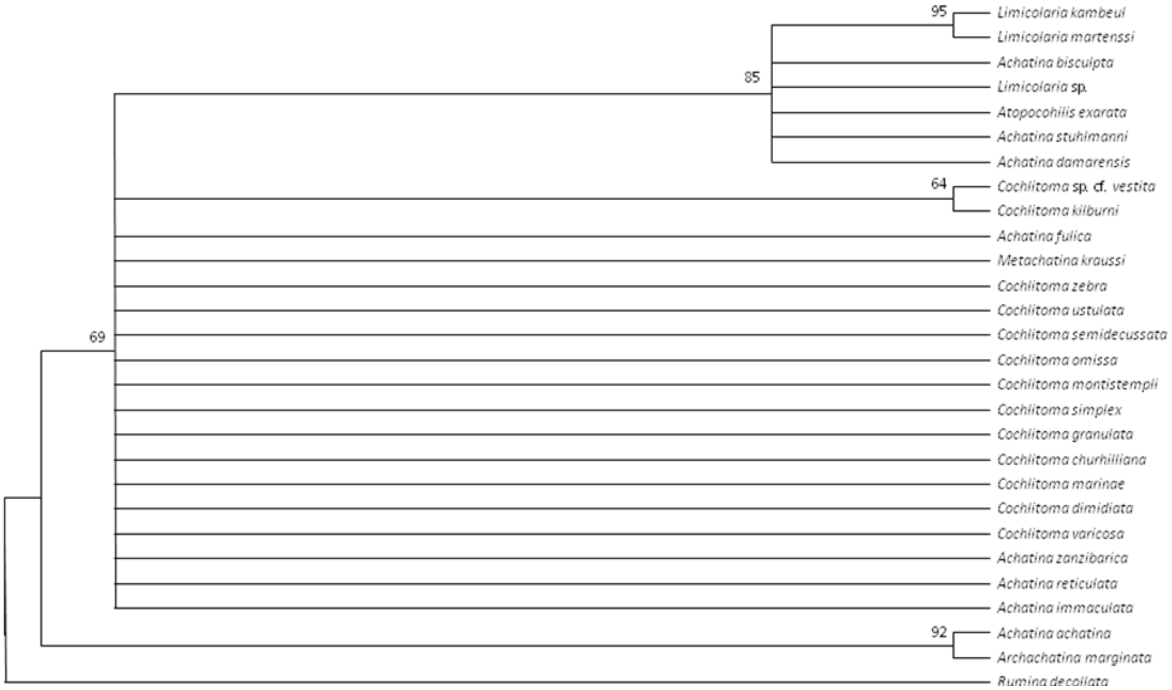
(A) BI (histone 3)

Appendix 4.10: Phylogenetic trees of the Achatinoidea based on the histone 3 gene using (**A**) Bayesian analysis, (**B**) neighbor-joining (p. 514) and (**C**) maximum parsimony based on 8404 equally parsimonious trees (p. 514). The phylogenies were constructed from 328 unambiguously aligned nucleotide sites and were rooted on the subulinid *Rumina decollata*. Bayesian posterior probabilities in (**A**) indicate support for individual branches in the Bayesian analysis based on the last 1000 trees. Posterior probabilities lower than 0.7 are not shown. Bootstrap values in (**B**) and (**C**) indicate the percentage support for individual branches based on 1000 replicates. Bootstrap values lower than 50% are not shown. The scale bar for (**A**) represents 1 substitutional change per 10 nucleotides while that of (**B**) represents 2 substitutional changes per 100 nucelotides. Note that *Achatina loveridgei* and *Limicolariopsis ruwenzoriensis* were not included in the phylogenies as they were not successfully sequenced.

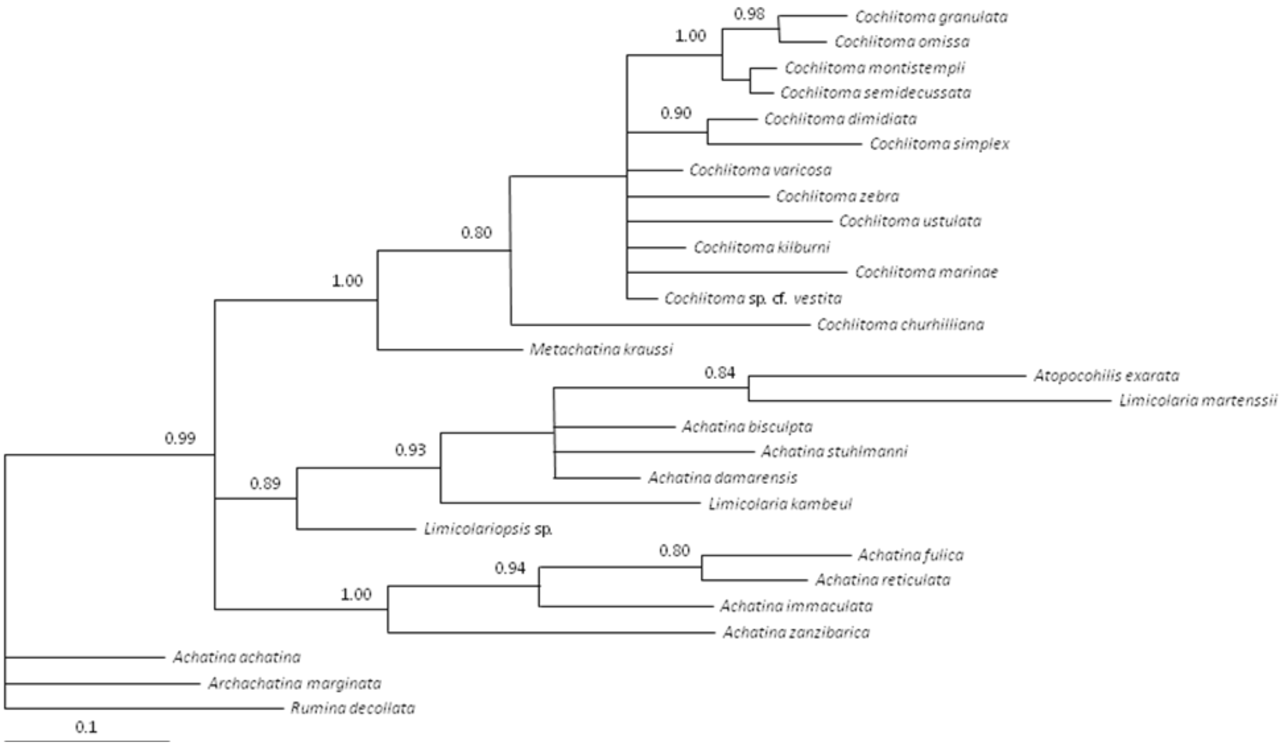
Appendix 4.10 (contd.)



(B) NJ (histone 3)



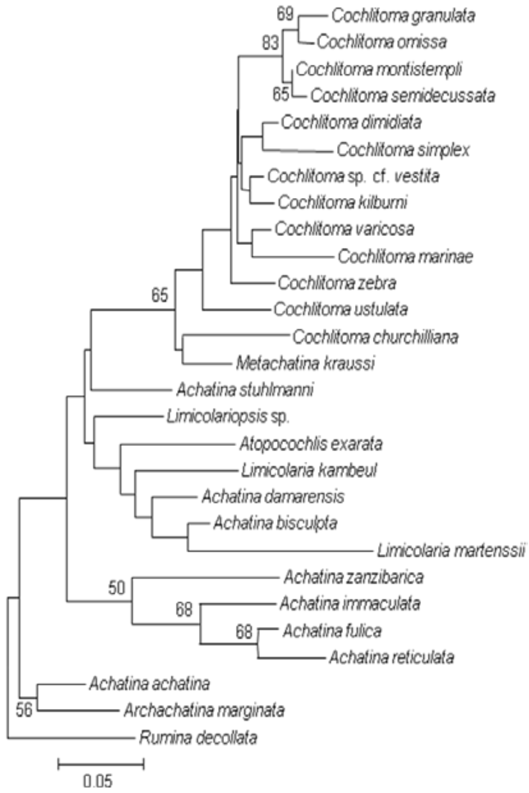
(C) MP (histone 3)



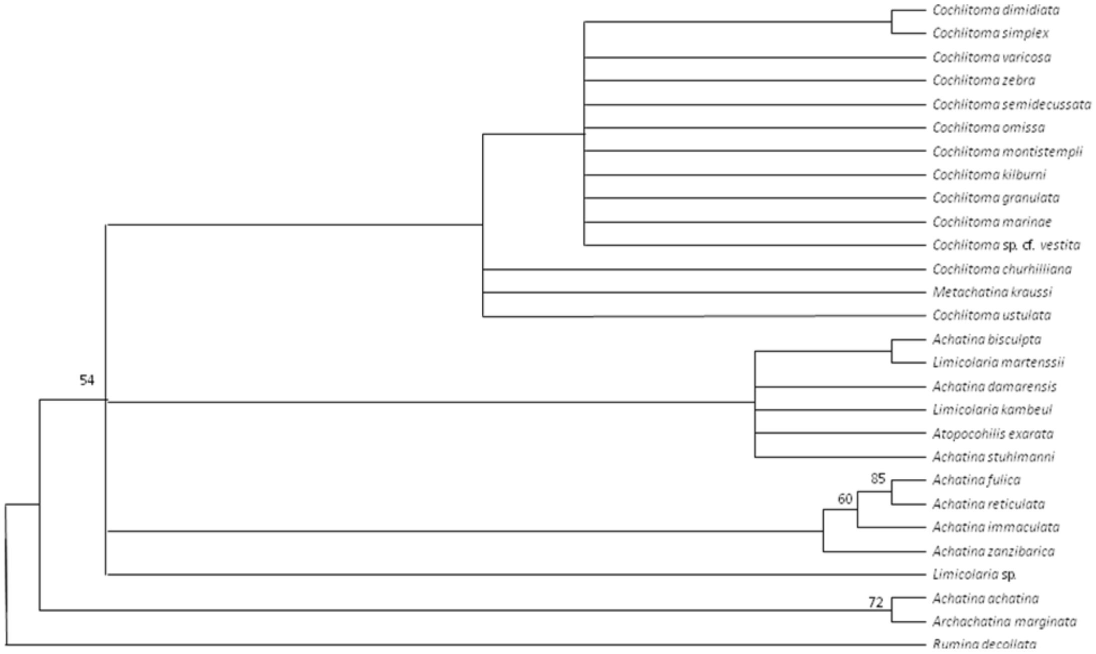
(A) BI (1st and 2nd codon positions of CO1 gene)

Appendix 4.11: Phylogenetic trees of the Achatinidae based on the 1st and 2nd codon positions of the CO1 gene using (**A**) Bayesian analysis, (**B**) neighbor-joining (p. 516) and (**C**) maximum parsimony based on 127 equally parsimonious trees (p. 516). The phylogenies were constructed from 427 unambiguously aligned nucleotide sites and were rooted on the subulinid *Rumina decollata*. Bayesian posterior probabilities in (**A**) indicate support for individual branches in the Bayesian analysis based on the last 1000 trees. Posterior probabilities lower than 0.7 are not shown. Bootstrap values in (**B**) and (**C**) indicate the percentage support for individual branches based on 1000 replicates. Bootstrap values lower than 50% are not shown. The scale bar for (**A**) represents 1 substitutional change per 10 nucleotides and that of (**B**) represents 5 substitutional changes per 100 nucleotides. Note that *Achatina loveridgei* and *Limicolariopsis ruwenzoriensis* were not included in the phylogenies as they were not successfully sequenced.

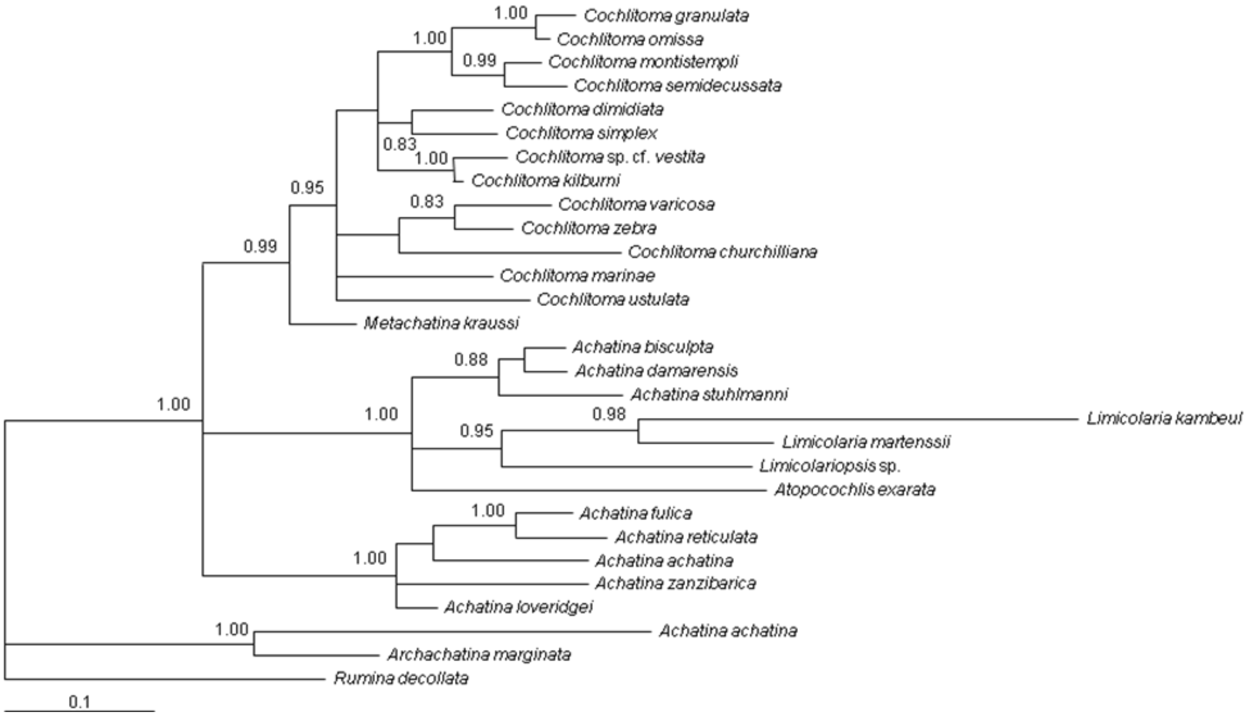
Appendix 4.11 (contd.)



(B) NJ (1st and 2nd codon positions of the CO1 gene)



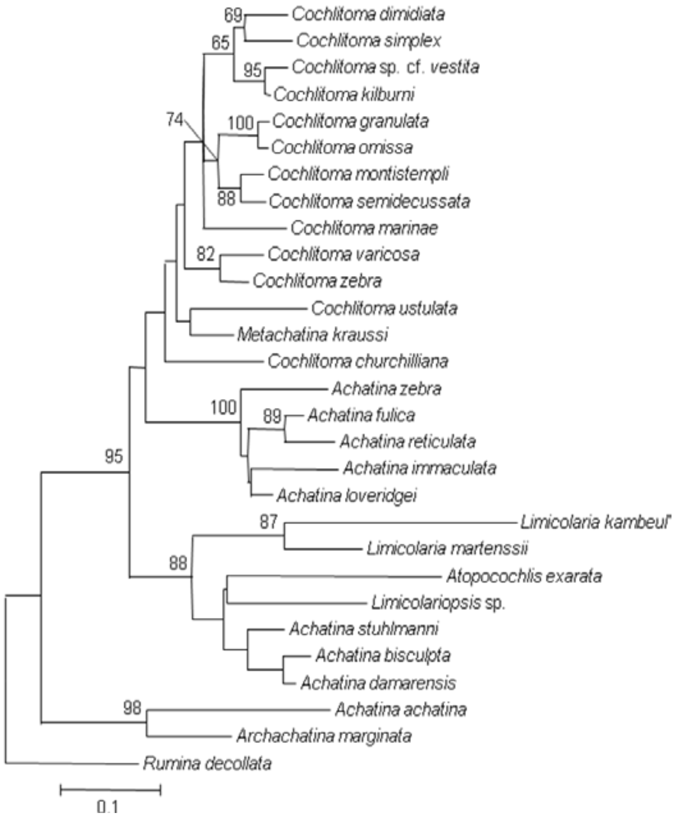
(C) MP (1st and 2nd codon positions of the CO1 gene)



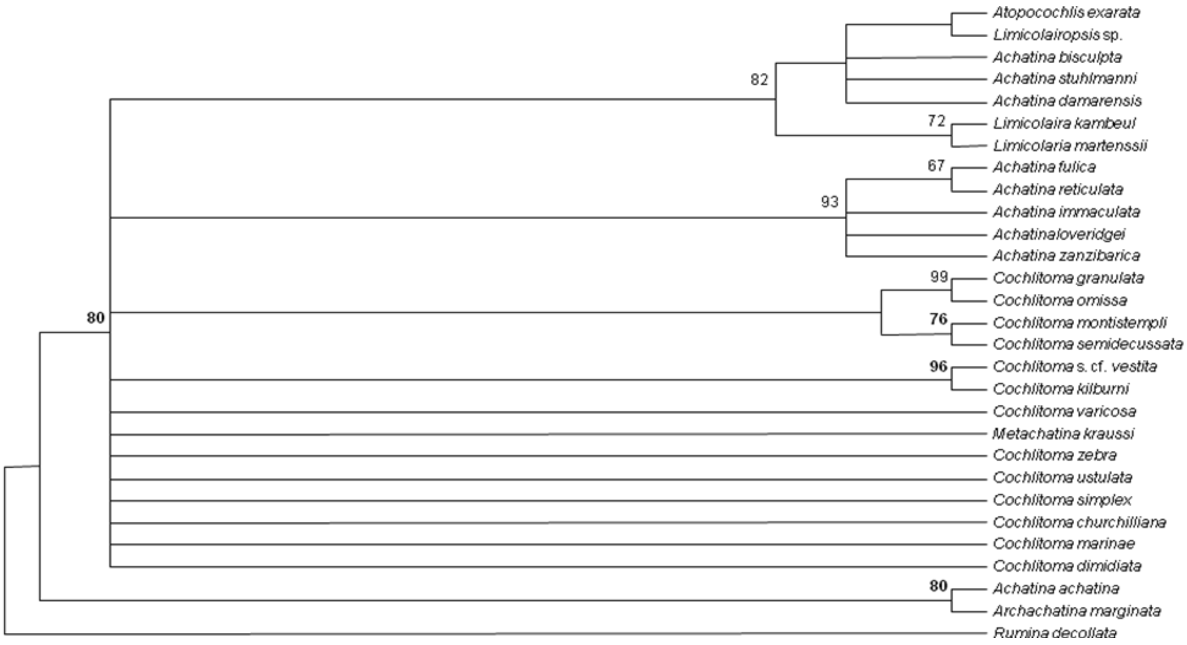
(A) BI (16S rRNA gene)

Appendix 4.12: Phylogenetic trees of the Achatinidae based on the 16S rRNA gene using (**A**) Bayesian analysis, (**B**) neighbor-joining (p. 518) and (**C**) maximum parsimony based on 11 equally parsimonious trees (p. 518). The phylogenies were constructed from 310 unambiguously aligned nucleotide sites and were rooted on the subulinid *Rumina decollata*. Bayesian posterior probabilities in (**A**) indicate support for individual branches in the Bayesian analysis based on the last 1000 trees. Posterior probabilities lower than 0.7 are not shown. Bootstrap values in (**B**) and (**C**) indicate the percentage support for individual branches based on 1000 replicates. Bootstrap values lower than 50% are not shown. The scale bar for (**A**) and (**B**) represents 1 substitutional change per 10 nucleotides. Note that *Limicolariopsis ruwenzoriensis* was excluded in the analyses as it was not successfully sequenced.

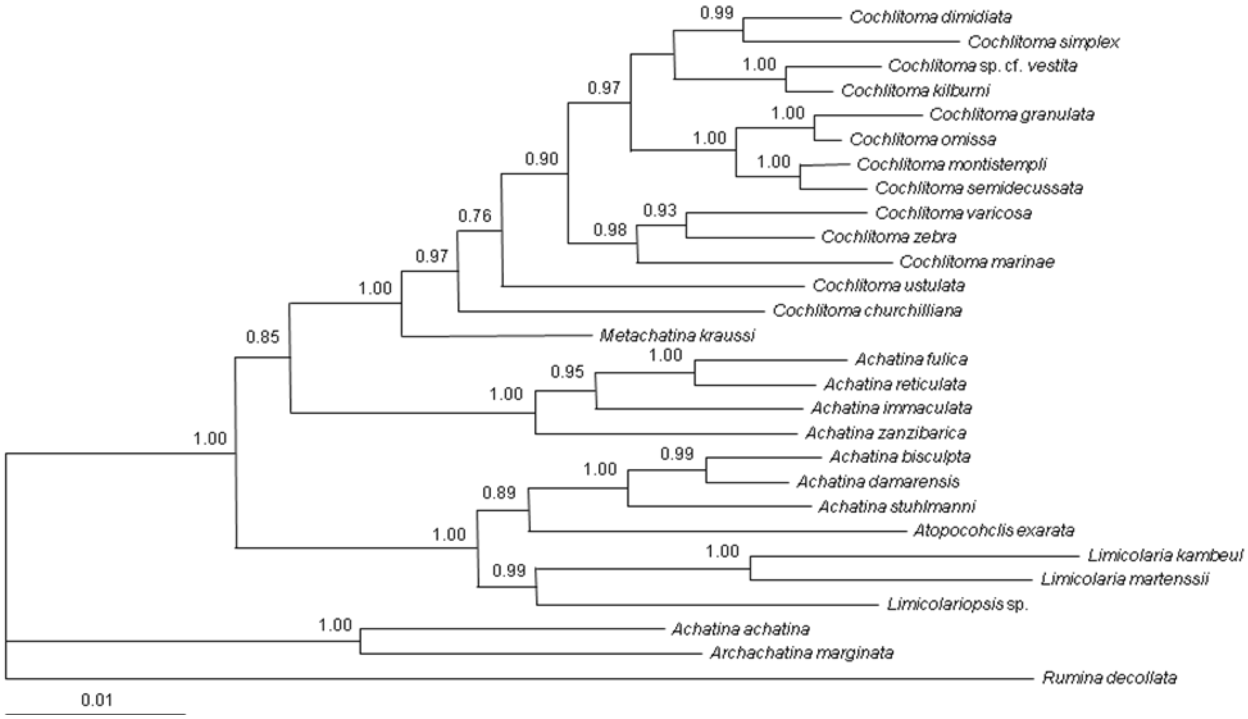
Appendix 4.12 (contd.)



(B) NJ (16S rRNA gene)



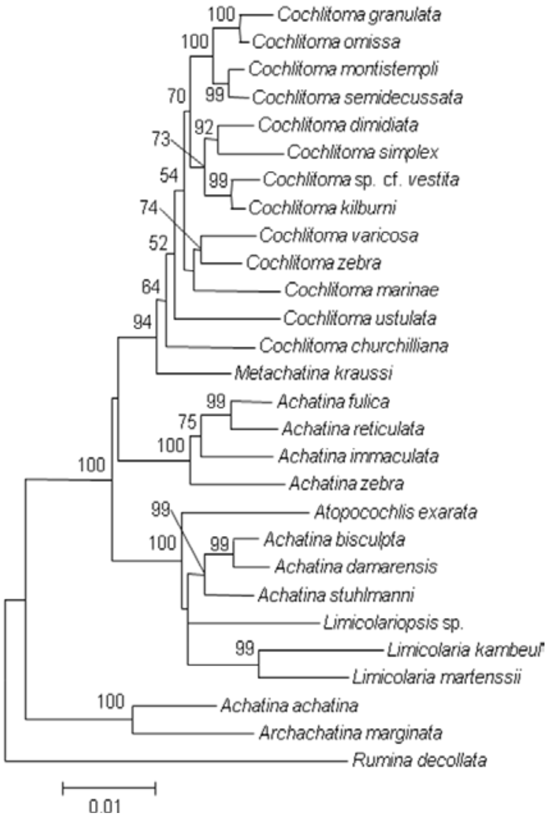
(C) MP (16S rRNA gene)



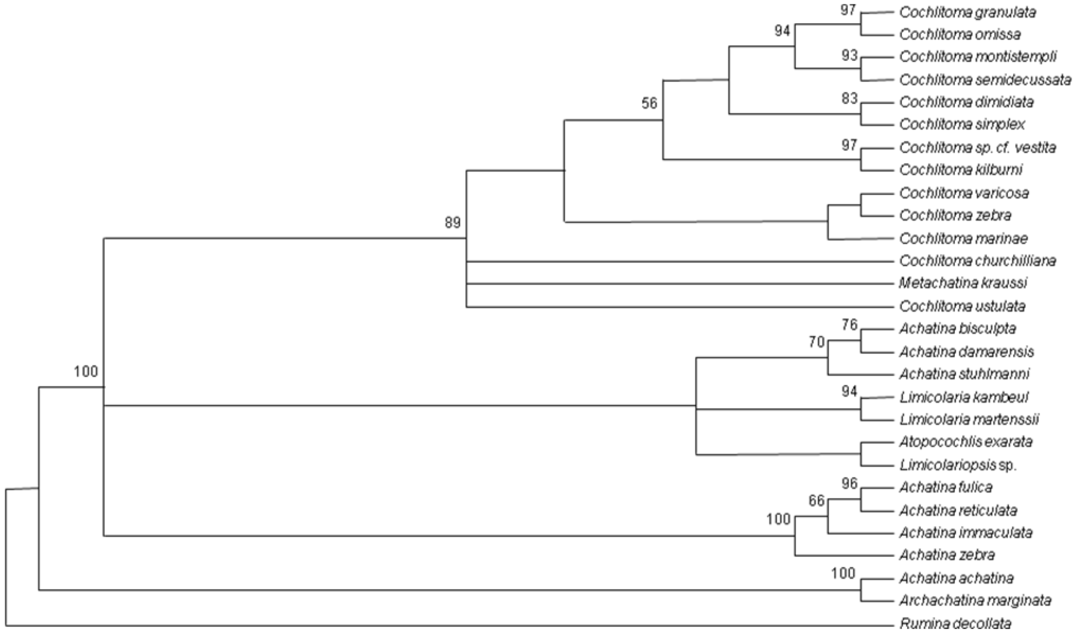
(A) BI (concatenated sequence – taxa with complete datasets only)

Appendix 4.13: Phylogenetic trees of the Achatinidae (taxa with complete datasets only) based on the combined dataset of the LSU rRNA, histone 3, the 1st and 2nd codon positions of the CO1 gene and the 16S rRNA using (**A**) Bayesian analysis, (**B**) neighbor-joining (p. 520) and (**C**) maximum parsimony based on four equally parsimonious trees (p. 520). The phylogenies were constructed from a concatenated sequence of 4713 nucleotides and were rooted on the subulinid *Rumina decollata*. Bayesian posterior probabilities in (**A**) indicate support for individual branches in the Bayesian analysis based on the last 1000 trees. Posterior probabilities lower than 0.7 are not shown. Bootstrap values in (**B**) and (**C**) indicate the percentage support for individual branches based on 1000 replicates. Bootstrap values lower than 50% are not shown. The scale bars for (**A**) and **(B)** represent 1 substitutional change per 100 nucleotides. Note that *Achatina loveridgei* and *Limicolariopsis ruwenzoriensis* were not included were not included in the phylogenies as they lack at least one of the genes used for the combined analyses.

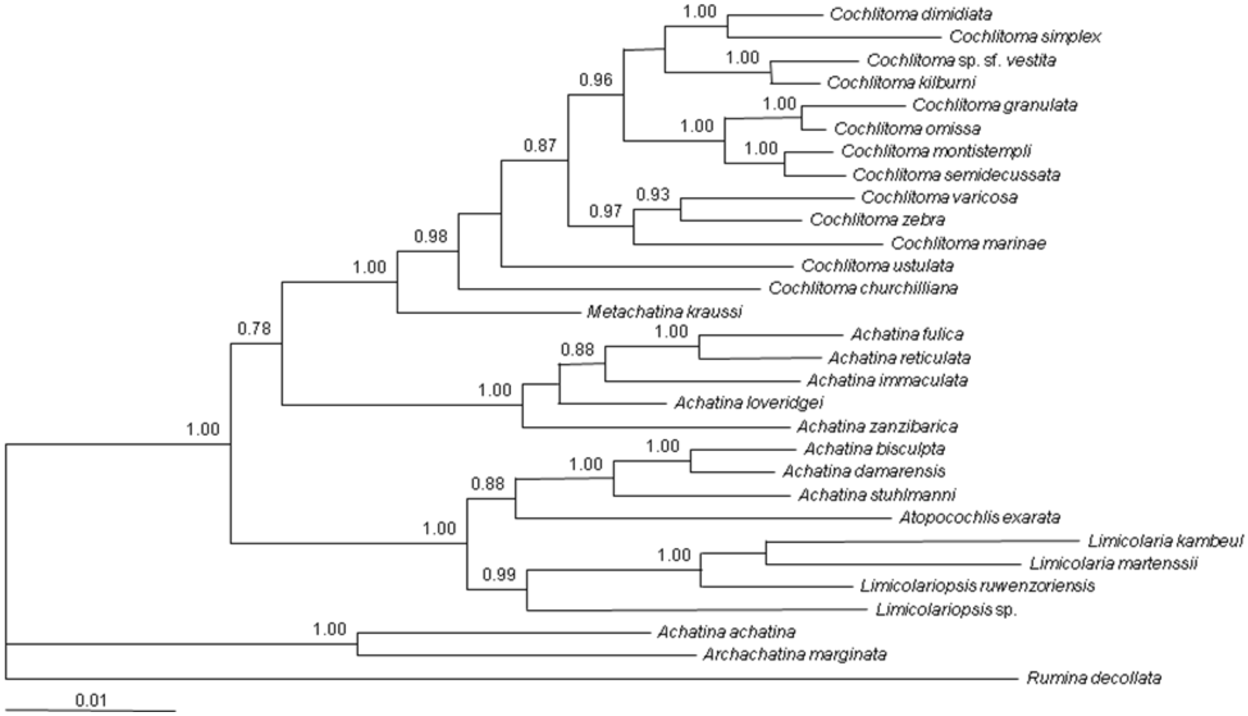
Appendix 4.13 (contd.)



(B) NJ (concatenated sequence – taxa with complete datasets only)



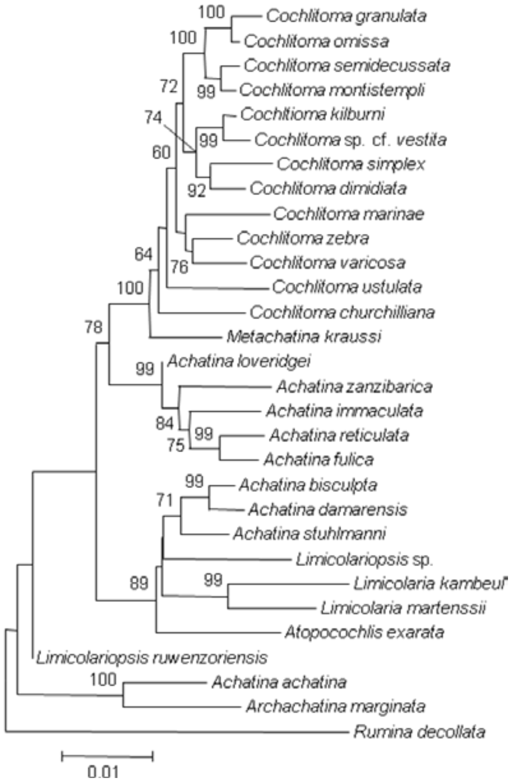
(C) MP (concatenated sequence – taxa with complete datasets only)



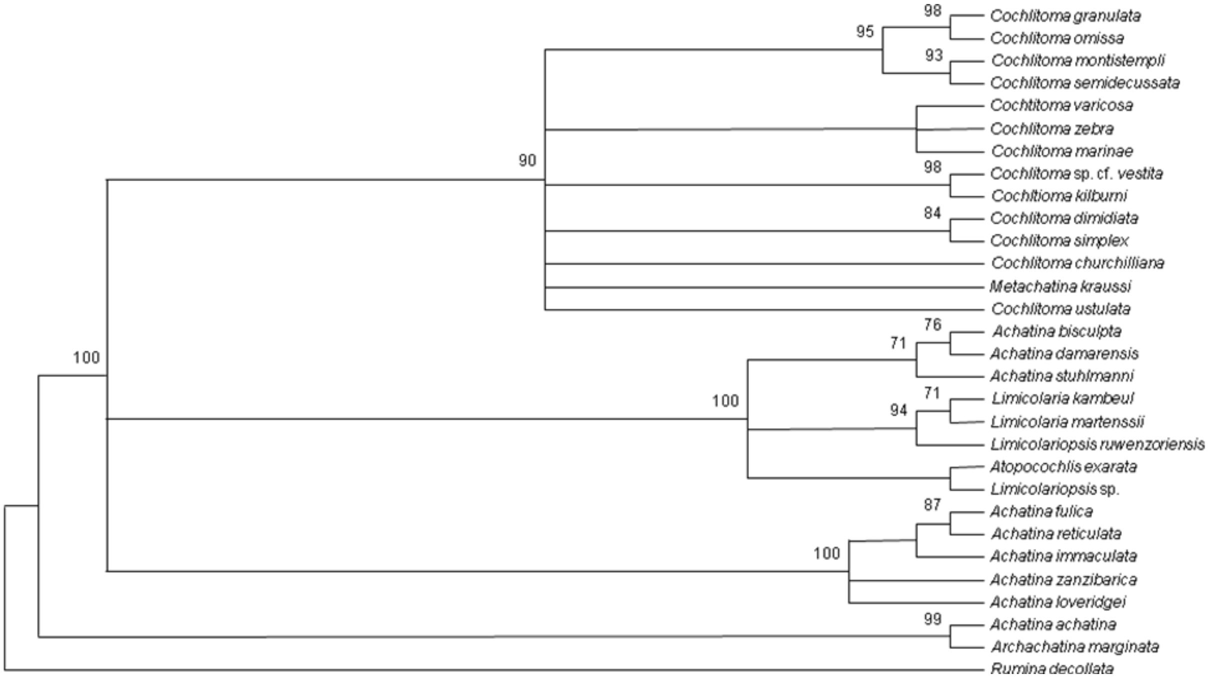
(A) BI (concatenated sequence – all taxa)

Appendix 4.14: Phylogenetic trees of the Achatinidae (all taxa) based on the combined dataset of the LSU rRNA, actin and histone 3 genes and the 1st and 2nd codon positions of the CO1 gene using (**A**) Bayesian analysis, (**B**) neighbor-joining (p. 522) and (**C**) maximum parsimony based on eight equally parsimonious trees (p. 522). The phylogenies were constructed from a concatenated sequence of 4713 nucleotides and were rooted on the subulinid *Rumina decollata*. Bayesian posterior probabilities in (**A**) indicate support for individual branches in the Bayesian analysis based on the last 1000 trees. Posterior probabilities lower than 0.7 are not shown. Bootstrap values in (**B**) and (**C**) indicate the percentage support for individual branches based on 1000 replicates. Bootstrap values lower than 50% are not shown. The scale bars for (**A**) and **(B)** represent 1 substitutional change per 100 nucleotides.

Appendix 4.14 (contd.)



(B) NJ (concatenated sequence – all taxa)



(C) MP (concatenated sequence – all taxa)

Appendix 5.1: Pair-wise uncorrected distances of the East African *Achatina* species using the SSCP fragment of the 16S rRNA gene (293 nucleotides for *A. fulica*).

	A. fulica	*A. zanzibarica*	*A. immaculata*
A. fulica	--		
A. zanzibarica	0.24518		
A. immaculata	0.22864	0.26893	
A. reticulata	0.14414	0.24952	0.22459

Appendix 5.2: Alignment of the 15 haplotypes for the global *Achatina fulica* populations based on 293 nucleotides of the 16S rRNA gene. Sequence for *Achatina reticulata* was used as outgroup.

```
                  ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                           10         20         30         40         50         60
Haplotype A       TAATTTGTCC TCTAATTAGG GTCTGGAATG AAGGGGGACA CAGGGGAGAG CTGTCTCCAA
Haplotype B       TAATTTGTCC TCTAATTAAG GTCTGGAATG AAGGGGGACA CGGGGGAGAG CTGTCTCCAA
Haplotype C       TAATTTGTCC TCTAATTAAG GTCTGGAATG AAGGGGGACA CAGGGGAGAG CTGTCTCCAA
Haplotype D       TAATTTGTCC TCTAATTAAG GTCTGGAATG AAGGGGGACA CAGGGGAGAG CTGTCTCCAA
Haplotype E       TAATTTGTCC TCTAATTAAG GTCTGGAATG AAGGGGGACA CCGGGGAGAG CTGTCTCCAA
Haplotype F       TAATTTGTCC TCTAATTAAG GTCTGGAATG AAGGGGGACA CAGGGGAGAG CTGTCTCCAA
Haplotype G       TAATTTGTCC TCTAATTAAG GTCTGGAATG AAGGGGGACA CAGGGGAGAG CTGTCTCCAA
Haplotype H       TAATTTGTCC TCTAATTAAG GTCTGGAATG AAGGGGGACA CAGGGGAGAG CTGTCTCCAA
Haplotype I       TAATTTGTCC TCTAATTAAG GTCTGGAATG AAGGGGGACA CAGGGGAGAG CTGTCTCCAA
Haplotype J       TAATTTGTCC TCTAATTAAG GTCTGGAATG AAGGGGGACA CAGGGGAGAG CTGTCTCCAA
Haplotype K       TAATTTGTCC TCTAATTAAG GTCTGGAATG AAGGGGGACA CAGGGGAGAG CTGTCTCCAA
Haplotype L       TAATTTGTCC TCTAATTAAG GTCTGGAATG AAGGGGGACA CAGGGGAGAG CTGTCTCCAA
Haplotype M       TAATTTGTCC TCTAATTAAG GTCTGGAATG AAGGGGGACA CAGGGGAGAG CTGTCTCCAA
Haplotype N       TAATTTGTCC TCTAATTAAG GTCTGGAATG AAGGGGGACA CAGGGGAGAG CTGTCTCCAA
Haplotype O       TAATTTGTCC TCTAATTAAG GTCTGGAATG AAGGGGGACA CAGGGGAGAG CTGTCTCCAA
A. reticulata     TAATTTGTCC TTTAATTTAG GTCTGGAATG AATGAGAACA CAGGGGAGAG CTGTCTCTAG
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                           70         80         90        100        110        120
Haplotype A       TAAGGTTAAT TTAACTTTCT TATCAGGTGA AAATTCCTGA GCCTCCGATG AAAGACGAGA
Haplotype B       TAAGGTTAAT TTAACTTTCT TATCAGGTGA AAATTCCTGA GCCTCCGATG AAAGACGAGA
Haplotype C       TAAGGTTAAT TTAACTTTCT TATCAGGTGA AAATTCCTGA GCCTCCGATG AAAGACGAGA
Haplotype D       TAAGGTTAAT TTAACTTTCT TATCAGGTGA AAATTCCTGA GCCTCCGATG AAAGACGAGA
Haplotype E       TAAGGTTAAT TTAACTTTCT TATCAGGTGA AAATTCCTGA GCCTCCGATG AAAGACGAGA
Haplotype F       TAAGGTTAAT TTAACTTTCT TATCAGGTGA AAATTCCTGA GCCTCCGATG AAAGACGAGA
Haplotype G       TAAGGTTAAT TTAACTTTCT TATCAGGTGA AAATTCCTGA GCCTCTGATG AAAGACGAGA
Haplotype H       TAAGGTTAAT TTAACTTTCT TATCAGGTGA AAATTCCTGA GCCTCCGATG AAAGACGAGA
Haplotype I       TAAGGTTAAT TTAACTTTCT TATCAGGTGA AAATTCCTGA GTCTCCGATG AAAGACGAGA
Haplotype J       TAAGGTTAAT TTAACTTTCT TATCAGGTGA AAATTCCTGA GTCTCCGATG AAAGACGAGA
Haplotype K       TAAGGTTAAT TTAACTTTCT TATCAGGTGA AAATTCCTGA GCCTCCGATG AAAGACGAGA
Haplotype L       TAAGGTTAAT TTAACTTTCT TATCAGGTGA AAATTCCTGA GGCTCCGATG AAAGACGAGA
Haplotype M       TAAGGTTAAT TTAACTTTCT TATCAGGTGA AAATTCCTGA GTCTCCGATG AAAGACGAGA
Haplotype N       TAAGGTTAAT TTAACTTTCT TATCAGGTGA AAATTCCTGA GTCTCCGATG AAAGACGAGA
Haplotype O       TAAGGTTAAT TTAACTTTCT TATCAGGTGA AAATTCCTGA GCCTCCGATG AAAGACGAGA
A. reticulata     TAAGGTTAAC TTAACTTCCT TATCAGGTGA AAATTCCTGA GCTTCTTTGG AAAGACGAGA
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                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                         130        140        150        160        170        180
Haplotype A      AGACCCTTAG AGTTTTTATT ATAACTTGAT ATATTAAAAT TCTTGTTCTG TTTTTGTTGG
Haplotype B      AGACCCTTAG AGTTTTTATT ATAACTTGAT ATATTAAAAT TCTTGTTCTG TTTTTGTTGG
Haplotype C      AGACCCTTAG AGTTTTTATT ATAACTTGAT ATATTAAGAT TCTTGTTCTG TTTTTGTTGG
Haplotype D      AGACCCTTAG AGTTTTTATT ATAACTTGAT ATATTAAAAT TCTTGTTCTG TTTTTGTTGG
Haplotype E      AGACCCTTAG AGTTTTTATT ATAACTTGAT ATATTAAGAT TCTTGTTCTG TTTTTGTTGG
Haplotype F      AGACCCTTAG AGTTTTTATT ATAACTTGAT ATATCAAGAT TCTTGTTCTG TTTTTGTTGG
Haplotype G      AGACCCTTAG AGTTTTTATT ATAACTTGAT ATATTAAAAT TCTTGTTCTG TTTTTGTTGG
Haplotype H      AGACCCTTAG AGTTTTTATT ATAACTTGAT ATATTAAGAT TCTTGTTCTG TTTTTGTTGG
Haplotype I      AGACCCTTAG AGTTTTTATT ATAACTTGAT GTATTTAAAT TCTTGTTCTG TTTTTGTTGG
Haplotype J      AGACCCTTAG AGTTTTTATT ATAACTTGAT GTATTTAAAT TCTTGTTCTG TTTTTGTTGG
Haplotype K      AGACCCTTAG AGTTTTTATT ATAACTTGAT ATATTAAAAT TCTTGTTCTG TTTTTGTTGG
Haplotype L      AGACCCTTAG AGTTTTTATT ATAACTTGAT GTATTTAAAT TCTTGTTCTG TTTTTGTTGG
Haplotype M      AGACCCTTAG AGTTTTTATT ATAACTTGAT GTATTTAAAT TCTTGTTCTG TTTTTGTTGG
Haplotype N      AGACCCTTAG AGTTTTTATT ATAACTTGAT GTATTTAAAT TCTTGTTCTG TTTTTGTTGG
Haplotype O      AGACCCTTAG AGTTTTTATT ATAATTTGAT ATATTAAAAT TCTTGTTCTG TTTTTGTTGG
A. reticulata    AGACCCTTAG AGTTTTAATA ATTATTTAGA TAAATAAAAT TCTACTATTG TTTTTGTTGG


                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                         190        200        210        220        230        240
Haplotype A      GGCGACAGGG TTACAATAGA TAA-CTTACC CTACCATA-- TTTTTATATG GCGATCATTA
Haplotype B      GGCGACAGGG TTACAATAGA TAA-CTTACC CTACCATA-- TTTTTATATG GCGATCATTA
Haplotype C      GGCGACAGGG TTACAATAGA TAA-CTTACC CTACCATA-- TTTTTATATG GCGATCATTA
Haplotype D      GGCGACAGGG TTACAATAGA TAA-CTTACC CTACCATA-- TTTTTATATG GCGATCATTA
Haplotype E      GGCGACAGGG TTACAATAGA TAA-CTTACC CTACCATA-- TTTTTATATG GCGATCATTA
Haplotype F      GGCGACAGGG TTACAATAGA TAA-CTTACC CTACCATA-- TTTTTATATG GCGATCATTA
Haplotype G      GGCGACAGGG TTACAATAGA TAA-CTTACC CTACCATA-- TTTTTATATG GCGATCATTA
Haplotype H      GGCGACAGGG TTACAATAGA TAA-CTTACC CTACCATA-- TTTTTATATG GCGATCATTA
Haplotype I      GGCGACAGGG TTACAACAGA TAA-CTTACC CTACCATA-- TTTTTATATG GCGATCATTA
Haplotype J      GGCGACAGGG TTACAATAGA TAA-CTTACC CTACCATA-- TTTTTATATG GCGATCATTA
Haplotype K      GGCGACAGGG TTACAATAGA TAA-CTTACC CTACCATA-- TTTTTATATG GCGATCATTA
Haplotype L      GGCGACAGGG TTACAACAGA TAA-CCTACC CTACCATA-- TTTTTATATG GCGATCATTA
Haplotype M      GGCGACAGGG TTACAACAGA TAA-CTTACC CTACCATA-- TTTTTATATG GCGATCATTA
Haplotype N      GGCGACAGGG TTACAATAGA TAA-CTTACC CTACCATG-- TTTTTATATG GCGATCATTA
Haplotype O      GGCGACAGGG TTACAATAGA TAA-CTTACC CTACCATA-- TTTTTATATG GCGATCATTA
A. reticulata    GGCGACAGGG TAACAATAGG TAAACTTACC CATTCATATA TTTTTATGCG TCGATAGTTA


                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|.
                         250        260        270        280        290
Haplotype A      TACTTTTAAT TAAGCTACCT AAGGGATAAC AGCGTAATCT TTTTTTTTTG GTTTGC
Haplotype B      TACTTTTAAT TAAGCTACCT AAGGGATAAC AGCGTAATCT TTTTTTTTTG GTTTGC
Haplotype C      TACTTTTAAT TAAGCTACCT AAGGGATAAC AGCGTAATCT TTTTTTTT-G GTTTGC
Haplotype D      TACTTTTAAT TAAGCTACCT AAGGGATAAC AGCGTAATCT TTTTTTTT-G GTTTGC
Haplotype E      TACTTTTAAT TAAGCTACCT AAGGGATAAC AGCGTAATCT TTTTTTTT-G GTTTGC
Haplotype F      TACTTTTAAT TAAGCTACCT AAGGGATAAC AGCGTAATCT TTTTTTTT-G GTTTGC
Haplotype G      TACTTTTAAT TAAGCTACCT AAGGGATAAC AGCGTAATCT TTTTTTTT-G GTTTGC
Haplotype H      TACTTTTAAT TAAGCTACCT AAGGGATAAC AGCGTAATCT TTTTTTTTTG GTTTGC
Haplotype I      TACTTTTAAT TAAGCTACCT AAGGGATAAC AGCGTAATCT TTTTTTTTTG GTTTGC
Haplotype J      TACTTTTAAT TAAGCTACCT AAGGGATAAC AGCGTAATCT TTTTATTT-G GTTTGC
Haplotype K      TACTTTTAAT TAAGCTACCT GAGGGATAAC AGCGTAATCT TTTTTTT--G GTTTGC
Haplotype L      TACTTTTAAT TAAGCTACCT AAGGGATAAC AGCGTAATCT TTTTTTT--G GTTTGC
Haplotype M      TACTTTTAAT TAAGCTACCT AAGGGATAAC AGCGTAATCT TTTTTTTT-G GTTTGC
Haplotype N      TACTTTTAAT TAAGCTACCT AAGGGATAAC AGCGTAATCT TTTTTTTT-G GTTTGC
Haplotype O      TACTTTTAAT TAAGCTACCT AAGGGATAAC AGCGTAATCT TTTATTTT-G GTTTGC
A. reticulata    TACTAATAAT TAAACTACCT AAGGGATAAC AGCGTAATCT TTTTTTTT-G GTTTGC
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Appendix 5.3: Log likelihood scores of the different models used for comparison for the 16S haplotypes of the global *A. fulica* populations using 293 nucleotides of the 16S rRNA gene. Likelihood Ratio Test revealed that GTR and TrN93 models were not significantly better than HKY85; the latter was therefore used for the phylogenetic analysis. Note that the K2P and F81 models are non-nested and therefore cannot be compared using LRT.

Model	**Log-Likelihood Score**
JC69	697.00855
JC69+Γ	696.73625
F81	676.85077
F81+Γ	676.50788
K2P	692.34383
K2P+Γ	691.96730
HKY85	**670.85793**
HKY85+Γ	670.25753
TN93	670.82611
TN93+Γ	670.23779
GTR	666.27323
GTR+Γ	666.03208

Appendix 6.1: Nematode species used for the *Angiostrongylus cantonensis* survey as found in GenBank Release No. 157 (22 December 2006) or GenBank Release No. 158 (15 February 2007) as indicated by (*).

Species	**Accession No.**	**Taxonomy**
Gordius aquaticus	X87985	Nematomorpha; Gordioida
Chordodes morgani	AF036639	Nematomorpha; Gordioida
Priapulus caudatus	Z38009	Priapulida; Priapulidae
Brachionus plicatilis	U49911	Rotifera; Monogononta
Axonolaimus helgolandicus	AY854232	Nematoda; Chromadorea; Araeolaimida; Axonolaimoidea; Axonolaimidae
Ascolaimus elongatus	AY854231	Nematoda; Chromadorea; Araeolaimida; Axonolaimoidea; Axonolaimidae
Odontophora rectangula	AY854233	Nematoda; Chromadorea; Araeolaimida; Axonolaimoidea; Axonolaimidae
Cylindrolaimus sp. 202149	AF202149	Nematoda; Chromadorea; Araeolaimida; Cylindrolaimidae
Tylocephalus auriculatus	AF202155	Nematoda; Chromadorea; Araeolaimida; Plectoidea; Plectidae
Plectus acuminatus strain BS9	AF037628	Nematoda; Chromadorea; Araeolaimida; Plectoidea; Plectidae
Plectus aquatilis	AF036602	Nematoda; Chromadorea; Araeolaimida; Plectoidea; Plectidae
Anaplectus sp. PDL-2005	AJ966473	Nematoda; Chromadorea; Araeolaimida; Plectoidea; Plectidae
Anisakis sp. WKT	U81575	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Anisakidae
Anisakis sp. Nadler	U94365	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Anisakidae
Contracaecum multipapillatum	U94370	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Anisakidae
Pseudoterranova decipiens	U94380	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Anisakidae
*Raphidascaris acus**	DQ503460	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Anisakidae
Terranova caballeroi	U94382	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Anisakidae
Ascaris suum	U94367	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Ascarididae
Ascaris lumbricoides	U94366	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Ascarididae
Baylisascaris procyonis	U94368	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Ascarididae
Baylisascaris transfuga	U94369	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Ascarididae
Parascaris equorum	U94378	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Ascarididae
Porrocaecum depressum	U94379	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Ascarididae
Toxascaris leonine	U94383	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Ascarididae
Heteroncheilus tunicatus	U94373	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Heterocheilidae
Goezia pelagia	U94372	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Raphidascarididae
Hysterothylacium fortalezae	U94374	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Raphidascarididae
Hysterothylacium pelagicum	U94375	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Raphidascarididae
Hysterothylacium reliquens	U94376	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Raphidascarididae
Iheringascaris inquies	U94377	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Raphidascarididae
Toxocara canis	U94382	Nematoda; Chromadorea; Ascaridida; Ascaridoidea; Toxocaridae
Nemhelix bakeri	DQ118537	Nematoda; Chromadorea; Ascaridida; Cosmocercoidea; Cosmocercidae
Raillietnema sp. V3060*	DQ503461	Nematoda; Chromadorea; Ascaridida; Cosmocercoidea; Cosmocercidae
Cruzia Americana	U94371	Nematoda; Chromadorea; Ascaridida; Cosmocercoidea; Kathlaniidae
Paraspidodera sp. 21303	AF083005	Nematoda; Chromadorea; Ascaridida; Heterakoidea; Aspidoderidae

Species	**Accession No.**	**Taxonomy**
*Heterakis gallinarum**	DQ503462	Nematoda; Chromadorea; Ascaridida; Heterakoidea; Heterakidae
*Heterakis sp.*14690	AF083003	Nematoda; Chromadorea; Ascaridida; Heterakoidea; Heterakidae
Chromadoropsis vivipara	AF047891	Nematoda; Chromadorea; Chromadorida; Chromadoridae
Chromadora nudicapitata	AY854205	Nematoda; Chromadorea; Chromadorida; Chromadoridae
Chromadora sp. BHMM_2005	AY854206	Nematoda; Chromadorea; Chromadorida; Chromadoridae
Atrochromadora microlaima	AY854204	Nematoda; Chromadorea; Chromadorida; Chromadoridae
Chromadorita tentabundum	AY854208	Nematoda; Chromadorea; Chromadorida; Chromadoridae
Chromadorina germanica	AY854207	Nematoda; Chromadorea; Chromadorida; Chromadoridae
Dichromadora sp. BHMM_2005	AY854209	Nematoda; Chromadorea; Chromadorida; Chromadoridae
Neochromadora BHMM_2005	AY854210	Nematoda; Chromadorea; Chromadorida; Chromadoridae
Spilophorella paradoxa	AY854211	Nematoda; Chromadorea; Chromadorida; Chromadoridae
Paracanthonchus caecus	AF047888	Nematoda; Chromadorea; Chromadorida; Cyatholaimidae
Paracyatholaimus intermedius	AJ966495	Nematoda; Chromadorea; Chromadorida; Cyatholaimidae
Praeacanthonchus punctatus	AY854214	Nematoda; Chromadorea; Chromadorida; Cyatholaimidae
Praeacanthonchus sp.	AF036612	Nematoda; Chromadorea; Chromadorida; Cyatholaimidae
Cyatholaimus sp. BHMM_2005	AY854213	Nematoda; Chromadorea; Chromadorida; Cyatholaimidae
Spirinia parasitifera	AY854217	Nematoda; Chromadorea; Desmodorida; Desmodoridae
Acanthopharynx micans	Y16911	Nematoda; Chromadorea; Desmodorida; Desmodoridae; Desmodorinae
Desmodora ovigera	Y16913	Nematoda; Chromadorea; Desmodorida; Desmodoridae; Desmodorinae
Desmodora communis	AY854215	Nematoda; Chromadorea; Desmodorida; Desmodoridae; Desmodorinae
Xyzzors sp.	Y16923	Nematoda; Chromadorea; Desmodorida; Desmodoridae; Desmodorinae
Metachromadora sp.	AF036595	Nematoda; Chromadorea; Desmodorida; Desmodoridae; Spiriniinae
Metachromadora remanei	AY854216	Nematoda; Chromadorea; Desmodorida; Desmodoridae; Spiriniinae
Catanema sp.	Y16912	Nematoda; Chromadorea; Desmodorida; Desmodoridae; Stilbonematinae
Eubostrichus dianae	Y16915	Nematoda; Chromadorea; Desmodorida; Desmodoridae; Stilbonematinae
Eubostrichus topiarus	Y16917	Nematoda; Chromadorea; Desmodorida; Desmodoridae; Stilbonematinae
Eubostrichus parasitiferus	Y16916	Nematoda; Chromadorea; Desmodorida; Desmodoridae; Stilbonematinae
Laxus oneistus	Y16919	Nematoda; Chromadorea; Desmodorida; Desmodoridae; Stilbonematinae
Laxus cosmopolites	Y16918	Nematoda; Chromadorea; Desmodorida; Desmodoridae; Stilbonematinae
Leptonemella sp.	Y16920	Nematoda; Chromadorea; Desmodorida; Desmodoridae; Stilbonematinae
Robbea hypermnestra	Y16921	Nematoda; Chromadorea; Desmodorida; Desmodoridae; Stilbonematinae
Stilbonema majum	Y16922	Nematoda; Chromadorea; Desmodorida; Desmodoridae; Stilbonematinae
Monoposthia costata	AY854221	Nematoda; Chromadorea; Desmodorida; Monoposthiidae
Nudora bipapillata	AY854222	Nematoda; Chromadorea; Desmodorida; Monoposthiidae
Calomicrolaimus parahonestus	AY854218	Nematoda; Chromadorea; Desmodorida; Richtersioidea; Microlaimidae
Calomicrolaimus sp. BHMM_2005	AY854219	Nematoda; Chromadorea; Desmodorida; Richtersioidea; Microlaimidae
Molgolaimus demani	AY854220	Nematoda; Chromadorea; Desmodorida; Richtersioidea; Microlaimidae
Diplogaster lethieri	AF036643	Nematoda; Chromadorea; Diplogasterida; Diplogasteridae

Species	**Accession No.**	**Taxonomy**
Aduncospiculum halicti	U61759	Nematoda; Chromadorea; Diplogasterida; Diplogasteridae
Pristionchus lheritieri	AF036640	Nematoda; Chromadorea; Diplogasterida; Neodiplogasteridae
Pristionchus pacificus	U81584	Nematoda; Chromadorea; Diplogasterida; Neodiplogasteridae
Pristionchus pacificus PS312	AF083010	Nematoda; Chromadorea; Diplogasterida; Neodiplogasteridae
Sabatieria punctata Strain 343	AY854237	Nematoda; Chromadorea; Monhysterida; Comesomatidae
Sabatieria sp. 355 BHMM_2005	AY854239	Nematoda; Chromadorea; Monhysterida; Comesomatidae
Sabatieria celtica	AY854234	Nematoda; Chromadorea; Monhysterida; Comesomatidae
Sabatieria punctata Strain 200	AY854235	Nematoda; Chromadorea; Monhysterida; Comesomatidae
Sabatieria punctata Strain 223	AY854236	Nematoda; Chromadorea; Monhysterida; Comesomatidae
Sabatieria sp. 210 BHM_2005	AY854238	Nematoda; Chromadorea; Monhysterida; Comesomatidae
Setosabatiera hilarula	AY854240	Nematoda; Chromadorea; Monhysterida; Comesomatidae
Desmolaimus zeelandicus	AY854229	Nematoda; Chromadorea; Monhysterida; Linhomoeidae
Terschellingia longicaudata	AY854230	Nematoda; Chromadorea; Monhysterida; Linhomoeidae
Cyartonema elegans	AY854203	Nematoda; Chromadorea; Monhysterida; Monhysterida incertae sedis
Tridentulus sp. PDL-2005	AJ966507	Nematoda; Chromadorea; Monhysterida; Monhysteridae
Diplolaimelloides meyli	AJ966507	Nematoda; Chromadorea; Monhysterida; Monhysteridae
Diplolaimella dievengatensis	AJ966482	Nematoda; Chromadorea; Monhysterida; Monhysteridae
Geomonhystera disjuncta	AJ966485	Nematoda; Chromadorea; Monhysterida; Monhysteridae
Sphaerolaimus hirsutus	AY854228	Nematoda; Chromadorea; Monhysterida; Sphaerolaimidae
Theristus acer	AJ966505	Nematoda; Chromadorea; Monhysterida; Xyalidae
Daptonema procerus	AF047889	Nematoda; Chromadorea; Monhysterida; Xyalidae
Daptonema hirsutum	AY854223	Nematoda; Chromadorea; Monhysterida; Xyalidae
Daptonema normandicum	AY854224	Nematoda; Chromadorea; Monhysterida; Xyalidae
Daptonema oxycerca	AY854225	Nematoda; Chromadorea; Monhysterida; Xyalidae
Daptonema setosum	AY854226	Nematoda; Chromadorea; Monhysterida; Xyalidae
Metadesmolaimus sp. PDL-2005	AJ966491	Nematoda; Chromadorea; Monhysterida; Xyalidae
Dentostomella sp.	AF036590	Nematoda; Chromadorea; Oxyurida; Oxyuroidea; Heteroxynematidae
Bunonema franzi	AJ966477	Nematoda; Chromadorea; Rhabditida; Bunonematoidea; Bunonematidae
Bunonema sp.	U81582	Nematoda; Chromadorea; Rhabditida; Bunonematoidea; Bunonematidae
Seleborca complexa	U81577	Nematoda; Chromadorea; Rhabditida; Cephaloboidea; Cephalobida
Cephaloboides sp. SB227	AF083027	Nematoda; Chromadorea; Rhabditida; Cephaloboidea; Cephalobidae
Acrobeloides nanus	DQ102707	Nematoda; Chromadorea; Rhabditida; Cephaloboidea; Cephalobidae
Acrobeloides bodenheimeri PS1158	AF202159	Nematoda; Chromadorea; Rhabditida; Cephaloboidea; Cephalobidae
Acrobeloides sp. PS1146	AF034391	Nematoda; Chromadorea; Rhabditida; Cephaloboidea; Cephalobidae
Acrobeles ciliates	AF202148	Nematoda; Chromadorea; Rhabditida; Cephaloboidea; Cephalobidae
Acrobeles sp. PS1156	U81576	Nematoda; Chromadorea; Rhabditida; Cephaloboidea; Cephalobidae
Acrobeles complexus WCUG2	U81577	Nematoda; Chromadorea; Rhabditida; Cephaloboidea; Cephalobidae
Cephalobus cubaensis	AF202161	Nematoda; Chromadorea; Rhabditida; Cephaloboidea; Cephalobidae
Cephalobus sp. PS1143	AF202158	Nematoda; Chromadorea; Rhabditida; Cephaloboidea; Cephalobidae

Species	**Accession No.**	**Taxonomy**
Cephalobus sp. PS1196	AF202160	Nematoda; Chromadorea; Rhabditida; Cephaloboidea; Cephalobidae
Cephalobus oryzae PS1165	AF034390	Nematoda; Chromadorea; Rhabditida; Cephaloboidea; Cephalobidae
Cervidellus alutus	AF202152	Nematoda; Chromadorea; Rhabditida; Cephaloboidea; Cephalobidae
Pseudacrobeles variabilis	AF202150	Nematoda; Chromadorea; Rhabditida; Cephaloboidea; Cephalobidae
Triligulla alluta	AF331911	Nematoda; Chromadorea; Rhabditida; Cephaloboidea; Cephalobidae
Zeldia punctada	U61760	Nematoda; Chromadorea; Rhabditida; Cephaloboidea; Cephalobidae
Myolaimus sp U81585	U81585	Nematoda; Chromadorea; Rhabditida; Myolaimoidea; Myolaimidae
Rhabditophanes sp. KR3021	AF202151	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Alloionematidae
Brevibucca sp. SB261	AF202163	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Brevibuccidae
Halicephalobus gingivalis	AF202156	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Panagrolaimidae
Panagrobelus stammeri	AF202153	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Panagrolaimidae
Plectonchus sp. PDL0025	AF202154	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Panagrolaimidae
Turbatrix aceti	AF202165	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Panagrolaimidae
Panagrellus redivivus	AF036599	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Panagrolaimidae
Panagrellus redivivus PS1163	AF083007	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Panagrolaimidae
Panagrolaimus subelongatus	AY284681	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Panagrolaimidae
Panagrolaimus davidi	AJ567385	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Panagrolaimidae
Panagrolaimus cf rigidus AF40	DQ285636	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Panagrolaimidae
Panagrolaimus sp. Sourhope farm7	AF430487	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Panagrolaimidae
Panagrolaimus sp. Sourhope farm5	AF430485	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Panagrolaimidae
Panagrolaimus sp. Sourhope farm6	AF430486	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Panagrolaimidae
Panagrolaimus sp. Sourhope farm4	AF430484	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Panagrolaimidae
Panagrolaimus sp. Sourhope farm3	AF430483	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Panagrolaimidae
Steinernema carpocapsae	AF036604	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Steinernematidae
Strongyloides stercoralis	M84229	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Strongyloididae
Strongyloides ratti	U81581	Nematoda; Chromadorea; Rhabditida; Panagrolaimoidea; Strongyloididae
Diploscapter sp PS1897	AF083009	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Diploscapteridae
Diploscapter sp PS2017	U81586	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Diploscapteridae
Heterorhabditis bacteriophora	AF036593	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Heterorhabditidae
Heterorhabditis hepialus	AF083004	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Heterorhabditidae
Heterorhabditis zelandica	AJ920368	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Heterorhabditidae
*Phasmarhabditis hermaphrodita**	DQ639981	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae
*Phasmarhabditis neopapillosa**	DQ639982	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae
Parasitorhabditis sp SB281	AF083028	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae
Rhabditoides inermiformis	AF083017	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae

Species	**Accession No.**	**Taxonomy**
Rhabditoides inermis DF5001	AF082996	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae
Rhabditoides regina	AF082997	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae
Poikilolaimus oxycerca SB200	AF083023	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae
Poikilolaimus regenfussi SB199	AF083022	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae
Choriorhabditis dudichi	AF083012	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae
Distolabrellus veechi	AF083011	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae
Distolabrellus veechi DF5024	AF082999	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae
Protorhabditis sp.	AF083024	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae
Protorhabditis sp DF5055	AF083001	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae
Cruznema tripartitum DF5015	U73449	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Mesorhabditinae
Mesorhabditis sp. PS1179	U73452	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Mesorhabditinae
Mesorhabditis spiculigera SB157	AF083016	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Mesorhabditinae
Mesorhabditis anisomorpha SB123	AF083013	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Mesorhabditinae
Teratorhabditis palmarum DF5019	U13937	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Mesorhabditinae
Teratorhabditis synpapillata SB131	AF083015	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Mesorhabditinae
Caenorhabditis briggsae PB102	U13929	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Peloderinae
Caenorhabditis elegans N2	X03680	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Peloderinae
Caenorhabditis sp CB5161	U13930	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Peloderinae
Caenorhabditis sp. PS1010	AF083006	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Peloderinae
Caenorhabditis japonica	AY602182	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Peloderinae
Caenorhabditis sp. DF5170	AY602181	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Peloderinae
Caenorhabditis sp. SB341	AY602180	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Peloderinae
Caenorhabditis plicata	AY602178	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Peloderinae
Caenorhabditis sp. CB5161	U13930	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Peloderinae
Caenorhabditis vulgaris	U13931	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Peloderinae
Caenorhabditis sonorae	AF083026	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Peloderinae
Caenorhabditis drosophilae	AF083025	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Peloderinae
Pellioditis marina	AF083021	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Peloderinae
Pelioditis mediterrenea	AF083020	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Peloderinae
Prodontorhabditis wirthi	AY602179	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Protorhabditinae
Crustorhabditis scanica SB125	AF083014	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae
Dolichorhabditis sp CEW1 *(=Oscheius)*	AF036591	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae
Oscheius sp. DF5000	AF082995	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae
Oscheius sp. BW282	AF082994	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae
Oscheius myriophila EM435	U81588	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae

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Oscheius insectivora	AF083019	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae
Oscheius dolichuroides	AF082998	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae
Rhabditis blumi DF5010	U13935	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae
Rhabditis sp PS1191	AF083008	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae
Rhabditis sp PS1010	AF083006	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae
Rhabditis myriophila EM435	U13936	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae
*Rhabditis colombiana**	AY751546	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae
Rhabditella axei DF5006	U13934	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae
Rhabditella sp. DF5044	AF083000	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae
Cuticularia sp. PS2083	U81583	Nematoda; Chromadorea; Rhabditida; Rhabditoidea; Rhabditidae; Rhabditinae
Necator americanus	AY295811	Nematoda; Chromadorea; Rhabditida; Strongylida; Ancylostomatoidea; Ancylostomatidae; Bunostominae
Kalicephalus cristatus	AJ920349	Nematoda; Chromadorea; Rhabditida; Strongylida; Diaphanocephaloidea; Diaphanocephalidae
Ancylostoma caninum	AJ920347	Nematoda; Chromadorea; Rhabditida; Strongylida; Ancylostomatoidea; Ancylostomatidae; Ancylostomatinae
Angiostrongylus cantonensis	AY295804	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Angiostrongylidae
Angiostrongylus costaricensis	This study	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Angiostrongylidae
Angiostrongylus malaysiensis	This study	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Angiostrongylidae
Angiostrongylus dujardini	This study	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Angiostrongylidae
Angiostrongylus vasorum	This study	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Angiostrongylidae
Aelurostrongylus abstrusus	AJ920366	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Angiostrongylidae
Didelphostrongylus hayesi	AY295806	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Angiostrongylidae
Crenosoma mephitidis	AY295805	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Crenosomatidae
Crenosoma vulpis	AJ920367	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Crenosomatidae
Otostrongylus circumlitus	AY295813	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Crenosomatidae
Troglostrongylus wilsoni	AY295820	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Crenosomatidae
Filaroides martis	AY295807	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Filaroididae
Oslerus osleri	AY295812	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Filaroididae
Parafilaroides decorus	AY295814	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Filaroididae
Metastrongylus salmi	AY295809	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Metastrongylidae
Metastrongylus elongatus	AJ920363	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Metastrongylidae
Skrjabingylus chitwoodrum	AY295819	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Metastrongylidae
Parelaphostrongylus odocoilei	AY295815	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Protostrongylidae; Elaphostrongylinae
Muellerius capillaries	AY295810	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Protostrongylidae; Elaphostrongylinae
Protostrongylus rufescens	AJ920364	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Protostrongylidae; Protostrongylinae
Halocercus invaginatus	AY295808	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Pseudaliidae

Species	**Accession No.**	**Taxonomy**
Pseudalius inflexus	AY295816	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Pseudaliidae
Stenurus minor	AY295817	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Pseudaliidae
Syngamus trachaea	AJ920344	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Syngamidae
Torynurus convolutes	AY295818	Nematoda; Chromadorea; Rhabditida; Strongylida; Metastrongyloidea; Unclassified Metastrongyloidea
Nematodirus battus	U01230	Nematoda; Chromadorea; Rhabditida; Strongylida; Molineoidea; Molineidae; Nematodirinae
Petrovinema poculatum	AJ920343	Nematoda; Chromadorea; Rhabditida; Strongylida; Strongyloidea; Strongylidae
Strongylus equines	DQ094176	Nematoda; Chromadorea; Rhabditida; Strongylida; Strongyloidea; Strongylidae
Cylicocyclus insignis	AJ920342	Nematoda; Chromadorea; Rhabditida; Strongylida; Strongyloidea; Strongylidae
Zoniolaimus mawsonae	AJ920338	Nematoda; Chromadorea; Rhabditida; Strongylida; Strongyloidea; Cloacinidae
Labiostrongylus bipapillosus	AJ920337	Nematoda; Chromadorea; Rhabditida; Strongylida; Strongyloidea; Cloacinidae
Hypodontus macropi	AJ920339	Nematoda; Chromadorea; Rhabditida; Strongylida; Strongyloidea; Cloacinidae
Chabertia ovina	AJ920341	Nematoda; Chromadorea; Rhabditida; Strongylida; Strongyloidea; Chabertiidae
Cyclodontostomum purvisi	AJ920340	Nematoda; Chromadorea; Rhabditida; Strongylida; Strongyloidea; Chabertiidae
Stephanurus dentatus	AJ920345	Nematoda; Chromadorea; Rhabditida; Strongylida; Strongyloidea; Stephanuridae
Deletrocephalus dimidiatus	AJ920346	Nematoda; Chromadorea; Rhabditida; Strongylida; Strongyloidea; Deletrocephalidae
Dictyocaulus eckerti P7B8	AY168857	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Dictyocaulidae; Dictyocaulinae
Dictyocaulus capreolus P3B2	AY168859	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Dictyocaulidae; Dictyocaulinae
Dictyocaulus sp. P6A1	AY168860	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Dictyocaulidae; Dictyocaulinae
Dictyocaulus filarial	AY168861	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Dictyocaulidae; Dictyocaulinae
Dictyocaulus capreolus P2C10	AY168862	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Dictyocaulidae; Dictyocaulinae
Dictyocaulus viviparous	AY168856	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Dictyocaulidae; Dictyocaulinae
Dictyocaulus filarial	AJ920362	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Dictyocaulidae; Dictyocaulinae
Dictyocaulus viviparous	AJ920361	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Dictyocaulidae; Dictyocaulinae
Haemonchus sp. V3091*	DQ503465	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Haemonchidae; Haemonchinae
Haemonchus contortus	L04153	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Haemonchidae; Haemonchinae
Haemonchus placei	L04154	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Haemonchidae; Haemonchinae
Haemonchus similis	L04152	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Haemonchidae; Haemonchinae
Ostertagia ostertagi	AJ920352	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Haemonchidae; Ostertagiinae
Ostertagia leptospicularis	AJ920351	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Haemonchidae; Ostertagiinae
Nippostrongylus brasiliensis	AJ920356	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Heligmonellidae; Nippostrongylinae
Heligmosomoides polygyrus	AJ920355	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Heligmosomatidae
Trichostrongylus colubriformis	AJ920350	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Trichostrongylidae
Tetrabothriostrongylus mackerrasae	AJ920359	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Mackerrastrongylidae
Herpetostrongylus pythonis	AJ920358	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Herpetostrongylidae

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Nicollina cameroni	AJ920357	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Nicollinidae
Filarinema flagrifer	AJ920354	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Dromaeostrongylidae
Amidostomum cygni	AJ920353	Nematoda; Chromadorea; Rhabditida; Strongylida; Trichostrongyloidea; Amidostomatidae
Teratocephalus lirellus	AF036607	Nematoda; Chromadorea; Rhabditida; Teratocephaloidea; Teratocephalidae; Teratocephalinae
Brumptaemilius justini	AF036589	Nematoda; Chromadorea; Rhigonematida
Anguillicola crassus	DQ118535	Nematoda; Chromadorea; Spirurida; Dracunculoidea; Anguillicolidae
Dracunculus medinensis	AY852268	Nematoda; Chromadorea; Spirurida; Dracunculoidea; Dracunculidae
Dracunculus oesophageus	AY852269	Nematoda; Chromadorea; Spirurida; Dracunculoidea; Dracunculidae
Dracunculus sp. V3104*	DQ503457	Nematoda; Chromadorea; Spirurida; Dracunculoidea; Dracunculidae
Philonema sp. A	U81574	Nematoda; Chromadorea; Spirurida; Dracunculoidea; Philometridae
Philometra obturans	AY852267	Nematoda; Chromadorea; Spirurida; Dracunculoidea; Philometridae
*Camallanus oxycephalus**	DQ503463	Nematoda; Chromadorea; Spirurida; Camallanida; Camallanidae
Acanthocheilonema viteae	DQ094171	Nematoda; Chromadorea; Spirurida; Filarioidea; Onchocercidae
Loa loa	DQ094173	Nematoda; Chromadorea; Spirurida; Filarioidea; Onchocercidae
Onchocerca cervicularis	DQ094174	Nematoda; Chromadorea; Spirurida; Filarioidea; Onchocercidae
Dirofilaria immitis	AF036638	Nematoda; Chromadorea; Spirurida; Filarioidea; Onchocercidae
Brugia malayi	AF036588	Nematoda; Chromadorea; Spirurida; Filarioidea; Onchocercidae
Wuchereria bancrofti	AF227234	Nematoda; Chromadorea; Spirurida; Filarioidea; Onchocercidae
Litomosoides sigmodontis	AF227233	Nematoda; Chromadorea; Spirurida; Filarioidea; Onchocercidae
Setaria digitata	DQ094175	Nematoda; Chromadorea; Spirurida; Filarioidea; Setariidae
Gnathostoma turgidum	Z96948	Nematoda; Chromadorea; Spirurida; Gnathostomatoidea; Gnathostomatidae
Gnathostoma neoprocyonis	Z96947	Nematoda; Chromadorea; Spirurida; Gnathostomatoidea; Gnathostomatidae
Gnathostoma binuncleatum	Z96946	Nematoda; Chromadorea; Spirurida; Gnathostomatoidea; Gnathostomatidae
Physaloptera alata	AY702703	Nematoda; Chromadorea; Spirurida; Physalopteroidea; Physalopteridae
*Physaloptera turgid**	DQ503459	Nematoda; Chromadorea; Spirurida; Physalopteroidea; Physalopteridae
Ascarophis arctica	DQ094172	Nematoda; Chromadorea; Spirurida; Spiruroidea; Cystidicolidae
*Spinitectus carolini**	DQ503565	Nematoda; Chromadorea; Spirurida; Spiruroidea; Cystidicolidae
*Thelazia lacrymalis**	DQ503458	Nematoda; Chromadorea; Spirurida; Thelazioidea; Thelaziidae
Aphelenchus avenae	AF036586	Nematoda; Chromadorea; Tylenchida; Aphelenchoidea; Aphelenchidae
Aphelenchoides fragariae	AJ966475	Nematoda; Chromadorea; Tylenchida; Aphelenchoidea; Aphelenchidae
Bursaphelenchus sp.	AF037369	Nematoda; Chromadorea; Tylenchida; Aphelenchoidoidea; Aphelenchoididae
Deladenus sp.	AJ966481	Nematoda; Chromadorea; Tylenchida; Sphaerulariidae
Criconema sp.	AJ966480	Nematoda; Chromadorea; Tylenchida; Tylenchina; Criconematoidea; Criconematidae; Criconematinae
Hemicycliophora conida	AJ966471	Nematoda; Chromadorea; Tylenchida; Tylenchina; Criconematoidea; Criconematidae; Hemicycliophorinae
Pratylenchus thornei	AJ966499	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Pratylenchidae; Pratylenchinae
Paratylenchus dianthus	AJ966496	Nematoda; Chromadorea; Tylenchida; Tylenchina; Criconematoidea; Tylenchulidae; Paratylenchidae
Tylenchulus semipentrans	AJ966511	Nematoda; Chromadorea; Tylenchida; Tylenchina; Criconematoidea; Tylenchulidae; Tylenchulinae

Species	**Accession No.**	**Taxonomy**
Ditylenchus angustus	AJ966483	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Anguinidae
Subanguina radicola	AF202164	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Anguinidae; Anguininae
Tylenchorhynchus maximus	AY993979	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Belonolaimidae
Geocenamus quadrifer	AY993977	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Belonolaimidae
Globodera pallid	AFO36592	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Heteroderidae; Heteroderinae
Scutellonema bradys	AJ966504	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Hoplolaimidae; Hoplolaiminae
Helicotylenchus dihystera	AJ966486	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Hoplolaimidae; Hoplolaiminae
Rotylenchus robustus	AJ966503	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Hoplolaimidae; Rotylenchulinae
Meloidogyne arenaria	U42342	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Meloidogynidae; Meloidogyninae
Meloidogyne incognita	U81578	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Meloidogynidae; Meloidogyninae
Meloidogyne javanica	AF442193	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Meloidogynidae; Meloidogyninae
Meloidogyne artiellia	AF442192	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Meloidogynidae; Meloidogyninae
Meloidogyne duytsi	AF442197	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Meloidogynidae; Meloidogyninae
Meloidogyne exigua	AF442200	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Meloidogynidae; Meloidogyninae
Meloidogyne hapla	AF442194	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Meloidogynidae; Meloidogyninae
Meloidogyne ichinohei	AF442191	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Meloidogynidae; Meloidogyninae
Meloidogyne maritima	AF442199	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Meloidogynidae; Meloidogyninae
Meloidogyne microtyla	AF442198	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Meloidogynidae; Meloidogyninae
Nacobbus aberrans	AJ966494	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Pratylenchidae; Nacobbinae
Pratylenchoides ritteri	AJ966497	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Pratylenchidae; Pratylenchinae
Pratylenchoides magnicauda	AF202157	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Pratylenchidae; Pratylenchinae
Hirschmanniella sp. JH_2003	AY284616	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Pratylenchidae; Pratylenchinae
Radopholus similis	AJ966502	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Pratylenchidae; Radopholinae
Pratylenchus goodyeri	AJ966498	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Pratylenchidae; Radopholinae
Boleodorus thylactus clone2	AY993976	Nematoda; Chromadorea; Tylenchida; Tylenchina; Tylenchoidea; Tylenchidae; Boleodorinae
Paractinolaimus macrolaimus	AY993978	Nematoda; Enoplea; Dorylaimida; Dorylaimina; Actinolaimoidea; Paractinolaiminae
Aporcelaimellus obtusicaudatus	DQ141212	Nematoda; Enoplea; Dorylaimida; Dorylaimina; Dorylaimoidea; Aporcelaimidae; Aporcelaiminae
Wilsonema schuurmansstekhoveni	AJ966513	Nematoda; Enoplea; Dorylaimida; Dorylaimina; Dorylaimoidea; Dorylaimidae
Mesodorylaimus cf. nigritulus AV-2005	AJ966490	Nematoda; Enoplea; Dorylaimida; Dorylaimina; Dorylaimoidea; Dorylaimidae; Laimydorinae
Mesodorylaimus japonicus	AJ966489	Nematoda; Enoplea; Dorylaimida; Dorylaimina; Dorylaimoidea; Dorylaimidae; Laimydorinae
Mesodorylaimus bastiani	AJ966488	Nematoda; Enoplea; Dorylaimida; Dorylaimina; Dorylaimoidea; Dorylaimidae; Laimydorinae
Pungentus sp. PDL-2005	AJ966501	Nematoda; Enoplea; Dorylaimida; Dorylaimina; Dorylaimoidea; Nordiidae; Pungentinae
Allodorylaimus sp. PDL-2005	AJ966472	Nematoda; Enoplea; Dorylaimida; Dorylaimina; Dorylaimoidea; Qudsianematidae
Eudorylaimus carteri	AJ966484	Nematoda; Enoplea; Dorylaimida; Dorylaimina; Dorylaimoidea; Qudsianematidae; Qudsianematinae

Species	**Accession No.**	**Taxonomy**
Microdorylaimus sp. PDL-2005	AJ966492	Nematoda; Enoplea; Dorylaimida; Dorylaimina; Dorylaimoidea; Qudsianematidae; Qudsianematinae
Longidorus elongates	AF036594	Nematoda; Enoplea; Dorylaimida; Dorylaimina; Longidoroidea; Longidoridae
Xiphinema rivesi	AF036610	Nematoda; Enoplea; Dorylaimida; Dorylaimina; Longidoroidea; Longidoridae
Tylencholaimus sp. PDL-2005	AJ966510	Nematoda; Enoplea; Dorylaimida; Dorylaimina; Tylencholaimoidea; Tylencholaimidae; Tylencholaiminae
Anoplostoma sp. BHMM_2005	AY854194	Nematoda; Enoplea; Enoplida; Enoploidea; Anoplostomatidae
Adoncholaimus fuscus	AY854195	Nematoda; Enoplea; Enoplida; Enoploidea; Enoplidae
Enoplus meridionalis	Y16914	Nematoda; Enoplea; Enoplida; Enoploidea; Enoplidae
Enoplus brevis	U88336	Nematoda; Enoplea; Enoplida; Enoploidea; Enoplidae
Enoplus communis	AY854192	Nematoda; Enoplea; Enoplida; Enoploidea; Enoplidae
Enoploides brunettii	AY854193	Nematoda; Enoplea; Enoplida; Enoploidea; Thoracostomopsidae
Syringolaimus striatocaudatus	AY854200	Nematoda; Enoplea; Enoplida; Ironoidea; Ironidae
Ironus dentifurcatus	AJ966487	Nematoda; Enoplea; Enoplida; Ironoidea; Ironidae
Calyptronema maxweberi	AY854199	Nematoda; Enoplea; Enoplida; Oncholaimoidea; Enchelidiidae
Viscosia viscose	AY854198	Nematoda; Enoplea; Enoplida; Oncholaimoidea; Oncholaimidae
Viscosia sp. BHMM_2005	AY854197	Nematoda; Enoplea; Enoplida; Oncholaimoidea; Oncholaimidae
Pontonema sp.	AF047890	Nematoda; Enoplea; Enoplida; Oncholaimoidea; Oncholaimidae
Oncholaimus sp. BHMM_2005	AY854196	Nematoda; Enoplea; Enoplida; Oncholaimoidea; Oncholaimidae
Alaimus sp. PDL-2005	AJ966514	Nematoda; Enoplea; Enoplida; Oxystominoidea; Alaimidae
Prismatolaimus intermedius	AF036603	Nematoda; Enoplea; Enoplida; Tripyloidea; Prismatolaimidae
Tobrilus gracilis	AJ966506	Nematoda; Enoplea; Enoplida; Tripyloidea; Tripylidae
Tripyla cf. filicaudata JH-2004 isolate TripFil2Z	AY284731	Nematoda; Enoplea; Enoplida; Tripyloidea; Tripylidae
Bathylaimus sp. PB-2005	AM234619	Nematoda; Enoplea; Enoplida; Tripyloidoidea; Tripyloididae
Bathylaimus assimilis	AJ966476	Nematoda; Enoplea; Enoplida; Tripyloidoidea; Tripyloididae
Bathylaimus sp. BHMM_2005	AY854201	Nematoda; Enoplea; Enoplida; Tripyloidoidea; Tripyloididae
Tripyloides sp. BHMM_2005	AY854202	Nematoda; Enoplea; Enoplida; Tripyloidoidea; Tripyloididae
Trischistoma monohystera	AJ966509	Nematoda; Enoplea; Enoplida; Tripyloidoidea; Tripyloididae
Mermis nigrescens	AF036641	Nematoda; Enoplea; Mermithida; Mermithoidea; Mermithidae
Mylonchulus arenicolus	AF036596	Nematoda; Enoplea; Mononchida; Mononchina; Mononchoidea; Mylonchulidae; Mylonchulinae
Anatonchus tridentatus	AJ966474	Nematoda; Enoplea; Mononchida; Mononchina; Anatonchoidea; Anatonchidae
Mononchus truncates	AJ966493	Nematoda; Enoplea; Mononchida; Mononchina; Mononchoidea; Mononchidae; Mononchinae
Prionchulus muscorum	AJ966500	Nematoda; Enoplea; Mononchida; Mononchina; Mononchoidea; Mononchidae; Prionchulinae
Clarkus sp. PDL-2005	AJ966479	Nematoda; Enoplea; Mononchida; Mononchina; Mononchoidea; Mononchidae; Prionchulinae
Trichinella spiralis	TSU60231	Nematoda; Enoplea; Trichocephalida; Trichinellidae
Trichinella papuae	AY851263	Nematoda; Enoplea; Trichocephalida; Trichinellidae
Trichinella britovi	AY851257	Nematoda; Enoplea; Trichocephalida; Trichinellidae
Trichinella murelli	AY851259	Nematoda; Enoplea; Trichocephalida; Trichinellidae
Trichinella pseudospiralis	AY851258	Nematoda; Enoplea; Trichocephalida; Trichinellidae
Trichinella native	AY851256	Nematoda; Enoplea; Trichocephalida; Trichinellidae
Trichinella zimbabwensis	AY851264	Nematoda; Enoplea; Trichocephalida; Trichinellidae
Trichinella nelson	AY851261	Nematoda; Enoplea; Trichocephalida; Trichinellidae

Species	**Accession No.**	**Taxonomy**
Trichuris suis	AY851265	Nematoda; Enoplea; Trichocephalida; Trichiuridae
Trichuris trichiura	DQ118536	Nematoda; Enoplea; Trichocephalida; Trichiuridae
Trichuris muris	AF036637	Nematoda; Enoplea; Trichocephalida; Trichiuridae
Tylolaimophorus minor	AJ966512	Nematoda; Enoplea; Triplonchida; Diphtherophorina; Diphtherophoroidea; Diphtherophoridae
Paratrichodorus pachydermus	AF036601	Nematoda; Enoplea; Triplonchida; Diphtherophorina; Trichodoroidea; Trichodoridae
Paratrichodorus anemones	AF036600	Nematoda; Enoplea; Triplonchida; Diphtherophorina; Trichodoroidea; Trichodoridae
Trichodorus primitivus	AF036609	Nematoda; Enoplea; Triplonchida; Diphtherophorina; Trichodoroidea; Trichodoridae

Appendix 6.2: Alignment of the 5’ end of the SSU rRNA gene for the Nematoda. Positions included for the phylogeny analyses were marked by “`m`” within “`NUCEOTIDES INCLUDED`”. This alignment included new nematode sequences from Chapter 6 *and* Chapter 7.

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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         10         20         30         40         50         60
Gordius_aquaticus                ---CTGGTTG ATYCTGCCAG TAGTCATATG CTT------- ---------- ----------
Priapulus_caudatus               AACCTGGTTG ATCCTGCCAG TAGTCATATG CTT------- ---------- ----------
Brachionus_plicatilis            -ACCTGGTTG ATCCTGCCAG TAGTCATATG CTT------- ---------- ----------
Chordodes_morgani                ---------- ---------- ---AAGCTTG CTT------- ---------- ----------
Paractinolaimus_macrolaimus      ---------- ---------- ---------- ---------- ---------- ----------
Aporcelaimellus_obtusicaudatus   ---------- ---------- ---------- ---------- ---------- ----------
Wilsonema_schuurmansstekhoveni   ---------- ---------- ---------- ---------- ---------- ----------
Mesodorylaimus_sp_cf_nigritul    ---------- ---------- ---------- ---------- ---------- ----------
Mesodorylaimus_bastiani          ---------- ---------- ---------- ---------- ---------- ----------
Mesodorylaimus_japonicus         ---------- ---------- ---------- ---------- ---------- ----------
Pungentus_sp._PDL_2005           ---------- ---------- ---------- ---------- ---------- ----------
Allodorylaimus_sp                ---------- ---------- ---------- ---------- ---------- ----------
Eudorylaimus_carteri             ---------- ---------- ---------- ---------- ---------- ----------
Microdorylaimus_sp               ---------- ---------- ---------- ---------- ---------- ----------
Longidorus_elongatus             ---------- ---------- ---------- ---------- ---------- ----------
Xiphinema_rivesi                 ---------- ---------- ---------- ---------- ---------- ----------
Tylencholaimus_sp                ---------- ---------- ---------- ---------- ---------- ----------
Anoplostoma_sp._BHMM_2005        ---------- ---------- ---------- ---------- ---------- ----------
Adoncholaimus_fuscus             ---------- ---------- ---------- ---------- ---------- ----------
Enoplus_meridionalis             ---------- ---------- GAATTCGTCG ACAACCTGGT TGATCCTGCC AGTAGTCATA
Enoplus_brevis_U88336            ---------- ---------- ---------- --AGCCTGGT TGATCCTGCC AGTAGTCATA
Enoplus_communis                 ---------- ---------- ---------- ---------- ---------- ----------
Enoploides_brunettii             ---------- ---------- ---------- ---------- ---------- ----------
Syringolaimus_striatocaudatus    ---------- ---------- ---------- ---------- ---------- ----------
Ironus_dentifurcatus             ---------- ---------- ---------- ---------- ---------- ----------
Calyptronema_maxweberi           ---------- ---------- ---------- ---------- ---------- ----------
Viscosia_sp._BHMM_2005           ---------- ---------- ---------- ---------- ---------- ----------
Viscosia_viscosa                 ---------- ---------- ---------- ---------- ---------- ----------
Pontonema_vulgare                ---------- ---------- ---------- --AACCTGGT TGATCCTGCC AGTAGTCATA
Oncholaimus_sp._BHMM_2005        ---------- ---------- ---------- ---------- ---------- ----------
Alaimus_sp_PDL_2005              ---------- ---------- ---------- ---------- ---------- ----------
Prismatolaimus_intermedius       ---------- ---------- ---------- ---------- ---------- ----------
Tobrilus_gracilis                ---------- ---------- ---------- ---------- ---------- ----------
Tripyla_cf_filicaudata_JH_2004   ---------- ---------- ---------- ---------- ---------- ----------
Bathylaimus_sp                   ---------- ---------- ---------- ---------- ---------- ----------
Bathylaimus_assimilis            ---------- ---------- ---------- ---------- ---------- ----------
Bathylaimus_sp._BHMM_2005        ---------- ---------- ---------- ---------- ---------- ----------
Tripyloides_sp._BHMM_2005        ---------- ---------- ---------- ---------- ---------- ----------
Trischistoma_monohystera         ---------- ---------- ---------- ---------- ---------- ----------
Mermis_nigrescens                ---------- ---------- ---------- ---------- ---------- ----------
Mylonchulus_arenicolus           ---------- ---------- ---------- ---------- ---------- ----------
Anatonchus_tridentacus           ---------- ---------- ---------- ---------- ---------- ----------
Mononchus_truncatus              ---------- ---------- ---------- ---------- ---------- ----------
Prionchulus_muscorum             ---------- ---------- ---------- ---------- ---------- ----------
Clarkus_sp                       ---------- ---------- ---------- ---------- ---------- ----------
Trichinella_spiralis             ---------- ---------- ---------- ---------- ---------- -----AAGCT
Trichinella_papuae               ---------- ---------- ---------- --TACCTGGT TGATCCTGCC AGTAGTCATA
Trichinella_britovi              ---------- ---------- ---------- --TACCTGGT TGATCCTGCC AGTAGTCATA
Trichinella_murrelli             ---------- ---------- ---------- --TACCTGGT TGATCCTGCC AGTAGTCATA
Trichinella_pseudospiralis       ---------- ---------- ---------- --TACCTGGT TGATCCTGCC AGTAGTCATA
Trichinella_nativa               ---------- ---------- ---------- --TACCTGGT TGATCCTGCC AGTAGTCATA
Trichinella_zimbabwensis         ---------- ---------- ---------- --TACCTGGT TGATCCTGCC AGTAGTCATA
Trichinella_nelsoni              ---------- ---------- ---------- --TACCTGGT TGATCCTGCC AGTAGTCATA
Trichuris_suis                   ---------- ---------- ---------- --TACCTGGT TGATCCTGCC AGTAGTCATA
Trichuris_trichiura              ---------- ---------- ---------- ---------- ---------- ----------
Trichuris_muris                  GCTTGCATGC CTGCAGGTCG ACTCTAGAGG ATCCCCGGGT ACCGAGCTCG AATTCAAGCT
Tylolaimophorus_minor            ---------- ---------- ---------- ---------- ---------- ----------
Paratrichodorus_pachydermus      ---------- ---------- ---------- ---------- ---------- ----------
Paratrichodorus_anemones         ---------- ---------- ---------- ---------- ---------- ----------
Trichodorus_primitivus           ---------- ---------- ---------- ---------- ---------- ----------
Axonolaimus_helgolandicus        ---------- ---------- ---------- ---------- ---------- ----------
Ascolaimus_elongatus             ---------- ---------- ---------- ---------- ---------- ----------
Odontophora_rectangula           ---------- ---------- ---------- ---------- ---------- ----------
Cylindrolaimus_sp._202149        ---------- ---------- ---------- ---------- ---------- ----------
Tylocephalus_auriculatus         ---------- ---------- ---------- ---------- ---------- ----------
Plectus_acuminatus_BS9           ---------- ---------- ---------- ---------- ---------- ----------
Plectus_aquatilis                ---------- ---------- ---------- ---------- ---------- ----------
Anaplectus_sp                    ---------- ---------- ---------- ---------- ---------- ----------
Anisakis_sp_WKT                  ---------- ---------- ---------- ---------- ---------- ----------
Anisakis_sp_Nadler               ---------- ---------- ---------- ---------- ---------- ---GGTTATA
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- ---------- ---------- ----------
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         10         20         30         40         50         60
Contracaecum_multipapillatum     ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Pseudoterranova_decipiens        ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Raphidascaris_acus               ---------- ---------- ---------- ---------- ---------- -------ATA
Terranova_caballeroi             ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Ascaris_suum                     ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Ascaris_lumbricoides             ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Baylisascaris_procyonis          ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Baylisascaris_transfuga          ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Parascaris_equorum               ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Porrocaecum_depressum            ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Toxascaris_leonina               ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Heterocheilus_tunicatus          ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Goezia_pelagia                   ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Hysterothylacium_fortalezae      ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Hysterothylacium_pelagicum       ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Hysterothylacium_reliquens       ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Iheringascaris_inquies           ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Toxocara_canis                   ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Nemhelix_bakeri                  ---------- ---------- ---------- ---------- ---------- --------CA
Raillietnema_sp._V3060           ---------- ---------- ---------- ---------- ---------- ----------
Cruzia_americana                 ---------- ---------- ---------- ---------- ---------- ---GGTTATA
Heterakis_sp_14690               ---------- ---------- ---------- ---------- ---------- --CGGTTATA
Heterakis_gallinarum             ---------- ---------- ---------- ---------- ---------- -------ATA
Paraspidodera_sp_21303           ---------- ---------- ---------- ---------- ---------- --CGGTCATA
Chromodora_nudicapitata          ---------- ---------- ---------- ---------- ---------- ----------
Chromadora_sp._BHMM_2005         ---------- ---------- ---------- ---------- ---------- ----------
Atrochromadora_microlaima        ---------- ---------- ---------- ---------- ---------- ----------
Chromadorina_germanica           ---------- ---------- ---------- ---------- ---------- ----------
Chromadorita_tentabundum         ---------- ---------- ---------- ---------- ---------- ----------
Dichromadora_sp._BHMM_2005       ---------- ---------- ---------- ---------- ---------- ----------
Neochromadora_BHMM_2005          ---------- ---------- ---------- ---------- ---------- ----------
Spilophorella_paradoxa           ---------- ---------- ---------- ---------- ---------- ----------
Paracanthonchus_caecus           ---------- ---------- ---------- ------CGGT TGATCCTGCC AGTAGTCATA
Paracyatholaimus_intermedius     ---------- ---------- ---------- ---------- ---------- ----------
Praeacanthonchus_punctatus       ---------- ---------- ---------- ---------- ---------- ----------
Praeacanthonchus_sp              ---------- ---------- ---------- ---------- ---------- ----------
Cyatholaimus_sp._BHMM_2005       ---------- ---------- ---------- ---------- ---------- ----------
Spirinia_parasitifera            ---------- ---------- ---------- ---------- ---------- ----------
Acanthopharynx_micans            ---------- --------GA ATTCGGCTTG ACAACCTGGT TGATCCTGCC AGTGGTCATA
Xyzzors_sp                       --------TG GAATTCGGCT TAATTCGTCG ACAACCTGGT TGATCCTGCC AGTGGTCATA
Metachromadora_sp                ---------- ---------- ---------- ---------- ---------- ----------
Metachromadora_remanei           ---------- ---------- ---------- ---------- ---------- ----------
Catanema_sp                      CCAGTGTGCT GGAATTCGGC TTATTCGTCG ACAACCTGGT TGATCCTGCC AGTGGTCATA
Eubostrichus_dianae              ---------- --------GA ATTCG--TCG ACAACCTGGT TGATCCTGCC AGTGGTCATA
Eubostrichus_topiarus            ---------- --------GA ATTCG--TCG ACAACCTGGT TGATCCTGCC AGTGGTCATA
Eubostrichus_parasitiferus       -----GAATT CGGCTTCCGA ATTCGT-CGA CCAACCTGGT TGATCCTGCC AGTGGTCATA
Laxus_oneistus                   ---------- -GAATTCG-- -------TCG ACAACCTGGT TGATCCTGCC AGTGGTCATA
Laxus_cosmopolitus               ---------- ----TTCG-- -------TCG ACAACCTGGT TGATCCTGCC AGTGGTCATA
Leptonemella_sp                  ---------- TGAATTCG-- ------TCGA CAACCTGGGT TGATCCTGCC AGTGGTCATA
Robbea_hypermnestra              ---------- -GAATTCG-- -------TCG -CAACCTGGT TGAACCTGCC AGTGGTCATA
Stilbonema_majum                 ---------- -GAATTCG-- -------TCG ACAACCTGGT TGATCCTGCC AGTGGTCATA
Monoposthia_costata              ---------- ---------- ---------- ---------- ---------- ----------
Nudora_bipapillata               ---------- ---------- ---------- ---------- ---------- ----------
Calomicrolaimus_parahonestus     ---------- ---------- ---------- ---------- ---------- ----------
Calomicrolaimus_sp._BHMM_2005    ---------- ---------- ---------- ---------- ---------- ----------
Molgolaimus_demani               ---------- ---------- ---------- ---------- ---------- ----------
Diplogaster_lethieri             ---------- ---------- ---------- ---------- ---------- -----AAGCT
Aduncospiculum_halicti           ---------- ---------- ---------- ---------- ---------- ----------
Pristionchus_lheritieri          ---------- ---------- ---------- ---------- ---------- -----AAGCT
Pristionchus_pacificus           ---------- ---------- ---------- ---------- ---------- ----------
Pristionchus_pacificus           ---------- ---------- ---------- ---------- ---------- ----------
Sabatieria_punctata_STRAIN_343   ---------- ---------- ---------- ---------- ---------- ----------
Sabatieria_sp._355_BHMM_2005     ---------- ---------- ---------- ---------- ---------- ----------
Sabatieria_celtica               ---------- ---------- ---------- ---------- ---------- ----------
Sabatieria_punctata_STRAIN_200   ---------- ---------- ---------- ---------- ---------- ----------
Sabatieria_punctata_STRAIN_223   ---------- ---------- ---------- ---------- ---------- ----------
Sabatieria_sp._210_BHM_2005      ---------- ---------- ---------- ---------- ---------- ----------
Setosabatieria_hilarula          ---------- ---------- ---------- ---------- ---------- ----------
Desmolaimus_zeelandicus          ---------- ---------- ---------- ---------- ---------- ----------
Terschellingia_longicaudata      ---------- ---------- ---------- ---------- ---------- ----------
Cyartonema_elegans               ---------- ---------- ---------- ---------- ---------- ----------
Tridentulus_sp                   ---------- ---------- ---------- ---------- ---------- ----------
Diplolaimelloides_meyli          ---------- ---------- ---------- ---------- ---------- ----------
Diplolaimella_diavengatensis     ---------- ---------- ---------- ---------- ---------- ----------
Geomonhystera_disjuncta          ---------- ---------- ---------- ---------- ---------- ----------
Sphaerolaimus_hirsutus           ---------- ---------- ---------- ---------- ---------- ----------
Theristus_acer                   ---------- ---------- ---------- ---------- ---------- ----------
Daptonema_procerus               ---------- ---------- ---------- ---------- ---------- ---GGTCATA
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- ---------- ---------- ----------
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         10         20         30         40         50
Daptonema_hirsutum               ---------- ---------- ---------- ---------- ---------- ----------
Daptonema_normandicum            ---------- ---------- ---------- ---------- ---------- ----------
Daptonema_oxycerca               ---------- ---------- ---------- ---------- ---------- ----------
Daptonema_setosum                ---------- ---------- ---------- ---------- ---------- ----------
Desmodora_communis               ---------- ---------- ---------- ---------- ---------- ----------
Desmodora_ovigera                ---------- --------GA ATTCG--TCG ACAACCTGGT TGATCCTGCC AGTGGTCATA
Metadesmolaimus_sp               ---------- ---------- ---------- ---------- ---------- ----------
Dentostomella_sp                 ---------- ---------- ---------- ---------- ---------- ----------
Bunonema_franzi                  ---------- ---------- ---------- ---------- ---------- ---------T
Bunonema_sp                      ---------- ---------- ---------- ---------- ---------- ----------
Seleborca_complexa               ---------- ---------- ---------- ---------- ---------- ----------
Acrobeloides_nanus               ---------- ---------- ---------- ---------- ---------- ----------
Acrobeloides_bodenheimeri        ---------- ---------- ---------- ---------- ---------- ----------
Acrobeloides_sp_PS1146           ---------- ---------- ---------- ---------- ---------- ----------
Acrobeles_ciliatus               ---------- ---------- ---------- ---------- ---------- ----------
Acrobeles_sp_PS1156              ---------- ---------- ---------- ---------- ---------- ----------
Acrobeles_complexus_WCUG2        ---------- ---------- ---------- ---------- ---------- ----------
Cephaloboides_sp_SB227           ---------- ---------- ---------- ------CTGA TTGATTCTGT CAGCGATGTA
Cephalobus_cubaensis             ---------- ---------- ---------- ---------- ---------- ----------
Cephalobus_sp._PS1143            ---------- ---------- ---------- ---------- ---------- ----------
Cephalobus_sp._PS1196            ---------- ---------- ---------- ---------- ---------- ----------
Cephalobus_oryzae_PS1165         ---------- ---------- ---------- ---------- ---------- ----------
Cervidellus_alutus               ---------- ---------- ---------- ---------- ---------- ----------
Pseudacrobeles_variabilis        ---------- ---------- ---------- ---------- ---------- ----------
Triligulla_aluta                 ---------- ---------- ---------- ---------- ---------- ----------
Zeldia_punctada                  ---------- ---------- ---------- ---------- ---------- ----------
Myolaimus_sp_U81585              ---------- ---------- ---------- ---------- ---------- ----------
Rhabditophanes_sp._KR3021        ---------- ---------- ---------- ---------- ---------- ----------
Brevibucca_sp._SB261             ---------- ---------- ---------- ---------- ---------- ----------
Halicephalobus_gingivalis        ---------- ---------- ---------- ---------- ---------- ----------
Panagrobelus_stammeri            ---------- ---------- ---------- ---------- ---------- ----------
Plectonchus_sp._PDL0025          ---------- ---------- ---------- ---------- ---------- ----------
Turbatrix_aceti                  ---------- ---------- ---------- ---------- ---------- ----------
Panagrellus_redivivus            ---------- ---------- ---------- ---------- ---------- ----------
Panagrellus_redivivus_PS1163     ---------- ---------- ---------- ---------- ---------- ----------
Panagrolaimus_subelongatus       ---------- ---------- ---------- ---------- ---------- ----------
Panagrolaimus_davidi             ---------- ---------- ---------- ---------- ---------- ----------
Panagrolaimus_cf_rigidus_AF40    ---------- ---------- ---------- ---------- ---------- ---------T
Panagrolaimus sp. Sourhope ED2   ---------- ---------- ---------- ---------- ---------- ----------
Panagrolaimus sp. Sourhope ED2   ---------- ---------- ---------- ---------- ---------- ----------
Panagrolaimus sp. Sourhope ED2   ---------- ---------- ---------- ---------- ---------- ----------
Panagrolaimus sp. Sourhope ED2   ---------- ---------- ---------- ---------- ---------- ----------
Panagrolaimus sp. Sourhope ED2   ---------- ---------- ---------- ---------- ---------- ----------
Steinernema_carpocapsae          ---------- ---------- ---------- ---------- ---------- ----------
Strongyloides_stercoralis        ---------- ---------- ---------- ---ACCTGGT TGATCCTGCC AGTAGTCATA
Strongyloides_ratti              ---------- ---------- ---------- ---------- ---------- ----------
Diploscapter_sp_PS1897           ---------- ---------- ---------- ---------- ---------- ---CGGTATA
Diploscapter_sp_PS2017           ---------- ---------- ---------- ---------- ---------- ----------
Heterorhabditis_bacteriophora    ---------- ---------- ---------- ---------- ---------- ----------
Heterorhabditis_hepialus         ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Heterorhabditis_zelandica        ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Parasitorhabditis_sp_SB281       ---------- ---------- ---------- ---------- ---------- ---GACGATA
Rhabditoides_inermiformis        ---------- ---------- ---------- ---------- ---------- ----------
Rhabditoides_inermis_DF5001      ---------- ---------- ---------- ---------- ---------- ---GATCATA
Rhabditoides_regina_DF5012       ---------- ---------- ---------- ---------- ---------- ---GGTGATA
Poikilolaimus_oxycerca_SB200     ---------- ---------- ---------- ---------- ---------- ----------
Poikilolaimus_regenfussi_SB199   ---------- ---------- ---------- ---------- ---------- ----------
Distolabrellus veechi DWF1604    ---------- ---------- ---------- ---------- -GGTTCTGTC AGTGGCGATA
Distolabrellus veechi DF5024     ---------- ---------- ---------- ---------- -GATTCTGTC AGTGGCGATA
Choriorhabditis_dudichi          ---------- ---------- ---------- ---------- ---------- ----------
Protorhabditis_sp                ---------- ---------- ---------- ---------- ---------- ---CGGTATA
Protorhabditis_sp_DF5055         ---------- ---------- ---------- ---------- ---------- ----------
Cruznema_tripartitum_DF5015      ---------- ---------- ---------- ---------- ---------- ----------
Mesorhabditis_sp_PS1179          ---------- ---------- ---------- ---------- ---------- ----------
Mesorhabditis_spiculigera_SB15   ---------- ---------- ---------- ---------- ---------- ----------
Mesorhabditis_anisomorpha_SB12   ---------- ---------- ---------- ---------- ---------- ----------
Teratorhabditis_palmarum_DF501   ---------- ---------- ---------- ---------- ---------- ----------
Teratorhabditis_synpapillata_S   ---------- ---------- -------GCC GCTACCTGAT TGATTCTGTC AGTGGCGATA
Caenorhabditis_briggsae_PB102    ---------- ---------- ---------- ---------- ---------- ----------
Caenorhabditis_elegans_N2        ---------- ---------- ---------- --ATACCTGA TTGATTCTGT CAGCGCGATA
Caenorhabditis_sp_CB5161         ---------- ---------- ---------- ---------- ---------- ----------
Caenorhabditis_sp_PS1010         ---------- ---------- ---------- ---------- ---------- ---CGCGATA
Caenorhabditis_japonica          ---------- ---------- ---------- ---------- ---------- ---CGCGATA
Caenorhabditis_sp_DF5170         ---------- ---------- ---------- ---------- ---------- --GCGCGATA
Caenorhabditis_sp_SB341          ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Caenorhabditis_plicata           ---------- ---------- ---------- ---------- ---------- ---CGCGATA
Caenorhabditis_vulgaris          ---------- ---------- ---------- ---------- ---------- ----------
Caenorhabditis_sonorae           ---------- ---------- ---------- ---------- ---------- ---CGCTATA
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- ---------- ---------- ----------
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                          10         20         30         40         50
Caenorhabditis_drosophilae       ---------- ---------- ---------- ---------- ---------- ---CGCGATA
Phasmarhabditis_hermaphrodita    ---------- ---------- ---------- ---------- ---------- ----------
Phasmarhabditis_neopapillosa     ---------- ---------- ---------- ---------- ---------- ----------
Phasmarhabditis_neopapillosa     ---------- ---------- ---------- ---------- ---------- ---CGCTGTA
Pellioditis_mediterranea_SB173   ---------- ---------- ---------- ---------- ---------- ---CGCTGTA
Pellioditis_marina               ---------- ---------- ---------- ---------- ---------- ---CGCTGTA
Prodontorhabditis_wirthi         ---------- ---------- ---------- ---------- ---------- ---------T
Crustorhabditis_scanica          ---------- ---------- ---------- ---------- ---------- ----------
Dolichorhabditis_sp_CEW1         ---------- ---------- ---------- ---------- ---------- ----------
Oscheius_sp_DF5000               ---------- ---------- ---------- --------GA TTGATTCTGT CAGCGCTGTA
Oscheius_sp_BW282                ---------- ---------- ---------- ---------- ---------- ---CGCTGTA
Oscheius_myriophila_EM435        ---------- ---------- ---------- ---------- ---------- ----------
Oscheius_insectivora             ---------- ---------- ---------- ---------- ---------- ---CGCTGTA
Oscheius_dolichuroides           ---------- ---------- ---------- ---------- ---------- ---CGCTGTA
Rhabditis_blumi_DF5010           ---------- ---------- ---------- ---------- ---------- ----------
Rhabditis_sp_PS1191              ---------- ---------- ---------- ---------- ---------- ---CGCTGTA
Rhabditis_sp_PS1010              ---------- ---------- ---------- ---------- ---------- ----------
Rhabditis_myriophila_EM435       ---------- ---------- ---------- ---------- ---------- ----------
Rhabditis_colombiana             ---------- ---------- ---------- ---------- ---------- ----------
Rhabditella_axei_DF5006          ---------- ---------- ---------- ---------- ---------- ----------
Rhabditella_sp_DF5044            ---------- ---------- ---------- ---------- ---------- ---CGATGTA
Cuticularia_sp_PS2083            ---------- ---------- ---------- ---------- ---------- ----------
Necator_americanus               ---------- ---------- ---------- ---------- ---------- ----------
Kalicephalus_cristatus           ---------- ---------- ---------- --GTACCTGA TTGATTCTGT CAGCGCTATA
Ancylostoma_caninum              ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Angiostrongylus_cantonensis      ---------- ---------- ---------- ---------- ---------- ----------
Angiostrongylus_costaricensis    ---------- ---------- ---------- ---------- ---------- ----------
Angiostrongylus_malaysiensis     ---------- ---------- ---------- ---------- ---------- ----------
Angiostrongylus_dujardini        ---------- ---------- ---------- ---------- ---------- ----------
Angiostrongylus_vasorum          ---------- ---------- ---------- ---------- ---------- ----------
Aulurostrongylus_abstrusus       ---------- ---------- ---------- ---------- ---------- ---CGATATA
Didelphostrongylus_hayesi        ---------- ---------- ---------- ---------- ---------- -----TATAT
Crenosoma_mephitidis             ---------- ---------- ---------- ---------- ---------- -----TATAT
Crenosoma_vulpis                 ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Otostrongylus_circumlitus        ---------- ---------- ---------- ---------- ---------- ----------
Troglostrongylus_wilsoni         ---------- ---------- ---------- ---------- ---------- ----------
Filaroides_martis                ---------- ---------- ---------- ---------- ---------- ----------
Oslerus_osleri                   ---------- ---------- ---------- ---------- ---------- ----------
Parafilaroides_decorus           ---------- ---------- ---------- ---------- ---------- ----------
Metastrongylus_salmi             ---------- ---------- ---------- ---------- ---------- ----------
Metastrongylus_elongatus         ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Skrjabingylus_chitwoodrum        ---------- ---------- ---------- ---------- ---------- ------TATA
Parelaphostrongylus_odocoilei    ---------- ---------- ---------- ---------- ---------- ----------
Muelerius_capillaris             ---------- ---------- ---------- ---------- ---------- ----------
Protostrongylus_rufescens        ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Halocercus_invaginatus           ---------- ---------- ---------- ---------- ---------- ----------
Pseudalius_inflexus              ---------- ---------- ---------- ---------- ---------- ----------
Stenurus_minor                   ---------- ---------- ---------- ---------- ---------- ----------
Torynurus_convolutus             ---------- ---------- ---------- ---------- ---------- ----------
Syngamus_trachea                 ---------- ---------- ---------- ---TACCTGA TTGATTCTGT CAGCGCTATA
Stephanurus_dentatus             ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Nematodirus_battus               ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Strongylus_equinus               ---------- ---------- ---------- ---------- ---------- ----TAAGCC
Labiostrongylus_bipapillosus     ---------- ---------- ---------- ---TACCTGA TTGATTCTGT CAGCGCTATA
Petrovinema_poculatum            ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Cylicocyclus_insignis            ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Chabartia_ovina                  ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Cyclodontostomum_purvisi         ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Zoniolaimus_mawsonae             ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Hypodontus_macropi               ---------- ---------- ---------- ---TACCTGA TTGATTCTGT CAGCGCTATA
Deletrocephalus_dimidiatus       ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Dictyocaulus_eckerti_P7B8        ---------- ---------- ---------- ---------- ---------- ----------
Dictyocaulus_capreolus_P3B2      ---------- ---------- ---------- ---------- ---------- ----------
Dictyocaulus_sp._P6A1            ---------- ---------- ---------- ---------- ---------- ----------
Dictyocaulus_filaria             ---------- ---------- ---------- ---------- ---------- ----------
Dictyocaulus_capreolus_P2C10     ---------- ---------- ---------- ---------- ---------- ----------
Dictyocaulus_viviparus           ---------- ---------- ---------- ---------- ---------- ----------
Haemonchus_sp._V3091             ---------- ---------- ---------- ---------- ---------- ----------
Haemonchus_contortus             ---------- ---------- ---------- ---TACCTGA TTGATTCTGT CAGCGCTATA
Haemonchus_placei                ---------- ---------- ---------- ---TACCTGA TTGATTCTGT CAGCGCTATA
Haemonchus_similis               ---------- ---------- ---------- ---TACCTGA TTGATTCTGT CAGCGCTATA
Ostertagia_ostertagi             ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Ostertagia_leptospicularis       ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Nippostrongylus_brasileinsis     ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Heligmosomoides_polygyrus        ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Trichostrongylus_colubriformis   ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Tetrabothriostrongylus mackerr   ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Herpestrongylus_pythonis         ---------- ---------- ---------- ---------- ---------- ---CGCTATA
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- ---------- ---------- ----------
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                              ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                      10         20         30         40         50
Nicollina_cameroni            ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Filarimena_flagrifer          ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Amidostomum_cygni             ---------- ---------- ---------- ---------- ---------- ---CGCTATA
Teratocephalus_lirellus       ---------- ---------- ---------- ---------- ---------- ----------
Brumptaemilius_justini        ---------- ---------- ---------- ---------- ---------- ----------
Anguillicola_crassus          ---------- ---------- ---------- ---------- ---------- ----------
Dracunculus_medinensis        ---------- ---------- ---------- ---------- ---------- ----------
Dracunculus_oesophageus       ---------- ---------- ---------- ---------- ---------- ----------
Dracunculus_sp._V3104         ---------- ---------- ---------- ---------- ---------- ----------
Philonema_sp_A                ---------- ---------- ---------- ---------- ---------- ----------
Philometra_obturans           ---------- ---------- ---------- ---------- ---------- ----------
Camallanus_oxycepahalus       ---------- ---------- ---------- ---------- ---------- ----------
Acanthocheilonema_viteae      ---------- ---------- ---------- ---------- ---------- ----------
Loa_loa                       ---------- ---------- ---------- ---------- ---------- ----------
Onchocerca_cervicalis         ---------- ---------- ---------- ---------- ---------- ----------
Dirofilaria_immitis           ---------- ---------- ---------- ---------- ---------- ----------
Brugia_malayi                 ---------- ---------- ---------- ---------- ---------- ----------
Wuchereria_bancrofti          ---------- ---------- ---------- ---------- ---------- ----------
Litomosoides_sigmodontis      ---------- ---------- ---------- ---------- ---------- ----------
Setaria_digitata              ---------- ---------- ---------- ---------- ---------- ----------
Gnathostoma_turgidum          ---------- ---------- ---------- --TCTCCGAT TGATTCTGTC GGCGATTATA
Gnathostoma_neoprocyonis      ---------- ---------- ---------- --TCTCCGAT TGATTCTGTC GGCGATTATA
Gnathostoma_binucleatum       ---------- ---------- ---------- --TCTCCGAT TGATTCTGTC GGCGATTATA
Physaloptera_alata            ---------- ---------- ---------- ---------- ---------- ----------
Physaloptera_turgida          ---------- ---------- ---------- ---------- ---------- ----------
Ascarophis_arctica            ---------- ---------- ---------- ---------- ---------- ----------
Spinitectus_carolini          ---------- ---------- ---------- ---------- ---------- ----------
Thelazia_lacrymalis           ---------- ---------- ---------- ---------- ---------- ----------
Aphelenchus_avenae            ---------- ---------- ---------- ---------- ---------- ----------
Aphelenchoides_fragariae      ---------- ---------- ---------- ---------- ---------- ----------
Bursaphelelenchus_sp          ---------- ---------- ---------- ---------- ---------- ----------
Deladenus_sp                  ---------- ---------- ---------- ---------- ---------- ----------
Criconema_sp                  ---------- ---------- ---------- ---------- ---------- ----------
Hemicycliophora_conida        ---------- ---------- ---------- ---------- ---------- ----------
Paratylenchus_dianthus        ---------- ---------- ---------- ---------- ---------- ----------
Pratylenchus_thornei          ---------- ---------- ---------- ---------- ---------- ----------
Tylenchulus_semipentrans      ---------- ---------- ---------- ---------- ---------- ----------
Ditylenchus_angustus          ---------- ---------- ---------- ---------- ---------- ----------
Subanguina_radicola           ---------- ---------- ---------- ---------- ---------- ----------
Tylenchorhynchus_maximus      ---------- ---------- ---------- ---------- ---------- ----------
Geocenamus_quadrifer          ---------- ---------- ---------- ---------- ---------- ----------
Globodera_pallida             ---------- ---------- ---------- ---------- ---------- ----------
Scutellonema_bradys           ---------- ---------- ---------- ---------- ---------- ----------
Helicotylenhcus_dihystera     ---------- ---------- ---------- ---------- ---------- ----------
Rotylenchus_robustus          ---------- ---------- ---------- ---------- ---------- --------CA
Meloidogyne_arenaria          ---------- ---------- ---------- -ATATCTGGT TGATCCTGCC TGAACTGATG
Meloidogyne_incognita_KT      ---------- ---------- ---------- ---------- ---------- ----------
Meloidogyne_javanica          ---------- ---------- ---------- ---------- ---------- ----------
Meloidogyne_artiellia         ---------- ---------- ---------- ---------- ---------- ----------
Meloidogyne_duytsi            ---------- ---------- ---------- ---------- ---------- ----------
Meloidogyne_exigua            ---------- ---------- ---------- ---------- ---------- ----------
Meloidogyne_hapla             ---------- ---------- ---------- ---------- ---------- ----------
Meloidogyne_ichinohei         ---------- ---------- ---------- ---------- ---------- ---------G
Meloidogyne_maritima          ---------- ---------- ---------- ---------- ---------- ----------
Meloidogyne_microtyla         ---------- ---------- ---------- ---------- ---------- ----------
Nacobbus_aberrans             ---------- ---------- ---------- ---------- ---------- ----------
Pratylenchoides_ritteri       ---------- ---------- ---------- ---------- ---------- ----------
Pratylenchoides_magnicauda    ---------- ---------- ---------- ---------- ---------- ----------
Hirschmanniella_sp._JH_2003   ---------- ---------- ---------- ---------- ---------- ----------
Radopholus_similis            ---------- ---------- ---------- ---------- ---------- ----------
Pratylenchus_goodeyi_VF       ---------- ---------- ---------- ---------- ---------- ----------
Boleodorus_thylactus_clone2   ---------- ---------- ---------- ---------- ---------- ---------T
Philippine Sequence 1         ---------- ---------- ---------- ---------- ---------- ----------
Philippine Sequence 2         ---------- ---------- ---------- ---------- ---------- ----------
Philippine Sequence 3         ---------- ---------- ---------- ---------- ---------- ----------
Philippine Sequence 4         ---------- ---------- ---------- ---------- ---------- ----------
Philippine Sequence 5         ---------- ---------- ---------- ---------- ---------- ----------
Philippine Sequence 6         ---------- ---------- ---------- ---------- ---------- ----------
Philippine Sequence 7         ---------- ---------- ---------- ---------- ---------- ----------
Tahiti Sequence 1             ---------- ---------- ---------- ---------- ---------- ----------
Tahiti Sequence 2             ---------- ---------- ---------- ---------- ---------- ----------
Thailand Sequence 1           ---------- ---------- ---------- ---------- ---------- ----------
Ogasawara Sequence 1          ---------- ---------- ---------- ---------- ---------- ----------
Ogasawara Sequence 2          ---------- ---------- ---------- ---------- ---------- ----------
Ivory Coast Sequence 1        ---------- ---------- ---------- ---------- ---------- ----------
Ivory Coast Sequence 2        ---------- ---------- ---------- ---------- ---------- ----------
Ivory Coast Sequence 3        ---------- ---------- ---------- ---------- ---------- ----------
Ivory Coast Sequence 4        ---------- ---------- ---------- ---------- ---------- ----------
NUCLEOTIDES INCLUDED          ---------- ---------- ---------- ---------- ---------- ----------
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         10         20         30         40         50
Ivory Coast Sequence 5           ---------- ---------- ---------- ---------- ---------- ----------
Ivory Coast Sequence 6           ---------- ---------- ---------- ---------- ---------- ----------
Ivory Coast Sequence 7           ---------- ---------- ---------- ---------- ---------- ----------
Singapore Sequence 1             ---------- ---------- ---------- ---------- ---------- ----------
Singapore Sequence 2             ---------- ---------- ---------- ---------- ---------- ----------
Singapore Sequence 3             ---------- ---------- ---------- ---------- ---------- ----------
Singapore Sequence 4             ---------- ---------- ---------- ---------- ---------- ----------
Nigerian Sequence 1              ---------- ---------- ---------- ---------- ---------- ----------
Nigerian Sequence 2              ---------- ---------- ---------- ---------- ---------- ----------
Nigerian Sequence 3              ---------- ---------- ---------- ---------- ---------- ----------
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- ---------- ---------- ----------


                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         70         80         90        100        110        120
Gordius_aquaticus                -----GTCTC AAAGATTAAG CCATGCATGT ATAA-GT--A T-AAAC-TA- --ACTTA-AA
Priapulus_caudatus               -----GTCTC AAAGATTAAG CCATGCATGT CTAA-GT--A C-AGAC-GG- --ATACA-AA
Brachionus_plicatilis            -----GTCTC AAAGATTAAG CCATGCATGT CTAA-GT--A C-ATAC-CT- --TAGCA-CG
Chordodes_morgani                -----GTCTC AAAGATTAAG CCATGCATGT CTAA-GT--A T-AAAC-TT- --ACTAC-Aa
Paractinolaimus_macrolaimus      TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A C-ATGC-CT- --TAATA-CG
Aporcelaimellus_obtusicaudatus   ---------- ---GAT-AAG CCATGCATGT CTAA-GC--A C-ATGC-CT- --TAATA-CG
Wilsonema_schuurmansstekhoveni   -------CTC AAAGATTAAG CCATGCATGT CTAT-GC--A C-AAGC-CG- --ATTAA-TG
Mesodorylaimus_sp_cf_nigritul    ---------- ---GATTAAG CCATGCATGT CTAA-GC--A C-ATGC-CT- --TAATA-CG
Mesodorylaimus_bastiani          ------TCTC AAAGATTAAG CCATGCATGT CTAA-GC--A C-ATGC-CT- --TTATA-AG
Mesodorylaimus_japonicus         -------CTC AAAGATTAAG CCATGCATGT CTAA-GC--A C-ATGC-CA- --TTTTA-TG
Pungentus_sp._PDL_2005           -------TTT AAAGATTAAG CCATGCATGT CTAA-GC--A C-ATGC-CT- --TAAAA-CG
Allodorylaimus_sp                -------CTC AAAGATTAAG CCATGCATGT CTAA-GC--A C-ATGC-CT- --TAATA-CG
Eudorylaimus_carteri             ------TCTC AAAGATTAAG CCATGCATGT CTAA-GC--A C-ATGC-CT- --TAATA-CG
Microdorylaimus_sp               --------TC AAAGATTAAG CCATGCATGT CTAA-GC--A C-ATGC-CT- --TAATA-CG
Longidorus_elongatus             --GCTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A C-ATGC-CT- --TAATA-CG
Xiphinema_rivesi                 ---------- ------TAAG CCATGCATGT CTAA-GC--A C-ATGC-CT- --TAATA-CG
Tylencholaimus_sp                --------CC AAAGATTAAG CCATGCATGT CTAA-GC--A C-ATGC-CT- --TAATA-CG
Anoplostoma_sp._BHMM_2005        ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A C-ATGC-CG- --ATTAA-TG
Adoncholaimus_fuscus             ----TGTCTC AAAGATTAAG CCATGCATGT CTAG-GC--A T-AAAT-GA- --ATCAA-TT
Enoplus_meridionalis             TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GT--A C-ATAC-TG- --ATTAA-TA
Enoplus_brevis_U88336            T-CTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GT--A C-ACAC-TG- --ATTAA-TA
Enoplus_communis                 ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GT--A C-ACAC-TG- --ATTAA-TA
Enoploides_brunettii             ----TGTCTC AAAGATTAAG CCATGCATGT CTCA-GT--A C-ATAC-TG- --ATTAA-TA
Syringolaimus_striatocaudatus    ----TGTCTC AAAGATTAAG CCATGCATGT GTAA-GC--A T-GAGC-CT- --CAAAA-TG
Ironus_dentifurcatus             -------CTC AAAGATTAAG CCATGCAAGT CTAA-GC--A C-ATGC-CG- --ATTAA-AG
Calyptronema_maxweberi           ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A C-AAGC-TA- --TTTAA---
Viscosia_sp._BHMM_2005           ----TGTCTC AAAGATTAAG CCATGCATGT CTCA-GC--A T-AAAT-AA- --ATTCCATT
Viscosia_viscosa                 ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-AAAT-GA- --ATTCA-TA
Pontonema_vulgare                TGCTTGTCTC AAAGACTAAG CCATGCATGT CTAA-GC--A C-AAAC-TA- --TT-AA-TT
Oncholaimus_sp._BHMM_2005        ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GT--A T-GAAC-TA- --TCTAG---
Alaimus_sp_PDL_2005              ---------- AAAGATTAAG CCATGCATGT CTAA-GC--A C-ACGC-CG- --ATAAA-TG
Prismatolaimus_intermedius       ---------- AAAGATTAAG CCATGCATGT CTAA-GC--A C-AAGC-CT- --AAGAA-TG
Tobrilus_gracilis                -------CTC AAAGATTAAG CCATGCATGT CTAA-GC--A C-AAGC-CC- --TTGAA-TG
Tripyla_cf_filicaudata_JH_2004   -------CTC AAAGATTAAG CCATGCATGT CTAA-GC--- -AGAGC-CC- --TTGAA-TG
Bathylaimus_sp                   ------TCTC AAAGATTAAG CCATGCAAGT CTTA-GC--A C-AAGC-CG- --TTAGTATG
Bathylaimus_assimilis            ------TCTC AAAGATTAAG CCATGCAAGT CTTA-GC--A C-AAGC-CG- --TTAGTATG
Bathylaimus_sp._BHMM_2005        ----TGTCTC AAAGATTAAG CCATGCAAGT CTAA-GC--A C-AAGC-CG- --TCAGTATG
Tripyloides_sp._BHMM_2005        ----TGTCTC AAAGATTAAG CCATGCAAGT CTAA-GC--A C-AAGC-CG- --TTAAA-TG
Trischistoma_monohystera         ------TCTC AAAGATTAAG CCATGCATGT CTAA-GC--A C-AAGC-CG- --AA-CAATG
Mermis_nigrescens                -GCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A C-ATGC-C-- --TTAAAACG
Mylonchulus_arenicolus           ---------- AAAGATTAAG CCATGCATGT GTAA-GC--A C-ATGC-C-- --TTAAAACG
Anatonchus_tridentacus           ---------- AAAGATTAAG CCATGCATGT GTAA-GC--A C-ATGC-C-- --TTAAAATG
Mononchus_truncatus              ------TCTC AAAGATTAAG CCATGCATGT CTAA-GC--A C-ATGC-C-- --TTAAAATG
Prionchulus_muscorum             ---------- AAAGATTAAG CCATGCATGT GTAA-GC--A C-ATGC-C-- --TTAAAATG
Clarkus_sp                       ------TCTC AAAGATTAAG CCATGCATGT GTAA-GC--A C-ATGC-C-- --TTAAAACG
Trichinella_spiralis             TGCTTGTCTC AAAGATTAAG CCATGCATGT GTAA-GC--A C-ACAC-TGT T-TTAAAA--
Trichinella_papuae               TGCTTGTCTC AAAGATTAAG CCATGCATGT GTAA-GC--A C-ACAC-TGT T-TTAAAA--
Trichinella_britovi              TGCTTGTCTC AAAGATTAAG CCATGCATGT GTAA-GC--A C-ACAC-TGT T-TTAAAA--
Trichinella_murrelli             TGCTTGTCTC AAAGATTAAG CCATGCATGT GTAA-GC--A C-ACAC-TGT T-TTAAAA--
Trichinella_pseudospiralis       TGCTTGTCTC AAAGATTAAG CCATGCATGT GTAA-GC--A C-ACAC-TGT T-TTAAAA--
Trichinella_nativa               TGCTTGTCTC AAAGATTAAG CCATGCATGT GTAA-GC--A C-ACAC-TGT T-TTAAAA--
Trichinella_zimbabwensis         TGCTTGTCTC AAAGATTAAG CCATGCATGT GTAA-GC--A C-ACAC-TGT T-TTAAAA--
Trichinella_nelsoni              TGCTTGTCTC AAAGATTAAG CCATGCATGT GTAA-GC--A C-ACAC-TGT G-TTAAAA--
Trichuris_suis                   TGCTTGTCTC AAAGACTAAG CCATGCAAGT GCAA-GC--G C-ACAC-CG- --CTGAA-CG
Trichuris_trichiura              ---------- AAAGATTAAG CCATGCAAGT GCAA-GC--G C-ATAT-CG- --GTCTA-CG
Trichuris_muris                  TGCTTGTCTC AAAGATTCCG CCATGCAATG GCAA-GC--G C-ACAC-CG- --CTGAA-CG
Tylolaimophorus_minor            ---------C AAAGATTAAG CCATGCATGT GCCA-GC--A C-ACGC-CC- --TTGTA-AG
Paratrichodorus_pachydermus      ---------C AAAGATTAAG CCATGCATGT CTAA-GC--A C-AAGC-CC- --TTGAA-TG
Paratrichodorus_anemones         --------TC AAAGATTAAG CCATGCATGT CTAA-GC--A C-ACGC-CC- --TTGAA-TG
Trichodorus_primitivus           ---------- ---------- CCATGCATGT CTAT-GC--A C-ACGC-CC- --TTGAA-TG
Axonolaimus_helgolandicus        ----TGTCTC AAAGATTAAG CCATGCATGT CTAT-GC--A C-AAGC-CT- --AACTA-AG
Ascolaimus_elongatus             ----TGTCTC AAAGATTAAG CCATGCATGT TTAT-GC--A C-AAGC-CT- --AACTA-AG
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- ---------- ---------- ----------
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         70         80         90        100        110        120
Odontophora_rectangula           ---------- ---------- ---------- ---------- --aagc-ct- --aata--ag
Cylindrolaimus_sp._202149        TGGCTGTCTC AAAGATTAAG CCATGCATGT CTAT-GC--A C-AAGC-CA- --AATTA-AG
Tylocephalus_auriculatus         ---------- ---------- -----CATGT CTAA-GC--A C-AAGC-CG- --ATTAA-TG
Plectus_acuminatus_BS9           ---------- ---------- ---------- ---------- --AAGC-CG- --TTTAA-TG
Plectus_aquatilis                TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAT-GC--A C-AAGC-CG- --AATA--TG
Anaplectus_sp                    -------CTC AAAGATTAAG CCATGCATGT CTAA-GC--A C-AAGC-CG- --AATA--CG
Anisakis_sp_WKT                  ---------- ---------- -------TGT CTAA-GTTCA AATGGC-CT- --ATAGA-AG
Anisakis_sp_Nadler               TGCTTATCTC GAAGGCTAAG CCATGCATGT CTAA-GTTCA AATGGC-CT- --ATAGA-AG
Contracaecum_multipapillatum     TGCTTATCTC AAAGGCTAAG CCATGCATGT CTAT-GTTCA AATGGC-CT- --ATAA--AG
Pseudoterranova_decipiens        TGCTTATCTC AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATGGC-CT- --ATAGA-AG
Raphidascaris_acus               TGCTTATCTC AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATAGC-CT- --ATAAA--G
Terranova_caballeroi             TGCTTATCTC AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATGGC-CT- --ATAAA-AG
Ascaris_suum                     TGCTTATCTC AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATGGC-CT- --ATAA--AG
Ascaris_lumbricoides             TGCTTATCTC AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATGGC-CT- --AAAA--AG
Baylisascaris_procyonis          TGCTTATCTC AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATGGC-CT- --ATAA--AG
Baylisascaris_transfuga          TGCTTATCTC AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATGGC-CT- --ATAA--AG
Parascaris_equorum               TGCTTATCTC AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATGGC-CT- --ATAA--AG
Porrocaecum_depressum            TGCTTATCTC AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATGGC-CT- --ATAA--AG
Toxascaris_leonina               TGCTTATCTC AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATGGC-CT- --ATAA--AG
Heterocheilus_tunicatus          TGCTTATCTC AAAGGCTAAG CCATGCATGT CTCA-GTTCA AATGGC-CT- --TAA---AG
Goezia_pelagia                   TGCTTATCTC AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATAGC-CT- --TTAA--AG
Hysterothylacium_fortalezae      TGCTTATCTC AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATAGC-CT- --AAA---AG
Hysterothylacium_pelagicum       TGCTTATCTC AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATAGC-CT- --ATAA--AG
Hysterothylacium_reliquens       TGCTTATCTC AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATAGC-CT- --ATAA--AG
Iheringascaris_inquies           TGCTTATCTG AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATAGC-CT- --ATAA--AG
Toxocara_canis                   TGCTTATCTC AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATGGC-CT- --TTAA--AG
Nemhelix_bakeri                  TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GTTCA AATAAC-CT- --ATAA--TG
Raillietnema_sp._V3060           ---------- --AGGCTAAG CCATGCATGT CTAA-GTTCA TATGAC-CT- --TTAA--AG
Cruzia_americana                 TGCTTGTCTC AAAGGCTAAG CCATGCATGT CTAA-GTTCA AATAAC-CT- --ATAA--TG
Heterakis_sp_14690               TGCTTGTCTC AAAGGCTAAG CCATGCATGT GTAT-GTTCA AATAAC-CT- --ATAA--AG
Heterakis_gallinarum             TGCTTGTCTC AAAGGTTAAG CCATGCATGT GTAT-GTTCA AATAAC-CT- --ATAA--AG
Paraspidodera_sp_21303           TGCT-GTCTC AAAGGCTAAG CC-TGCATGT CTAA-GTTCA AATAAC-CT- --TTAA--TG
Chromodora_nudicapitata          ----TGTCTC AAAGATTAAG CCATGCATGT GTAA-GA--A T-AAAC-CG- --AATA--TG
Chromadora_sp._BHMM_2005         ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GA--A T-AAAC-CG- --AATA--TG
Atrochromadora_microlaima        ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GA--A T-AAAC-CG- --AATA--TG
Chromadorina_germanica           ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GA--A T-AAAC-CG- --AATA--TG
Chromadorita_tentabundum         ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-AAGC-CG- --AATA--TG
Dichromadora_sp._BHMM_2005       ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GA--A T-AAAC-CG- --AATA--TG
Neochromadora_BHMM_2005          ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A -TAAAC-CG- --AATA--TG
Spilophorella_paradoxa           ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-AAGC-CG- --AATA--TG
Paracanthonchus_caecus           TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-AAGC-CG- --ATTAA-TG
Paracyatholaimus_intermedius     TGCCTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A C-AAGC-CA- --TAGAA-TG
Praeacanthonchus_punctatus       ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-AAGC-CG- --ATTAA-TG
Praeacanthonchus_sp              ------YMTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-AAGC-CG- --ATAAA-TG
Cyatholaimus_sp._BHMM_2005       ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-AAGC-CG- --ATTAA-TG
Spirinia_parasitifera            ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-GAGC-CG- --AATAA-TG
Acanthopharynx_micans            TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-GAGC-CA- --AATAA-TG
Xyzzors_sp                       TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-GAGC-CG- --AATTA-TG
Metachromadora_sp                ---CTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-GAGC-CG- --AATTA-TG
Metachromadora_remanei           ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-GAGC-CG- --AATTA-TG
Catanema_sp                      TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-GAGC-CG- --AATGA-TG
Eubostrichus_dianae              TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAAAGC--A T-GAGC-CG- --ATTTA-TG
Eubostrichus_topiarus            TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-AAGC-CG- --ATAAA-TG
Eubostrichus_parasitiferus       TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-AAGC-CG- --AATAA-TG
Laxus_oneistus                   TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-GAGC-CG- --AATTA-TG
Laxus_cosmopolitus               TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-GAGC-CG- --AATTA-TG
Leptonemella_sp                  TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A G-AGCC--G- --AATTA-TG
Robbea_hypermnestra              TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-GAGC-CG- --AATTA-TG
Stilbonema_majum                 TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-AAGC-CG- --AATTA-TG
Monoposthia_costata              ----TGTCTC AAAGATTAAG CCATGCATGT GCAA-GT--A -TGAAC-CA- -ATTTGAACT
Nudora_bipapillata               ----TGTCTC AAAGATTAAG CCATGCATGT TTAA-GC--A C-AAGC-CG- --ATTAA-TG
Calomicrolaimus_parahonestus     ----TGTCTC AAAGATTAAG CCATGCACGT TTAA-AT--A C-AAGC-CT- --CAAAA-TG
Calomicrolaimus_sp._BHMM_2005    ----TGTCTC AAAGATTAAG CCATGCACGT TTAA-AT--A C-AAGC-CT- --CAAAA-TG
Molgolaimus_demani               ----TGTCTC AAAGATTAAG CCATGCACGT TTAT-AT--A C-AAAC-CT- --TCAAA-TG
Diplogaster_lethieri             TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GA--A C-ATAT-GT- --GTAAA--C
Aduncospiculum_halicti           ---------- ---------- ---------- ---------- G-ATAG-TT- --CTTGA--A
Pristionchus_lheritieri          TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GA--A C-ATAT-GT- --GTAAA--C
Pristionchus_pacificus           ---------- ---------- -------TGT CTAA-GA--A C-ATAT-GT- --GTAAA--C
Pristionchus_pacificus           ---------A AAAGATTAAG CCATGCATGT CTAA-GA--A C-ATAT-GT- --GTAAA--C
Sabatieria_punctata_STRAIN_343   ----TGTCTC AAAGATTAAG CCATGCATGT TTAA-GC--A G-AAGC-CG- --CACAA-TG
Sabatieria_sp._355_BHMM_2005     ----TGTCTC AAAGATTAAG CCATGCATGT TTAA-GC--A G-AAGC-CG- --CACAA-TG
Sabatieria_celtica               ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A G-AAGC-CG- --TACAC--G
Sabatieria_punctata_STRAIN_200   ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A G-AAGC-CG- --AACAA-CG
Sabatieria_punctata_STRAIN_223   ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A G-AAGC-CG- --AACAA-TG
Sabatieria_sp._210_BHM_2005      ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A G-AAGC-CG- --AACAA-CG
Setosabatieria_hilarula          ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A G-AAGC-CG- --TACTA-CG
Desmolaimus_zeelandicus          ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A C-AAGC-TG- --AATA--CA
Terschellingia_longicaudata      ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GT--A T-AAGC-TA- --AATTA-AA
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- ---------- ---------- ----------
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                                         70         80         90        100        110        120
Cyartonema_elegans              ----TGTCTC AAAGATTAAG CCATGCATGT CTCA-GT--A C-AAGC-TG- --AAATA-AA
Tridentulus_sp                  ------TCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-A-GC-TG- --GAAA--CA
Diplolaimelloides_meyli         ---------- ---------- -CATGCATGT CTAA-GC--A T-GCGC-TG- --AAGTA-AA
Diplolaimella_diavengatensis    ---------- ---------- ---TGCATGT CTAA-GC--A T-GCGT-TG- --AATTT-AA
Geomonhystera_disjuncta         -------CTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-GAGC-TA- --AATTA-AA
Sphaerolaimus_hirsutus          ----TGTCTC AAAGATTAAG CCATGCACGT GCAA-GC--A C-AAGC-TG- --AATTA-AA
Theristus_acer                  ---------C AAAGATTAAG CCATGCATGT CTAA-GC--A T-GAAC-TA- --AAGTA-AA
Daptonema_procerus              TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAC-GC--A T-AAAC-GA- --ATCTA-AA
Daptonema_hirsutum              ----TGTCTC AAAGATTAAG CCATGCATGT CTAC-GC--A T-AAAC-GA- --ATCTA-AA
Daptonema_normandicum           ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-AAAC-TG- --AACTA-AA
Daptonema_oxycerca              ----TGTCTC AAAGATTAAG CCATGCATGT CTAC-GC--A T-AAAC-GA- --ATCTA-AA
Daptonema_setosum               ----TGTCTC AAAGATTAAG CCATGCATGT CTAC-GC--A T-AAAC-GA- --ATCTA-AA
Desmodora_communis              ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-GAGC-CG- --TATAA-TG
Desmodora_ovigera               TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GC--A T-GAGC-CG- --AATAA-TG
Metadesmolaimus_sp              -------TTT AAAGATTAAG CCATGCATGT CTAC-GC--A T-AAAC-GA- --ATCTA-AA
Dentostomella_sp                ---------- -----TTAAG CCATGCATGT -TAA-GT--T T-AAAT-AC- --ACATT-AA
Bunonema_franzi                 GCTT-GTCTC AAAGATTAAG CCATGCATGT TATA-AA--A C-TTGC-CC- --TAGAA-TG
Bunonema_sp                     ---------- ---------- ---------- ---------- ---------- ---------G
Seleborca_complexa              ---------- ---------- -------TGT CTAA-GT--A T-AAAC-GA- --TTTAA-TC
Acrobeloides_nanus              ---------- --AGATTAAG CCATGCATGT CTAA-GT--A T-AAAC-GA- --TTTAA-TC
Acrobeloides_bodenheimeri       ---------- ---------- ---------- ---------- --AAAC-GG- --CTTGT-CC
Acrobeloides_sp_PS1146          ---------- ---------- -------TGT CTAA-GT--A T-AAAC-GA- --TTTAA-TC
Acrobeles_ciliatus              ---------- ---------- ---------- ---------- --AAAC-GA- --TTTAA-TC
Acrobeles_sp_PS1156             ---------- ---------- ---------- ---------- --AAAC-GA- --TTTAA-TC
Acrobeles_complexus_WCUG2       ---------- ---------- ---------- ---------- --AAAC-GA- --TTTAA-TC
Cephaloboides_sp_SB227          TGCTCAAGTA AAAGATTAAG CCATGCATGC ATA--GT--T C-AAAT-TT- --T-----TG
Cephalobus_cubaensis            ---------- ---------- ---------- ---------- --AAAC-GA- --CTCGA-TC
Cephalobus_sp._PS1143           ---------- ---------- ---------- ---------- --AAAC-GA- --TTTAA-TC
Cephalobus_sp._PS1196           ---------- ---------- ---------- ---------- --AAAC-GA- --TTTAA-TC
Cephalobus_oryzae_PS1165        ---------- ---------- -------TGT CTAA-GT--A T-AAAC-GA- --TTTAA-TC
Cervidellus_alutus              ---------- ---------- ---------- ---------- --AAAC-GA- --TTTAA-TC
Pseudacrobeles_variabilis       ---------- ---------- ---------- ---------- --AAAC-GA- --TTTAA-TC
Triligulla_aluta                ----TGTCTC AAAGATTAAG CCATGCATGT CTAA-GT--A T-AAAC-GA- --TTTAA-TC
Zeldia_punctada                 ---------- ---------- ---------- ---------- -------GA- --TTTAA-TC
Myolaimus_sp_U81585             ---------- ---------- -------TGT CTCA-GT--A C-AAAC-CA- --CTTGT-TG
Rhabditophanes_sp._KR3021       ---------- ---------- ---------- ---------- -------AA- --CGTTC-AC
Brevibucca_sp._SB261            TGCTTGTCTC AAAGATTAAG CCATGCATGT CTCA-GT--G C-AGAC-TA- --TTTGA-AA
Halicephalobus_gingivalis       ---------C AAAGATTAAG CCATGCATGT CTAA-GT--- ---ACA-TG- --TGAGT-AC
Panagrobelus_stammeri           --------TC AAAGATTAAG CCATGCATGT TTAA-GT--G C----A-TG- -TGTTAT-AC
Plectonchus_sp._PDL0025         ---------- ---------- --ATGCATGT CTAA-GT--G C----A-TG- -TGTTAT-AC
Turbatrix_aceti                 --------TG AAAGATTAAG CCATGCATGT CTAA-GT--A C---TT-GC- -ATATAA-AT
Panagrellus_redivivus           ---------- -------TAG CCATGCATGT CTAA-GT--A C--ATG-TA- -GCTTGC-CT
Panagrellus_redivivus_PS1163    ---------- ---------- --ATGCATGT CTAA-GT--A C--ATG-TA- -GCTTGC-CT
Panagrolaimus_subelongatus      -------CTC AAAGATTAAG CCATGCATGN CTAA-GT--A C--ATG-TG- -TAATTTAAC
Panagrolaimus_davidi            -GCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GT--A C--ATG-TG- -TAATTAAAC
Panagrolaimus_cf_rigidus_AF40   GCTTGGTCTC AAAGATTAAG CCATGCATGT CTAA-GT--A C--ATG-TG- -TAATTAAAC
Panagrolaimus sp. Sourhope ED2  -------TCC AAAGATTAAG CCATGCATGT CTAA-GT--A C--ATG-TG- --TATATAAC
Panagrolaimus sp. Sourhope ED2  ---------- ---------- ---------- ---------- ---------- -------AAC
Panagrolaimus sp. Sourhope ED2  ---------- ---------- ---------- ---------- ---------- ---ATATAAC
Panagrolaimus sp. Sourhope ED2  ---------- ---------- ---------- ---------- ---------- -------AAC
Panagrolaimus sp. Sourhope ED2  ---------- ---------- ---------- ---------- -------TG- TAAATTAAAC
Steinernema_carpocapsae         ---------- ---------- ---------G TTAA-GT--T T--AAA--C- -GAATCA-AA
Strongyloides_stercoralis       TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GT--A T--AAA-CA- AATTCATACT
Strongyloides_ratti             ---------- ---------- -------TGT GTAA-GT--A C--AAT-GT- --TTTAA-AC
Diploscapter_sp_PS1897          TGCTCAAGTA AAAGATTAAG CCATGCATGC TC---GC--A C-AACT-CG- --ATTAT-GA
Diploscapter_sp_PS2017          ---------- ---------- -------TGC TC---GC--A C-AACT-CG- --ATTAT-TA
Heterorhabditis_bacteriophora   ---------- AAAGATTAAG CCATGCATGT ACT--GT--T -------CA- --ACTAA-CG
Heterorhabditis_hepialus        TGCTTACGTA AAAGACTAAG CCATGCATGT ACTG-TT--C ---------- --AGCTTACG
Heterorhabditis_zelandica       TGCTTACGTA AAAGACTAAG CCATGCATGT ACT--GT--T C-AGCC-AA- --------CG
Parasitorhabditis_sp_SB281      TGCTTATGTA GAAGATTAAG CCATGCATAT GTCA-GT--T C-CTGC-CC- --TCGCA-CG
Rhabditoides_inermiformis       ---------- AAAGATTAAG CCATGCATGT CTAA-GT--A T-AGCG-TG- --CAA---AC
Rhabditoides_inermis_DF5001     TGCTCAGTTA GAAGATTAAG CCATGTACGT CTAA-GT--T C-ATCT-CT- --CG----AA
Rhabditoides_regina_DF5012      CGCTTATGTC AAAGATTAAG CCATGCATGT ATTC-GT--A C-GACC-AT- --CTCA--TG
Poikilolaimus_oxycerca_SB200    -------GTA AAAGATTAAG CCATGCACGT GTAA-GT--T C-ACAT-CT- --TTTA--TG
Poikilolaimus_regenfussi_SB199  ---------- ---GATTAAG CCATGCACGT TTAA-GT--T CACGCT-GA- --TTAA--CG
Distolabrellus veechi DWF1604   TGCTTATGTA -GAGATTAAG CCATGCATGT GTAA-TT--A TTAAC-CAT- --CTAA--TG
Distolabrellus veechi DF5024    TGCTTATGTA TGAGATTAAG CCATGCATGT ATAT-GT--- TCAAC-CAT- --CTAA--TG
Choriorhabditis_dudichi         ---------- ---------- -TTAAGCCAT GCAT-GT-AA WAGTA-CAT- --CGRA--TA
Protorhabditis_sp               TGCTTAAGTA AAAGATTAAG CCATGCATGT TCGT-TC--A TCT---CGA- --TTAT--GA
Protorhabditis_sp_DF5055        ---------- ---------- --ATGCATGC ATAA-GT--- T-CAG-CTT- --TATC--AA
Cruznema_tripartitum_DF5015     ---------- ---------- ---------- -TGC-GT--G T-TCA-ACG- --T-----AA
Mesorhabditis_sp_PS1179         ---------- ---------- -------TAT CTTA-GT--T C-AGCC-CT- --TTTA--CG
Mesorhabditis_spiculigera_SB15  -----AAGTA AAAGATTAAG CCATGCATAT CTAA-GT--T C-CCAC-CC- --TCGCT-CG
Mesorhabditis_anisomorpha_SB12  ---------- AAAGATTAAG CCATGCATAT GTAA-GT--C C-AACC-AAT --TTAT--CG
Teratorhabditis_palmarum_DF501  ---------- ---GATTAAG CCATGCATGT ATTC-GA--A C-GGTC-ATT --TTAT---G
Teratorhabditis_synpapillata_S  TGCTTATGTT AAAGATTAAG CCATGCATGT ATTA-GA--A C-GGTC-TC- --AC-----G
Caenorhabditis_briggsae_PB102   ---------- ---GATTAAG CCATGCATG- CTTT-G---A T-TCAT-CA- --A-------
Caenorhabditis_elegans_N2       TGCTCAAGTA AAAGATTAAG CCATGCATG- CTTT-G---A T-TCAT-CA- --A-------
NUCLEOTIDES INCLUDED            ---------- ---------- ---------- ---------- ---------- ----------
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                                          70         80         90        100        110        120
Caenorhabditis_sp_CB5161         ---------- ---GATTAAG CCATGCATG- CTTT-G---A T-TCAT-CA- --A-------
Caenorhabditis_sp_PS1010         TGCTCAAGTA AA-GATTAAG CCATGCATG- CTT--G---A T-TCAT-CA- --A-------
Caenorhabditis_japonica          TGCTCAAGTA AAAGATTAAG CCATGCATG- CTTT-G---A T-TCAT-AA- --A-------
Caenorhabditis_sp_DF5170         TGCTCAAGTA AAAGATTAAG CCATGCATG- CTA--G---A T-TCAT-CA- --A-------
Caenorhabditis_sp_SB341          TGCTCAAGTA AAAGATTAAG CCATGCATG- TTG--G---T T--CAT-CG- --TAAG----
Caenorhabditis_plicata           TGCTTAAGTA AAAGATTAAG CCATGCATG- CTTT-G---A T-TCAT-AA- --A-------
Caenorhabditis_vulgaris          ---------- ---GATTAAG CCATGCATG- CTTT-G---A T-TCAT-CA- --A-------
Caenorhabditis_sonorae           TGCTCAAGTA AAAGATTAAG CCATGCATG- TTG--G---T T-CATC-GT- --AA------
Caenorhabditis_drosophilae       TGCTCAAGTA AAAGATTAAG CCATGCATG- CTG--G---A T-TCAT-CA- --A-------
Phasmarhabditis_hermaphrodita    -------GCT TGTCTCAAAG ATTAAGCCAT GCA--TG--- ---TCGAGTT TATATATAAA
Phasmarhabditis_neopapillosa     -------GCT TGTCTCAAAG ATTAAGCCAT GCA--TG--- ---TCGAGTT CATTTT---A
Phasmarhabditis_neopapillosa     TGCTCAAGTA AAAGATTAAG CCATGCATGT AAAAAGT--T C-AACT-TT- ---------T
Pellioditis_mediterranea_SB173   TGCTCAAGTA AAAGATTAAG CCATGCATGT AAAAAGT--T C-AACT-TT- ---------A
Pellioditis_marina               TGCTCAAGTA AAAGATTAAG CCATGCATGT AAAAAGT--T C-AACT-TT- ---------T
Prodontorhabditis_wirthi         TGCTCAAGTA AAAGATTAAG CCATGCATGC A--CAGT--C C-AATC-GA- --CTTTTCGA
Crustorhabditis_scanica          ---------- ---GATTAAG CCATGCATGA TGTCAGT--G C-GACC-AC- --ACGTATTG
Dolichorhabditis_sp_CEW1         ---------- ---------- ---CGCATGT AAAAAGT--T C-AACT-TT- --AT-----A
Oscheius_sp_DF5000               TGCTCAAGTA AAAGATTAAG CCATGCATGT AAAAAGT--T C-AACC-TT- --AT-----G
Oscheius_sp_BW282                TGCTCAAGTA AAAGATTAAG CCATGCATGT AAAAAGT--T C-AACT-TT- --TT------
Oscheius_myriophila_EM435        ---------- ---GATTAAG CCATGCATGT AAAA-GT--T C-AACT-TT- --T-------
Oscheius_insectivora             TGCTCAAGTA AAAGATTAAG CCATGCATGT ATAAAGT--A C-AGCT-TT- --TA------
Oscheius_dolichuroides           TGCTCAAGTA AAAGATTAAG CCATGCATGT GAAAAGT--T C-AACC-TT- --AT-----G
Rhabditis_blumi_DF5010           ---------- ---GACTAAG CCATGCATGT CTCA-G---A T-CCCC-AT- --TT----CA
Rhabditis_sp_PS1191              TGCTCACGCT AAAGATTAAG CCATGCAAGC TTGAGAT--- C-ACCC-TT- --TT------
Rhabditis_sp_PS1010              ---------- ---------- -------TG- CTT--G---A T-TCAT-CA- --A-------
Rhabditis_myriophila_EM435       ---------- ---GATTAAG CCATGCATGT A-AAAGT--T C-AACT-TT- --T-------
Rhabditis_colombiana             ---------- ---------- ---------- --AAAGT--T A-GCTT-TT- --A-----AA
Rhabditella_axei_DF5006          ---------- ---GATTAAG CCATGCATGT AT--AGT--T C-ATTT-TT- --T-------
Rhabditella_sp_DF5044            TGCTCACGTA AAAGATTAAG CCATGCATGT AT--AGT--T C-ATTT-TT- --T-------
Cuticularia_sp_PS2083            ---------- ---------- -------CGT GT-AAGT--T C-ACAT-CT- --TTTA--TG
Necator_americanus               ---------- ----ATTAAG CCATGCATGT CGA--GT--T C-ATCT--A- --------AA
Kalicephalus_cristatus           TGCTCAGTTT AAAGACTAAG CCATGCATGT CGA--GT--T C-ATCTTT-- --------GA
Ancylostoma_caninum              TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT--A- --------AA
Angiostrongylus_cantonensis      ---------- ----ATTAAG CCATGCATGA GGA--GT--T C-AGCT-TT- --------AA
Angiostrongylus_costaricensis    ---------- ---------- ---------A GGA--GT--T C-AGCT-TC- --------AA
Angiostrongylus_malaysiensis     ---------- ---------- ---------A GGA--GT--T C-AGCT-TC- --------AA
Angiostrongylus_dujardini        ---------- ---------- ---------A GGA--GT--T C-AGCT-TC- --------AA
Angiostrongylus_vasorum          ---------- ---------- ---------A GGA--GT--T C-AGCT-TC- --------AA
Aulurostrongylus_abstrusus       TGTTCAGTTA AAAGGTTAAG CCATGCACGA GGA--GT--T C-AACT-TC- --------AA
Didelphostrongylus_hayesi        GCTCAGTTAA AAGATT-AAG CCATGCATGT GGA--GT--T C-AGCT-TT- --A-----AA
Crenosoma_mephitidis             GCTCAGTTAA AAGATTGAAG CCATGCATGT GGA--GT--T C-AGCT-TC- --------AA
Crenosoma_vulpis                 TGCTCGGTTA AAAGATTACA AGCCATGCAT GT---GT--A G-TTCAGCTA --------AA
Otostrongylus_circumlitus        ---------- ---GATTAAG CCATGCATGT CGA--GT--T C-AGCT-TC- --------AA
Troglostrongylus_wilsoni         ---------- ---GATTAAG CCATGCATGT TGA--GT--T C-AGCT-TC- --------AA
Filaroides_martis                ---------- ---GATTAAG CCATGCATGT CGA--GT--T C-AGCT-TC- --------AA
Oslerus_osleri                   ---------- ---GATTAAG CCATGCATGT CGA--GT--T C-AACT-TC- --------AA
Parafilaroides_decorus           ---------- ----ATTAAG CCATGCATGT CGA--GT--T C-AGCT-TC- --------AA
Metastrongylus_salmi             ---------- -----TTAAG CCATGCATGT CGA--GT--T C-AACT-TC- --------AA
Metastrongylus_elongatus         TGCTCAGTTA AAAGATTAAG CCATGCATGT CGA--GT--T C-AACT-TC- --------AA
Skrjabingylus_chitwoodrum        TGCTCAGTTA AAAGATTAAG CCATGCAATG TGGA-GT--T C-AGCT-TC- --------AA
Parelaphostrongylus_odocoilei    ---------- ----ATTAAG CCATGCATGT GGA--GT--T C-AACT-TC- --A-----AA
Muelerius_capillaris             ---------- ---------- -------TGT GGA--GT--T C-AATT-TC- --T-----AT
Protostrongylus_rufescens        TGCTCAGTTA AAAGATTAAG CCATGCATGT GGA--GT--T C-AACT-TC- --------AA
Halocercus_invaginatus           ---------- ---------- -------TGT CGA--GT--T C-AGCT-TT- --G-----AA
Pseudalius_inflexus              ---------- ---------- -CATGCATGT CGA--GT--T C-AACT-TC- --------AA
Stenurus_minor                   ---------- ----ATTAAG CCATGCATGT CGA--GT--T C-AGCT-TC- --------AA
Torynurus_convolutus             ---------- ----ATTAAG CCATGCATGT CGA--GT--T C-AGCT-TC- --------AA
Syngamus_trachea                 TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCTT--- --------GA
Stephanurus_dentatus             TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT--A- --------TG
Nematodirus_battus               TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT-TT- --------GA
Strongylus_equinus               ATGCTTGTCC AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT-T-- --------AA
Labiostrongylus_bipapillosus     TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCTA--- --------AA
Petrovinema_poculatum            TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCA--C- --------AA
Cylicocyclus_insignis            TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT--C- --------AA
Chabartia_ovina                  TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT--A- --------AA
Cyclodontostomum_purvisi         TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT--A- --------AA
Zoniolaimus_mawsonae             TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT--A- --------AA
Hypodontus_macropi               TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCTA--- --------AA
Deletrocephalus_dimidiatus       TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT--A- --------AA
Dictyocaulus_eckerti_P7B8        ---------- -AAGATTAAG CCATGCATGT CGA--GT--T C-AACC-TG- --TA----TA
Dictyocaulus_capreolus_P3B2      ---------- -AAGATTAAG CCATGCATGT CGA--GT--T C-AACT-TG- --TG----AA
Dictyocaulus_sp._P6A1            ---------- -AAGATTAAG CCATGCATGT CGA--GT--T C-AACT-TT- --AA-----A
Dictyocaulus_filaria             ---------- -AAGATTAAG CCATGCATGT CGA--GT--T C-AACT-AA- --AA----AA
Dictyocaulus_capreolus_P2C10     ---------- -AAGATTAAG CCATGCATGT CGA--GT--T C-AACT-TG- --TG----AA
Dictyocaulus_viviparus           ---------- -AAGATTAAG CCATGCATGT CGA--GT--T C-AACT-TT- --TC----AA
Haemonchus_sp._V3091             ---------- ---------- -CATGCATGT CGA--GT--T C-ATCT-TT- --G-----AA
Haemonchus_contortus             TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT-TT- --G-----AA
Haemonchus_placei                TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT-TT- --G-----AA
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- ---------- ---------- ----------
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                                        70         80         90        100        110        120
Haemonchus_similis               TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT-TT- --G-----AA
Ostertagia_ostertagi             TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT-AA- --------AA
Ostertagia_leptospicularis       TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT-AA- --------AA
Nippostrongylus_brasileinsis     TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT--A- --------TA
Heligmosomoides_polygyrus        TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT--A- --------AA
Trichostrongylus_colubriformis   TGCTCAGTTT AAAGATTAAG CCATGCATGT GGA--GT--T C-ATCT-AA- --------AA
Tetrabothriostrongylus mackerr   TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT-TT- --------GA
Herpestrongylus_pythonis         TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT--C- --------AA
Nicollina_cameroni               TGCTCAGTTT AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCT--C- --------AA
Filarimena_flagrifer             TGCTCAGTTA AAAGATTAAG CCATGCATGT CGA--GT--T C-ATCC-CT- --------GA
Amidostomum_cygni                TGCTCAGTTT AAAGACTAAG CCATGCATGT CGA--GT--T C-ATCT---- --------AA
Teratocephalus_lirellus          --------TC AAAGATTAAG CCATGCATGT CTAA-GC--A T-GAGC-CA- --ATTAA-TG
Brumptaemilius_justini           ---------- AAAGATTAAG CCATGCATGT CTAA-GT--T C-AAAT-AA- --CCTAA-AG
Anguillicola_crassus             ---------C AAAGATTAAG CCATGCATGT CTAT-GT--T T-AAAT-AT- -CCTATAAAG
Dracunculus_medinensis           ---------- ---------- ---------- ---------- --ATTG-CC- --TATAA-TG
Dracunculus_oesophageus          ---------- ---------- ---------- ---------- ---TTG-CC- --TATAA-TG
Dracunculus_sp._V3104            ---------- ---------- ---------- ---A-GT--T C-ATAC-TG- -CCTTAAATG
Philonema_sp_A                   ---------- ---------- -------TGT CCAA-GT--T C-AAAT-TG- -CCTATAATG
Philometra_obturans              ---------- ---------- ---------- ---------- --ATTG-CC- --TATAA-TG
Camallanus_oxycepahalus          ---------- ---------- --------TG TCAAAGT--T C-AAATTGC- --TTATAATG
Acanthocheilonema_viteae         ---------- -----TTAAG CCATGCATGT GTAA-GT--T C-AAATAAA- -CCTATAAGG
Loa_loa                          -GCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GT--T C-AAATAAA- -CCTATAATG
Onchocerca_cervicalis            TGCTTGTCTC AAAGATTAAG CCATGCATGT CTAA-GT--T C-AAATAAA- -CCTATAATG
Dirofilaria_immitis              ---------- ---------- --GCCATGCA TGTCTAATTT C-AAATAAA- -CCTATAATG
Brugia_malayi                    ---------- AAAGATTAAG CCATGCATGT CTAA-GT--T C-AAATAAA- -CCTATAATG
Wuchereria_bancrofti             ---------- --------AG CCATGCATGT CTAA-GT--T C-AAATAAA- -CCTATAATG
Litomosoides_sigmodontis         ---------- ---------- ---------- -----GT-CT C-AAATAAA- -CCTATAAAG
Setaria_digitata                 --------TC AAAGATTAAG CCATGCATGT GTAA-GT--T C-AAATAAA- -CCTAAAATG
Gnathostoma_turgidum             TGCTTGTCTC AAAGGTTAAG CCATGCATGT CTGC-GT--G C-CAAC-TC- --TCGAA-AA
Gnathostoma_neoprocyonis         TGCTTGTCTC AAAGGTTAAG CCATGCATGT CTGC-GT--G C-CAAC-TC- --TCGAA-AA
Gnathostoma_binucleatum          TGCTTGTCTC AAAGGTTAAG CCATGCATGT CTGC-GT--G C-CTAC-TC- --TTGAA-AA
Physaloptera_alata               ---------- ---------- --ATGCATGT CTAA-GT--T C-AAAT-AA- -CCTATAATG
Physaloptera_turgida             ---------- ---------G CCATGCATGT CTAT-GT--T C-AAAT-AA- -CCTATAATG
Ascarophis_arctica               ---------- -----TTAAG CCATGCATGT CTAA-GT--T C-AAAT-AA- -CCTATAATG
Spinitectus_carolini             ---------- ---------- ---------- CTAA-GT--T C-AAAC-AA- -CCTATAATG
Thelazia_lacrymalis              ---------- --------AG CCATGCATGT CTAA-GT--T C-AAAT-AA- -CCTAAAATG
Aphelenchus_avenae               ---------- ---------- ---------- ---------- ---------- ---------a
Aphelenchoides_fragariae         TGCTTGTCTC AAAGATTAAG CCATGCATGT GTAA-GT--A G-AGTT-GA- --TATAA--A
Bursaphelelenchus_sp             ---------- ---------- ---------- ---------- --GGAG-TA- --TTATA-CA
Deladenus_sp                     TGCTTGTCTC AAAGATTAAG CCATGCATGT ATAA-GT--A T-AANC-GA- --TTTTA-TC
Criconema_sp                     ---------- --AGATTAAG CCATGCATGT ATAA-GT--A C-ACGC-CT- --TGAAA-AG
Hemicycliophora_conida           TGCTTGTCTC AAAGATTAAG CCATGCATGT ATTA-GT--A C-AAGC-CT- --TAACA-AG
Paratylenchus_dianthus           TGCTTGTCTC AAAGATTAAG CCATGCATGT ATAA-GT--A C-AAAC-CT- --TCATA-AG
Pratylenchus_thornei             TGCTTGTCTC AAAGATTAAG CCATGCATGT ATAA-GT--A T-AAAC-GC- --TTTAA-GC
Tylenchulus_semipentrans         -------CTC AAAGATTAAG CCATGCATGT CTAA-GT--A T-AATC-GT- --CTTGA-AC
Ditylenchus_angustus             ---------C AAAGATTAAG CCATGCATGT CTAA-GT--T T-AAAC-GA- --TTAAT--C
Subanguina_radicola              TGCTTGTCTC AAAGATTAAG CCATGCATGT ATAA-GT--A T-AAAC-GA- --TTTTA-TC
Tylenchorhynchus_maximus         TGCTTGTCTC AAAGATTAAG CCATGCATGT ATAA-GT--A T-AAAC-GA- --CTTGA-TC
Geocenamus_quadrifer             TGCTTGTCTC AAAGATTAAG CCATGCATGT ATAA-GT--A T-AAAC-GA- --TTTTA-TC
Globodera_pallida                ---------- AAAGATTAAG CCATGCATGT ATAA-GT--G T-AACC-TG- --CCAGACAG
Scutellonema_bradys              -GCTTGTCTC AAAGATTAAG CCATGCATGT ATAA-GT--A T-AACC-TG- --CCAGA-CA
Helicotylenhcus_dihystera        ------TCTC AAAGATTAAG CCATGCATGT CTAA-GT--A T-AACC-TG- --CCAGA-CA
Rotylenchus_robustus             TGCTTGTCTC AAAGATTAAG CCATGCATGT ATAA-GT--A T-AACC-TG- --CCAGA-CA
Meloidogyne_arenaria             TGTTTATTTC AAAGATTAAG CCATGCATGT ATAA-GT--T T-AATC-GT- --TTA---TC
Meloidogyne_incognita_KT         ---------- ---------- -------TGT ATAA-GT--T T-AATC-GT- --TTA---TC
Meloidogyne_javanica             ---------- ---------C CCAGGCMSSM AWAA-GT--T T-ATTC-GT- --TTA---TC
Meloidogyne_artiellia            ---TTGTTTT AAAGATTAAG CCATGCATGT ACAA-GT--T T-AATC-GC- --ATTA--GC
Meloidogyne_duytsi               -GCTTGTCTC AAAGATTAAG CCATGCATGT ATAA-GT--T T-AATC-GT- --TTTC--AC
Meloidogyne_exigua               TGCTTGTCTC AAAGATTAAG CCATGCATGT ATAA-GT--T T-AATC-GA- --TTTT--TC
Meloidogyne_hapla                TGCTTGTCTC AAAGATTAAG CCATGCATGT ATAA-GT--T T-AATC-GT- --ATTT--AC
Meloidogyne_ichinohei            TGCTTGTCTC AAAGATTAAG CCATGCATGT ATCA-GT--T T-AATC-GC- --ATCA--GC
Meloidogyne_maritima             TGCTTGTCTC AAAGATTAAG CCATGCATGT ATAA-GT--T T-AATC-GT- --TTT---AC
Meloidogyne_microtyla            TGCTTGTCTC AAAGATTAAG CCATGCATGT ATAA-GT--T T-AATC-GT- --TTTT--AC
Nacobbus_aberrans                TGCTTGTCTC AAAGATTAAG CCATGCATGT ATAA-GT--A T-AAAC-GA- --CTTGA-TC
Pratylenchoides_ritteri          -------TTT AAAGATTAAG CCATGCATGT ATAA-GT--A T-AAAC-GA- --TTTTA-TC
Pratylenchoides_magnicauda       ---------- ---------- ---------- ---------- --aaac-ga- --tttta-tc
Hirschmanniella_sp._JH_2003      -------CTC AAAGATTAAG CCATGCATGT ATAA-GT--A T-AAAC-GA- -CTTTGA-TC
Radopholus_similis               ---------- AAAGATTAAG CCATGCATGT C-AA-GT--A TAAATC-GA- --AA----CG
Pratylenchus_goodeyi_VF          ---------C AAAGATTAAG CCATGCATGT ATAA-GT--A T-AAAC-GC- --ATA---GC
Boleodorus_thylactus_clone2      GCTTTGTCTC AAAGATTAAG CCATGCATGT ATAA-GT--A C-AAAC-GA- --CTCGA-TC
Philippine Sequence 1            ---------- ---------- ---------- ---------- ---------- ----------
Philippine Sequence 2            ---------- AAGGATTAAG CCATGCATGA GGA--GT--T C-AGCT-TT- --------AA
Philippine Sequence 3            ---------- ---------- ---------T ATAA-AT--T C-AACG-T-- --------AA
Philippine Sequence 4            ---------- ---------- ---------T CTAA-GT--A C--ATG-TG- ----TTTAAC
Philippine Sequence 5            ---------- ---------- ---------T CGA--GT--T C-ATCT--A- --------AA
Philippine Sequence 6            ---------- ---------- ---------T ATAAAGT--T C-ATCA---- ------TTTT
Philippine Sequence 7            ---------- ---------- ---------- CTTT-G---A T-TCAT-CA- --A-------
Tahiti Sequence 1                ---------- ---------- ---------- ---------- ---------- ----------
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- ---------- ---------- ----------
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                                         70         80         90        100        110        120
Tahiti Sequence 2                ---------- ---------- ---------G GGA--GT--T C-AGCT-TT- --------AA
Thailand Sequence 1              ---------- -AGATTTAAG CCATGCATGT CTAT-GTTCA AATAAC-CT- --ATAA--AG
Ogasawara Sequence 1             ---------- ---------- ---------T CTAA-GT--A C--ATG-TG- --TATTTAAC
Ogasawara Sequence 2             ---------- ----ATTAAG CCATGCATGT CGA--GT--A C-ATTG-TA- ---------A
Ivory Coast Sequence 1           ---------- ---------- ---------T CGA--GT--T C-AACT-TC- --------AA
Ivory Coast Sequence 2           ---------- ---------- ---------T CGA--GT--T C-AACT-TT- -------AAA
Ivory Coast Sequence 3           ---------- ---------- ---------T CGA--GT--T C-AACT-TC- --------AA
Ivory Coast Sequence 4           ---------- ---------- ---------T CGA--GT--T C-AACT-TC- --------AA
Ivory Coast Sequence 5           ---------- ---------- ---------T CTAT-GTTCA AATAAC-CT- --ATAA--AG
Ivory Coast Sequence 6           ---------- ---------- ---------T CGA--GT--T C-AACT-TC- --------AA
Ivory Coast Sequence 7           ---------- ---------- ---------T CGA--GT--T C-AACT-TC- -------AAA
Singapore Sequence 1             ---------- ---------- ---------- TATAAAT--T C-AACG-TA- ---------A
Singapore Sequence 2             ---------- ---------- ---------T CTAT-GTTCA AATAAC-CT- --ATAA--AG
Singapore Sequence 3             ---------- ---------- ---------- CTTT-G---A T-TCAT-CA- --A-------
Singapore Sequence 4             ---------- ---------- ---------T CGA--GT--T C-AACT-TC- --------AA
Nigerian Sequence 1              ---------- ---------- ---------- ---------- ---------- ----------
Nigerian Sequence 2              ---------- ---------- ---------T CGA--GT--T C-ATCT--A- --------AA
Nigerian Sequence 3              ---------- ---------- ---------T CGA--GT--T C-AACT-TC- -------AAA
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- ---------- ---------- ----------


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                                        130        140        150        160        170        180
Gordius_aquaticus                GTG-AAA-CC GCGAATGGCT CATTAA-ATC AGTTA-TGGT -TTATTAGAT CGT-AC-AA-
Priapulus_caudatus               GTG-AAA-CC GCGAATGGCT CATTAA-ATC AGTTA-TGGT -TCCTTAGAT CTT-AC-TA-
Brachionus_plicatilis            GTG-AAA-CC GCGAATGGCT CATTAA-ATC AGTTA-TGGT -TCCTTAGAT CGT-TC-AT-
Chordodes_morgani                GTG-AAA-CC GCGAATGGCT CATTAA-ATC AGTTA-TGGT -TTATTAGAT CGT-CC-CA-
Paractinolaimus_macrolaimus      GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-CCGT -TTACTAGAA AAT-AG-TT-
Aporcelaimellus_obtusicaudatus   GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-CCGT -TTACTAGAA TAT-AG-TT-
Wilsonema_schuurmansstekhoveni   GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-CTGT -TTACTTGAT CTT-GA-CT-
Mesodorylaimus_sp_cf_nigritul    GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-CCGT -TTACTAGAA TAT-AG-TT-
Mesodorylaimus_bastiani          GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-AATT -TTACTGGAA TAT-AG-TT-
Mesodorylaimus_japonicus         GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-CCGT -TTACTAGAA TAT-AG-TT-
Pungentus_sp._PDL_2005           GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TCGT -TTATTAGAA TAT-CG-TT-
Allodorylaimus_sp                GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TCGT -TTATTAGAA TAT-CG-TT-
Eudorylaimus_carteri             GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TCGT -TTATTAGAA TAT-CG-TT-
Microdorylaimus_sp               GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TCGT -TTATTAGAA TAT-CG-TT-
Longidorus_elongatus             GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TCGT -TTACTAGAA AAT-AT-TT-
Xiphinema_rivesi                 GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-CCGT -TTACTAGAA AAT-CA-GT-
Tylencholaimus_sp                GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-CCGT -TTATTAGAA TAT-CG-TT-
Anoplostoma_sp._BHMM_2005        GTA-AAG-CC GCGAATGGCT CATTAC-AAC AGCTA-TAGT -TTACAGGAT GAT-GC-TG-
Adoncholaimus_fuscus             GTG-AAG-CC GCGAATGGCT CATTAC-ACC AGCTG-AAAT -TTACTGGAT ATA-TC-CT-
Enoplus_meridionalis             GTG-AAG-CT GTGAATGGCT CATTAC-AAC AGCCG-TAGT -TTATTTGAT TCA-TA-GA-
Enoplus_brevis_U88336            GTG-AAG-CT GTGAATGGCT CATTAC-AAC AGCCG-TAGT -TTATTTGAT TTA-TA-GA-
Enoplus_communis                 GTG-AAG-CT GTGAATGGCT CATTAC-AAC AGCCG-TAGT -TTATTTGAT TTA-TA-GA-
Enoploides_brunettii             GTG-AAA-CC GCAAATGGCT CATTAC-AAC AGCTA-TAGT -TTATTAGAT CTT-AA-CT-
Syringolaimus_striatocaudatus    GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-TTGT -TTATTTGAT CTA-AT-GG-
Ironus_dentifurcatus             GTA-AAG-CC GCGAATAGCT CATTAC-AAC AGCCT-CTGT -TTATTAGAT CTT-TC-TT-
Calyptronema_maxweberi           GTGTAAG-CC GCGAATGGCT CATTAT-AAC AGCCA-TTGT -TTACTGGAT ATA-TC-TT-
Viscosia_sp._BHMM_2005           GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TAGT -TCACTGGAT ATA-TT-AC-
Viscosia_viscosa                 GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TCGT -TTAATGGAT ATA-TT-TT-
Pontonema_vulgare                GTG-AAG-CT GCTAATGGCT CATTAT-AAC AGCCA-TAGT -TTACTGGTT ATA-TT-CC-
Oncholaimus_sp._BHMM_2005        TGT-AAA-CC GCGAATGGCT CATTAC-AAC AGCCA-TAGT -TTACTGGAT ATA-TT-CC-
Alaimus_sp_PDL_2005              GCA-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-TAGT -TTATTAGAT CTT-AC-TT-
Prismatolaimus_intermedius       GTA-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-TAGT -TTACTGGAT CTT-AC-TT-
Tobrilus_gracilis                GCA-AAG-CC GCACATGGCT CATTAC-AAC AGCCA-CAGT -TTATTAGAT CGT-AC-TT-
Tripyla_cf_filicaudata_JH_2004   GTA-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-CAAT -TTACTAGGT CTC-CT-TT-
Bathylaimus_sp                   GTA-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TAGT -TTACTAGAT AGT-TC-AT-
Bathylaimus_assimilis            GTA-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TAGT -TTACTAGAT AGT-TC-AT-
Bathylaimus_sp._BHMM_2005        GTA-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TAGT -TTATTAGAT AGT-TC-AT-
Tripyloides_sp._BHMM_2005        GTA-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TAGT -TTATTAGAT AGT-TC-CT-
Trischistoma_monohystera         GTA-AAG-CC GCGAATGGCT CATTAC-AAC AGCTA-TCGT -TTATTAGAT CTT-AA-TT-
Mermis_nigrescens                GTA-AAG-CC GCGAATGGCT CGGTAT-AAC AGCTA-CGGT -TTATTAGAT GTT-TG-TT-
Mylonchulus_arenicolus           GTA-AAG-CC GCGAATGGCT CGGTAT-AAC AGCTG-TTGT -TTACTAGAC CAT-AG-TT-
Anatonchus_tridentacus           GTA-AAG-CC GCGAATGGCT CGGTAT-AAC AGCCA-CCGT -TTATTAGAT CTT-AG-TT-
Mononchus_truncatus              GTA-AAG-CC GCGAATGGCT CGGTAT-AAC AGCCG-CTGT -TTATTAGAT TTT-AG-TT-
Prionchulus_muscorum             GTA-AAG-CC GCGAATGGCT CGGTAT-AAC AGCCA-CCGT -TTATTAGAC GTT-AG-TT-
Clarkus_sp                       GTA-AAG-CC GCGAATGGCT CGGTAT-AAC AGCCA-CTGT -TTATTAAAC TCT-AG-TT-
Trichinella_spiralis             GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-CAGT -TTATTAGAA CTT-AC-A--
Trichinella_papuae               GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-CAGT -TTATTAGAA CTT-AC-A--
Trichinella_britovi              GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-CAGT -TTATTAGAA CTT-AC-A--
Trichinella_murrelli             GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-CAGT -TTATTAGAA CTT-AC-A--
Trichinella_pseudospiralis       GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-CAGT -TTATTAGAA CTT-AC-A--
Trichinella_nativa               GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-CAGT -TTATTAGAA CTT-AC-A--
Trichinella_zimbabwensis         GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-CAGT -TTATTAGAA CTT-AC-A--
Trichinella_nelsoni              GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-CAGT -TTATTAGAA CTT-AC-A--
Trichuris_suis                   GTG-AAG-CC GCGAATGGCT CATTAC-AGC AGTCA-TTGT -TCGCAAGAA CTG-AT-GT-
Trichuris_trichiura              GTT-AAG-CC GCGAATGGCT CATTAC-AGC AGTCG-TTGT -TCGCTAGAA CTG-AT-GT-
NUCLEOTIDES INCLUDED             -mm-mmm-mm mmmmmmmmmm mmmmmm-mmm mmmmm-mmmm -mmmmmmmmm mmm-------
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                                        130        140        150        160        170        180
Trichuris_muris                 GTG-AAG-CC GCGAATGGCT CATTAT-AAC AGCCA-TTGT -TCGCAAGAA CTG-AT-AT-
Tylolaimophorus_minor           GCG-AAG-CC GCGAATGGCT CATTAT-AAC AGCCG-TTGT -TTACTAGAT GAT-CC-AT-
Paratrichodorus_pachydermus     GTG-AAG-CC GCGAAAAGCT CATTAC-AAC AGCCA-TAGT -TTATTGGAT CTT-TA-CC-
Paratrichodorus_anemones        GCG-AAG-CC GCGAAAAGCT CATTAC-AAC AGCCA-TAGT -TTATTGGAT CTT-TC-CT-
Trichodorus_primitivus          GTG-AAG-CC GCGAAAAGCT CATTAC-AAC ASCCR-TAGT -TTATTGGAT GTT-TA-CG-
Axonolaimus_helgolandicus       GTG-AAG-CC GCGAATTGCT CATTAC-AAC AGCCA-TTGT -TTACTGGAT CTT-AA-TA-
Ascolaimus_elongatus            GTG-AAG-CC GCGAATTGCT CATTAC-AAC AGCCA-TTGT -TTACTGGAT CTT-AA-TA-
Odontophora_rectangula          GTG-AAG-CC GCGAATTGCT CATTAC-AAC AGCCA-TTGT -TTACTGGAT CTT-AA-AA-
Cylindrolaimus_sp._202149       GTG-AAG-CC GCGAATCGCT CATTAC-AAC AGCCA-TAGT -TTACTTGAT CTT-AA-AA-
Tylocephalus_auriculatus        GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-CTGT -TTACTTGAT CTT-GA-CT-
Plectus_acuminatus_BS9          GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-CTGT -TTACTTGAT CTT-GA-CT-
Plectus_aquatilis               GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-CTGT -TTACTTGAT CTT-GA-TT-
Anaplectus_sp                   GTG-AAA-CC GCGAATGGCT CATTAC-AAC AGCCA-CTGT -TTACTTGAT CTT-GA-TT-
Anisakis_sp_WKT                 GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT GTT-GA-TA-
Anisakis_sp_Nadler              GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT GTT-GA-TA-
Contracaecum_multipapillatum    GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-CG-
Pseudoterranova_decipiens       GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT GTT-GA-TA-
Raphidascaris_acus              GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TA-
Terranova_caballeroi            GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT GTT-GA-TA-
Ascaris_suum                    GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TA-
Ascaris_lumbricoides            GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-AA-
Baylisascaris_procyonis         GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TA-
Baylisascaris_transfuga         GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TA-
Parascaris_equorum              GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TA-
Porrocaecum_depressum           GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TA-
Toxascaris_leonina              GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TC-
Heterocheilus_tunicatus         GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TAAT -ATACTTGAT CTT-GA-TA-
Goezia_pelagia                  GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TA-
Hysterothylacium_fortalezae     GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TA-
Hysterothylacium_pelagicum      GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TA-
Hysterothylacium_reliquens      GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TA-
Iheringascaris_inquies          GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TA-
Toxocara_canis                  GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TG-
Nemhelix_bakeri                 GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TTAT -TTACTTGAT CTT-GA-TA-
Raillietnema_sp._V3060          GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TTAT -TTACTTGAT CTT-GA-TA-
Cruzia_americana                GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TA-
Heterakis_sp_14690              GTG-AAA-CC GCGAACGGCT CATTAT-ACC AGCTA-TAAT -ATACTTGAT CTT-GACTA-
Heterakis_gallinarum            GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TAAT -ATACTTGAT GTT-GATTA-
Paraspidodera_sp_21303          GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TA-
Chromodora_nudicapitata         GTA-AAT-CC GCGAATGGCT CATTAT--TC AGCCA-CAAA -TCATTGGAT CTA-AT-CA-
Chromadora_sp._BHMM_2005        GTA-AAT-CC GCGAATGGCT CATTAC-AAC AGCTT-TAGT -TTGTTGGAT CTA-AT-CC-
Atrochromadora_microlaima       GTA-AAT-CC GCGAATGGCT CATTAC-AAC AGCCT-TAGT -TTGTTGGAT CTA-AA-TC-
Chromadorina_germanica          GTA-AAT-CC GCGAATGGCT CATTAC-AAC AGCCA-TAAT -TTATTGGAT CTA-AC-AT-
Chromadorita_tentabundum        GTA-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-TAGT -TTATTGGAT CTT-AG-AG-
Dichromadora_sp._BHMM_2005      GTA-AAT-CC GCGAATGGCT CATTAC-AAC AGCCT-TAGT -TTGTTGGAT CTA-AA-TC-
Neochromadora_BHMM_2005         GTA-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-TAGT -TTATTGGAT CTT-AG-AG-
Spilophorella_paradoxa          GTT-AAG-CC GCGAATGGCT CATTAC-AAC AGCCA-TAGT -TTGTTGGAT CTA-AA-AT-
Paracanthonchus_caecus          GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TAGT -TTATTGGAC CTT-CT-CT-
Paracyatholaimus_intermedius    GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TAGT -TTATTGGAT CTT-CT-CT-
Praeacanthonchus_punctatus      GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TAGT -TTATTGGAT CTT-CT-CT-
Praeacanthonchus_sp             GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TAGT -TTATTGGAT CTT-CT-CT-
Cyatholaimus_sp._BHMM_2005      GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TAGT -TTATTGGAT CTT-CT-CT-
Spirinia_parasitifera           GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTT-GA-TT-
Acanthopharynx_micans           GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTT-GT-TT-
Xyzzors_sp                      GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCT-TTGT -TTCTTGGAT CTT-GA-AC-
Metachromadora_sp               GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTT-GA-TT-
Metachromadora_remanei          GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTT-GA-TT-
Catanema_sp                     GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TCGT -TTCTTGGAT CTT-AC-TT-
Eubostrichus_dianae             GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTT-AG-TT-
Eubostrichus_topiarus           GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTT-AC-TT-
Eubostrichus_parasitiferus      GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTT-AC-TT-
Laxus_oneistus                  GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTT-AC-TT-
Laxus_cosmopolitus              GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTT-AC-TT-
Leptonemella_sp                 GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCTG-TTGT -TTCTTGGAT CTT-AC-TT-
Robbea_hypermnestra             GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTT-AC-TT-
Stilbonema_majum                GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTT-AC-TT-
Monoposthia_costata             GTG-AAA-CT STSAATGGCT CATTAA-ATC AGTTA-TAGT -TTGTTTGAT GGT-AC-GT-
Nudora_bipapillata              GTG-AAG-CC GCGGACAGCT CATTAA-TAC ACTCC-TAAT -CCTAGCAAT GCT-TA-CC-
Calomicrolaimus_parahonestus    GTG-AAA-TC GCGAATAGCT CATTAC-AAC AGCCA-TTGT -TTCTTGGAT CTT-AC-TT-
Calomicrolaimus_sp._BHMM_2005   GTG-AAA-TC GCGAATAGCT CATTAC-AAC AGCCA-TTGT -TTCTTGGAT CTT-AC-TT-
Molgolaimus_demani              GTG-AAA-TC GCGAATAGCT CATTAC-AAC AGCCA-TTGT -TTCTTGGAT CTT-AC-TT-
Diplogaster_lethieri            ATG-AAT-CT GCGAACGGCT CATTATTAAC ACCCG-TAAT -CTACCCAGT TTT-CG-TA-
Aduncospiculum_halicti          CTG-AAT-CT GCGAACGGCT CATTAA-AAC GGCTA-TAAT -TTACTCGAA TTA-TC-A--
Pristionchus_lheritieri         ATG-AAT-CT GCGAACGGCT CATTATTAAC ACCCG-TAAT -CTACCCAGT TTT-CG-TA-
Pristionchus_pacificus          ATG-AAT-CT GCGAACGGCT CATTATTAAC ACCCA-TAAT -CTACCCAGT TTT-CG-TA-
Pristionchus_pacificus          ATG-AAT-CT GCGAACGGCT CATTATTAAC ACCCA-TAAT -CTACCCAGT TTT-CG-TA-
Sabatieria_punctata_STRAIN_343  GTA-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTC-TA-AT-
Sabatieria_sp._355_BHMM_2005    GTA-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTC-TA-AT-
NUCLEOTIDES INCLUDED            -mm-mmm-mm mmmmmmmmmm mmmmmm-mmm mmmmm-mmmm -mmmmmmmmm mmm-------
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                                        130        140        150        160        170        180
Sabatieria_celtica               GTA-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TCGT -TTCTTGGAT CTC-TC-GA-
Sabatieria_punctata_STRAIN_200   GTA-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TCGT -TTCTTGGAT CTC-TT-AT-
Sabatieria_punctata_STRAIN_223   GTA-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TCGT -TTCTTGGAT CTC-TC-AT-
Sabatieria_sp._210_BHM_2005      GTA-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TCGT -TTCTTGGAT CTC-TT-AT-
Setosabatieria_hilarula          GTA-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TCGT -TTCTTGGAT CTC-TC-GA-
Desmolaimus_zeelandicus          GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TAGT CTACTTGGT- CTT-GA-AA-
Terschellingia_longicaudata      GTG-AAA-CC GCGAATGGCT CATTAC-AAC AGCCG-TTGT TCCCTTGAGA CTA-TG-AA-
Cyartonema_elegans               GTG-AAA-CC GCGAATGGCT CATTAC-AAC AGCCG-TTGT TCCCTAGAGA CTA-CG-A--
Tridentulus_sp                   GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTC-TT-CT-
Diplolaimelloides_meyli          GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTC-TT-CT-
Diplolaimella_diavengatensis     ATG-AAG-CC GCGAATAGCT CATTAT-AAC AGCCG-TTGT -TTCTTGGAT CTT-CT-CT-
Geomonhystera_disjuncta          GTG-AAG-CC GCGAATAGCT CATTAC-AAT AGCCG-TTGT -TTCTTGGAT CCT-CA-AT-
Sphaerolaimus_hirsutus           GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTC-AT-CC-
Theristus_acer                   GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCG-TCGT -TTCTTAGAT CTC-CG-AT-
Daptonema_procerus               GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTC-CG-TT-
Daptonema_hirsutum               GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTC-CG-CT-
Daptonema_normandicum            GTA-AAG-CC GCGAATAGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTC-CG-CA-
Daptonema_oxycerca               GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTC-CG-TT-
Daptonema_setosum                GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTC-CG-CT-
Desmodora_communis               GTG-AAG-CC GCGAATGGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTT-GT-TT-
Desmodora_ovigera                GTG-AAG-CT GCGAATGGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTT-GT-TT-
Metadesmolaimus_sp               GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCG-TTGT -TTCTTGGAT CTC-CG-CT-
Dentostomella_sp                 GTG-AAA-CC GCGAAAGGCT CATTAT-AAC AGCTA-TTAT -TTACTTGAT ATT-GA-TA-
Bunonema_franzi                  GCG-AAT-TC GCGGACGGCT CATTAC-AAC AGAGA-TAAT -TTGCTTGAT TTA-GA-TT-
Bunonema_sp                      GCA-AAT-CC GCGGACGGCT CATTAC-AAC AGAGC-TAAT -TTTCTTGAT TTT-GA-CG-
Seleborca_complexa               GTG-AAA-CC GCGAATGGCT CATTAT-AAC AGCTT-TGA- -TTCCTTGGA CGT-AG-AC-
Acrobeloides_nanus               GTG-AAA-CC GCGAATGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT CTT-GA-CA-
Acrobeloides_bodenheimeri        GTG-AAA-CC GCGAATGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT CTT-GA-CA-
Acrobeloides_sp_PS1146           GTG-AAA-CC GCGAATGGCT CATTAT-AAC AGCTA-CAAT -TTATTTGAT CTT-GA-CA-
Acrobeles_ciliatus               GTG-AAA-CC GCGAATGGCT CATTAA-TAC AGTAA-AAAC -CTACAAGAT GTT-GA-CA-
Acrobeles_sp_PS1156              GTG-AAA-CC GCGAATGGCT CATTAA-TAC AGTAA-AAAC -CTACAAGAT GTT-GA-CA-
Acrobeles_complexus_WCUG2        GTG-AAA-CC GCGAATGGCT CATTAA-TAC AGTAA-AAAC -CTACAAGAT GTT-GA-CA-
Cephaloboides_sp_SB227           TTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAC -TTT-TTGCT G---------
Cephalobus_cubaensis             GTG-AAA-CC GCGAATGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT CTT-GA-CT-
Cephalobus_sp._PS1143            GTG-AAA-CC GCGAATGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT CTT-GA-CA-
Cephalobus_sp._PS1196            GTG-AAA-CC GCGAATGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT CTT-GA-CA-
Cephalobus_oryzae_PS1165         GTG-AAA-CC GCGAATGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT CTT-GA-CA-
Cervidellus_alutus               GTG-AAA-CC GCGAATGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT CTT-GA-CA-
Pseudacrobeles_variabilis        GTG-AAA-CC GCGAATGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT TTT-GA-CT-
Triligulla_aluta                 GTG-AAA-CC GCGAATGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT CTT-GA-CA-
Zeldia_punctada                  GTG-AAA-CC GCGAATGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT CTT-GA-CA-
Myolaimus_sp_U81585              GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT TTT-GA-TA-
Rhabditophanes_sp._KR3021        GTG-AAA-CC GCGGAAAGCT CATTAT-AAC AGCTA-TAAT -TTACACGGC AAA-TT-CC-
Brevibucca_sp._SB261             GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TTAT -TTACTTGAC GTG-AC-AA-
Halicephalobus_gingivalis        ACG-AAA-CC GCGCAAAGCT CATTAC-AAC AGCTA-AAAT -GTATACGGT GAG-AT-AC-
Panagrobelus_stammeri            ACG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTT-TAAC -CTACTTGAT TTA-GA-CA-
Plectonchus_sp._PDL0025          ACG-AAA-CC GCGAAAGGCT CATTAC-AAC GGCTT-TACT -TTACTTGAT TTT-GA-CT-
Turbatrix_aceti                  GCG-AAA-CC GCGCATAGCT CATTAT-AAC AGTCC-TAAT -TTACAAGTA TAT-GA-TT-
Panagrellus_redivivus            ACG-AAA-CC GCGTATGGCT CATTAC-AAC AGCTA-TGAT -TCTATTGAT CAT-GA-CA-
Panagrellus_redivivus_PS1163     ACG-AAA-CC GCGTATGGCT CATTAC-AAC AGCTA-TGAT -TCTATTGAT CAT-GA-CA-
Panagrolaimus_subelongatus       ACG-AAA-CC GCGTATGGCT CATTAT-AAC AGCTA-AAAT -TTACTTGAT TTT-GA-CT-
Panagrolaimus_davidi             ACG-AAA-CC GCGTATGGCT CATTAT-AAC AGCTA-AAAT -TTACTTGAT TTT-GA-CT-
Panagrolaimus_cf_rigidus_AF40    ACG-AAA-CC GCGTATGGCT CATTAT-AAC AGCTA-AAAT -TTACTTGAT TTT-GA-CT-
Panagrolaimus sp. Sourhope ED2   ACG-AAA-CC GCGTATGGCT CATTAT-AAC AGCTA-AAAT -TTACTTGAT TTT-GA-CT-
Panagrolaimus sp. Sourhope ED2   ACG-AAA-CC GCGTATGGCT CATTAT-AAC AGCTA-AAAT -TTACTTGAT TTT-GA-CT-
Panagrolaimus sp. Sourhope ED2   ACG-AAA-CC GCGTATGGCT CATTAT-AAC AGCTA-AAAT -TTACTTGAT TTT-GA-CT-
Panagrolaimus sp. Sourhope ED2   ACG-AAA-CC GCGTATGGCT CATTAT-AAC AGCTA-AAAT -TTACTTGAT TTT-GA-CT-
Panagrolaimus sp. Sourhope ED2   ACG-AAA-CC GCGTATGGCT CATTAT-AAC AGCTA-AAAT -TTACTTGAT TTT-GA-CT-
Steinernema_carpocapsae          GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCGA-TAAT -TGACTAAAC GAT-GT-TA-
Strongyloides_stercoralis        GTG-AAA-CT GCGAATGGCT CATTAA-ATC AGTTA-TAGT -TTATTTGAT GGT-TT-CT-
Strongyloides_ratti              ATG-AAA-CC GCGGAAAGCT CATTAT-AAC AGCTA-TAGA -CTACACGGT AAA-TA-TT-
Diploscapter_sp_PS1897           GTG-AAG-CT GCGCACGGCT CATTAG-CAC GGTTT-CGAC CTTTTTCGGA TAT-CT----
Diploscapter_sp_PS2017           GTG-AAG-CT GCGCACGGCT CATTAG-CAC GGTTT-CGAC CTTTTTCGGA TAT-CT----
Heterorhabditis_bacteriophora    GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATA-TCAT -TTATTCGGT AAT-A-----
Heterorhabditis_hepialus         GTG-AAA-C- GCGAACGGCT CATTAG-AGC AGATA-TCAT -TTATTCGGT AAT-A-----
Heterorhabditis_zelandica        GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATA-TCAT -TTATTCGGT AAT-A-----
Parasitorhabditis_sp_SB281       GCA-GTA-CT GTGAACGGCT CATTAT-AAC AGTTA-AAAT -TTGCATGAA GCT-TT-TC-
Rhabditoides_inermiformis        GTG-AAA-CT GCGAACGGCT AATTAT-ACC AGCTA-TAAT -TTACTAGAT TTT-GA-CA-
Rhabditoides_inermis_DF5001      GTG-AAA-CT GCGGGCGGCT CATTAT-ATC AGTTA-TGAT -TTACTTGAT TTT-GA-TT-
Rhabditoides_regina_DF5012       GTT-AAA-CT GCGAACGGCT CATTAC-AAC AGCCA-AAAT -CAGCATGAG GTG-TA-C--
Poikilolaimus_oxycerca_SB200     GTG-AAA-CC GCGAATGGCT CATTAC-AAC AGCTA-TAAT -TTACTTGAT GTT-GA-CT-
Poikilolaimus_regenfussi_SB199   GTG-AAA-CC GCGAATGGCT CATTAC-AAC AGCTA-TAAT -TTACTTGAT GTT-GA-CA-
Distolabrellus veechi DWF1604    GTG-AAA-CT GCGAACGGCT CATTAC-AAC AGTTA-AAAT -CAGCGTGAA GCT-TA-C--
Distolabrellus veechi DF5024     GTG-AAA-CT GCGAACGGCT CATTAC-AAC AGTTA-AAAT -CAGCGTGAA GCT-TA-C--
Choriorhabditis_dudichi          GAG-AAA-CT GCGTACGGCT CATTAG-AGC AGATA-TGCA -CTTGTCGAG GTT-Y-----
Protorhabditis_sp                GTG-AAA-CT GCGCACGGCT CATTAG-AAC GGTTT-ATA- -CCTATTTCG GAT-GT----
Protorhabditis_sp_DF5055         GCG-AAA-CT GCGAATGGCT CATTAG-AGC AGTTA-ATAG -CCTTTCCGT TGA-TC----
Cruznema_tripartitum_DF5015      GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATA-TATT -TTATTCCGG TGA-TC-C--
NUCLEOTIDES INCLUDED             -mm-mmm-mm mmmmmmmmmm mmmmmm-mmm mmmmm-mmmm -mmmmmmmmm mmm-------
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                                         130        140        150        160        170        180
Mesorhabditis_sp_PS1179          GGT-AGA-CT GTGAACGGCT CATTAT-AAC AGTTA-AAAT -CCTCGCGAA GTT-AG-C--
Mesorhabditis_spiculigera_SB15   GTG-GTA-CT GTGAACGGCT CATTAC-AAC AGTTG-AAAT -TCGCGTGAA ATC-CT-TC-
Mesorhabditis_anisomorpha_SB12   GTT-AGA-CT GTGAACGGCT CATTAC-AAC GGTCA-AAAT -CGGCACGAA GTA-GT-C--
Teratorhabditis_palmarum_DF501   GCC-CAT-CT GCGAACGGCT CATTAC-AAC AGTTA-AAAT -TCGCATGAC GAT-TG-T--
Teratorhabditis_synpapillata_S   ACC-TAT-CT GCGAACGGCT CATTAC-AAC AGTTA-AAAT -CCGCATGAC GAT-TG-T--
Caenorhabditis_briggsae_PB102    -TG-AAA-TT GCGTACGGCT CATTAG-AGC AGATA-TCAC -CTTGTTCGG AAT-CC-T--
Caenorhabditis_elegans_N2        -TG-AAA-TT GCGTACGGCT CATTAG-AGC AGATA-TCAC -CTTATCCGG GAT-CC-G--
Caenorhabditis_sp_CB5161         -TG-AAA-TT GCGTACGGCT CATTAG-AGC AGATA-TCAC -CTTATTCGG AAT-CC----
Caenorhabditis_sp_PS1010         -TG-AAA-TT GCGTACGGCT CATTAG-AGC AGATA-TCAT -CTCGTTCGG AAT-TC----
Caenorhabditis_japonica          -TG-AAA-TT GCGTACGGCT CATTAG-AGC AGATA-TCAC -CTTTCTCGG AAT-CC----
Caenorhabditis_sp_DF5170         -TG-AAA-TT GCGTACGGCT CATTAG-AGC AGATA-TCAT -TTTACTCGG AAT-TC----
Caenorhabditis_sp_SB341          -AG-AAA-CT GCGAACGGCT CATTAG-AGC AGATA-TCAC -ATCCTTCGG CAT-TC----
Caenorhabditis_plicata           -TG-AAA-TT GCGTACGGCT CATTAG-AGC AGATG-TATT -CTCATTCGG CGG-TC----
Caenorhabditis_vulgaris          -TG-AAA-TT GCGTACGGCT CATTAG-AGC AGATA-TCAC -CTTGTTCGG AAT-CC----
Caenorhabditis_sonorae           GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATA-TCAC -TTCCTTCGG CGA-TA----
Caenorhabditis_drosophilae       -TG-AAA-TT GCGTACGGCT CATTAG-AGC AGATA-TCAT -TTTACTCGG AAT-TC----
Phasmarhabditis_hermaphrodita    TAG-AAA-CT GCGTACGGCT CATTAG-AGC AGATTTAAAT -GATTCCGGG TAT-C-----
Phasmarhabditis_neopapillosa     AAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATTTAAAT -GATTCCAGG TAT-C-----
Phasmarhabditis_neopapillosa     GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGCTA-TCAT -TCTCTTCGG CTA-TC----
Pellioditis_mediterranea_SB173   GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGCTA-TCAT -TCTCTTCGG GTA-TC----
Pellioditis_marina               GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGCTA-TCAT –TCTCTTCGG CTA-TC----
Prodontorhabditis_wirthi         ATG-AAA-CT GCGGACGGCT CATTAT-AGC ATTGA-AACG -TTATTCTGG CAC-CA-T--
Crustorhabditis_scanica          GTT-CGA-CT GTGAACGGCT CATTAT-AAC AGTTA-AAAT -CAGCATGAA GTA-TA-T--
Dolichorhabditis_sp_CEW1         GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATA-TAAT -ATACCCGAG ATA-TC-T--
Oscheius_sp_DF5000               GTG-AAA-CT GCGAACGGCT CATTAT-AGC AGATA-TAAT -GTACCCGAG AAT-AT-C--
Oscheius_sp_BW282                GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGCTA-TCAT -TCTCTTCGG ATA-TC-C--
Oscheius_myriophila_EM435        CTG-AAA-CT GCGAACGGCT CATTAG-AGC AGCTA-TCAT -TCTCTTCGG ATA-TC-C--
Oscheius_insectivora             GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGCTA-TCAT -TCTCTTCGG ATA-TC-C--
Oscheius_dolichuroides           GTG-AAA-CT GCGAACGGCT CATTAT-AGC AGATA-TAAT -GTACCCGAG ATA-TT-C--
Rhabditis_blumi_DF5010           CGG-AAT-CG GCGAACGGCT CAATAT-TAC AGCTA-TCAC -TTATT-CGG TGA-T-----
Rhabditis_sp_PS1191              GGG-AAATCA GCGGCTAGCT CATTAC-AAC AGATC-TTAC -TTATTTCGA AGA-GA-T--
Rhabditis_sp_PS1010              -TG-AAA-TT GCGTACGGCT CATTAG-AGC AGATA-TCAT -CTCGTTCGG AAT-TC-T--
Rhabditis_myriophila_EM435       CTG-AAA-CT GCGAACGGCT CATTAG-AGC AGCTA-TCAT -TCTCTTCGG ATA-TC-C--
Rhabditis_colombiana             GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGCTA-TCAT -TCTCTTCGG ATA-TC-C--
Rhabditella_axei_DF5006          CTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATT-TTAC -CTATTCCGA AAT-CT----
Rhabditella_sp_DF5044            CTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATT-TTAC -CTATTCCGA AAT-CT----
Cuticularia_sp_PS2083            GTG-AAA-CC GCGAATGGCT CATTAC-AAC AGCTA-TAAT -TTACTGGAT GTT-GA-CT-
Necator_americanus               GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAC -TTATTCGGA AAG-TC----
Kalicephalus_cristatus           GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA ATG-TC----
Ancylostoma_caninum              GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAC -TTATTCGGA AAG-TC----
Angiostrongylus_cantonensis      GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TGAT -TTATTCGGA AAA-TC----
Angiostrongylus_costaricensis    GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TGAT -TTATTCGGA AAA-TC----
Angiostrongylus_malaysiensis     GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TGAT -TTATTCGGA AAA-TC----
Angiostrongylus_dujardini        GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC----
Angiostrongylus_vasorum          GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC----
Aulurostrongylus_abstrusus       GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAG-TT----
Didelphostrongylus_hayesi        GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TATT -TTAATCGGT AAT-TT----
Crenosoma_mephitidis             GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC----
Crenosoma_vulpis                 GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTTGGA AAA-TC----
Otostrongylus_circumlitus        GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC----
Troglostrongylus_wilsoni         GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC----
Filaroides_martis                GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC----
Oslerus_osleri                   GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAG-AC----
Parafilaroides_decorus           GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC----
Metastrongylus_salmi             GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC----
Metastrongylus_elongatus         GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC----
Skrjabingylus_chitwoodrum        GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATA-TCAT -TTATTCGGA AAT-TC----
Parelaphostrongylus_odocoilei    GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC-C--
Muelerius_capillaris             GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TG----
Protostrongylus_rufescens        GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TT----
Halocercus_invaginatus           GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC----
Pseudalius_inflexus              GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC-T--
Stenurus_minor                   GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC----
Torynurus_convolutus             GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC----
Syngamus_trachea                 GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAC -TTATTCGGA ACG-TG----
Stephanurus_dentatus             GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAG-TC----
Nematodirus_battus               GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC-C--
Strongylus_equinus               GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAC -TTATTCGGA AAG-TC----
Labiostrongylus_bipapillosus     GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAC -TTATTCGGA AAA-TC----
Petrovinema_poculatum            GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAC -TTATTCGGA AAG-TC----
Cylicocyclus_insignis            GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAC -TTATTCGGA AAG-TC----
Chabartia_ovina                  GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAC -TTATTCGGA AAG-TC----
Cyclodontostomum_purvisi         GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAC -TTATTCGGA AAG-TC----
Zoniolaimus_mawsonae             GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAC -TTATTCGGA AAG-TC----
Hypodontus_macropi               GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAC -TTATTCGGA AAG-TC----
Deletrocephalus_dimidiatus       GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAC -TTATTCGGA AAA-TC----
Dictyocaulus_eckerti_P7B8        GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TAAT -TTATTCGGA ATT-AT-T--
Dictyocaulus_capreolus_P3B2      GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TAAT -TTATTCGGA ATT-AT-T--
NUCLEOTIDES INCLUDED             -mm-mmm-mm mmmmmmmmmm mmmmmm-mmm mmmmm-mmmm -mmmmmmmmm mmm-------
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                                          130        140        150        160        170        180
Dictyocaulus_sp._P6A1            GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TAAT -TTATTCGGA ATT-AT-T--
Dictyocaulus_filaria             GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TAAT -TTCATCGGA AAA-TC-C--
Dictyocaulus_capreolus_P2C10     GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TAAT -TTATTCGGA ATT-AT-t--
Dictyocaulus_viviparus           GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TAAT -TTATTCGGA ATT-AT-T--
Haemonchus_sp._V3091             GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA ACG-TC----
Haemonchus_contortus             GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA ACG-TC----
Haemonchus_placei                GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA ACG-TC----
Haemonchus_similis               GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA ACG-TC----
Ostertagia_ostertagi             GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC----
Ostertagia_leptospicularis       GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA ACA-TC----
Nippostrongylus_brasileinsis     GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA ACG-TC----
Heligmosomoides_polygyrus        GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA ACG-TC----
Trichostrongylus_colubriformis   GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA ACG-TC----
Tetrabothriostrongylus mackerr   GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA ACG-TC----
Herpestrongylus_pythonis         GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA ACG-TC----
Nicollina_cameroni               GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAG-TC----
Filarimena_flagrifer             GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA ACG-TC----
Amidostomum_cygni                GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC----
Teratocephalus_lirellus          GTG-AAG-CC GCGAATAGCT CATTAC-AAC AGCCA-TTGT -TTACTTGAT CTT-GA-TA-
Brumptaemilius_justini           GTC-AAA-CC GCGTACGGCT CATTAT-AAC AGCCA-TAAT -ATACTTGAC GTT-GA-CT-
Anguillicola_crassus             GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGGT CTT-GA-TA-
Dracunculus_medinensis           GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GG-AT-
Dracunculus_oesophageus          GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TT-
Dracunculus_sp._V3104            GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT CTT-GA-TT-
Philonema_sp_A                   GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -ATACTTGAT TCT-GA-TT-
Philometra_obturans              GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TTAT -TTACTTGAT TTT-GA-TT-
Camallanus_oxycepahalus          GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCCA-TAAT -ATACTTGAT GTT-GA-TT-
Acanthocheilonema_viteae         GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -GTACTTGAT GTT-GA-TT-
Loa_loa                          GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -GTACTTGAT GTT-GA-TT-
Onchocerca_cervicalis            GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -GTACTTGAT GTT-GA-TT-
Dirofilaria_immitis              GTG-AAA-CC GCGAACGGCT CAT--T-AAC AGCTA-TAAT -GTACTTGAT GTT-GA-TT-
Brugia_malayi                    GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -GTACTTGAT GTT-GA-TT-
Wuchereria_bancrofti             GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -GTACTTGAT GTT-GA-TT-
Litomosoides_sigmodontis         GTG-AAA-CC GCGAACGGCT CATNAT-NAC AGCCTCTAAT -GTACCTGAT GCT-GA-CT-
Setaria_digitata                 GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -GTACTTGAT GTT-GA-TT-
Gnathostoma_turgidum             GTG-AAA-CC GCGAATGGCT CATTAC-GAC AGCTA-TGAT -TTACTTGAT CTT-GA-TA-
Gnathostoma_neoprocyonis         GTG-AAA-CC GCGAATGGCT CATTAC-GAC AGCTA-TGAT -TTACTTGAT CTT-GA-TA-
Gnathostoma_binucleatum          GTG-AAA-CC GCGAATGGCT CATTAC-GAC AGCTA-TGAT -TTACTTGAT CTT-GA-TA-
Physaloptera_alata               GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -GTACTTGAT CTT-GA-TC-
Physaloptera_turgida             GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-CAAT -GTACTTGAT CTT-GA-TT-
Ascarophis_arctica               GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -GTACTTGAT CTT-GA-TA-
Spinitectus_carolini             GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -GTACTTGAT CTT-GA-TA-
Thelazia_lacrymalis              GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -GTACTTGAT GTT-GA-TT-
Aphelenchus_avenae               GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGGTA-TAAT -TTACTTGAT CTT-GA-AA-
Aphelenchoides_fragariae         GCG-AAA-CT GCGAACGGCT CATTAC-AAC AGATA-TAAT -TTACTTGTT CTA-TT-CC-
Bursaphelelenchus_sp             GCG-AAA-CT GCGAACGGCT CATTAC-AAC AGATA-TAAT -TTACTAGTT CTT-GA-TC-
Deladenus_sp                     GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT TTT-CA-CT-
Criconema_sp                     GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TAAT -CTACTCGGT CTT-GA-AC-
Hemicycliophora_conida           GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCCA-TAAT -TTACTCGAT CTT-GA-AC-
Paratylenchus_dianthus           GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -TTACTAGAC CTT-GA-GC-
Pratylenchus_thornei             GTG-AAA-CT GCGTACGGCT CATTAC-AAC AGCAA-TAAT -TTACTTGAT CTT-GA-CA-
Tylenchulus_semipentrans         GAG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TGAT -TTACTTGAT CTT-GA-AC-
Ditylenchus_angustus             GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TGAT -TTACTTGAT CTT-GA-CC-
Subanguina_radicola              GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT CTT-GA-CT-
Tylenchorhynchus_maximus         GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT CTT-GA-CA-
Geocenamus_quadrifer             GTG-AAA-CC GCGAACAGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT CTT-GA-CT-
Globodera_pallida                GGG-AAA-CT GCGTACGGCT CATTAC-ACC AGCTA-TAAT -TTACTTGAC CTT-GA-CT-
Scutellonema_bradys              GGG-AAA-CT GCGTACGGCT CATTAC-ACC AGCTG-TAAT -TTACTTGAC CTT-GA-CA-
Helicotylenhcus_dihystera        GGG-AAA-CT GCGTACGGCT CATTAC-ACC AGCCT-TAAT -TTACTTGAC CTT-GA-CA-
Rotylenchus_robustus             GGG-AAA-CT GCGTACGGCT CATTAC-ACC AGCCT-TAAT -TTACTTGAC CTT-GA-CA-
Meloidogyne_arenaria             GAG-AAA-CC GCGAACGGCT CATTAC-AAT GGCCA-TTAT -TTACTTGAT CTT-GA-TT-
Meloidogyne_incognita_KT         GAG-AAA-CC GCGAACGGCT CATTAC-AAT GGCCA-TTAT -TTACTTGAT CTT-GA-TT-
Meloidogyne_javanica             GAG-AAA-CC GCGAACGGCT MAWWAC-AAT GGCCA-TGAT -TTACTTGAT CTT-GA-TT-
Meloidogyne_artiellia            GAG-AAA-CC GCGAACGGCT CATTAC-AAT GGCCA-TTAT -TTACTTGAT CTT-GA-CA-
Meloidogyne_duytsi               GAG-AAA-CC GCGAACGGCT CATTAC-AAT GGCCA-TGAT -TTACTTGAT CTT-GA-TA-
Meloidogyne_exigua               GAG-AAA-CC GCGATCGGCT CATTAC-AAT GGCCA-TGAT -TTACTTGAT CTT-GA-TT-
Meloidogyne_hapla                GAG-AAA-CC GCGAACGGCT CATTAC-AAT GGCCA-TGAT -TTACTTGAT CTT-GA-TA-
Meloidogyne_ichinohei            GAG-AAA-CC GCGAACGGCT CATTAC-AAT AGCCA-TTAT -TTACTTGAT CTT-GA-TCA
Meloidogyne_maritima             GAG-AAA-CC GCGAACGGCT CATTAC-AAT GGCCA-TGAT -TTACTTGAT CTT-GA-TTA
Meloidogyne_microtyla            GAG-AAA-CC GCGAACGGCT CATTAC-AAT GGCCA-TGAT -TTACTTGAT CTT-GA-TA-
Nacobbus_aberrans                GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT CTT-GA-CA-
Pratylenchoides_ritteri          GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT CTT-GA-CT-
Pratylenchoides_magnicauda       GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT CTT-GA-CT-
Hirschmanniella_sp._JH_2003      GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -TTACTGGAT CTT-GA-CA-
Radopholus_similis               ATG-AAA-CC GCAAACGGCT CATTAC-ACC AGCAG-TGAT -CTATTTGAC CTT-GA-TA-
Pratylenchus_goodeyi_VF          GTG-AAA-CT GCGAACGGCT CATTAC-AAC AGCTG-TAAT -TTACTTGAT CTT-GA-AA-
Boleodorus_thylactus_clone2      GTG-AAA-CC GCGAACGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT CTT-GA-CA-
Philippine Sequence 1            -TG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TGAT -TTATTCGGA AAA-TC----
NUCLEOTIDES INCLUDED             -mm-mmm-mm mmmmmmmmmm mmmmmm-mmm mmmmm-mmmm -mmmmmmmmm mmm-------
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                                         130        140        150        160        170        180
Philippine Sequence 2            GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TGAT -TTATTCGGA AAA-TC----
Philippine Sequence 3            GTG-AAA-TT GCGAACGGCT CATTAG-AGC AGCTA-TTAT TCTCTTCGGT ATCAT-----
Philippine Sequence 4            ACG-AAA-CC GCGTATGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT TTT-GA-CA-
Philippine Sequence 5            GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAC -TTATTCGGA AAG-TC----
Philippine Sequence 6            GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATA-TTAT -TTTCTTCGA ATA-T-----
Philippine Sequence 7            -TG-AAA-TT GCGTACGGCT CATTAG-AGC AGATA-TCAC -CTTGTTCGG AAT-AT----
Tahiti Sequence 1                -TG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TGAT -TTATTCGGA AAA-TC----
Tahiti Sequence 2                GTG-AAA-CT GCGAACGGCT TATTAG-AGC AGATG-TGAT -TTATTCGGA AAA-TC----
Thailand Sequence 1              GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TAAT -ATACTTGAT CTT-GACTA-
Ogasawara Sequence 1             ACG-AAA-CC GCGTATGGCT CATTAT-AAC AGCTA-TAAT -TTACTTGAT TTT-GA-CA-
Ogasawara Sequence 2             ATG-AAA-CT GCGAACGGCT CATTAG-AGC AGATATTAAT GATTGCAGAG -TA-TC----
Ivory Coast Sequence 1           GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-TC----
Ivory Coast Sequence 2           GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAG-AC----
Ivory Coast Sequence 3           GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAA-AT----
Ivory Coast Sequence 4           GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTACTCGGT AAAGAC----
Ivory Coast Sequence 5           GTG-AAA-CC GCGAACGGCT CATTAC-AAC AGCTA-TAAT -ATACTTGAT CTT-GACTA-
Ivory Coast Sequence 6           GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTACTCGGT AAA-GAC---
Ivory Coast Sequence 7           GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AA--GAC---
Singapore Sequence 1             GTG-AAA-TT GCGAACGGCT CATTAG-AGC AGCTA-TTAT -TCTCTTCGG -TA-TC----
Singapore Sequence 2             GTG-AAR-CC GCGAACGGCT CATTRC-AAC AGCTA-TAAT -ATACTTGAT CTT-GACTA-
Singapore Sequence 3             -TG-AAA-TT GCGTACGGCT CATTAG-AGC AGATA-TCAC -CTTGTTCGG AAT-CC-T--
Singapore Sequence 4             GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAG-AC----
Nigerian Sequence 1              -TG-AAA-CT GCGAACGGST CATTAG-AGC AGATG-TTAT -TTATTCGGA AAA-TA----
Nigerian Sequence 2              GAG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCWC -TTATTCGGA AAG-TC----
Nigerian Sequence 3              GTG-AAA-CT GCGAACGGCT CATTAG-AGC AGATG-TCAT -TTATTCGGA AAG-ATGTA-
NUCLEOTIDES INCLUDED             -mm-mmm-mm mmmmmmmmmm mmmmmm-mmm mmmmm-mmmm -mmmmmmmmm mmm-------


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                                         190        200        210        220        230        240
Gordius_aquaticus                ------CC-- ------CACA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCT-A
Priapulus_caudatus               ------TCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-A
Brachionus_plicatilis            ------AC-- ------TACA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA--
Chordodes_morgani                ------AC-- ------CACA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCT-G
Paractinolaimus_macrolaimus      -----ATCC- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-A
Aporcelaimellus_obtusicaudatus   -----ATCC- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-A
Wilsonema_schuurmansstekhoveni   -----ATCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-A
Mesodorylaimus_sp_cf_nigritul    -----ATCT- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-A
Mesodorylaimus_bastiani          -----ATCT- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-A
Mesodorylaimus_japonicus         -----TTCC- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-A
Pungentus_sp._PDL_2005           -----ATCC- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-A
Allodorylaimus_sp                -----ATCT- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-A
Eudorylaimus_carteri             -----ATCC- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-A
Microdorylaimus_sp               -----ATCT- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCG-A
Longidorus_elongatus             -----ATCC- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-A
Xiphinema_rivesi                 -----ATCC- ------TACT CGGATAAC-- TGTGGCAATT CTAGAGCTAA TACGTGCG-A
Tylencholaimus_sp                -----TTCC- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-A
Anoplostoma_sp._BHMM_2005        -----T---- ------TGAT AGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Adoncholaimus_fuscus             -----T---- ------TACA TGGATAAC-- TGTGGTAATT CTACAGCTAA TACACGCA-T
Enoplus_meridionalis             -----GT--- ------TACA TGGATACC-- TGTGGTAACC TAAGAGCTAA TACGCGCA-A
Enoplus_brevis_U88336            -----GT--- ------TACA CGGATACC-- TGTGGTAACC TAAGAGCTAA TACACGCA-A
Enoplus_communis                 -----GT--- ------TACA CGGATACC-- TGTGGTAACC TAAGAGCTAA TACGCGCA-A
Enoploides_brunettii             -----C---- ------TACT TGGATACC-- TGTGGTAACC TAAGAGCTAA TACATGCA-A
Syringolaimus_striatocaudatus    -----TTT-- ------TACA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-T
Ironus_dentifurcatus             -----TCC-- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-A
Calyptronema_maxweberi           -----TAC-- ------TACA TGGATAAC-- TGTGGTAATT CTACAGCTAA TACACGCT-C
Viscosia_sp._BHMM_2005           -----TCC-- ------TACA TGGATAAC-- CGTGGTAATT CTACGGCTAA TACACGCT-T
Viscosia_viscosa                 ---------- ------TACA TGGATAAC-- TGTGGTAATT CTACAGCTAA TACACGCA-T
Pontonema_vulgare                -----AAT-- ------TACA TGGATAAC-- TGTGGTAATT CTACAGCTAA TACACGCA-T
Oncholaimus_sp._BHMM_2005        -----AT--- ------TACA TGGATAAC-- TGTGGTAATT CTACAGCTAA TACACGCA-T
Alaimus_sp_PDL_2005              -----TCC-- ------TACA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCC-T
Prismatolaimus_intermedius       -----TCC-- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTA- TACACGCA-T
Tobrilus_gracilis                -----TCC-- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-G
Tripyla_cf_filicaudata_JH_2004   ---------- ------TACT TGGATAAC-- TGAGCTAATT GTTGAGCTAA TACATGCA-C
Bathylaimus_sp                   -----TAC-- ------TACA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-A
Bathylaimus_assimilis            -----TAC-- ------TACA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-A
Bathylaimus_sp._BHMM_2005        -----ACC-- ------TACA TGGATAAC-- TGAGGTAATT CTTGAGCTAA TACATGCT-A
Tripyloides_sp._BHMM_2005        -----TAC-- ------TACA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCT-A
Trischistoma_monohystera         -----TCC-- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCC-T
Mermis_nigrescens                -----ATC-- ------TACT TGGATAAC-- TGCGGTAATT CTAGAGCTAA TACATGCA-A
Mylonchulus_arenicolus           -----TCT-- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-C
Anatonchus_tridentacus           -----ATC-- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-C
Mononchus_truncatus              -----ATC-- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-C
Prionchulus_muscorum             -----ATC-- ------TACT CGGATAAC-- TGTGGCAATT CTAGAGCTAA TACGTGCA-C
Clarkus_sp                       -----ATC-- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-C
Trichinella_spiralis             ---------- ------ATCA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Trichinella_papuae               ---------- ------TACA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Trichinella_britovi              ---------- ------ATCA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
NUCLEOTIDES INCLUDED             ---------- ------mmmm mmmmmmmm-- mmmmmmmmmm mmmmmmmmmm mmmmmmmm--
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                                        190        200        210        220        230        240
Trichinella_murrelli             ---------- ------ATCA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Trichinella_pseudospiralis       ---------- ------TACA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Trichinella_nativa               ---------- ------ATCA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Trichinella_zimbabwensis         ---------- ------TACA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Trichinella_nelsoni              ---------- ------CTCA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Trichuris_suis                   ---------- ------CACT TGGATAAC-- TGTGGAAATT CTAGAGCTAA TAC-TGCC-T
Trichuris_trichiura              -----C---- ------CACT TGGATAAC-- TATGGAAATG CTAGAGCTAA TACATGCC-T
Trichuris_muris                  -----C---- ------CACT TGGATAAC-- TGTGGAAATT CTAGAGCTAA TACATGCC-T
Tylolaimophorus_minor            ---------- ------TACA TGGATACC-- TGTTGTAATT CAAGAGCTAA TACATGCG--
Paratrichodorus_pachydermus      -----TTCT- ------TACA CGGATAAC-- TGCGGTAATT CTGGAGCTAC TACGTGCA-T
Paratrichodorus_anemones         -----TCT-- ------TACA CGGATACC-- TGCGGTAATT CTGGAGCTAC TACGTGCA-T
Trichodorus_primitivus           -----TTCC- ------TACA AGGACACC-- TGCGGTAATT CTGGAGCTAA TACTTGCG--
Axonolaimus_helgolandicus        ------TCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA--
Ascolaimus_elongatus             ------TCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA--
Odontophora_rectangula           ------TCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Cylindrolaimus_sp._202149        ------TCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Tylocephalus_auriculatus         -----ATCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-A
Plectus_acuminatus_BS9           -----ATCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-A
Plectus_aquatilis                -----ATCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-A
Anaplectus_sp                    -----ATCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-A
Anisakis_sp_WKT                  ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Anisakis_sp_Nadler               ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Contracaecum_multipapillatum     ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Pseudoterranova_decipiens        ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Raphidascaris_acus               ------tcc- ------tacg tggataac-- tgtggtaatt ctagagctaa tacatgca-c
Terranova_caballeroi             ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Ascaris_suum                     ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Ascaris_lumbricoides             ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Baylisascaris_procyonis          ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Baylisascaris_transfuga          ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Parascaris_equorum               ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Porrocaecum_depressum            ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Toxascaris_leonina               ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Heterocheilus_tunicatus          ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Goezia_pelagia                   ------TCCC ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Hysterothylacium_fortalezae      ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Hysterothylacium_pelagicum       ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Hysterothylacium_reliquens       ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Iheringascaris_inquies           ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Toxocara_canis                   ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Nemhelix_bakeri                  ------TCC- ------TACT TGGATAAC-- TGAGGTAATT CTTGAGCTAA TACAATGCAG
Raillietnema_sp._V3060           ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Cruzia_americana                 ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Heterakis_sp_14690               ------TCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Heterakis_gallinarum             ------TCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Paraspidodera_sp_21303           ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Chromodora_nudicapitata          ------GT-- ------TACT TGGATAAC-- TGTTCAAAAG GAAGAGCTAA GACATGCC-T
Chromadora_sp._BHMM_2005         ---------- ------CACA GCAATAAC-- TGTGGAAAAG CCAGAGCTAA CTC-TGCA-T
Atrochromadora_microlaima        ---------- ------CACA GCAATAAC-- TGTGGAAAAG CCAGAGCTAA CTC-TGCA-T
Chromadorina_germanica           -------CC- ------TACT TGGATACC-- TGTGGAAAAT CCAGAGCTAA TACATGCACC
Chromadorita_tentabundum         ------TCC- ------TACT TGGATACC-- TGTGGAAAAT CTAGAGCTAA TACACGCA-A
Dichromadora_sp._BHMM_2005       ---------- ------CACA GCAATAAC-- TGTGGAAAAG CCAGAGCTAA CTCTGCAT--
Neochromadora_BHMM_2005          ------TCC- ------TACT TGGATACC-- TGTGGTAATT CTAGAGCTAA TACACGCA-A
Spilophorella_paradoxa           ------CC-- ------TACT TGGATACC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Paracanthonchus_caecus           ------CA-- ------TACT TGGATACC-- TGTGGTAATT CTAGAGCTAA TACACGCA-A
Paracyatholaimus_intermedius     ------CA-- ------TACT TGGATACC-- TGTGGTAATT CTAGAGCTAA TACACGCA-G
Praeacanthonchus_punctatus       ------C--- ------TACT TGGATACC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Praeacanthonchus_sp              ------C--- ------TACT TGGATACC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Cyatholaimus_sp._BHMM_2005       ------CA-- ------TACT TGGATACC-- TGTGGTAATT CTAGAGCTAA TACACGCA-A
Spirinia_parasitifera            ---------- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGTG-A
Acanthopharynx_micans            ---------- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-A
Xyzzors_sp                       ---------- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-A
Metachromadora_sp                ---------- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-A
Metachromadora_remanei           ---------- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-A
Catanema_sp                      ---------- ------TACT CGGATAAC-- TGTGGTAATT CTAGAGCTAA TACGTGCC-A
Eubostrichus_dianae              ------T--- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-A
Eubostrichus_topiarus            ------T--- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-A
Eubostrichus_parasitiferus       ------T--- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-A
Laxus_oneistus                   ---------- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACGTGCA-A
Laxus_cosmopolitus               ---------- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-A
Leptonemella_sp                  ---------- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-A
Robbea_hypermnestra              ---------- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGTA-T
Stilbonema_majum                 ---------- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-A
Monoposthia_costata              ------GC-- ------TACT CGGATAAC-- CGTAGTAATT CTAGAGCTAA TACGTGCA--
Nudora_bipapillata               ---------- ------AATA TGGATATC-- TGTGCTAATT GTAGAGCTAA TACACGCA-G
Calomicrolaimus_parahonestus     ------TC-- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Calomicrolaimus_sp._BHMM_2005    ------TC-- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Molgolaimus_demani               ------TC-- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA--
NUCLEOTIDES INCLUDED             ---------- ------mmmm mmmmmmmm-- mmmmmmmmmm mmmmmmmmmm mmmmmmmm--
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                                        190        200        210        220        230        240
Diplogaster_lethieri             ------TCC- ------AAAA CGGATATC-- TGCGTTAATT TTGGAGCTAA TACGTGCA-C
Aduncospiculum_halicti           ------TCC- ------TAAA CGGATATC-- TGCGATAATT TTGGAGCTAA TACGTGCC-C
Pristionchus_lheritieri          ------TCC- ------AAAA CGGATATC-- TGCGTTAATT TTGGAGCTAA TACGTGCA-C
Pristionchus_pacificus           ------TCC- ------AAAA CGGATATC-- TGCGTTAATT TTGGAGCTAA TACGTGCA-C
Pristionchus_pacificus           ------TCC- ------AAAA CGGATATC-- TGCGTTAATT TTGGAGCTAA TACGTGCA-C
Sabatieria_punctata_STRAIN_343   ------TT-- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Sabatieria_sp._355_BHMM_2005     ------TT-- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Sabatieria_celtica               ------TC-- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCC-T
Sabatieria_punctata_STRAIN_200   -------T-- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Sabatieria_punctata_STRAIN_223   ------TT-- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Sabatieria_sp._210_BHM_2005      ------TT-- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Setosabatieria_hilarula          ------TC-- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCC-T
Desmolaimus_zeelandicus          ------TCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA--
Terschellingia_longicaudata      ---------- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACACGCA-c
Cyartonema_elegans               ---------- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACACGCC-C
Tridentulus_sp                   ------C--- ------TACT TGGATATC-- TCTGGTAATT CTAGAGCTAA TACATGCA--
Diplolaimelloides_meyli          ------C--- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCAA-
Diplolaimella_diavengatensis     ------C--- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCCT-
Geomonhystera_disjuncta          ------T--- ------TACT TGGATACC-- TGTGGTAATT CTAGAGCTAA TACATGCGA-
Sphaerolaimus_hirsutus           ------T--- ------TACT TGGATAAC-- TGTCGAAATG CGAGAGCTAA TACATGCAA-
Theristus_acer                   ------T--- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCAT-
Daptonema_procerus               ------T--- ------TACT TGGATATG-- TGCTGCAATT CAGGACTTAA TACATGCAA-
Daptonema_hirsutum               ------TT-- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCAA-
Daptonema_normandicum            ------A--- ------TACT TGGATAAC-- TGAGGTAATT CTTGAGCTAA TACACGCAA-
Daptonema_oxycerca               ------T--- ------TACT TGGATATG-- TGCTGCAATT CAGGACTTAA TACATGCAA-
Daptonema_setosum                ------TT-- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCAA-
Desmodora_communis               ---------- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCAA-
Desmodora_ovigera                ---------- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-A
Metadesmolaimus_sp               ------TT-- ------TACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCAA-
Dentostomella_sp                 ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Bunonema_franzi                  ------CC-- ------CAAG TGGATAAC-- TTTGGTAATT CTGGAGCTAA TACATGCCT-
Bunonema_sp                      ------TCC- ------CAAT TGGACAAC-- TTTGGTAATT CTGGAGCTAA TACATGCCT-
Seleborca_complexa               -----ACAAT CC----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-T
Acrobeloides_nanus               ------CAAT CC----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-T
Acrobeloides_bodenheimeri        ------CTAT CC----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-T
Acrobeloides_sp_PS1146           ------CAAT CC----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-T
Acrobeles_ciliatus               ------CAAT CC----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Acrobeles_sp_PS1156              ------CAAT CC----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Acrobeles_complexus_WCUG2        ------CAAT CC----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Cephaloboides_sp_SB227           ------TCCT C-----TATG AGGATAAC-- TGCGATAAAT TTGGAGCTAA TACATATT-T
Cephalobus_cubaensis             ------CAAT CC----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-T
Cephalobus_sp._PS1143            ------CAAT CC----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-T
Cephalobus_sp._PS1196            ------CAAT CC----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-T
Cephalobus_oryzae_PS1165         ------CAAT CC----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-T
Cervidellus_alutus               ------CAAT CC----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-T
Pseudacrobeles_variabilis        ------TCAT CC----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-T
Triligulla_aluta                 ------CAAT CC----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-T
Zeldia_punctada                  ------CTAT CC----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-T
Myolaimus_sp_U81585              ------TCC- ------TACT TGGACATATC TGAGGAAAAT CTTGAGCTAA TACATGCA-C
Rhabditophanes_sp._KR3021        ------C--- ------TAGT TGGATAAC-- TGAGGTAATT CTTGAGCTAA TACACGCAAT
Brevibucca_sp._SB261             ------TCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-T
Halicephalobus_gingivalis        ------CAT- ------TAAA TGGATATC-- TGCGGTAAAT CTGGAGCTAA TACATGCA-A
Panagrobelus_stammeri            ------TNTA TCT---TACA TGGATAAC-- NGTGGTAATT CTGGAGCTAA TACATGCACT
Plectonchus_sp._PDL0025          ------TTAT CC----TACA TGGATAAC-- TGTGGTAATT CTGGAGCTAA TACATGCA-C
Turbatrix_aceti                  ------TATC ------TACA CGGATAAC-- TTTGGCAATT CTGGAGCTAA TACGTGCA-T
Panagrellus_redivivus            ------CTTT CC----TATA TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-T
Panagrellus_redivivus_PS1163     ------CTTT CC----TATA TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-T
Panagrolaimus_subelongatus       ------TTTA TCC---TACA TGGATAAC-C TGTGGTAATT CTGGAGCTAA TACATGCA-T
Panagrolaimus_davidi             ------TTTA TCC---TACA TGGATAAC-- TGTGGTAATT CTGGAGCTAA TACATGCA-T
Panagrolaimus_cf_rigidus_AF40    ------TTTA TCC---TACA TGGATAAC-- TGTGGTAATT CTGGAGCTAA TACATGCA-T
Panagrolaimus sp. Sourhope ED2   ------TTTA TCC---TACA TGGATAAC-- TGTGGTAATT CTGGAGCTAA TACATGCA-T
Panagrolaimus sp. Sourhope ED2   ------TTTA TCC---TACA TGGATAAC-- TGTGGTCATT CTGGAGCTAA TACATGCA-T
Panagrolaimus sp. Sourhope ED2   ------TTTA TCC---TACA TGGATAAC-- TGTGGTAATT CTGGAGCTAA TACATGCA-T
Panagrolaimus sp. Sourhope ED2   ------TTTA TCC---TACA TGGATAAC-- TGTGGTAATT CTGGAGCTAA TACATGCA-T
Panagrolaimus sp. Sourhope ED2   ------TTTA TCC---TACA TGGATAAC-- TGTGGTAATT CTGGAGCTAA TACATGCA-T
Steinernema_carpocapsae          ------ATCC TT----TAAA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGGT-T
Strongyloides_stercoralis        ------TGC- ------TACA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCTKA
Strongyloides_ratti              ------T--- ------TAGT TGGATAAC-- TGAGGTAATT CTTGAGCTAA TACACGCT-T
Diploscapter_sp_PS1897           ---------- ------CAAT GGGATAAC-- TGCGGAAATA CTGGAGCTAA TACCTGCA-C
Diploscapter_sp_PS2017           ---------- ------CAAT GGGATAAC-- TGCGGAAATA CTGGAGCTAA TACCTGCA-C
Heterorhabditis_bacteriophora    ---------- ------TTTT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-T
Heterorhabditis_hepialus         ---------- ------TTTT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-T
Heterorhabditis_zelandica        ---------- ------TCTT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-T
Parasitorhabditis_sp_SB281       ------C--- ------CGTA TGGATACT-- TCTAGTAATT CTGGAGCTAA TACATACT-A
Rhabditoides_inermiformis        ------ATCC ------TACA TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-C
Rhabditoides_inermis_DF5001      ------A--- ------TCTA TGGATAAC-- TGCGGTAATT CTGGAGCTAA AACATGCA-T
Rhabditoides_regina_DF5012       ---------- ------CTTA TGGATACT-- TGCAGTAATT CTGGAGCTAA TACACGTG-C
Poikilolaimus_oxycerca_SB200     ------ATCC ------TACT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-T
NUCLEOTIDES INCLUDED             ---------- ------mmmm mmmmmmmm-- mmmmmmmmmm mmmmmmmmmm mmmmmmmm--
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                                          190        200        210        220        230        240
Poikilolaimus_regenfussi_SB199    ------ATCC ------TACT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-T
Distolabrellus veechi DWF1604     ---------- ------TGAG TGGATACT-- TTCAGTAATT CTGGAGCTAA TACATGTT-C
Distolabrellus veechi DF5024      ---------- ------TGAG TGGATACT-- TTCAGTAATT CTGGAGCTAA TACATGTT-C
Choriorhabditis_dudichi           ---------- ------CCCM TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-A
Protorhabditis_sp                 ------ATCC ------TTTT GGGATAAC-- TGCGGAAATA CTGGAGCTAA TACCTGCA-C
Protorhabditis_sp_DF5055          ---------- ------CCTT GGGATAAC-- TGCGGAAATT CTGGAGCTAA TACCATTA-A
Cruznema_tripartitum_DF5015       ---------- ------AAGA TGGATAAC-- TGCGGAAATA CTGGAGCTAA TACATGCA-A
Mesorhabditis_sp_PS1179           ---------- ------ATTT TGGATACT-- TCTAGTAATT CTGGAGCTAA TACACGTG-T
Mesorhabditis_spiculigera_SB15    ---------- ------TCAA TGGATACT-- TCTAGTAATT CTGGAGCTAA TACAGTGC-A
Mesorhabditis_anisomorpha_SB12    ---------- ------TCCC CGGATACT-- TCTAGTAATT CTGGAGCTAA TACGGCGC-A
Teratorhabditis_palmarum_DF501    ---------- ------TTCT TGGATACT-- TTCAGTAATT CTGGAGCTAA TAC--GTA-A
Teratorhabditis_synpapillata_S    ---------- ------TTTC TGGATACT-- TTCAGTAATT CTGGAGCTAA TAC--GTA-C
Caenorhabditis_briggsae_PB102     ---------- ------AATA TGGATAAC-- TGCGGAAATA CTGGAGCTAA TACATGCA-A
Caenorhabditis_elegans_N2         -----GATCC -----TCATA TGGATAAC-- TGCGGAAATA CTGGAGCTAA TACATGCA-A
Caenorhabditis_sp_CB5161          ---------- ------TATA TGGATAAC-- TGCGGAAATA CTGGAGCTAA TACATGCA-A
Caenorhabditis_sp_PS1010          ---------- -----TAATA TGGATAAC-- TGCGGAAATA CTGGAGCTAA TACATGCA-A
Caenorhabditis_japonica           ---------- -----TGAAA AGGATAAC-- TGCGGAAATT CTGGAGCTAA TACATGCG-A
Caenorhabditis_sp_DF5170          ---------- ------TATA TGGATAAC-- TGCGGAAATA CTGGAGCTAA TACATGCA-T
Caenorhabditis_sp_SB341           ---------- -----CAAAT TGGATAAC-- TGCGGAAATA CTGGAGCTAA TACATGCA-A
Caenorhabditis_plicata            ---------- ----CTTAAA TGGATATC-- TGCGGAAATT CTGGAGCTAA TACATGCC-G
Caenorhabditis_vulgaris           ---------- ------TATA TGGATAAC-- TGCGGAAATA CTGGAGCTAA TACATGCA-A
Caenorhabditis_sonorae            ---------- -----TCTTA TGGATAAC-- TGCGGAAATA CTGGAGCTAA TACATGCA-A
Caenorhabditis_drosophilae        ---------- ------CATA TGGATAAC-- TGCGGAAATA CTGGAGCTAA TACATGCA-T
Phasmarhabditis_hermaphrodita     ---------- ------CTAT TGGATAAC-- TGTGGTAATT CTGGAGCTAA TACATGCA-A
Phasmarhabditis_neopapillosa      ---------- ------CTTT TGGATAAC-- TGTGGTAATT CTGGAGCTAA TACATGCA-A
Phasmarhabditis_neopapillosa      ---------- ------CTGA TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCA-A
Pellioditis_mediterranea_SB173    ---------- ------CTAG TGGATAAC-- TTCGGTAATT CTGGAGCTAA TACATGCA-A
Pellioditis_marina                ---------- ------CTGA TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCA-A
Prodontorhabditis_wirthi          ---------- ------AACG AGGATATC-- TGCGGAAATA CTGGAGTTAA TACTTGCCTA
Crustorhabditis_scanica           ---------- ------CTTT TGGATACT-- TTCAGTAATT CTGGAGCTAA TACATACG-C
Dolichorhabditis_sp_CEW1          ---------- ------TTAG TGGATAAC-- TGCGGTAAAT CTGGAGCTAA TACATGTC-A
Oscheius_sp_DF5000                ---------- ------TTAA TGGATAAC-- TGCGGTAAAT CTGGAGCTAA TACATGCA-A
Oscheius_sp_BW282                 ---------- ------TTTA TGGATAAC-- TGCGGAAATT CTGGAGCTAA TACATGCA-A
Oscheius_myriophila_EM435         ---------- ------TTTA TGGATAAC-- TGCGGAAATT CTGGAGCTAA TACATGCA-A
Oscheius_insectivora              ---------- ------TTTA TGGATAAC-- TGCGGAAATT CTGGAGCTAA TACATGCA-A
Oscheius_dolichuroides            ---------- ------TTAA TGGATAAC-- TGCGGTAAAT CTGGAGCTAA TACATGCA-A
Rhabditis_blumi_DF5010            ---------- ------CCTT TGGATAAC-- TGCGGAAATA CTGGAGCTAA TACATGCA-A
Rhabditis_sp_PS1191               ---------- ------CATT TGGATAAC-- TGCGGAAATA CTGGAGCTAA TACATGCA-A
Rhabditis_sp_PS1010               ---------- ------AATA TGGATAAC-- TGCGGAAATA CTGGAGCTAA TACATGCA-A
Rhabditis_myriophila_EM435        ---------- ------TTTA TGGATAAC-- TGCGGAAATT CTGGAGCTAA TACATGCA-A
Rhabditis_colombiana              ---------- ------TTTA TGGATAAC-- TGCGGAAATT CTGGAGCTAA TACATGCA-A
Rhabditella_axei_DF5006           ---------- ------TATT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-A
Rhabditella_sp_DF5044             ---------- ------TATT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-A
Cuticularia_sp_PS2083             ------ATCC ------TACT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-T
Necator_americanus                ---------- ------CTTT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCG-A
Kalicephalus_cristatus            ---------- ------CTTT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCG-A
Ancylostoma_caninum               ---------- ------CTTT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCG-A
Angiostrongylus_cantonensis       ---------- ------CTAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-T
Angiostrongylus_costaricensis     ---------- ------CTAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-T
Angiostrongylus_malaysiensis      ---------- ------CTAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-T
Angiostrongylus_dujardini         ---------- ------CTAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-G
Angiostrongylus_vasorum           ---------- ------TTAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Aulurostrongylus_abstrusus        ---------- ------CACC TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-G
Didelphostrongylus_hayesi         ---------- ------GAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-G
Crenosoma_mephitidis              ---------- ------CATT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Crenosoma_vulpis                  ---------- ------CAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Otostrongylus_circumlitus         ---------- ------CATT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Troglostrongylus_wilsoni          ---------- ------CAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Filaroides_martis                 ---------- ------CAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Oslerus_osleri                    ---------- ------GAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Parafilaroides_decorus            ---------- ------CAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCT-A
Metastrongylus_salmi              ---------- ------CAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Metastrongylus_elongatus          ---------- ------CAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Skrjabingylus_chitwoodrum         ---------- ------CAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGTG-A
Parelaphostrongylus_odocoilei     ---------- ------TTAA TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATATG-C
Muelerius_capillaris              ---------- ------ACAA TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-A
Protostrongylus_rufescens         ---------- ------AACT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Halocercus_invaginatus            ---------- ------CAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCT-a
Pseudalius_inflexus               ---------- ------CAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATTCT-A
Stenurus_minor                    ---------- ------CAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCT-A
Torynurus_convolutus              ---------- ------CAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCT-A
Syngamus_trachea                  ---------- ------GTTT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCG-A
Stephanurus_dentatus              ---------- ------CTAT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCG-A
Nematodirus_battus                ---------- ------TTTT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCG-T
Strongylus_equinus                ---------- ------CTAT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCA-A
Labiostrongylus_bipapillosus      ---------- ------CTAT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCG-A
Petrovinema_poculatum             ---------- ------CTTT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCA-A
Cylicocyclus_insignis             ---------- ------CTAT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCG-A
NUCLEOTIDES INCLUDED              ---------- ------mmmm mmmmmmmm-- mmmmmmmmmm mmmmmmmmmm mmmmmmmm--
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                                         190        200        210        220        230        240
Chabartia_ovina                  ---------- ------CTTT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCG-A
Cyclodontostomum_purvisi         ---------- ------CTTT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCG-A
Zoniolaimus_mawsonae             ---------- ------CTAT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCG-A
Hypodontus_macropi               ---------- ------CTAT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCG-A
Deletrocephalus_dimidiatus       ---------- ------CTAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Dictyocaulus_eckerti_P7B8        ---------- ------CGAA TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Dictyocaulus_capreolus_P3B2      ---------- ------CGAA TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Dictyocaulus_sp._P6A1            ---------- ------CGAA TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Dictyocaulus_filaria             ---------- ------ACTA TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-A
Dictyocaulus_capreolus_P2C10     ---------- ------CGAA TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Dictyocaulus_viviparus           ---------- ------CGAA TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Haemonchus_sp._V3091             ---------- ------CTTT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-A
Haemonchus_contortus             ---------- ------CTTT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-A
Haemonchus_placei                ---------- ------CTTT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-A
Haemonchus_similis               ---------- ------CTTT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-A
Ostertagia_ostertagi             ---------- ------CTAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Ostertagia_leptospicularis       ---------- ------CTAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Nippostrongylus_brasileinsis     ---------- ------CTAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCA-A
Heligmosomoides_polygyrus        ---------- ------CTAT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCA-A
Trichostrongylus_colubriformis   ---------- ------CTAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGTA-A
Tetrabothriostrongylus mackerr   ---------- ------TTTT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCG-A
Herpestrongylus_pythonis         ---------- ------CTAT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCA-A
Nicollina_cameroni               ---------- ------CTAT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCA-A
Filarimena_flagrifer             ---------- ------GTTT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCA-A
Amidostomum_cygni                ---------- ------CTTT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCA-A
Teratocephalus_lirellus          ------TCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACACGCA-C
Brumptaemilius_justini           ------TCC- ------TACG TGGATAAC-- TGTGRTAATT CTAGAGCTAA TACATGCA-C
Anguillicola_crassus             ------TAC- ------TACA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Dracunculus_medinensis           ------TTCA C-----TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Dracunculus_oesophageus          ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-T
Dracunculus_sp._V3104            ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Philonema_sp_A                   ------TCC- ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Philometra_obturans              ------CCA- ------TACG TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-C
Camallanus_oxycepahalus          ------TCC- ------CACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Acanthocheilonema_viteae         ------ATCC ------AACG TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-C
Loa_loa                          ------ATCC ------AACG TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-C
Onchocerca_cervicalis            ------ATCC ------AACG TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-C
Dirofilaria_immitis              ------ATCC ------AACT TGGATAAC-- TGTGGCAATT CTAGTGTTGA TACATGCA-C
Brugia_malayi                    ------ATCT ------AACG TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-C
Wuchereria_bancrofti             ------ATCC ------AACG TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-C
Litomosoides_sigmodontis         ------GGCC ------AACG TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-C
Setaria_digitata                 ------ATCC ------AACT TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-C
Gnathostoma_turgidum             ------CTC- ------TACT TGGATATC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Gnathostoma_neoprocyonis         ------TTC- ------TACT TGGATATC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Gnathostoma_binucleatum          ------TTC- ------TACT TGGATATC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Physaloptera_alata               ------ATCC ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Physaloptera_turgida             ------ATCC ------TACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Ascarophis_arctica               ------ATCC ------AACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Spinitectus_carolini             ------ATCC ------AACG TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Thelazia_lacrymalis              -----TATCC ------AACG TGGATAAC-- TGTGGCAATT CTAGAGCTAA TACATGCA-C
Aphelenchus_avenae               ------GAAT CC----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCC-C
Aphelenchoides_fragariae         ------TT-- ------TAAA CGGATAAC-- TGCGGTAATT CTGGAGCCAA TACGTGCC-A
Bursaphelelenchus_sp             ------C--- ------TATA TGGATAAC-- TGCGGTAATT -TGGAGCCAA TACATGCA-T
Deladenus_sp                     ------ATAC C-----TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-T
Criconema_sp                     ------AGT- ------TACT CGGATAAC-- TGTGGTAATT CTAGAGCTAA TACGTGCA-C
Hemicycliophora_conida           ------CCAC ------TACA AGGATAAC-- TGTGGTAATT CTAGAGCTAA TACTTGCA-C
Paratylenchus_dianthus           ------AAC- ------TACT TGGATACC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Pratylenchus_thornei             ------ACC- ------TACA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Tylenchulus_semipentrans         ------AGT- ------TACT CGGATAAC-- TGTGGTAATT CTAGAGCTAA TACGTGCA-C
Ditylenchus_angustus             ------TATA C-----TACA TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Subanguina_radicola              ------ATCC ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Tylenchorhynchus_maximus         ------ACC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Geocenamus_quadrifer             ------TCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Globodera_pallida                ------TCT- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Scutellonema_bradys              ------ACC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Helicotylenhcus_dihystera        ------ACC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Rotylenchus_robustus             ------ACC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Meloidogyne_arenaria             ------GTC- ------TAAA TGGATAAC-- TGTGGAAAAG CTAGAGCTAA TACATGCA-C
Meloidogyne_incognita_KT         ------GTC- ------TAAA TGGATAAC-- TGTGGAAAAG CTAGAGCTAA TACATGCA-C
Meloidogyne_javanica             ------GTC- ------TAAA TGGATAAC-- TGTGGAAAAG CTAGAGCTAA TACATGCA-C
Meloidogyne_artiellia            ------CTCC ------TAAA TGGACAAC-- TGTGGAAAAG CTAGAGCTAA TACATGCA-C
Meloidogyne_duytsi               ------ATCC ------TAAC TGGACAAC-- TGTGGAAAAG CTAGAGCTAA TACATGCA-C
Meloidogyne_exigua               ------TATC ------TAAA TGGATAAC-- TGTGGAAAAT CTAGAGCTAA TACATGCA-C
Meloidogyne_hapla                ------ATCC ------TAAA TGGACAAC-- TGTGGAAAAG CTAGAGCTAA TACATGCA-C
Meloidogyne_ichinohei            ------ATCC ------TAAA TGGATAAC-- TGTGGAAAAG CTAGAGCTAA TACATGCA-C
Meloidogyne_maritima             ------ATCC ------TAAA TGGACAAC-- TGTGGAAAAG CTAGAGCTAA TACATGCA-C
Meloidogyne_microtyla            ------ATCC ------TAAA TGGACAAC-- TGTGGAAAAG CTAGAGCTAA TACATGCA-C
Nacobbus_aberrans                ------ACC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
NUCLEOTIDES INCLUDED             ---------- ------mmmm mmmmmmmm-- mmmmmmmmmm mmmmmmmmmm mmmmmmmm--
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                                         190        200        210        220        230        240
Pratylenchoides_ritteri          ------TCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Pratylenchoides_magnicauda       ------TCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Hirschmanniella_sp._JH_2003      ------CACC ------TACM TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Radopholus_similis               ------ACC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Pratylenchus_goodeyi_VF          ------CCCA ------CACA CGGATAAC-- TGTGGTAATT CTAGAGCTAA TACGTGCA-C
Boleodorus_thylactus_clone2      ------ATCC ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Philippine Sequence 1            ---------- ------CTAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-T
Philippine Sequence 2            ---------- ------CTAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-T
Philippine Sequence 3            ---------- ------CTAT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACACGTA-A
Philippine Sequence 4            ------TAAA TCC---TACA TGGATAAC-- TGTGGTAATT CTGGAGCTAA TACATGCA-C
Philippine Sequence 5            ---------- ------CTTT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACATGCG-A
Philippine Sequence 6            ---------- ------TTCG AGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Philippine Sequence 7            ---------- ------TATA TGGATAAC-- TGCGGAAATA CTGGAGCTAA TACATGTC-A
Tahiti Sequence 1                ---------- ------CTAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-T
Tahiti Sequence 2                ---------- ------CTAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-T
Thailand Sequence 1              ------TCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Ogasawara Sequence 1             ------TAAA TCC---TACA TGGATAAC-- TGTGGTAATT CTGGAGCTAA TACATGCA-C
Ogasawara Sequence 2             ---------- -----TATTT TGGATAAC-- TGTGGTAATT CTGGAGCTAA TACATGCA-T
Ivory Coast Sequence 1           ---------- ------CAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Ivory Coast Sequence 2           ---------- ------AAAC TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Ivory Coast Sequence 3           ---------- -----TAATT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCT-A
Ivory Coast Sequence 4           ---------- ------GAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Ivory Coast Sequence 5           ------TCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Ivory Coast Sequence 6           ---------- ------GAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Ivory Coast Sequence 7           ---------- ------GAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATTCT-A
Singapore Sequence 1             ---------- ----ATCTAT TGGATAAC-- TGCGGCAATT CTGGAGCTAA TACACGTA-A
Singapore Sequence 2             ------TCC- ------TACT TGGATAAC-- TGTGGTAATT CTAGAGCTAA TACATGCA-C
Singapore Sequence 3             ---------- ------AATA TGGATAAC-- TGCGGAAATA CTGGAGCTAA TACATGCA-A
Singapore Sequence 4             ---------- ------GAAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Nigerian Sequence 1              ---------- ------TAAC TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCG-A
Nigerian Sequence 2              ---------- ------CTTT TGGATAAC-- TGCGGCAATT CTGGAGMTAA TACATGCG-A
Nigerian Sequence 3              ---------- ------ATAT TGGATAAC-- TGCGGTAATT CTGGAGCTAA TACATGCT-A
NUCLEOTIDES INCLUDED             ---------- ------mmmm mmmmmmmm-- mmmmmmmmmm mmmmmmmmmm mmmmmmmm--
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                                         250        260        270        280        290        300
Gordius_aquaticus                AAAAG-TCGA ATC------- ---------- ---------- GCGAGGTCCG ACCGCTTTT-
Priapulus_caudatus               TCAAGCTCCG ACC------- ---------- ---------- TTACGGGACG AGCGCTTTT-
Brachionus_plicatilis            AAAAGCTCCG ACC------- ---------- ---------- GTATGGGAAG AGCGCTTTT-
Chordodes_morgani                AAACG-TCGA ATC------- ---------- ---------- GCGAGGTTCG ACTGCTTTT-
Paractinolaimus_macrolaimus      AAAAGCTCTG CCC------- ---------- ---------- GCAAGGAACG AGCGCATTT-
Aporcelaimellus_obtusicaudatus   AAAAGCTCCG CCC------- ---------- ---------- GCAAGGAACG AGCGCATTT-
Wilsonema_schuurmansstekhoveni   ACAAGCTCCG ACC------- ---------- ---------- TTACGGGACG AGCGCATTT-
Mesodorylaimus_sp_cf_nigritul    AAAAGCTCCG ACC------- ---------- ---------- GCAAGGGACG AGCGCATTT-
Mesodorylaimus_bastiani          AAAAGCTCTG ACC------- ---------- ---------- GCAAGGAACG AGCGCATTT-
Mesodorylaimus_japonicus         AAAAGCTCTG CCCT------ ---------- ---------- TCACGGAAAG AGCGCATTT-
Pungentus_sp._PDL_2005           TAAAGCTCTG CCC------- ---------- ---------- GTAAGGAACG AGCGCATTT-
Allodorylaimus_sp                TAAAGCTCCG CCC------- ---------- ---------- GAAAGGAACG AGCGCATTT-
Eudorylaimus_carteri             TAAAGCTCTG CCC------- ---------- ---------- GCAAGGAACG AGCGCATTT-
Microdorylaimus_sp               TAAAGCTCTG ACC------- ---------- ---------- GAAAGGAACG AGCGCATTT-
Longidorus_elongatus             AAAAGCTCAG ACT------- ---------- ---------- GAAAGGAATG AGCGCATTT-
Xiphinema_rivesi                 AAAAGCTCGT TTC------- ---------- ---------- GCAAGATTCG AGCGCATTT-
Tylencholaimus_sp                AAAAGCTCCG CCC------- ---------- ---------- GCAAGGAACG AGCGCATTT-
Anoplostoma_sp._BHMM_2005        TTATATCCAG ACC------- ---------- ---------- TTACGGAATG GATGCAGTT-
Adoncholaimus_fuscus             CAAAACCCCG AC-------- ---------- ---------- -TAACGAAGG GGTGCGTTT-
Enoplus_meridionalis             TTATGCCCTG ACT------- ---------- ---------- TCACAGGAAG GGCGCGGTT-
Enoplus_brevis_U88336            TTAAGTCCAG ACC------- ---------- ---------- TCACGGAACG GACGCGGTT-
Enoplus_communis                 TTAAGTCCAG ACCT------ ---------- ---------- -CACGGAACG GACGCGGTT-
Enoploides_brunettii             CAAAGCCCTA TTGC------ ---------- ---------- --------AG GGCGCATTT-
Syringolaimus_striatocaudatus    TTATGCTCAG ACC------- ---------- ---------- TTACGGAATG AGCGCATTT-
Ironus_dentifurcatus             CAAAGCCCTG ACC------- ---------- ---------- GTAAGGAAGG GGTGCACTT-
Calyptronema_maxweberi           CAAAACCCCA ACT------- ---------- ---------- -TTACGGAGG GGTGCGTTT-
Viscosia_sp._BHMM_2005           CAAAACCCAA CCT------- ---------- ---------- --TACGGTGG GGTGCGTTT-
Viscosia_viscosa                 CAAAACCCAA CCT------- ---------- ---------- --TACGGTGG GGTGCGTTT-
Pontonema_vulgare                CAAAACACCC GACT------ ---------- ---------- TCGATGGAGG GGTGCGATTT
Oncholaimus_sp._BHMM_2005        CAAAGCCCTG ACT------- ---------- ---------- --TCGGAAAG GGTGCGTTA-
Alaimus_sp_PDL_2005              TGAAGCCGAA ACC------- ---------- ---------- TTACGGAATC GGCGCATTT-
Prismatolaimus_intermedius       GAAAGCTCTG ACC------- ---------- ---------- GTTCGGGAGG AGCGCATTT-
Tobrilus_gracilis                CAAAGCTCGG AC-------- ---------- ---------- TCACG-AACG AGCGCATTT-
Tripyla_cf_filicaudata_JH_2004   CAAAGCTTCG ACC------- ---------- ---------- TTACGGAAGG AGCGCATTT-
Bathylaimus_sp                   CAAA-CGGCA CCC------- ---------- ---------- TTATGGGAGC CGCGCTTTT-
Bathylaimus_assimilis            CAAA-CGGCA CCC------- ---------- ---------- TTATGGGAGC CGCGCTTTT-
Bathylaimus_sp._BHMM_2005        CAAA-CGGCG ACC------- ---------- ------TTTC ACGAGGGAGC CGCGCTTTT-
Tripyloides_sp._BHMM_2005        CAAA-CTGTG ACTTC----- ---------- --------GC AAGAAGAAGC AGTGCTTTT-
Trischistoma_monohystera         TCAA-CTCTG ACC------- ---------- ---------- TTACGGAAGG AGCGCGTTT-
Mermis_nigrescens                GAAAGCTCGG ACC------- ---------- ---------- TTCGGGAAAG AGCGCATTT-
Mylonchulus_arenicolus           GAAAGCTCCG ACCC------ ---------- ---------- TTGAGGAAAG AGCGCATTT-
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- ---------- ---------- ----------
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                                         250        260        270        280        290        300
Anatonchus_tridentacus           GTAAGCTCGG ACC------- ---------- ---------- TTAGGGAAAG AGCGCATTT-
Mononchus_truncatus              GAAAGCTCGG ACC------- ---------- ---------- TTT-GGAAAG AGCGCATTT-
Prionchulus_muscorum             GAAGGCTCGG ACC------- ---------- ---------- TTTTGGGAAG AGCGCATTT-
Clarkus_sp                       GCAGGCTCGG ACC------- ---------- ---------- TTTTGGGAAG AGCGCATTT-
Trichinella_spiralis             AAAAACTTCA ACTG------ ---------- ---------- AATTGGTTGA AGTGCTTTT-
Trichinella_papuae               AAAAACTTCA ACTG------ ---------- ---------- AAATGGTTGA AGTGCTTTT-
Trichinella_britovi              AAAAACTTCA ACTG------ ---------- ---------- AATTGGTTGA AGTGCTTTT-
Trichinella_murrelli             AAAAACTTCA ACTG------ ---------- ---------- AATTGGTTGA AGTGCTTTT-
Trichinella_pseudospiralis       AAAAACTTCA ACTA------ ---------- --------TA CAATGGTTGA AGTGCTTTT-
Trichinella_nativa               AAAAACTTCA ACTG------ ---------- ---------- AATTGGTTGA AGTGCTTTT-
Trichinella_zimbabwensis         AAAAACTTCA ACTG------ ---------- ---------- AAATGGTTGA AGTGCTTTT-
Trichinella_nelsoni              AAAAACTTCA ACTG------ ---------- ---------- AATTGGTTGA AGTGCTTTT-
Trichuris_suis                   CGAAGCTCGG TCGCG----- ---------- --------CG CAACGCTCGG AGCGCATTT-
Trichuris_trichiura              CGAAGCTCAG TCGC------ ---------- ------GCGC TGCGCGTCGG AGCGCGTTT-
Trichuris_muris                  CAAAGCTTCG GCGC------ ---------- --------GC AATGCGCGGA GACGCATTT-
Tylolaimophorus_minor            AAAAACTCAG ACC------- ---------- ---------- TTCGGGAATG AGTGCTTTT-
Paratrichodorus_pachydermus      TAAA-CGACG ACC------- ---------- ---------- TTACGGAAGT CGTGCATTT-
Paratrichodorus_anemones         TAAA-CGACA ACC------- ---------- ---------- TCACGGAAGT CGTGCATTT-
Trichodorus_primitivus           AAATGCGACA ACC------- ---------- ---------- TCACGGGAGT CGTGCATTT-
Axonolaimus_helgolandicus        AACAGCTCTG ACC------- ---------- ---------- GCAAGGGATG AGCGCATTT-
Ascolaimus_elongatus             AACAGCTCTG ACC------- ---------- ---------- GCAAGGGATG AGCGCATTT-
Odontophora_rectangula           C-AAGCTCTG ACC------- ---------- ---------- GCAAGGGATG AGCGCATTT-
Cylindrolaimus_sp._202149        CAAAGCTCTG ACC------- ---------- ---------- GTAAGGGAGG AGTGCATTT-
Tylocephalus_auriculatus         AAAAGCTCCG ACC------- ---------- ---------- TTACGGGACG AGCGCATTT-
Plectus_acuminatus_BS9           TAAAGCTCCG ACC------- ---------- ---------- TTACGGGACG AGCGCATTT-
Plectus_aquatilis                TAAAGCTCCG ACC------- ---------- ---------- TTACGGGACG AGCGCATTT-
Anaplectus_sp                    CCAAGCTCCG ACC------- ---------- ---------- GTAAGGGACG AGCGCATTT-
Anisakis_sp_WKT                  CAAAGCTCCG AT-------- ---------- ---------- TA-TTTGACG AGCGCATCT-
Anisakis_sp_Nadler               CAAAGCTCCG AT-------- ---------- ---------- TT-TTTGACG AGCGCATCT-
Contracaecum_multipapillatum     CAAAGCTCCG AT-------- ---------- ---------- TT-TTTGACG AGCGCATCT-
Pseudoterranova_decipiens        CAAAGCTCCG AT-------- ---------- ---------- TT-TTTGACG AGCGCATCT-
Raphidascaris_acus               CAAAGCTCCG AA-------- ---------- ---------- TT-TTTGACG AGCGCATCT-
Terranova_caballeroi             CAAAGCTCCG AA-------- ---------- ---------- TC-ATTGACG AGCGCATCT-
Ascaris_suum                     CAAAGCTCCG AT-------- ---------- ---------- TT-TCTGACG AGCGCATCT-
Ascaris_lumbricoides             CAAAGCTCCG AA-------- ---------- ---------- TT-TTTGACG AGCGCATCT-
Baylisascaris_procyonis          CAAAGCTCCG AT-------- ---------- ---------- TT-TCTGACG AGCGCATCT-
Baylisascaris_transfuga          CAAAGCTCCG AT-------- ---------- ---------- TT-TCTGACG AGCGCATCT-
Parascaris_equorum               CAAAGCTCCG AT-------- ---------- ---------- TT-TCTGACG AGCGCATCT-
Porrocaecum_depressum            CAAAGCTCCG AA-------- ---------- ---------- TT-TTTGACG AGCGCATCT-
Toxascaris_leonina               CAAAGCTCAG AT-------- ---------- ---------- TT-TCTGACG AGCGCATTT-
Heterocheilus_tunicatus          CAAAGCTCCG AC-------- ---------- ---------- TC-GTCGACG AGCGCATCT-
Goezia_pelagia                   CAAAGCTCCG AA-------- ---------- ---------- TT-TTTGACG AGCGCATCT-
Hysterothylacium_fortalezae      CAAAGCTCCG AA-------- ---------- ---------- TC-TTTGACG AGCGCATCT-
Hysterothylacium_pelagicum       CAAAGCTCCG AA-------- ---------- ---------- TT-TTTGACG AGCGCATCT-
Hysterothylacium_reliquens       CAAAGCTCCG AA-------- ---------- ---------- TT-TTTGACG AGCGCATCT-
Iheringascaris_inquies           CAAAGCTCCG AA-------- ---------- ---------- TT-TTTGACG AGCGCATCT-
Toxocara_canis                   CAAAGCTCCG AT-------- ---------- ---------- TT-TGTGACG AGCGCATCT-
Nemhelix_bakeri                  CAAAGCTCCG AT-------- ---------- ---------- TT-T-TGACG AGCGCATCT-
Raillietnema_sp._V3060           CAAAGCCCCG AT-------- ---------- ---------- TT-T-TGACG GGCGCATCT-
Cruzia_americana                 CAAAGCTCCG AC-------- ---------- ---------- TC-GTTGACG AGCGCATCT-
Heterakis_sp_14690               CAAAGCTCCG AT-------- ---------- ---------- ---AATGACG AGCGCATCT-
Heterakis_gallinarum             CAAAGCTCCG AT-------- ---------- ---------- ---TTTGACG AGCGCATCT-
Paraspidodera_sp_21303           CGAAGCTCTG AT-------- ---------- ---------- -T-TTTGACG AGCGCATCT-
Chromodora_nudicapitata          CGAAGGTCAA GC-------- ---------- ---------- GC-AAGCTTG ATCGCACTT-
Chromadora_sp._BHMM_2005         TCAAGTCCCG AC-------- ---------- ---------- TT-CGGAAGG GACGCATTT-
Atrochromadora_microlaima        TCAAGTCCCG AC-------- ---------- ---------- TT-CGGAAGG GACGCATTT-
Chromadorina_germanica           AACAG--CCA AC-------- ---------- ---------- TT-CGGAAGG CTGGCAATT-
Chromadorita_tentabundum         TCAAGCCCTA ACCT------ ---------- ---------- TT-TGGAAAG GGCGCATTT-
Dichromadora_sp._BHMM_2005       TCAAGTCCCG AC-------- ---------- ---------- TT-CGGAAGG GACGCATTT-
Neochromadora_BHMM_2005          TCAAGCCCCA ACC------- ---------- ---------- TGACGGGCGG GGCGCATTT-
Spilophorella_paradoxa           TTAAACCCCA AAC------- ---------- ---------- TTACGTGCGG GGTGCATTT-
Paracanthonchus_caecus           CAAAACCCTG AC-------- ---------- ---------- TT-CGGAAGG GGTGCATTT-
Paracyatholaimus_intermedius     CAAAACCCTG AC-------- ---------- ---------- TT-CGGAAGG GGTGCATTT-
Praeacanthonchus_punctatus       GAAAGCCCCG AC-------- ---------- ---------- TT-CGGGAGG GGCGCATTT-
Praeacanthonchus_sp              GAAAGCCC-G AC-------- ---------- ---------- TT-CGGGAGG GGCGCATTT-
Cyatholaimus_sp._BHMM_2005       CAAAACCCTG AC-------- ---------- ---------- TT-CGGAAGG GGTGCATTT-
Spirinia_parasitifera            AAAAGCTCCA ACC------- ---------- ---------- TTACGGAAGG AGTGCATTT-
Acanthopharynx_micans            CCAAGCTCTG ACC------- ---------- ---------- TTACGGAAGG AGCGCATTT-
Xyzzors_sp                       CCAAGCTCTG ACC------- ---------- ---------- TTGGGGAAGG AGTGCATTT-
Metachromadora_sp                CCAAGCTCCG ACC------- ---------- ---------- TTGCGGAAGG AGCGCATTT-
Metachromadora_remanei           CCAAGCTCCG ACC------- ---------- ---------- TTGCGGAAGG AGCGCATTT-
Catanema_sp                      ACAAGCTCCG ACT------- ---------- ---------- TCGCGGAAGG AGCGCATTT-
Eubostrichus_dianae              TCAGGCTGCG ACCT------ ---------- ---------- TTTTGGAAGC AGTGCATTT-
Eubostrichus_topiarus            CCAAGCTCCA ACC------- ---------- ---------- TTACGGAAGG AGCGCATTT-
Eubostrichus_parasitiferus       CCAAGCTCCA ACC------- ---------- ---------- TTACGGAAGG AGCGCATTT-
Laxus_oneistus                   TCAAGCTCCG ACC------- ---------- ---------- TTACGGAAGG AGTGCATTT-
Laxus_cosmopolitus               TCAAGCTCCG ACC------- ---------- ---------- TTGCGGAAGG AGCGCATTT-
Leptonemella_sp                  CTCAGCTTCG ACC------- ---------- ---------- TTACGGAAGG AGCGCATTT-
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- ---------- ---------- ----------
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                                  ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                          250        260        270        280        290        300
Robbea_hypermnestra               TCAAGCTCCG CCC------- ---------- ---------- TCACGGAAGG AGTGCATTT-
Stilbonema_majum                  CAAAGCTCCG ACC------- ---------- ---------- TTACGGAAAG AGCGCATTT-
Monoposthia_costata               ACAAACCCCG ACT------- ---------- ---------- TCT-GGGAGG GGCGCATTT-
Nudora_bipapillata                AAAAGCCCAA GTT------- ---------- ---------- TCT-----TG GGTGCATTT-
Calomicrolaimus_parahonestus      ACAAGTTCCG ACG------- ---------- ---------- --TAAGGAGG AACGCATTT-
Calomicrolaimus_sp._BHMM_2005     ACAAGTTCCG ACG------- ---------- ---------- --TAAGGAGG AACGCATTT-
Molgolaimus_demani                TCAAGTTCCA ACG------- ---------- ---------- --CAAGAAGG AACGCATTT-
Diplogaster_lethieri              CAAAGCACCG CCA------- ---------- ---------- GCAATGGTAG TGCGCACAT-
Aduncospiculum_halicti            CGAGTCAATG GCC------- ---------- ---------- TC-ACGGCGT TGCGCACTT-
Pristionchus_lheritieri           CAAAGCACCG CCA------- ---------- ---------- GCAATGGTAG TGCGCACAT-
Pristionchus_pacificus            CAACGTGCTG CTA------- ---------- ---------- GCAATAGTGG CACGCACTT-
Pristionchus_pacificus            CAACGTGCTG CTA------- ---------- ---------- GCAATAGTGG CACGCACTT-
Sabatieria_punctata_STRAIN_343    TAAAGCTCTG ACC------- ---------- ---------- TTACGGGACG AGCGCATTT-
Sabatieria_sp._355_BHMM_2005      TAAAGCTCTG ACC------- ---------- ---------- TTACGGGACG AGCGCATTT-
Sabatieria_celtica                TGAAGCTCTG ACC------- ---------- ---------- TTCGGGGACG AGCGCATTT-
Sabatieria_punctata_STRAIN_200    TAAAGCTCCG ACC------- ---------- ---------- TTACGGAACG AGCGCATTT-
Sabatieria_punctata_STRAIN_223    CAAAGCTCCG ACC------- ---------- ---------- TTACGGGACG AGCGCATTT-
Sabatieria_sp._210_BHM_2005       TAAAGCTCCG ACC------- ---------- ---------- TTACGGAACG AGCGCATTT-
Setosabatieria_hilarula           TGAAGCTCTG ACC------- ---------- ---------- TTCGGGGACG AGCGCATTT-
Desmolaimus_zeelandicus           AAGAACTCTG CCC------- ---------- ---------- TTCGGGAACG AGTGCGTTT-
Terschellingia_longicaudata       TGAAGCCCTG ACC------- ---------- ---------- TTGCGGGAAG GGTGCATTT-
Cyartonema_elegans                TAAAGCCCCG ACC------- ---------- ---------- TTGCGGAAGG GGTGCATTT-
Tridentulus_sp                    TCAAGACCCG ACG------- ---------- ---------- --CAAGGACG GTCGCAATT-
Diplolaimelloides_meyli           CTAATCCCCG ATC------- ---------- ---------- GCAAGTGACG GGAGCACTT-
Diplolaimella_diavengatensis      TGTAGCTCTG ATC------- ---------- ---------- GTAAGTGATG AGCGCATTT-
Geomonhystera_disjuncta           CTAAGGGCCG AAC------- ---------- ---------- TCACGTGACG CTTGCATTT-
Sphaerolaimus_hirsutus            -GAAGCCCTG ACC------- ---------- ---------- TTTTGGGATG GGTGCACTT-
Theristus_acer                    TCGAGCTCCG CCC------- ---------- ---------- GCAAGGAACG AGCGCATTT-
Daptonema_procerus                TCGAGCCCCG ACT------- ---------- ---------- TCACAGGACG GGCGCATTT-
Daptonema_hirsutum                TCGAGCTCCG ACT------- ---------- ---------- TAACAGGACG AGCGCATTT-
Daptonema_normandicum             TCGAGCTCTG ACC------- ---------- ---------- -TTTGGGACG AGTGCATTT-
Daptonema_oxycerca                TCGAGCCCCG ACT------- ---------- ---------- TCACAGGACG GGCGCATTT-
Daptonema_setosum                 TCGAGCTCCG ACT------- ---------- ---------- TAACAGGACG AGCGCATTT-
Desmodora_communis                ACAAGCTCCG ACC------- ---------- ---------- TTACGGAAGG AGCGCATTT-
Desmodora_ovigera                 CCAAGCTCCG ACC------- ---------- ---------- TT-TGGAAGG AGTGCGTTT-
Metadesmolaimus_sp                TCGAGCTCCG ACTT------ ---------- ---------- AACAGGACG- AGCGCATTT-
Dentostomella_sp                  CAAAGCTCTG AT-------- ---------- ---------- TTATTTGTGG AGCGCATCT-
Bunonema_franzi                   CGATGCCCTG ACC------- ---------- ---------- GTGAGGAAAG GGTGCAGTT-
Bunonema_sp                       CGATGCCCCG ACC------- ---------- ---------- GCAAGGAAAG GGTGCAGTT-
Seleborca_complexa                TAAAGCTCCG ACC------- ---------- ---------- TCACGGGAAG AGTGCATTT-
Acrobeloides_nanus                TAAAGCTCTG ACC------- ---------- ---------- TCACGGGAAG AGTGCATTT-
Acrobeloides_bodenheimeri         TAAAGCTCTG ACC------- ---------- ---------- TCACGGGAAG AGTGCATTT-
Acrobeloides_sp_PS1146            TAAAGCTCCG ACC------- ---------- ---------- TCACGGGAAG AGTGCATTT-
Acrobeles_ciliatus                CTAAGCTCTG CCT------- ---------- ---------- TCACGGGTAG AGTGCATTT-
Acrobeles_sp_PS1156               CTAAGCTCTG CCT------- ---------- ---------- TCACGGGTAG AGTGCATTT-
Acrobeles_complexus_WCUG2         CTAAGCTCTG CCT------- ---------- ---------- TCACGGGTAG AGTGCATTT-
Cephaloboides_sp_SB227            AAAAG-CATG CTC------- ---------- ---------- TCACGAGCAT -GTACCATT-
Cephalobus_cubaensis              TAAAGCTCTG ACC------- ---------- ---------- TCGCGGGAAG AGTGCATTT-
Cephalobus_sp._PS1143             TAAAGCTCTG ACC------- ---------- ---------- TCACGGGAAG AGTGCATTT-
Cephalobus_sp._PS1196             TAAAGCTCTG ACC------- ---------- ---------- TCACGGGAAG AGTGCATTT-
Cephalobus_oryzae_PS1165          TAAAGCTCTG ACC------- ---------- ---------- TCACGGGAAG AGTGCATTT-
Cervidellus_alutus                TAAAGCTCTG ACC------- ---------- ---------- TAACGGGAAG AGTGCATTT-
Pseudacrobeles_variabilis         TAAAGCTCTG ACC------- ---------- ---------- TTCCGGGAAG AGTGCATTT-
Triligulla_aluta                  TAAAGCTCTG ACC------- ---------- ---------- TAACGGGAAG AGTGCATTT-
Zeldia_punctada                   TAAAGCTCTG ACC------- ---------- ---------- TCACGGGAAG AGTGCATTT-
Myolaimus_sp_U81585               CAAAGCTCCG A--------- ---------- ---------- -TTCATGACG AGCGCATTT-
Rhabditophanes_sp._KR3021         CTAAGCCACA TCC------- ---------- ---------- --------GT GGTGCGTTT-
Brevibucca_sp._SB261              CAAATGCTCC GAC------- ---------- ---------- -TTCGGGACG AGCGCACAT-
Halicephalobus_gingivalis         TATATGTTGT ATA------- ---------- --------GT TATCTATATG ACGGCAGTT-
Panagrobelus_stammeri             AAAAGCCGGC CAG------- ---------- ---------- -TAATGGTTG GTTGCACTT-
Plectonchus_sp._PDL0025           TAAAGCCCGG CTA------- ---------- ---------- GCGATAGTCG GGTGCACTT-
Turbatrix_aceti                   TGATGCCTAA CTT------- ---------- ---------- ----TTGTTG GGTGCAGTT-
Panagrellus_redivivus             AAAAGCGGGG TCA------- ---------- ---------C TCGTTGGCAC CGTGCACTT-
Panagrellus_redivivus_PS1163      AAAAGCGGGG TCA------- ---------- ---------C TCGTTGGCAC CGTGCACTT-
Panagrolaimus_subelongatus        AAAAGATAWA ACA------- ---------- --------TT TTTWTGTTWT ATTGCGTAT-
Panagrolaimus_davidi              AAAAGATGTT TTT------- ---------- ---------- GTAAAAAAAC ATTGCATAT-
Panagrolaimus_cf_rigidus_AF40     AAAAGATTAT ACA------- ---------- --------TT TTTATGTATA ATTGCGTAT-
Panagrolaimus sp. Sourhope ED2    AAAAGACAAA TTT------- ---------- --------CT TATGGGATTT GTTGCATAT-
Panagrolaimus sp. Sourhope ED2    AAAAGACAAA TTT------- ---------- --------CT TATGGGATTT GTTGCATAT-
Panagrolaimus sp. Sourhope ED2    AAAAGACAAA TTT------- ---------- --------CT TATGGGATTT GTTGCATAT-
Panagrolaimus sp. Sourhope ED2    AAAAGATGTT ATA------- ---------- --------TT TGATTGTAAC ATTGCGTAT-
Panagrolaimus sp. Sourhope ED2    AAAAGATGTT ATA------- ---------- --------TT TGATTGTAAC ATTGCGTAT-
Steinernema_carpocapsae           TGTAACAAAA CGT------- ---------- ---------- -TTATCGGTT TGTTCATTT-
Strongyloides_stercoralis         AAAGCCCCGA CTTCT----- ---------- ---------- ----GGAAGG GGTGTATTT-
Strongyloides_ratti               TTTATACCAC ATT------- ---------- ---------- -------AGT GGTGCGTTT-
Diploscapter_sp_PS1897            TTAAAAACCC GAC------- ---------- ---------- -GTAAGTAGG GTTGCAATT-
Diploscapter_sp_PS2017            TTAAAAACCC GAC------- ---------- ---------- -GTAAGTAGG GTTGCAATT-
Heterorhabditis_bacteriophora     CAATGCCCCA ACT------- ---------- ---------- --TCGGAAGG GGTGCAATT-
NUCLEOTIDES INCLUDED              ---------- ---------- ---------- ---------- ---------- ----------
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                        250        260        270        280        290        300
Heterorhabditis_hepialus         CTATGCCCCA ACT------- ---------- ---------- --TCGGAAGG GGTGCAATT-
Heterorhabditis_zelandica        CTATGCCCCA ACT------- ---------- ---------- TC--GGAAGG GGTGCAATT-
Parasitorhabditis_sp_SB281       GCGCTTC--- ---------- ---------- ---------- ---------G GCGTCATTT-
Rhabditoides_inermiformis        CAAAGCTCTG ACC------- ---------- ---------- GTAAGGAACG AGCGCATTT-
Rhabditoides_inermis_DF5001      CAAAACCCAG ATC------- ---------- ---------- GTAAGAGGCG GGTGCACTT-
Rhabditoides_regina_DF5012       GACCTT---- ---------- ---------- ---------- --------CG GGTTCATTT-
Poikilolaimus_oxycerca_SB200     CAAAGCTCTG ACA------- ---------- ---------- ---CCCTCGG AGCGCATTT-
Poikilolaimus_regenfussi_SB199   CAAAGCTCTG ACA------- ---------- ---------- ---CCCTCGG AGCGCATTT-
Distolabrellus veechi DWF1604    GCACGGGCAA CCG------- ---------- ---------- ---------- -TGTCATTT-
Distolabrellus veechi DF5024     GCACGGGCAA CCG------- ---------- ---------- ---------- -TGTCATTT-
Choriorhabditis_dudichi          TATGCCCCGA CTC------- ---------- ---------- ---ACGGAGG GGTGCACTT-
Protorhabditis_sp                ACATAACCGG ACG------- ---------- ---------- --CAAGTACG GTTGCAATT-
Protorhabditis_sp_DF5055         CAAAGCTTGG AAG------- ---------- ---------- --CAATTCCA AGTGCAGTT-
Cruznema_tripartitum_DF5015      CGAAACCCCG AC-------- ---------- ---------- -TTCGGAAGG GGTGCAATT-
Mesorhabditis_sp_PS1179          GCACTTC--- ---------- ---------- ---------- ---------G GTGTCATTT-
Mesorhabditis_spiculigera_SB15   GTGCTTC--- ---------- ---------- ---------- ---------G GCACCATTT-
Mesorhabditis_anisomorpha_SB12   CTTCGGY--- ---------- ---------- ---------- ---------- --GTCATAC-
Teratorhabditis_palmarum_DF501   GCGTGCTTCG G--------- ---------- ---------- ---------- -CACCACTT-
Teratorhabditis_synpapillata_S   TCGTGCTTCG G--------- ---------- ---------- ---------- -CACCACTT-
Caenorhabditis_briggsae_PB102    CTAAACCCCA ACG------- ---------- ---------- --TAAGGCGG GGTGCAATT-
Caenorhabditis_elegans_N2        CTATACCCCA ACG------- ---------- ---------- --CAAGGCGG GGTGCAATT-
Caenorhabditis_sp_CB5161         CTATACCCCA ACG------- ---------- ---------- --CAAGGCGG GGTGCAATT-
Caenorhabditis_sp_PS1010         TTAAACCCTG ACG------- ---------- ---------- --CAAGGACG GGTGCAATT-
Caenorhabditis_japonica          CTATACTCCA ACG------- ---------- ---------- --CAAGGCGG GGTGCAATT-
Caenorhabditis_sp_DF5170         TTAAACCTCG ACG------- ---------- ---------- --TAAGGAGA GGTGCAATT-
Caenorhabditis_sp_SB341          CTAAGCCCTG ACG------- ---------- ---------- --TAAGGAGG GGTGCAATT-
Caenorhabditis_plicata           AAATTCCCCG ACG------- ---------- ---------- --CAAGGAGG GGGGCAATA-
Caenorhabditis_vulgaris          CTAAGCCCCA ACG------- ---------- ---------- --TAAGGCGG GGTGCAATT-
Caenorhabditis_sonorae           CTAAGCCCTG ACG------- ---------- ---------- --CAAGGAGG GGTGCAATT-
Caenorhabditis_drosophilae       TTAAACCTCA ACG------- ---------- ---------- --TAAGGCGA GGTGCAATT-
Phasmarhabditis_hermaphrodita    CAATGCTCAG TTT------- ---------- ---------- ----CGGCTG AGTGCAGTT-
Phasmarhabditis_neopapillosa     CAATGCTCAG TTT------- ---------- ---------- ----CGGCTG AGTGCAGTT-
Phasmarhabditis_neopapillosa     TAAAGCCTCG ACT------- ---------- ---------- TC--GGAAGA GGTGCAGAT-
Pellioditis_mediterranea_SB173   TTAAGCCTCG ACT------- ---------- ---------- TC--GGAAGA GGTGCAGTT-
Pellioditis_marina               TAAAGCCTCG ACT------- ---------- ---------- TC--GGAAGA GGTGCAGAT-
Prodontorhabditis_wirthi         TGATGTCCTG CCCGACG--- ---------- ---------- --TAAGTCAG GCTGCGGTT-
Crustorhabditis_scanica          --ACGTCAGT ---------- ---------- ---------- ----YTCTGA CGT-CATTT-
Dolichorhabditis_sp_CEW1         CAAAAGCTAG GCTC--G--- ---------- ---------- ------CTTA GCTGCAGGT-
Oscheius_sp_DF5000               TTAAAGCTAG G-TTC----- ---------- ---------- -----GTCTA GCTGCAGGT-
Oscheius_sp_BW282                CAAAACCTCG ACTTT----- ---------- ---------- -----GAAGA GGTGCAGAT-
Oscheius_myriophila_EM435        CAAAACCTCG ACTTT----- ---------- ---------- -----GAAGA GGTGCAGAT-
Oscheius_insectivora             TAAAACCCCG ACTTT----- ---------- ---------- -----GAAGG GGTGCAGTT-
Oscheius_dolichuroides           AAAAAGCTAG ATTC------ ---------- ---------- -----GTCTA GCTGCAGGT-
Rhabditis_blumi_DF5010           C-ATGCCGTG TCTTT-G--- ---------- ---------- ------ACAC GGTGCAATT-
Rhabditis_sp_PS1191              CGAAACCCCG ACTTT----- ---------- ---------- -----GAAGG GGTGCGGTT-
Rhabditis_sp_PS1010              TTAAACCCTG ACGCAAG--- ---------- ---------- ------GACG GGTGCAATT-
Rhabditis_myriophila_EM435       CAAAACCTCG ACTTT----- ---------- ---------- -----GAAGA GGTGCAGAT-
Rhabditis_colombiana             TAAAAGCCCG AC-------- ---------- ---------- TC--ACGAAG GGCTGCAGT-
Rhabditella_axei_DF5006          TAAAGCCCAT CCTTACG--- ---------- ---------- ------GGTG GGTGCAGAT-
Rhabditella_sp_DF5044            TAAAGCCCAT CCTTACG--- ---------- ---------- ------GGTG GGTGCAGAT-
Cuticularia_sp_PS2083            CAAAGCTCTG ACACCCT--- ---------- ---------- ------CGG- AGCGCATTT-
Necator_americanus               ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Kalicephalus_cristatus           TTATACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Ancylostoma_caninum              ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Angiostrongylus_cantonensis      ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Angiostrongylus_costaricensis    ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Angiostrongylus_malaysiensis     ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Angiostrongylus_dujardini        TTAAGCCCTA ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Angiostrongylus_vasorum          TTAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Aulurostrongylus_abstrusus       TAGGACCCTG ACT------- ---------- ---------- TT--CGGAAG GGTGCAATT-
Didelphostrongylus_hayesi        ATAAACTCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Crenosoma_mephitidis             TTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Crenosoma_vulpis                 TTAGACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Otostrongylus_circumlitus        TTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Troglostrongylus_wilsoni         TTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Filaroides_martis                TTAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Oslerus_osleri                   TAAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Parafilaroides_decorus           TTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Metastrongylus_salmi             TTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Metastrongylus_elongatus         TTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Skrjabingylus_chitwoodrum        TTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Parelaphostrongylus_odocoilei    ATAAACCCTG ACT------- ---------- ---------- CT-GTGAAAG GGTGCAATT-
Muelerius_capillaris             TAAAATCCTG ACT------- ---------- ---------- TT--TGAAAG GATGCAATT-
Protostrongylus_rufescens        TTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Halocercus_invaginatus           TTAGACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Pseudalius_inflexus              TTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Stenurus_minor                   TTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Torynurus_convolutus             TTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- ---------- ---------- ----------
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         250        260        270        280        290        300
Syngamus_trachea                 GTAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAGTT-
Stephanurus_dentatus             ATAAGCCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Nematodirus_battus               TTAGGCCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Strongylus_equinus               ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Labiostrongylus_bipapillosus     ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Petrovinema_poculatum            ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Cylicocyclus_insignis            ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Chabartia_ovina                  ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Cyclodontostomum_purvisi         ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Zoniolaimus_mawsonae             ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Hypodontus_macropi               ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Deletrocephalus_dimidiatus       ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Dictyocaulus_eckerti_P7B8        TAAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Dictyocaulus_capreolus_P3B2      TAAAACCCTA ACG------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Dictyocaulus_sp._P6A1            TAAAACCCCG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Dictyocaulus_filaria             AATAACCCTG ACG------- ---------- ---------- TT-TTGAAAG GGTGCAGTT-
Dictyocaulus_capreolus_P2C10     TAAAACCCTA ACG------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Dictyocaulus_viviparus           TAGAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Haemonchus_sp._V3091             ATAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Haemonchus_contortus             ATAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Haemonchus_placei                ATAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Haemonchus_similis               ATAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Ostertagia_ostertagi             TTAAACCCTG ACT------- ---------- ---------- TT--TGGAAG GGTGCAATT-
Ostertagia_leptospicularis       TTAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Nippostrongylus_brasileinsis     TAAAACCCTG ACT------- ---------- ---------- TT--TGGAAG GGTGCAATT-
Heligmosomoides_polygyrus        GAAAACCCTG ACT------- ---------- ---------- TT--TGGAAG GGTGCAATT-
Trichostrongylus_colubriformis   ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Tetrabothriostrongylus mackerr   TTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Herpestrongylus_pythonis         AGAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Nicollina_cameroni               AGAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Filarimena_flagrifer             TGAAACCCTG ACT------- ---------- ---------- CT--TGAAAG GGTGCAATT-
Amidostomum_cygni                ATATACCCTG ACT------- ---------- ---------- AT--TGAAAG GGTGCAATT-
Teratocephalus_lirellus          CAAAGCTCAG ACC------- ---------- ---------- TTTCGGGACG AGCGCATTT-
Brumptaemilius_justini           CAAAGCTCGG ATT------- ---------- ---------- TT---TGAAG AGCGCATCT-
Anguillicola_crassus             CAACGCTCCG ATT------- ---------- ---------- TAC--TGACG AGCGCATCT-
Dracunculus_medinensis           CAAAGCTCCG GAT------- ---------- ---------- TTTATTGACG AGCGCATCT-
Dracunculus_oesophageus          CAAAGCTCTG AGA------- ---------- ---------T TATATCGAGG AGCGCATCT-
Dracunculus_sp._V3104            CAAAGCTCCG ATT------- ---------- ---------- TTA-TTGACG AGCGCATCT-
Philonema_sp_A                   CAAAGCTCCA AAT------- ---------- ---------- TTC--TGACG AGCGCATCT-
Philometra_obturans              CAAAGCTCGG ACTAC----- ---------- -------AAA TTT--AGACG AGCGCATCT-
Camallanus_oxycepahalus          CAAAGCTCTG AT-------- ---------- ---------- TTTT-TGACG AGCGCATCT-
Acanthocheilonema_viteae         CAAAGCTCCG AC-------- ---------- ---------- TTAT-GGACG AGCGCATCT-
Loa_loa                          CAAAGCTCCG AC-------- ---------- ---------- TTTT-GAACG AGCGCATCT-
Onchocerca_cervicalis            CAAAGCTCCG AC-------- ---------- ---------- TTTT-GGACG AGCGCATCT-
Dirofilaria_immitis              CAAAGCTCTG AC-------- ---------- ---------- TTTTTGAACG AGCGCATCT-
Brugia_malayi                    CAAAGCTCCG AA-------- ---------- ---------- TTTT-AAACG AGCGCATCT-
Wuchereria_bancrofti             CAAAGCTCCG AT-------- ---------- ---------- TTTT-AGACG AGCGCATCT-
Litomosoides_sigmodontis         CAAAGCTCCG AC-------- ---------- ---------T TGTTTGAACG AGCGCATCT-
Setaria_digitata                 CAAAGCTCCG AC-------- ---------- ---------- TTTT-GGACG AGCGCATCT-
Gnathostoma_turgidum             CAAAGCTCCG AC-------- ---------- ---------- TCTG-TGACG AGCGCATTT-
Gnathostoma_neoprocyonis         CAAAGCTCCG AC-------- ---------- ---------- TTTG-TGACG AGCGCATTT-
Gnathostoma_binucleatum          CAAAGCTCCG AC-------- ---------- ---------- TCTG-TGACG AGCGCATTT-
Physaloptera_alata               CAAAGCTCTG AC-------- ---------- ---------T TTC--GGATG AGCGCATCT-
Physaloptera_turgida             CAAAGCTCTG AC-------- ---------- ---------T TTT--GGACG AGCGCATCT-
Ascarophis_arctica               CAAAGCTCCG AC-------- ---------- ---------T TTACTGGACG AGCGCATCT-
Spinitectus_carolini             CAAAGCTCCG AC-------- ---------- --------TT TTAGTGGACG AGCGCATCT-
Thelazia_lacrymalis              CAAAGCTCAA AC-------- ---------- ---------T TAC--GGATG AGCGCATCT-
Aphelenchus_avenae               TAAAGCTCTG AC-------- ---------- ---------C TCGCGGGAAG AGTGCATTT-
Aphelenchoides_fragariae         ATAAGTACTT TTCA------ ---------- ---------G CAATGAGAAG TATGCACTT-
Bursaphelelenchus_sp             CAAGCCTCGG CC-------- ---------- ---------T TCGGGTTCGG GGTGCAATT-
Deladenus_sp                     ACATGCTCGG ACC------- ---------- ---------- TTGCGGAAAG AGTGCATTT-
Criconema_sp                     CGATGCTGTC CC-------- ---------- ---------- TCGCGGGGC- AGTGCATTT-
Hemicycliophora_conida           CGAAG--CTG TC-------- ---------- ---------- CCCCAAGGGC AGTGCATTT-
Paratylenchus_dianthus           CGAAGTTGTT CC-------- ---------- ---------- TCACGGAGC- AATGCATTT-
Pratylenchus_thornei             CAAAGCTCCG AC-------- ---------- --------CC GCGAGGGGAG AGCGCATTT-
Tylenchulus_semipentrans         CGAAGCTACC TC-------- ---------- ---------- TTGC-GGGGT AGTGCATTT-
Ditylenchus_angustus             CTAAGCTCTT ACC------- ---------- ---------- TTACGGAAAG AGTGCATTT-
Subanguina_radicola              CAAAGCTCTG ACC------- ---------- ---------- TTACGGAAAG AGTGCATTT-
Tylenchorhynchus_maximus         CAAAGCTCCG ACC------- ---------- ---------- GTAAGGGAAG AGCGCATTT-
Geocenamus_quadrifer             CAAAGCTCTG ACC------- ---------- ---------- TTACGGGAAG AGCGCATTT-
Globodera_pallida                CAAAGCTCCA ATCTT----- ---------- ---------- CCCAGAGCGG AGCGCATTT-
Scutellonema_bradys              CAAAGCTTCG ATCCCTT--- ---------- ---------- GA-GGAGAGG AGTGCATTT-
Helicotylenhcus_dihystera        CAAAGCTCCG ATCCTC---- ---------- ---------- GC-GGAGAGG AGCGCATTT-
Rotylenchus_robustus             CAAAGCTCCG ATCCCTT--- ---------- ---------- GCTGGAGAGG AGCGCATTT-
Meloidogyne_arenaria             TAAAGCTTTG TCC------- ---------- ---------- TTACGG-AAA AGCGCATTT-
Meloidogyne_incognita_KT         TAAAGCTTTG TCC------- ---------- ---------- TTACGGAAAA -GCGCATTT-
Meloidogyne_javanica             CAAAGCTTTG TCC------- ---------- ---------- TTACGGWWMA -GCGCATTT-
Meloidogyne_artiellia            CAAAGCTTTG ACCCTTT--- ---------- ---------- ACGGGGAAAA AGCGCATTT-
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- ---------- ---------- ----------
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         250        260        270        280        290        300
Meloidogyne_duytsi               CAAAGCTTTG TCC------- ---------- ---------- TTCCGGAAA- AGCGCATTT-
Meloidogyne_exigua               TAAAGCTTTG TCC------- ---------- ---------- TTACGGAAA- AGCGCATTT-
Meloidogyne_hapla                TAAAGCTTTG TCC------- ---------- ---------- TTACGGAAA- AGCGCATTT-
Meloidogyne_ichinohei            AAAAGCTCCG ACCC------ ---------- ---------- CTCGGGGGAG AGCGTATTT-
Meloidogyne_maritima             TAAAGCTTTG TCC------- ---------- ---------- TTACGGAAA- AGCGCATTT-
Meloidogyne_microtyla            TAAAGCTTTG TCC------- ---------- ---------- TTACGGAAA- AGCGCATTT-
Nacobbus_aberrans                AAAAGCTCCG ACC------- ---------- ---------- TAAAGGAAAG AGCGCATTT-
Pratylenchoides_ritteri          CAAAGCTCCG ACC------- ---------- ---------- TTACGGGAAG AGCGCATTT-
Pratylenchoides_magnicauda       CAAAGCTCCG ACC------- ---------- ---------- TTACGGGAAG AGCGCATTT-
Hirschmanniella_sp._JH_2003      CAAAGCCTCG ACC------- ---------- ---------- GCGAGGGAAG GGCGCATTT-
Radopholus_similis               AAAAACTCCC AAC------- ---------- ---------- GCAAGGAGGG AGCGCATTT-
Pratylenchus_goodeyi_VF          CAAAGCTCTG ATCCGCGCTT ---------- ---------- GCGTGGAAAG AGCGCATTT-
Boleodorus_thylactus_clone2      CAAAGCTCCG ACC------- ---------- ---------- TCGCGGGAGG AGCGCATTT-
Philippine Sequence 1            ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Philippine Sequence 2            ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Philippine Sequence 3            TTTAGCCCCG ACT------- ---------- ---------- CA--CGAAGG GGTACGGTT-
Philippine Sequence 4            AAAAGTTGAA TCT------- ---------- ---------- TA-TGGATTC AATGCGTAT-
Philippine Sequence 5            ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Philippine Sequence 6            CAAAGCCCTG ACT------- ---------- ---------- TC--GGAAAG GGTGCAGAT-
Philippine Sequence 7            TACATCCCCA ACG------- ---------- ---------- --TAAGGCGG GGTGCAATT-
Tahiti Sequence 1                ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Tahiti Sequence 2                ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Thailand Sequence 1              CAAAGCTCCG AT-------- ---------- ---------- ----TTGAAG AGCGCATCT-
Ogasawara Sequence 1             AAAAGTTGAA ACT------- ---------- ---------- -TATGGTTTC AATGCGTAT-
Ogasawara Sequence 2             CAATGCTCAG TTT------- ---------- ---------- ----CGGCTG AGTGCGGTT-
Ivory Coast Sequence 1           TTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Ivory Coast Sequence 2           TTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Ivory Coast Sequence 3           YTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Ivory Coast Sequence 4           TTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Ivory Coast Sequence 5           CAAAGCTCCG AT-------- ---------- ---------- ----TTGACG AGCGCATCT-
Ivory Coast Sequence 6           TTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Ivory Coast Sequence 7           TAAAACCCTG ACT------- ---------- ---------- TT--TGGAAG GGTGCAATT-
Singapore Sequence 1             TTTAGCCCCG ACT------- ---------- ---------- CA--CGAAGG GGTACGGTT-
Singapore Sequence 2             CAAAGCTCCG AT-------- ---------- ---------- ----TTGAAG AGCGCATCT-
Singapore Sequence 3             CTAAACCCCA ACG------- ---------- ---------- --TAAGGCGG GGTGCAATT-
Singapore Sequence 4             TAAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAGTT-
Nigerian Sequence 1              CTAAACCCTG ACT------- ---------- ---------- TT--TGAAAG GGTGCAATT-
Nigerian Sequence 2              ATAAACCCTG ACT------- ---------- ---------- TT--CGAAAG GGTGCAATT-
Nigerian Sequence 3              GTAAACCCTG ACT------- ---------- ---------- TA--TGAAAG GGTGCAGTT-
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- ---------- ---------- ----------


                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         310        320        330        340        350        360
Gordius_aquaticus                A-TTAGA--- ACAAAAACTA ACG------- ---------- ---------- ----------
Priapulus_caudatus               A-TTAGA--- CC-AAACCAA TCG------- ---------- --------GG TTT-----CG
Brachionus_plicatilis            A-TTAGA--- CCAAAACCAA TGG------- ---------- --------GG T-------CG
Chordodes_morgani                A-TTAGA--- ACAAAAACTA ACA------- ---------- ---------- ----------
Paractinolaimus_macrolaimus      A-TTAGAA-- TAAAAACCAA TCA------- ---------- --------GG TTT-----CG
Aporcelaimellus_obtusicaudatus   A-TTAGAA-- TAAAAACCAA TCG------- ---------- --------GG TTT-----CG
Wilsonema_schuurmansstekhoveni   A-TTAGA--- CCAAAACCAA TCG------- ---------- --------GG CTT-----CG
Mesodorylaimus_sp_cf_nigritul    A-TTAGAA-- TAAAAACCAA TCG------- ---------- --------GG CCT-----CG
Mesodorylaimus_bastiani          A-TTAGAA-- TAAAAACCAA TCG------- ---------- --------GG TTT-----CG
Mesodorylaimus_japonicus         A-TTAGAA-- TAAAAACCAA TCG------- ---------- --------GG CTT-----CG
Pungentus_sp._PDL_2005           A-TTAGAA-- TAAAAACCAA TCG------- ---------- --------GG TTT-----CG
Allodorylaimus_sp                A-TTAGAA-- TAAAAACCAA TCG------- ---------- --------AG CTT-----CG
Eudorylaimus_carteri             A-TTAGAA-- TAAAAACCAA TCG------- ---------- --------AG CTT-----CG
Microdorylaimus_sp               A-TTAGAA-- TAAAAACCAA TCG------- ---------- --------AG CTT-----CG
Longidorus_elongatus             A-TTAKAA-- TAAAAACCAA TCG------- ---------- --------GG TCT-A--AAA
Xiphinema_rivesi                 A-TTAGAA-- TAAAAACCAA TCG------- ---------- --------GG CCCAT--AAA
Tylencholaimus_sp                A-TTAGAA-- TAAAAACCAA TCG------- ---------- --------GG CCT----CGT
Anoplostoma_sp._BHMM_2005        A-TTAGAA-- TAAA-ACCAA GCA------- ---------- --------GG CTT----GCC
Adoncholaimus_fuscus             G-TTACT--- TCAA-ACCAA TCG------- ---------- --------GG CTT-----CG
Enoplus_meridionalis             A-TTAGA--- CCAAAACCAA TCG------- ---------- --------GG CTT-----GT
Enoplus_brevis_U88336            A-TTAGA--- CCAAAACCAA TCG------- ---------- --------GG CTT------G
Enoplus_communis                 A-TTAGA--- CCAAAACCAA TCG------- ---------- --------GG CTT-----GT
Enoploides_brunettii             A-TTAGG--- ACAAAACCAA TCG------- ---------- --------GG CTT----GCC
Syringolaimus_striatocaudatus    A-TTAGA--- ACAAAACCAA TCG------- ---------- --------GA CTT----CGG
Ironus_dentifurcatus             A-TTAGA--- ACAAAACCAA TCG------- ---------- --------AG CCT----CTG
Calyptronema_maxweberi           G-TTACT--- TCAA-ATCAA TCG------- ---------- --------GA CTT-----CG
Viscosia_sp._BHMM_2005           G-TTACA--- ACAA-ACCGA TCA------- ---------- --------GA CCT-----CG
Viscosia_viscosa                 G-TTACT--- TCAA-ACCAA TCG------- ---------- --------GA CTT-----CG
Pontonema_vulgare                GATTACT--- TCAA-ATCAA TCG------- ---------- --------GA CTT-----CG
Oncholaimus_sp._BHMM_2005        G-TTACT--- TCAA-ACTGA TCG------- ---------- --------GT CTT-----CG
Alaimus_sp_PDL_2005              A-TTAGA--- TCAAAACCAA TCG------- ---------- --------GA CTT-----CG
Prismatolaimus_intermedius       A-TTAGA--- ACAAAACCAA TCG------- ---------- --------GG CCTT----CG
Tobrilus_gracilis                A-TTAGA--- GCAAAACCAA TCG------- ---------- --------GG CTT-----CG
Tripyla_cf_filicaudata_JH_2004   A-TTAGA--- CTAAAGCCAA TCG------- ---------- --------GA CCT---TCGG
NUCLEOTIDES INCLUDED             m-mmmmm--- mmmm-mmmmm mmm------- ---------- ---------- ----------
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                        310        320        330        340        350        360
Bathylaimus_sp                   A-TTAGA--- ACAAAACCAA TCG-CTTCA- ---------- -------GTG CTT-----CG
Bathylaimus_assimilis            A-TTAGA--- ACAAAACCAA TCG-CTTCA- ---------- -------GTG CTT-----CG
Bathylaimus_sp._BHMM_2005        A-TTAGA--- ACAAAACCAA TCG-CGCTG- ---------- -------TGG TTT-----CG
Tripyloides_sp._BHMM_2005        A-TTAGA--- ACAAAACCAA TCG----CG- ---------- -------CTA CTT-----CG
Trischistoma_monohystera         A-TTAGA--- ACAAAACCAA TCG------- ---------- --------GG CTT-----CG
Mermis_nigrescens                A-TTAGA--- TCAAAACCAA TCG------- ---------- --------GG CTT-----TT
Mylonchulus_arenicolus           A-TTAGA--- CCAAAACCAA TCG-----A- ---------- -------GTA CTT-----CG
Anatonchus_tridentacus           A-TTAGA--- CCAAAACCAA TCA------- ---------- --------AG CTT-----CG
Mononchus_truncatus              A-TTAGA--- CCAAAACCAG TCG------- ---------- --------AG TTT-----CG
Prionchulus_muscorum             A-TTAGA--- CCAAAACCAA TCG------- ---------- --------AG CTT-----CG
Clarkus_sp                       A-TTAGA--- CCAAAACCAA TCG------- ---------- --------GG CTT-----CG
Trichinella_spiralis             A-TTAGAA-- CAAAAACCGA ACG------- ---------- -------GCG TTT-----GA
Trichinella_papuae               A-TTAGAA-- CAAAAACCGA ACG------- ---------- -------GCG TCT-----GG
Trichinella_britovi              A-TTAGAA-- CAAAAACCGA ACG------- ---------- -------GCG TTT-----GG
Trichinella_murrelli             A-TTAGAA-- CAAAAACCGA ACG------- ---------- -------GCG TTT-----GG
Trichinella_pseudospiralis       A-TTAGAA-- CAAAAACCGA ACG------- ---------- -------GCG TTC-----GA
Trichinella_nativa               A-TTAGAA-- CAAAAACCGA ACG------- ---------- -------GCG TTT-----GA
Trichinella_zimbabwensis         A-TTAGAA-- CAAAAACCGA ACG------- ---------- -------GCG TCT-----GG
Trichinella_nelsoni              A-TTAGAA-- CAAAAACCGA ACG------- ---------- -------GCG TTT-----GA
Trichuris_suis                   A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GAC GCA------G
Trichuris_trichiura              A-TTTGA--- ACAAAACCAA TCG------- ---------- -------GAC GCA------G
Trichuris_muris                  A-TTGGT--- ACAAAACCAA TCG------- ---------- -------GAC TTT-----CG
Tylolaimophorus_minor            A-TTAGT--- -CTAAACCAA TCGG------ ---------- -------GCC GCA-----AG
Paratrichodorus_pachydermus      G-TTAGA--- CC-AAACCAA TCG------- ---------- -------GTC TT------CG
Paratrichodorus_anemones         G-TTAGA--- -AAAAACCAA TCG------- ---------- -------GTC TT------CG
Trichodorus_primitivus           A-TTAGA--- -TTAAACCAA TCG------- ---------- -------GTC CTT----CGG
Axonolaimus_helgolandicus        A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GGC TT-----GCC
Ascolaimus_elongatus             A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GGC TT-----GCC
Odontophora_rectangula           A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GG- TT-----CGT
Cylindrolaimus_sp._202149        A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GGC TT-----CGG
Tylocephalus_auriculatus         A-TTAGA--- CCAAAACCAA TCG------- ---------- -------GGC TT-----CGG
Plectus_acuminatus_BS9           A-TTAGA--- CCAAAACCAA TCG------- ---------- -------GGC TT-----CGG
Plectus_aquatilis                A-TTAGA--- CCAAAACCAA TCG------- ---------- -------GGC TT-----CGG
Anaplectus_sp                    A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GGC TT-----CGG
Anisakis_sp_WKT                  A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Anisakis_sp_Nadler               A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Contracaecum_multipapillatum     A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TA-----ACG
Pseudoterranova_decipiens        A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Raphidascaris_acus               A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Terranova_caballeroi             A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT CT-----CGG
Ascaris_suum                     A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Ascaris_lumbricoides             A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Baylisascaris_procyonis          A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Baylisascaris_transfuga          A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Parascaris_equorum               A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Porrocaecum_depressum            A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Toxascaris_leonina               A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Heterocheilus_tunicatus          A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT CT-----CGG
Goezia_pelagia                   A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Hysterothylacium_fortalezae      A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Hysterothylacium_pelagicum       A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GAC CT-----CGG
Hysterothylacium_reliquens       A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Iheringascaris_inquies           A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CCG
Toxocara_canis                   A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Nemhelix_bakeri                  A-TTAGA--- TTAAAGCCAA TCG------- ---------- -------GGT TT-----CGG
Raillietnema_sp._V3060           A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GAT TT-----CGG
Cruzia_americana                 A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Heterakis_sp_14690               A-TTAGA--- TTAAAACCAA TCA------- ---------- -------GGT TT-TGT-CGA
Heterakis_gallinarum             A-TTAGA--- TTAAAACCAA TCA------- ---------- -------GGT TT-----CGG
Paraspidodera_sp_21303           A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGC YT-----CGG
Chromodora_nudicapitata          C-TTAGA--- -AAAGACCAA TTG------- ---------- --------GC TT-----CGG
Chromadora_sp._BHMM_2005         G-TTAGA--- ACAAGACCAA TTG------- ---------- --------GC TT-----CGG
Atrochromadora_microlaima        G-TTAGA--- ACAAGACCAA TTG------- ---------- --------GC TT-----CGG
Chromadorina_germanica           A-TTAGT--- ACAAGACCAA TTG------- ---------- --------GC TT-----CGG
Chromadorita_tentabundum         A-TTAGA--- ACAAAACCAA TTG------- ---------- --------GC TT-----CGG
Dichromadora_sp._BHMM_2005       G-TTAGA--- ACAAGACCAA TTG------- ---------- --------GC TT-----CGG
Neochromadora_BHMM_2005          A-TTAGA--- ACAAAACCAA TTG------- ---------- --------GC TT-----CGG
Spilophorella_paradoxa           A-TTAGA--- ACAAAACCAA TTG------- ---------- --------GC TT-----CGG
Paracanthonchus_caecus           A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GAC TT-------G
Paracyatholaimus_intermedius     A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GGC TT-------G
Praeacanthonchus_punctatus       A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GGC TT-------G
Praeacanthonchus_sp              A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GGC TT-------G
Cyatholaimus_sp._BHMM_2005       A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GAC TT-------G
Spirinia_parasitifera            A-TTAGA--- CCAAGACCAA TCA------- ---------- -------GGC TT-----TGC
Acanthopharynx_micans            A-TTAGA--- CCAAGACCAA TTA------- ---------- -------GGC TC-----CGG
Xyzzors_sp                       G-TTAGA--- CCAAGACCAA TCA------- ---------- -------GGC TT-----TGC
Metachromadora_sp                A-TTAGA--- CCAAGACCAA TCG------- ---------- -------GGC TC-----TGC
Metachromadora_remanei           A-TTAGA--- CCAAGACCAA TCG------- ---------- -------GGC TC-----TGC
NUCLEOTIDES INCLUDED             m-mmmmm--- mmmm-mmmmm mmm------- ---------- ---------- ----------
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                        310        320        330        340        350        360
Catanema_sp                      A-TTAGG--- CCAAAACCAA TCG------- ---------- -------GGC CT-----CGG
Eubostrichus_dianae              A-TTAAA--- CCAAAACCAA TCA------- ---------- -------GAC TT-----CGG
Eubostrichus_topiarus            A-TTAGA--- ACAAAACCAA TCA------- ---------- -------GGC TC-----CGG
Eubostrichus_parasitiferus       A-TTAGA--- CCAAAACCAA TCA------- ---------- -------GGC TT-----CGG
Laxus_oneistus                   A-TTAGA--- CCAAAATCAA TCA------- ---------- -------GGC TT-----TGC
Laxus_cosmopolitus               A-TTAGA--- CCAAAATCAA TCG------- ---------- -------GGC TT-----TGC
Leptonemella_sp                  A-TTAGA--- CCAAAACCAA TCG------- ---------- -------GGC TC-----GTC
Robbea_hypermnestra              A-TTAGA--- CCAAGACCAA TCA------- ---------- -------GGC TC-----TGC
Stilbonema_majum                 A-TTAGA--- CCAAAACCAA TCA------- ---------- -------GGC TT-----CGG
Monoposthia_costata              A-TTAGA--- TAAAAGGCTG ACGCG----- ---------- -------GGC TC-----TGC
Nudora_bipapillata               A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GGC TT------GT
Calomicrolaimus_parahonestus     A-TTAGA--- ACTAAACCAA TCG------- ---------- -------GGC TT------GC
Calomicrolaimus_sp._BHMM_2005    A-TTAGA--- ACTAAACCAA TCG------- ---------- -------GGC TT------GC
Molgolaimus_demani               A-TTAGA--- ACTAAACCAA TCG------- ---------- -------GGC TT------GC
Diplogaster_lethieri             A-TTAGA--- TCAAGACCTA TTG------- ---------- -------GGG CA------AC
Aduncospiculum_halicti           A-TTAGA--- ACAAGACCAA TCG------- ---------- -------TGC TT------GC
Pristionchus_lheritieri          A-TTAGA--- TCAAGACCTA TTG------- ---------- -------GGG CA------AC
Pristionchus_pacificus           A-TTAAA--- TCAAGGCCGA TTG------- ---------- -------GGG CA------AC
Pristionchus_pacificus           A-TTAGA--- TCAAGGCCGA TTG------- ---------- -------GGG CA------AC
Sabatieria_punctata_STRAIN_343   A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GGC TT-----TGG
Sabatieria_sp._355_BHMM_2005     A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GGC TT-----TGG
Sabatieria_celtica               A-TTAGA--- ACAAAACCAA TGG------- ---------- -------GGT T-------CG
Sabatieria_punctata_STRAIN_200   A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Sabatieria_punctata_STRAIN_223   A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GGC TT-----CGG
Sabatieria_sp._210_BHM_2005      A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GGT TT-----CGG
Setosabatieria_hilarula          A-TTAGA--- ACAAAACCAA TGG------- ---------- -------GGT T------CGC
Desmolaimus_zeelandicus          A-TTAGA--- CCAAAACCAA TCG------- ---------- -------GTC TT-----CGG
Terschellingia_longicaudata      A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GGG CA-----ACC
Cyartonema_elegans               A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GGG CA-----ACC
Tridentulus_sp                   A-TTAGA--- ACAAGACCAT CCG------- ---------- -------GTC CT-----CGG
Diplolaimelloides_meyli          A-TTAGA--- CCAAAGCCAT CCG------- ---------- -------G-C TT-----CGG
Diplolaimella_diavengatensis     A-TTAGA--- TCAAGACCA- TCC------- ---------- -------GGC TT-----CGG
Geomonhystera_disjuncta          A-TTAGA--- TCAAGACTAA CCG------- ---------- -------GCT T------CGG
Sphaerolaimus_hirsutus           A-TTAGA--- GCAAAACCAA TCA------- ---------- -------GCC T------CGG
Theristus_acer                   A-TTAGA--- CTAAAACTAA TCT------- ---------- -------GCA CT-----TGT
Daptonema_procerus               A-TTAGC--- TCAAAACCAA TCA------- ---------- -------GCT T------CGG
Daptonema_hirsutum               A-TTAGA--- CCAAAACCAA TCG------- ---------- -------GCG CA-----AGC
Daptonema_normandicum            A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GTG CT-----TGC
Daptonema_oxycerca               A-TTAGC--- TCAAAACCAA TCA------- ---------- -------GCT T------CGG
Daptonema_setosum                A-TTAGA--- CCAAAACCAA TCG------- ---------- -------GCG C------AAG
Desmodora_communis               A-TTAGA--- CCAAGACCAA TCA------- ---------- -------GTC TC-----TGA
Desmodora_ovigera                A-TTAGA--- CCAAGACCAA TCA------- ---------- -------GAC AT-----TCG
Metadesmolaimus_sp               A-TTAGA--- CCAAAACCAA TCG------- ---------- -------GCG CA-----AGC
Dentostomella_sp                 A-TTACA--- CTACAACCAA TCG------- ---------- -------GGC GT-----CAG
Bunonema_franzi                  A-TTAGA--- TCAAAACCAA ACG------- ---------- -------GGC TT-----GCC
Bunonema_sp                      A-TTAGA--- ACAAAACCAA ACG------- ---------- -------GGC TC-----GCC
Seleborca_complexa               A-TTAGA--- ACAAAACCAA GCG------- ---------- -------GCT T------CGG
Acrobeloides_nanus               A-TTAGA--- ACAAAACCAA GCG------- ---------- -------GCT T------CGG
Acrobeloides_bodenheimeri        A-TTAGA--- ACAAAACCAA GCG------- ---------- -------GCT T------CGG
Acrobeloides_sp_PS1146           A-TTAGA--- ACAAAACCAA GCG------- ---------- -------GCT T------CGG
Acrobeles_ciliatus               A-TTAGA--- ACAAAACCAA GCG------- ---------- -------GCT T------CGG
Acrobeles_sp_PS1156              A-TTAGA--- ACAAAACCAA GCG------- ---------- -------GCT T------CGG
Acrobeles_complexus_WCUG2        A-TTAGA--- ACAAAACCAA GCG------- ---------- -------GCT T------CGG
Cephaloboides_sp_SB227           A-TTAGT--- ACAA-ACCAT GCA------- ---------- -------G-- ----------
Cephalobus_cubaensis             A-TTAGG--- ACAAAACCAA GCG------- ---------- -------GCT T------CGG
Cephalobus_sp._PS1143            A-TTAGA--- ACAAAACCAA GCG------- ---------- -------GCT T------CGG
Cephalobus_sp._PS1196            A-TTAGA--- ACAAAACCAA GCG------- ---------- -------GCT T------CGG
Cephalobus_oryzae_PS1165         A-TTAGA--- ACAAAACCAA GCG------- ---------- -------GCT T------CGG
Cervidellus_alutus               A-TTAGA--- ACAAAACCAA GCG------- ---------- -------GCT T------CGG
Pseudacrobeles_variabilis        A-TTAGA--- ACAAAACCAA GCG------- ---------- -------GCT T------CGG
Triligulla_aluta                 A-TTAGA--- ACAAAACCAA GCG------- ---------- -------GCT T------CGG
Zeldia_punctada                  A-TTAGG--- ACAAAACCAA GCG------- ---------- -------GCT T------CGG
Myolaimus_sp_U81585              A-TTAGA--- CCAAAACCAA TCG------- ---------- -------GGC T------TGC
Rhabditophanes_sp._KR3021        A-TTTGA--- TTAA-ACTA- ---------- ---------- ---------- ----------
Brevibucca_sp._SB261             A-TTAGA--- CCGAAACCAA CCG------- ---------- --------GG CTT----GCC
Halicephalobus_gingivalis        A-TTAGA--- ACAAAACCAA TGG------- ---------- --------GC TTT----GCC
Panagrobelus_stammeri            A-TTAGA--- ACAAAACCAA GCG------- ---------- --------GC TTT----GCC
Plectonchus_sp._PDL0025          A-TTAGT--- ACAAAACCAA GCG------- ---------- --------GC TTT----GCC
Turbatrix_aceti                  A-TTAGT--- ACAAAACCAT CCG------- ---------- --------AC TT-----CGG
Panagrellus_redivivus            A-TTAGA--- ACAAAACCAA C--------- ---------- ---------- TT-----GTT
Panagrellus_redivivus_PS1163     A-TTAGA--- ACAAAACCAA C--------- ---------- ---------- TT-----GTT
Panagrolaimus_subelongatus       A-TTAGTA-- TTAAAACCAA GCA------- ---------- --------TT CTT----YGG
Panagrolaimus_davidi             A-TTAGTA-- TTAAAACCAA GCA------- ---------- --------TT CTT----CGG
Panagrolaimus_cf_rigidus_AF40    A-TTAGTA-- TTAAAACCAA GCA------- ---------- --------TT CTT----CGG
Panagrolaimus sp. Sourhope ED2   A-TTAGTA-- TTAAAACCAA GCA------- ---------- --------GT CCT---TTGG
Panagrolaimus sp. Sourhope ED2   A-TTAGTA-- TTAAAACCAA GCA------- ---------- --------GT CCT---TTGG
Panagrolaimus sp. Sourhope ED2   A-TTAGTA-- TTAAAACCAA GCA------- ---------- --------GT CCT---TTGG
Panagrolaimus sp. Sourhope ED2   A-TTAGTA-- TTAAAACCAA GCA------- ---------- --------TT CTT-----CG
NUCLEOTIDES INCLUDED             m-mmmmm--- mmmm-mmmmm mmm------- ---------- ---------- ----------
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                                  ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                          310        320        330        340        350        360
Panagrolaimus sp. Sourhope ED2    A-TTAGTA-- TTAAAACCAA GCA------- ---------- --------TT CTT-----CG
Steinernema_carpocapsae           A-TTAGA--- TCAAAACCAA GCG------- ---------- --------AC TC-----CGG
Strongyloides_stercoralis         A-TTAGAT-- AAAAAACCAA TGA------- ---------- ---------C TT-----CGG
Strongyloides_ratti               A-TTTGA--- TTAA-ACCAT TT-------- ---------- ---------T TT-----CGG
Diploscapter_sp_PS1897            A-TTAGG--- CCAA-ACCAA TCG------- ---------- --------TC CT-----CGT
Diploscapter_sp_PS2017            A-TTAGG--- CCAA-ACCAA TCG------- ---------- --------TC CT-----CGT
Heterorhabditis_bacteriophora     A-TTAGA--- ACAG-ACCAA TCG------- ---------- --------TC CT-----TGG
Heterorhabditis_hepialus          A-TTAGA--- ACAG-ACCAA TCG------- ---------- --------TC CT-----TGG
Heterorhabditis_zelandica         A-TTAGA--- ACAG-ACCAA TCG------- ---------- --------TC CT-----CGG
Parasitorhabditis_sp_SB281        A-TTAGA--- TTC--ACCAA CCG------- ---------- ---------C TT-----CGG
Rhabditoides_inermiformis         A-TTAGA--- ACAAAACCAA TCG------- ---------- --------GC TT-----CGG
Rhabditoides_inermis_DF5001       A-TTAGA--- CTTATACCAG CCG------- ---------- --------GG CA-----GCC
Rhabditoides_regina_DF5012        T-TTAGA--- TTC--ACTAA CCG------- ---------- --------GG CAA----CCG
Poikilolaimus_oxycerca_SB200      A-TTAGA--- ACAAAACCAA TCG------- ---------- --------GC TT-----TGG
Poikilolaimus_regenfussi_SB199    A-TTAGA--- ACAAAACCAA TCG------- ---------- --------GC TT-----CGG
Distolabrellus veechi DWF1604     A-TTAGA--- ATC--ACCAA CCG------- ---------- --------CT TC------GG
Distolabrellus veechi DF5024      A-TTAGA--- ATC--ACCAA CCG------- ---------- --------CT TC------GG
Choriorhabditis_dudichi           A-TTAGT--- ACAG-ACCAA TCC------- ---------- ---------T TC----AAAA
Protorhabditis_sp                 A-TTAGG--- CCAA-ACCAA TCG------- ---------- --------TC TT-----CGG
Protorhabditis_sp_DF5055          A-TTAGC--- GAAG-ACCAA TCC------- ---------- --------TC CT-----CGG
Cruznema_tripartitum_DF5015       A-TTAGT--- GCAA-ACCAA TCG------- ---------- --------TC TT-----CGG
Mesorhabditis_sp_PS1179           A-TTAGA--- TTC--ACCAA CCG------- ---------- ---------C TT-----CGG
Mesorhabditis_spiculigera_SB15    A-TTAGA--- TTC--ACCAA CCA------- ---------- ---------C -------CGG
Mesorhabditis_anisomorpha_SB12    A-TCAGA--- CGAC-ACCAA CCG------- ---------- ---------C CT-----CGG
Teratorhabditis_palmarum_DF501    A-TTAGA--- -TCG-ACCAA CCG------- ---------- ---------C TT-----AGG
Teratorhabditis_synpapillata_S    A-TTAGA--- -TCG-ACCAA CCG------- ---------- ---------C TT-----CGG
Caenorhabditis_briggsae_PB102     A-TTAGA--- ACAG-ACCAA ACG------- ---------- --------TT TT-----CGG
Caenorhabditis_elegans_N2         A-TTAGA--- ACAG-ACCAA ACG------- ---------- --------TT TT-----CGG
Caenorhabditis_sp_CB5161          A-TTAGA--- ACAG-ACCAA ACG------- ---------- --------TT CT-----CGG
Caenorhabditis_sp_PS1010          A-TTAGA--- ACAA-GCCAG ACG------- ---------- --------TT CT-----CGG
Caenorhabditis_japonica           A-TTAGA--- ACAG-ACCAA ACG------- ---------- --------TT TT-----CGG
Caenorhabditis_sp_DF5170          A-TTAGA--- ACAG-ATCAA ACG------- ---------- --------TT TT-----CGG
Caenorhabditis_sp_SB341           A-TTAGA--- ACAG-ACCAA CCG------- ---------- --------TC CT---AACCG
Caenorhabditis_plicata            A-TTAGA--- TTAC-ACCAA CCG------- ---------- --------TC TT-----CGG
Caenorhabditis_vulgaris           A-TTAGA--- ACAG-ACCAA ACG------- ---------- --------TT TT-----CGG
Caenorhabditis_sonorae            A-TTAGA--- ACAG-ACCAA CCG------- ---------- --------TC CT-----CGG
Caenorhabditis_drosophilae        A-TTAGA--- ACAA-ATCAA ACG------- ---------- --------TT TT-----CGG
Phasmarhabditis_hermaphrodita     A-TTAGT--- ACGA-ACCAA TCG------- ---------- --------CT TT-----CGG
Phasmarhabditis_neopapillosa      A-TTAGT--- ACGA-ACCAA TCG------- ---------- --------CT CT-----CGG
Phasmarhabditis_neopapillosa      A-TTAGT--- ACAA-ACCAA TCG------- ---------- --------TT TT-----CGG
Pellioditis_mediterranea_SB173    A-TTAGT--- TCAA-ACCAA TCG------- ---------- --------TC C------TGG
Pellioditis_marina                A-TTAGT--- ACAA-ACCAA TCG------- ---------- --------TT TT-----CGG
Prodontorhabditis_wirthi          A-TTAGT--- GAAG-GCCAA CCG------- ---------- --------TC TC-----TGA
Crustorhabditis_scanica           A-TTAGA--- TTC--ACCAA CCG------- ---------- --------CT TC-----GGC
Dolichorhabditis_sp_CEW1          A-TTAGT--- GCAA-ACCAA TCG------- ---------- --------TT TT-----CGG
Oscheius_sp_DF5000                A-TTATT--- TCAA-ACCAA TCG------- ---------- --------TC TT-----CGG
Oscheius_sp_BW282                 A-TTAGT--- ACAA-ACCAA TCG------- ---------- --------TC TT-----CGG
Oscheius_myriophila_EM435         A-TTAGT--- ACAA-ACCAA TCG------- ---------- --------TC TT-----CGG
Oscheius_insectivora              A-TTAGT--- ACAA-ACCAA TCG------- ---------- --------TC TT-----CGG
Oscheius_dolichuroides            A-TTATT--- TCAA-ACCAA TCG------- ---------- --------TC TT-----CGG
Rhabditis_blumi_DF5010            A-TTAGT--- ACAA-ATCAA TCG------- ---------- --------CT TT-----CGG
Rhabditis_sp_PS1191               A-TTAGT--- ACAA-ACCAA TCG------- ---------- --------TC TT-----CGG
Rhabditis_sp_PS1010               A-TTAGA--- ACAA-GCCAG ACG------- ---------- --------TT CT-----CGG
Rhabditis_myriophila_EM435        A-TTAGT--- ACAA-ACCAA TCG------- ---------- --------TC TT-----CGG
Rhabditis_colombiana              TATTAGT--- ACAA-ACCAA TCG------- ---------- --------TC TT-----CGG
Rhabditella_axei_DF5006           A-TTAGT--- ACAA-ACCAA TCG------- ---------- --------TC T------CTG
Rhabditella_sp_DF5044             A-TTAGT--- ACAA-ACCAA TCG------- ---------- --------TC T------CTG
Cuticularia_sp_PS2083             A-TTAGA--- ACAAAACCAA TCG------- ---------- --------GC TT-----TGG
Necator_americanus                A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Kalicephalus_cristatus            A-TTAGA--- GCAA-ATCAG TCA------- ---------- --------TC TT-----CGG
Ancylostoma_caninum               A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------CC TT-----CGG
Angiostrongylus_cantonensis       A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Angiostrongylus_costaricensis     A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Angiostrongylus_malaysiensis      A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Angiostrongylus_dujardini         A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Angiostrongylus_vasorum           A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Aulurostrongylus_abstrusus        A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Didelphostrongylus_hayesi         A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Crenosoma_mephitidis              A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Crenosoma_vulpis                  A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Otostrongylus_circumlitus         A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Troglostrongylus_wilsoni          A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Filaroides_martis                 A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Oslerus_osleri                    A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TA-----CGG
Parafilaroides_decorus            A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Metastrongylus_salmi              A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TA-----CGG
Metastrongylus_elongatus          A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TA-----CGG
Skrjabingylus_chitwoodrum         A-TTAGA--- GCAA-ATCAG TCA------- ---------- --------TT TT-----CGG
NUCLEOTIDES INCLUDED              m-mmmmm--- mmmm-mmmmm mmm------- ---------- ---------- ----------
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                        310        320        330        340        350        360
Parelaphostrongylus_odocoilei    A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Muelerius_capillaris             A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Protostrongylus_rufescens        A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Halocercus_invaginatus           A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Pseudalius_inflexus              A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Stenurus_minor                   A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Torynurus_convolutus             A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Syngamus_trachea                 A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Stephanurus_dentatus             A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Nematodirus_battus               A-TTAGA--- GCAA-ATCAA TCT------- ---------- --------CC TT-----CGG
Strongylus_equinus               A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Labiostrongylus_bipapillosus     A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Petrovinema_poculatum            A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Cylicocyclus_insignis            A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Chabartia_ovina                  A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Cyclodontostomum_purvisi         A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Zoniolaimus_mawsonae             A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Hypodontus_macropi               A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Deletrocephalus_dimidiatus       A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Dictyocaulus_eckerti_P7B8        A-TTAGA--- GCAA-ATCAG TGA------- ---------- --------TC TT-----CGG
Dictyocaulus_capreolus_P3B2      A-TTAGA--- GCAA-ATCAG TGA------- ---------- --------TC TT-----CGG
Dictyocaulus_sp._P6A1            A-TTAGA--- GCAA-ATCAG TGA------- ---------- --------TC TT-----CGG
Dictyocaulus_filaria             A-TTAGA--- GCAA-ATCAA TCA------- ---------- ------TCCT TA-----CGG
Dictyocaulus_capreolus_P2C10     A-TTAGA--- GCAA-ATCAG TGA------- ---------- --------TC TT-----CGG
Dictyocaulus_viviparus           A-TTAGA--- GCAA-ATCAG TGA------- ---------- --------TC TT-----CGG
Haemonchus_sp._V3091             A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------CT TT-----CGG
Haemonchus_contortus             A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------CT TT-----CGG
Haemonchus_placei                A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------CT TT-----CGG
Haemonchus_similis               A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------CT TT-----CGG
Ostertagia_ostertagi             A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Ostertagia_leptospicularis       A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Nippostrongylus_brasileinsis     A-TTAGT--- GCAA-ACCAA TCA------- ---------- --------TC TT-----CGG
Heligmosomoides_polygyrus        A-TTAGA--- GCAA-ACCAA TCA------- ---------- --------CC TT-----CGG
Trichostrongylus_colubriformis   A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------CC TT-----CGG
Tetrabothriostrongylus mackerr   A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TT-----CGG
Herpestrongylus_pythonis         A-TTAGA--- GCAA-ACCAA TCA------- ---------- --------CC TT-----CGG
Nicollina_cameroni               A-TTAGA--- GCAA-ACCAA TCA------- ---------- --------CC TT-----CGG
Filarimena_flagrifer             A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------CC CT-----CGG
Amidostomum_cygni                A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------CC TT-----CGG
Teratocephalus_lirellus          A-TTAGA--- ACAAAACCAA TCG------- ---------- -------GGC TT-----CGG
Brumptaemilius_justini           A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT CT-----CGG
Anguillicola_crassus             A-TTAGA--- ACAAAACCAA TCG------- ---------- -------AGC TG-----CGG
Dracunculus_medinensis           A-TAAGGA-- TTAAAACCAA GTC------- ---------- ---GTAGTCT TTAAA--CGG
Dracunculus_oesophageus          A-TTAGA--- CTAAAACCAA TCG------- ---------- ----AGCGGT TTTAAAACTG
Dracunculus_sp._V3104            A-TTAGA--- CTAAAACCAA TCG------- ---------- ----AGCCAA TTAAA--CGG
Philonema_sp_A                   A-TTAGA--- TTAAAACCAA TCGGGCATAT AACTTCATTC GTGGAGTGAT A-------GG
Philometra_obturans              A-TTAGAC-- TAAAAACCAA TCGAGATGGT GTCTCTCCGC GCCATGCGGG -TGGCATAAC
Camallanus_oxycepahalus          A-TTAGAC-- CAAAAACCAA TCG------- ---------- -------AGA TTATTCGTGC
Acanthocheilonema_viteae         A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TATTGGCTTA
Loa_loa                          A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TATT----AG
Onchocerca_cervicalis            A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TATT----GG
Dirofilaria_immitis              A-TTAGA--- TTAAAACCAA TCGGAACAAA ---------- -------TTT GATCT---GA
Brugia_malayi                    A-TTAGA--- TTAAAACCAA TCG------- ---------- ------GATT ATTAATTTTA
Wuchereria_bancrofti             A-TTAGA--- TTAAAACCAA TCG------- ---------- ------GATT ATTAATTAAC
Litomosoides_sigmodontis         A-TTAGA--- TTAAAACCAA TGG------- ---GGTGGTC ATCAGCTGCT GCTGCTGGCC
Setaria_digitata                 A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGT TATTT---GA
Gnathostoma_turgidum             A-TTAGA--- ACAAAACCAA TCG------- ---------- -------AGC TTC-----GG
Gnathostoma_neoprocyonis         A-TTAGA--- ACAAAACCAA TCG------- ---------- -------AGC TTC-----GG
Gnathostoma_binucleatum          A-TTAGA--- ACAAAACCAA TCG------- ---------- -------AGC TTC-----GG
Physaloptera_alata               A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGC TTC-----CG
Physaloptera_turgida             A-TTAGA--- TTAAAACCAA TCG------- ---------- -------GGC TTC-----AA
Ascarophis_arctica               A-TTAGG--- TTAAAACCAA TCG------- ---------- -------GGC TT------TG
Spinitectus_carolini             A-TTAGA--- TTAAATCCAA TCG------- ---------- -------GTG AAC-----TT
Thelazia_lacrymalis              A-TTAGAATG AAAAAACCAA TGG------- ---------- -------GGT TT-----ATG
Aphelenchus_avenae               A-TTAGA--- TCAAAACCAA GCG------- ---------- -------G-C TT------CG
Aphelenchoides_fragariae         A-TCGGA--- GCAAAACTAA TCT------- ---------- ---------- -----T----
Bursaphelelenchus_sp             A-TTGGA--- GCAAAACCAG TTT------- ---------- -------G-- TA--------
Deladenus_sp                     A-TTAGA--- ACAAAACCAG GCG------- ---------- -------G-C TT-----CGG
Criconema_sp                     G-TTGGA--- GCAAAACCAG GCG------- ---------- -------G-C TT-----CGG
Hemicycliophora_conida           A-TTGGA--- GCAAAACCAG GCG------- ---------- --------AC TT-----CGG
Paratylenchus_dianthus           A-TTTGA--- GCAAAACCAG GCG------- ---------- -------G-C TT-----CGG
Pratylenchus_thornei             A-TTAGA--- ACAAAACCAA GCG------- ---------- -------G-C TT-----CGG
Tylenchulus_semipentrans         A-TTGGA--- GCAAAACCAA GCG------- ---------- -------G-C TT-----CGG
Ditylenchus_angustus             A-TTAGA--- ACAAAACCAG GCG------- ---------- -------G-C TT-------G
Subanguina_radicola              A-TTAGA--- ACAAAACCAA GCG------- ---------- --------AC TT-----CGG
Tylenchorhynchus_maximus         A-TTAGA--- ACAAAACCAA GCG------- ---------- -------G-C TT-----CGG
Geocenamus_quadrifer             A-TTCGA--- ACAAAACCAA GCG------- ---------- -------G-C TT-----CGG
Globodera_pallida                G-TTCGCC-- ACAAAACCAA GCG------- ---------- -------C-C TT-----CGG
NUCLEOTIDES INCLUDED             m-mmmmm--- mmmm-mmmmm mmm------- ---------- ---------- ----------
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         310        320        330        340        350        360
Scutellonema_bradys              G-TTCGCC-- ACAAAACCAA GCGG------ ---------- -------CCC GC---AAGGG
Helicotylenhcus_dihystera        G-TTCGCC-- ACAAAACCAA GCG------- ---------- -------CCC TT----CTGG
Rotylenchus_robustus             G-TTCGCC-- ACAAAACCAA GCG------- ---------- -------CCC TC----ACGG
Meloidogyne_arenaria             A-TTAGA--- ACAAAACCAC G-C------- ---------- -------G-G CTT----CGG
Meloidogyne_incognita_KT         A-TTAGA--- ACAAAACCAC GCG------- ---------- -------G-C TT-----CGG
Meloidogyne_javanica             A-TTAGA--- ACAAAACCAC GCG------- ---------- -------G-C TT-----CGG
Meloidogyne_artiellia            A-TTTGA--- ACAAAACCAT GCA------- ---------- -------G-C TT-----CGG
Meloidogyne_duytsi               A-TTTGA--- ACAAAACCAA GCG------- ---------- -------G-C TT-----CGG
Meloidogyne_exigua               A-TTAGA--- ACAAAACCAC GCG------- ---------- -------G-C TT-----CGG
Meloidogyne_hapla                A-TTAGA--- ACAAAACCAA GCG------- ---------- -------G-C TT-----CGG
Meloidogyne_ichinohei            A-TTGGA--- ACAAAACCAA GCA------- ---------- -------G-C TT-----CGG
Meloidogyne_maritima             A-TTTGA--- ACAAAACCAA GCG------- ---------- -------G-C TT-----CGG
Meloidogyne_microtyla            A-TTGGA--- ACAAAACCAA GTG------- ---------- -------G-C TT-----CGG
Nacobbus_aberrans                A-TTAGA--- ACAAAACCAA ACG------- ---------- -------G-C TT-----CGG
Pratylenchoides_ritteri          A-TTCGA--- ACAAAACCAA GCG------- ---------- -------G-C TT-----CGG
Pratylenchoides_magnicauda       A-TTCGA--- ACAAAACCAA GCG------- ---------- -------G-C TT-----CGG
Hirschmanniella_sp._JH_2003      G-TTAGA--- ACAAAACCAA ACG------- ---------- -------G-C TT-----CAG
Radopholus_similis               G-TTCGCC-- ACAAAACCAA GCC------- ---------- -------C-C CT-----CGG
Pratylenchus_goodeyi_VF          A-TTAGA--- ACAAAACCAA GCG------- ---------- -------G-C TT-----CGG
Boleodorus_thylactus_clone2      A-TTAGA--- ACAAAACCAA GCG------- ---------- ------GG-C GC-----CTC
Philippine Sequence 1            A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Philippine Sequence 2            A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Philippine Sequence 3            A-TTAGT--- ACAG-ACCAA TCG------- ---------- --------TC TT-----CGG
Philippine Sequence 4            A-TTAGT--T GAAA-ACCAA GCA------- ---------- --------TC TT-----CGG
Philippine Sequence 5            A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------CC TT-----CGG
Philippine Sequence 6            A-TTAGT--- ACAA-ACCAA TCG------- ---------- --------TT T------CTG
Philippine Sequence 7            A-TTAGA--- ACAG-ACCAA ACG------- ---------- --------TT TT-----CGG
Tahiti Sequence 1                A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Tahiti Sequence 2                A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TT-----CGG
Thailand Sequence 1              A-TTAGA--- TTAAAACCAA TCA------- ---------- -------GGC CTTCATTGGG
Ogasawara Sequence 1             A-TTAGT--- TGAAAACCAA GCA------- ---------- --------TC TT-----CGG
Ogasawara Sequence 2             A-TTAGT--- ACGA-ACTGA TCG------- ---------- --------TC TT-----CGG
Ivory Coast Sequence 1           A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TA-----CGG
Ivory Coast Sequence 2           A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TA-----CGG
Ivory Coast Sequence 3           A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TA-----CGG
Ivory Coast Sequence 4           A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TA-----CGG
Ivory Coast Sequence 5           A-TTAGA--- TTAAAACCAA TCA------- ---------- -------GGC CT-TCATCGG
Ivory Coast Sequence 6           A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TA-----CGG
Ivory Coast Sequence 7           A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TC-----CGG
Singapore Sequence 1             A-TTAGT--- ACAG-ACCAA TCG------- ---------- --------TC TT-----CGG
Singapore Sequence 2             A-TTAGA--- TTAAAACCAA TCA------- ---------- -------GGC CTTCTTTGGG
Singapore Sequence 3             A-TTAGA--- ACAG-ACCAA ACG------- ---------- --------TT TT-----CGG
Singapore Sequence 4             A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TC TA-----CGG
Nigerian Sequence 1              A-TTAGA--- GCAA-ATCAG TCA------- ---------- --------TT TT-----CGG
Nigerian Sequence 2              A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------CC TT-----CGG
Nigerian Sequence 3              A-TTAGA--- GCAA-ATCAA TCA------- ---------- --------TT TA-----CGG
NUCLEOTIDES INCLUDED             m-mmmmm--- mmmm-mmmmm mmm------- ---------- ---------- ----------


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                                         370        380        390        400        410        420
Gordius_aquaticus                ---------- ---------- ---------- -TTTTTGGTG A--CTCTGGA TAACTTTGT-
Priapulus_caudatus               G--CCCG--- ---------- ---------T TCTTTTGGTG A--CTCTGGA TAACCTTGC-
Brachionus_plicatilis            C--AAGATCC C--------- ---------T TTGTATGGTG A--CTCTGGA TAACTTTGT-
Chordodes_morgani                ---------- ---------- --------GT TTTTGTGGTG A--CTCTGGA TAACTTTGT-
Paractinolaimus_macrolaimus      G--CCTG--- ---------- ---------- TAATTTGGTG A--ATCTGAA TAACTTT---
Aporcelaimellus_obtusicaudatus   G--CCCG--- ---------- ---------- TAATTTGGTG A--ATCTGAA TAACTTT---
Wilsonema_schuurmansstekhoveni   G--CCTG--- ---------- ---------A GACGTTGGTG A--CTCTGAA TAACTGA---
Mesodorylaimus_sp_cf_nigritul    G--CTCG--- ---------- ---------- TAATTTGGTG A--ATCTGAA TAACTTT---
Mesodorylaimus_bastiani          G--CCCG--- ---------- ---------- TTTATTGGTG A--ATCTGAA TAACTTT---
Mesodorylaimus_japonicus         G--CTCG--- ---------- ---------- TAATTTGGTG A--ATCTGAA TAACTTT---
Pungentus_sp._PDL_2005           G--CCCG--- ---------- ---------- TAATTTGGTG A--ATCTGAA TAACTTT---
Allodorylaimus_sp                G--CTCG--- ---------- ---------- TAATTTGGTG A--ATCTGAA TAACTTT---
Eudorylaimus_carteri             G--TTCG--- ---------- ---------- TAATTTGGTG A--ATCTGAA TAACTTT---
Microdorylaimus_sp               G--CTCG--- ---------- ---------- TAATTTGGTG A--ATCTGAA TAACTTT---
Longidorus_elongatus             G--CCCG--- ---------- ---------- CTGTTTGGTG A--ATCTGAA TAACTTT---
Xiphinema_rivesi                 G--CCCG--- ---------- ---------- TAATTTGGTG A--ATCTGAA TAACTTT---
Tylencholaimus_sp                G--TCCG--- ---------- ---------- TGATTTGGTG A--ATCTGAA TAACTTT---
Anoplostoma_sp._BHMM_2005        T--G------ ---------- ---------- CCATTTGGTG A--ATCTGAA TAACCCA---
Adoncholaimus_fuscus             G--CCTG--- ---------- ---------- AAAACTGGTG A--AACTGAA CAATTTA---
Enoplus_meridionalis             C--CCGG--- ---------- ---------- TTTTTTGGTG A--CTCTGAA TAACTCT---
Enoplus_brevis_U88336            C--CCGG--- ---------- ---------- TTTTTTGGTG A--CTCTGAA TAACTCT---
Enoplus_communis                 C--CCGG--- ---------- ---------- TTTTTTGGTG A--CTCTGAA TAACTCT---
Enoploides_brunettii             C--G------ ---------- ---------- CCGTTTGGTG G--ATCTGAA TAACTTT---
Syringolaimus_striatocaudatus    T--CCG---- ---------- ---------- CCTTTTGGTG A--ATCTGAA TACCTCA---
Ironus_dentifurcatus             G--CTCG--- ---------- ---------- TCAATTGGTG A--ATCTGAA TAATTTT---
Calyptronema_maxweberi           G--TCTG--- ---------- ---------- CATTCAAGTG A--TTTTAGA CAATTTA---
Viscosia_sp._BHMM_2005           G--TCTG--- ---------- ---------- AATCCAAGTG A--TATTGAA CAATTTA---
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- -mmmmmmmmm m--mmmmmmm mmmmmm----
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         370        380        390        400        410        420
Viscosia_viscosa                 G--TCTG--- ---------- ---------- AAATCAAGTG A--TATTGAA CAATTTA---
Pontonema_vulgare                G--TCTG--- ---------- ---------- ATGTCAAATG A--TATTGAA CAATTTA---
Oncholaimus_sp._BHMM_2005        G--ACTG--- ---------- ---------- TAATCAAGTG A--GATTGAA CTATTTA---
Alaimus_sp_PDL_2005              G--TCCG--- ---------- ---------- CTCTTTGGTG A--ATCTGAA TAACTCA---
Prismatolaimus_intermedius       G--GCCCG-- ---------- ---------- CCAGTTGGTG A--ATCTGAA TAACTTT---
Tobrilus_gracilis                G--CCCG--- ---------- ---------- TTCTTTGGTG A--ATCTGAA TAACTCT---
Tripyla_cf_filicaudata_JH_2004   G--TCCG--- ---------- ---------- TCCATTGGTG A--TTCTAAA TAACTCT---
Bathylaimus_sp                   G--CATTGTT GCG------- ---------- TAATTTGGTG A--GTCTGAA TAACTTG---
Bathylaimus_assimilis            G--CATTGTT GCG------- ---------- TAATTTGGTG A--GTCTGAA TAACTTG---
Bathylaimus_sp._BHMM_2005        G--CTGCAGT GCG------- ---------- TCATTTGGTG A--GTCTGAA TAACTTG---
Tripyloides_sp._BHMM_2005        G--TGGTGCG ---------- ---------- TTATTTGGTG A--ATCTGAA TAACTTG---
Trischistoma_monohystera         G--CCCG--- ---------- ---------- TCATTTGGTG A--ATCTGAA TAACTTT---
Mermis_nigrescens                G--CTCG--- ---------- ---------- TGTTTTGGTG A--CTCTGAA TAACTCA---
Mylonchulus_arenicolus           G--TGCTTG- ---------- ---------- TGTTTTGGTG A--CTCTGAA TAACTTA---
Anatonchus_tridentacus           G--CTTG--- ---------- ---------- TGTTTTGGTG A--CTCTGAA TAACTAA---
Mononchus_truncatus              G--CTTG--- ---------- ---------- ATTGTTGGTG A--CTCTGAA TAACTAA---
Prionchulus_muscorum             G--CTTG--- ---------- ---------- TGTTTTGGTG A--CTCTGAA TAACTAA---
Clarkus_sp                       G--CCTG--- ---------- ---------- TGTTTTGGTG A--CTCTGAA TAACTAA---
Trichinella_spiralis             C--GAATGTT GAACGTCGAA A--------- CTGTTTGGTG A--ATCTGAA TAACTATT--
Trichinella_papuae               C--TGATGCT GAACGTCGAA A--------- CTCTTTGGTG A--ATCTGAA TAACTATT--
Trichinella_britovi              C--GAATGTT GAACGTCGAA A--------- CTGTTTGGTG A--ATCTGAA TAACTATT--
Trichinella_murrelli             C--GAATGTT GAACGTCGAA A--------- CTGTTTGGTG A--ATCTGAA TAACTATT--
Trichinella_pseudospiralis       C--TTGTGTT GAACGTCGAA A--------- CTCTTTGGTG A--ATCTGAA TAACTATT--
Trichinella_nativa               C--GAATGTT GAACGTCGAA A--------- CTGTTTGGTG A--ATCTGAA TAACTATT--
Trichinella_zimbabwensis         C--TGATGCT GAACGTCGAA A--------- CTCTTTGGTG A--ATCTGAA TAACTATT--
Trichinella_nelsoni              C--GAATGTT GAACGTCGAA A--------- CTGTTTGGTG A--ATCTGAA TAACTATT--
Trichuris_suis                   G--CTATCTA TTGGTCTGGG TCCGCGA--- AAGGTTGGTG A--ATCGGAA TAACTAT---
Trichuris_trichiura              G--CTAGCTA TTGGTCTGAG TCCGCGA--- AATGTTGGTG A--ATCGGAA TAACTAT---
Trichuris_muris                  C--TCTTTGC GTCCGTCCGT CA-------- ACGGTTGGTG A--ATCGGAA TAACTAT---
Tylolaimophorus_minor            G--TCCG--- ---------- ---------- CTCTTTGGTG A--ATCTGAA TAACTTA---
Paratrichodorus_pachydermus      G--ACCG--- ---------- ---------- CCATTTGGTG A-ACTCTGAA TAACTTT---
Paratrichodorus_anemones         G--ACCG--- ---------- ---------T CCATTTGGTG A--CTCTGAA TAATTCC---
Trichodorus_primitivus           G--ACCG--- ---------- ---------- CCATTTGGTG A-ACTCTGAA TAACTTA---
Axonolaimus_helgolandicus        ---T------ ---------- ---------- GTCTTTGGTG G--ATCTGAA TAACTCA---
Ascolaimus_elongatus             ---T------ ---------- ---------- GTCTTTGGTG G--ATCTGAA TAACTCA---
Odontophora_rectangula           ---CCC---- ---------- ---------- GTCTTTGGTG G--ATCTGAA TAACTCA---
Cylindrolaimus_sp._202149        ---CCT---- ---------- ---------- GTGTTTGGTG G--ATCTGAA TAACTCA---
Tylocephalus_auriculatus         ---CCTG--- ---------- ---------A AACGTTGGTG A--CTCTGAA TAACTGA---
Plectus_acuminatus_BS9           ---CCTG--- ---------- ---------- AACGGTGGTG A--CTCTGAA TAACTGA---
Plectus_aquatilis                ---CCTG--- ---------- ---------- AACGGTGGTG A--CTCTGAA TAACTGA---
Anaplectus_sp                    ---CCTG--- ---------- ---------- AGGTTTGGTG A--ATCTGAA TAACTGA---
Anisakis_sp_WKT                  ---CCCG--- ---------- ---------- TCAATTGGTG A--CTCTGAA TAACTATA--
Anisakis_sp_Nadler               ---CCCG--- ---------- ---------- TCAATTGGTG A--CTCTGAA TAACTATG--
Contracaecum_multipapillatum     ---CCCG--- ---------- ---------- TCAATTGGTG A--CTCTGAA TAACTATA--
Pseudoterranova_decipiens        ---CCCG--- ---------- ---------- TCAATTGGTG A--CTCTGAA TAACTATA--
Raphidascaris_acus               ---CCCG--- ---------- ---------- TTTGTTGGTG A--CTCTGAA TAACTATA--
Terranova_caballeroi             ---CCCG--- ---------- ---------- TCAATTGGTG A--CTCTGAA TAACTAAG--
Ascaris_suum                     ---CCCG--- ---------- ---------- TCAATTGGTG A--CTCTGAA TAACTATA--
Ascaris_lumbricoides             ---CCCG--- ---------- ---------- TAAATTGGTG A--CTCTGAA TAACTATA--
Baylisascaris_procyonis          ---CCCG--- ---------- ---------- TCAATTGGTG A--CTCTGAA TAACTATA--
Baylisascaris_transfuga          ---CCCG--- ---------- ---------- TCAATTGGTG A--CTCTGAA TAACTATA--
Parascaris_equorum               ---CCCG--- ---------- ---------- TTAATTGGTG A--CTCTGAA TAACTATA--
Porrocaecum_depressum            ---CCCG--- ---------- ---------- TCAATTGGTG A--CTCTGAA TAACTATA--
Toxascaris_leonina               ---CCCG--- ---------- ---------- TCAATTGGTG A--CTCTGAA TAACTATT--
Heterocheilus_tunicatus          ---CCCG--- ---------- ---------- TCAATTGGTG A--CTCTGAA TAACTATG--
Goezia_pelagia                   ---CCCG--- ---------- ---------- TTTGTTGGTG A--CTCTGAA TAACTATG--
Hysterothylacium_fortalezae      ---CCCG--- ---------- ---------- TTCGTTGGTG A--CTCTGAA TAACTGTA--
Hysterothylacium_pelagicum       ---CCCG--- ---------- ---------- TTTGTTGGTG A--CTCTGAA TAACTATA--
Hysterothylacium_reliquens       ---CCCG--- ---------- ---------- TTTGTTGGTG A--CTCTGAA TAACTATG--
Iheringascaris_inquies           ---CCCG--- ---------- ---------- TTTGTTGGTG A--CTCTGAA TAACTATG--
Toxocara_canis                   ---CCCG--- ---------- ---------- TAAATTGGTG A--CTCTGAA TAACTGTA--
Nemhelix_bakeri                  ---CCCG--- ---------- ---------- TCAATTGGTG A--CTCTGAA TAGCTATG--
Raillietnema_sp._V3060           ---TCCG--- ---------- ---------- TCATTTGGTG A--CTCTGAA TAGCTATC--
Cruzia_americana                 ---CCCG--- ---------- ---------- TCAATTGGTG A--CTCTGAA TAACTATG--
Heterakis_sp_14690               ---CCTG--- ---------- ---------- TTCATTGGTG A--CTCTGAA TAGCTCA---
Heterakis_gallinarum             ---CCTG--- ---------- ---------- TTTATTGGTG A--CTCTGAA TAGCTTA---
Paraspidodera_sp_21303           ---CCCG--- ---------- ---------- TCAACTGGTG A--CTCTGAA TAGCTATA--
Chromodora_nudicapitata          C---CA---- ---------- ---------- TCCATTGGTG A--ATCTTCC GAAGAAA---
Chromadora_sp._BHMM_2005         C---CA---- ---------- ---------- TCTATTGGTG A--ATCTGAG CAACTTA---
Atrochromadora_microlaima        C---CA---- ---------- ---------- TCTATTGGTG A--ATCTGAG CAACTTA---
Chromadorina_germanica           C---CA---- ---------- ---------- TCTATTGGTG A--ATCTGAA TAACTAC---
Chromadorita_tentabundum         C---CA---- ---------- ---------- TGAATTGGTG A--ATCTGAA TAACTAC---
Dichromadora_sp._BHMM_2005       C---CA---- ---------- ---------- TCTATTGGTG A--ATCTGAG CAACTTA---
Neochromadora_BHMM_2005          C---CA---- ---------- ---------- TTAATTGGTG A--ATCTGAA TAACTAC---
Spilophorella_paradoxa           C---CA---- ---------- ---------- TTCCTTGGTG A--ATCTGAA TAACTAC---
Paracanthonchus_caecus           T---CCG--- ---------- ---------- TAGTTTGGTG A--ATCTGAA TAACTCA---
Paracyatholaimus_intermedius     C---CCG--- ---------- ---------- TCGTTTGGTG A--ATCTGAA TAACTCA---
Praeacanthonchus_punctatus       C---CCG--- ---------- ---------- TCGTTTGGTG A--ATCTGAA TAACTCA---
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- -mmmmmmmmm m--mmmmmmm mmmmmm----
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         370        380        390        400        410        420
Praeacanthonchus_sp              C---CCG--- ---------- ---------- TCTTTTGGTG A--ATCTGAA TAACTCA---
Cyatholaimus_sp._BHMM_2005       T---CCG--- ---------- ---------- TAGTTTGGTG A--ATCTGAA TAACTCA---
Spirinia_parasitifera            ----CTG--- ---------- ---------- TAATCTGGTG A--CTCTGAA TAACTTT---
Acanthopharynx_micans            C---CTA--- ---------- ---------- GTATCTGGTG A--CTCTGAA TAACTTT---
Xyzzors_sp                       ----CTG--- ---------- ---------- GAATCTGGTG A--CTCTGAA TAACTTT---
Metachromadora_sp                ----CTG--- ---------- ---------- ACTTTTGGTG A--CTCTGAA TAACTTT---
Metachromadora_remanei           ----CTG--- ---------- ---------- ACTTTTGGTG A--CTCTGAA TAACTTT---
Catanema_sp                      C---TCG--- ---------- ---------- TACTTTGGTG A--CTCTGAA TAACTTT---
Eubostrichus_dianae              T---CTG--- ---------- ---------- TTTTCTGGTG A--TTCTGAA TAACTCT---
Eubostrichus_topiarus            C---CTG--- ---------- ---------- TTTTTTGGTG A--ATCTGAA TAACTCT---
Eubostrichus_parasitiferus       C---CTG--- ---------- ---------- CCGTTTGGTG A--CTCTGAA TAACTGT---
Laxus_oneistus                   ----CTG--- ---------- ---------- TGATTTGGTG A--CTCTGAA TAACTGT---
Laxus_cosmopolitus               ----CTG--- ---------- ---------- TGATTTGGTG A--CTCTGAA TAACTGT---
Leptonemella_sp                  ----CCG--- ---------- ---------- TTGTTTGGTG A--CTCTGAA TAACTAT---
Robbea_hypermnestra              ----CTG--- ---------- ---------- TGATCTGGTG A--CTCTGAA TAACTTT---
Stilbonema_majum                 T---CTG--- ---------- ---------T ACTTTTGGTG A--CTCTGAA TAACTGT---
Monoposthia_costata              T---CGC--- ---------- ---------- TGATCCGATG A--TTCATGA TAACTCG---
Nudora_bipapillata               C---CCG--- ---------- ---------- TTTGTTGGTG A--ATCTGAG TAATTGT---
Calomicrolaimus_parahonestus     ----CCG--- ---------- ---------- TTGTTTGGTG A--ATCTGAA TAACTCC---
Calomicrolaimus_sp._BHMM_2005    ----CCG--- ---------- ---------- TTGTTTGGTG A--ATCTGAA TAACTCC---
Molgolaimus_demani               ----CCG--- ---------- ---------- TTGTTTGGTG A--ATCTGAA TAACTCC---
Diplogaster_lethieri             ---------- ---------- ---------- CCACTTGATG A--CTCTGAA TATTTTT---
Aduncospiculum_halicti           ----A----- ---------- ---------- TGTTTTGGTG A--CTCTGAA TAATTC----
Pristionchus_lheritieri          ---------- ---------- ---------- CCACTTGATG A--CTCTGAA TATTTTT---
Pristionchus_pacificus           ---------- ---------- ---------- CCTTTTGGTG A--CTCTGAA TAATTTT---
Pristionchus_pacificus           ---------- ---------- ---------- CCTTTTGGTG A--CTCTGAA TAATTTT---
Sabatieria_punctata_STRAIN_343   ---CCTG--- ---------- ---------- TTCGTTGGTG A--CTCTGAA TAACTCT---
Sabatieria_sp._355_BHMM_2005     ---CCTG--- ---------- ---------- TTCGTTGGTG A--CTCTGAA TAACTCT---
Sabatieria_celtica               ---CCCC--- ---------- ---------- TCGGTTGGTG A--CTCTGAA TAACTAC---
Sabatieria_punctata_STRAIN_200   ---CCCG--- ---------- ---------- TCCGTTGGTG A--CTCTGAA TAACTAC---
Sabatieria_punctata_STRAIN_223   ---CCCG--- ---------- ---------- TCCGTTGGTG A--CTCTGAA TAACTAC---
Sabatieria_sp._210_BHM_2005      ---CCCG--- ---------- ---------- TCCGTTGGTG A--CTCTGAA TAACTAC---
Setosabatieria_hilarula          ---CCC---- ---------- ---------- TCGGTTGGTG A--CTCTGAA TAACTAC---
Desmolaimus_zeelandicus          ---ACT---- ---------- ---------- GTATTTGGTG A--ATCTGAA TAACTCA---
Terschellingia_longicaudata      ---CG----- ---------- ---------- CTGTTTGGTG A--ATCTGAA TAACCCA---
Cyartonema_elegans               ---CG----- ---------- ---------- TCAGTTGGTG A--ATCTGAA TAACCCG---
Tridentulus_sp                   ---ACCG--- ---------- ---------- TTCTTTGGTG A--CTCTGAA TAACTGA---
Diplolaimelloides_meyli          ---CCG---- ---------- ---------- TACTTTGGTG A--CTCTGGA TAACATC---
Diplolaimella_diavengatensis     ---CCG---- ---------- ---------- TGTTTTGATG A--CTCTGAA TAATCCA---
Geomonhystera_disjuncta          ---CCGT--- ---------- ---------- TAACTTGGTG A--CTCTGAA TAACTCA---
Sphaerolaimus_hirsutus           ---CTGT--- ---------- ---------- CACATTGGTG A--ATCTGAA TAACTGA---
Theristus_acer                   ---GCAGC-- ---------- ---------- AAGTTTGGTG A--CTCTGAA TAACTCA---
Daptonema_procerus               ---CTG---- ---------- ---------- TTCACTGGTG A--ATCTGAA TAACTAC---
Daptonema_hirsutum               ---CG----- ---------- ---------- TTTTCTGGTG A--ATCTGAA TAACTAC---
Daptonema_normandicum            ---ACTG--- ---------- ---------- TGGTTTGGTG A--ATCTGAA TAACTGA---
Daptonema_oxycerca               ---CTG---- ---------- ---------- TTCACTGGTG A--ATCTGAA TAACTAC---
Daptonema_setosum                ---CCG---- ---------- ---------- TTTTCTGGTG A--ATCTGAA TAACTAC---
Desmodora_communis               ---CTG---- ---------- ---------- TAATCTGGTG A--CTCTGAA TAACTTA---
Desmodora_ovigera                T---CTG--- ---------- ---------- TAATTTGGTG A--CTCTGAA TAACTTT---
Metadesmolaimus_sp               ---CG----- ---------- ---------- TTTTCTGGTG A--ATCTGAA TAACTAC---
Dentostomella_sp                 ---CTCG--- ---------- ---------- TGTTTTGGTG A--CTCTGAA TACCTATA--
Bunonema_franzi                  ---CG----- ---------- ---------- TGTTTTGTTG A--CTCTGAA TAACCAT---
Bunonema_sp                      ---CG----- ---------- ---------- TCTTGTGTTG A--CTCTGGA TAACATGGA-
Seleborca_complexa               --CTG----- ---------- ---------- TTTATGGTTG A--CTCATAG TAACTGA---
Acrobeloides_nanus               --CTG----- ---------- ---------- TTTCTGGTTG A--CTCATAG TAACTGA---
Acrobeloides_bodenheimeri        --CTG----- ---------- ---------- TTTCTGGTTG A--CTCATAG TAACTGA---
Acrobeloides_sp_PS1146           --CTG----- ---------- ---------- TTTATGGTTG A--CTCATAG TAACTGA---
Acrobeles_ciliatus               --CTG----- ---------- ---------- TTTTCGGTTG A--CTCAAAA TAACTAA---
Acrobeles_sp_PS1156              --CTG----- ---------- ---------- TTTTCGGTTG A--CTCAAAA TAACTAA---
Acrobeles_complexus_WCUG2        --CTG----- ---------- ---------- TTTTCGGTTG A--CTCAAAA TAACTAA---
Cephaloboides_sp_SB227           ---------- ---------- ---------- -CGTTTGTTG A--CTCTGAA TATCGTA---
Cephalobus_cubaensis             --CCG----- ---------- -------TCT CAACTGGTTG A--CTCATAG TAACTGA---
Cephalobus_sp._PS1143            --CTG----- ---------- ---------- TTTCTGGTTG A--CTCATAG TAACTGA---
Cephalobus_sp._PS1196            --CTG----- ---------- ---------- TTTCTGGTTG A--CTCATAG TAACTGA---
Cephalobus_oryzae_PS1165         --CTG----- ---------- ---------- TTTCTGGTTG A--CTCATAG TAACTGA---
Cervidellus_alutus               --CTG----- ---------- ---------- TTTCTGGTTG A--CTCATAG TAACTGA---
Pseudacrobeles_variabilis        --CTG----- ---------- ---------- TTTTCGGTTG A--CTCATAG TAACTGA---
Triligulla_aluta                 --CTG----- ---------- ---------- TTTCTGGTTG A--CTCATAG TAACTGA---
Zeldia_punctada                  --CTG----- ---------- ---------- TTTCTGGTTG A--CTCATAG TAACTGA---
Myolaimus_sp_U81585              --CCG----- ---------- ---------T TGTTTGGT-G A--CTCTGAA TAACTCC---
Rhabditophanes_sp._KR3021        ---------- ---------- ---------G AAATTGGTTG A--CTCAAAA TATCTTT---
Brevibucca_sp._SB261             --CG------ ---------- --------TT TGCTTAGGTG A--CTCTGAA TATGTCT---
Halicephalobus_gingivalis        --C------- ---------- ---------- ATTTATGTTA A--CTCTAGA TAATGCT---
Panagrobelus_stammeri            --G------- ---------- ---------- TTTTTTGTTG A--CTCTGAA TAATTCC---
Plectonchus_sp._PDL0025          --G------- ---------- ---------- TTTTTTGTTG A--CTCTGAA TAATTCC---
Turbatrix_aceti                  --TC------ ---------- ---------- GGTTTTGTTA A--CTCTGGA TAATGTT---
Panagrellus_redivivus            ---------- ---------- ---------- GATTTTGTTG A--CTCGGAA TAATTATTAC
Panagrellus_redivivus_PS1163     ---------- ---------- ---------- GATTTTGTTG A--CTCGGAA TAATTATTAC
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- -mmmmmmmmm m--mmmmmmm mmmmmm----
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                                  ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                          370        380        390        400        410        420
Panagrolaimus_subelongatus        --AATG---- ---------- ---------- TTTTGTGTTG A--AKCTGAA TATATCAT--
Panagrolaimus_davidi              G-ATG----- ---------- ---------- TTTTGTGTTG A--AACTGAA TATATCAT--
Panagrolaimus_cf_rigidus_AF40     G-ATG----- ---------- ---------- TTTTGTGTTG A--ACCTGAA TATATCT---
Panagrolaimus sp. Sourhope ED2    G-ATTG---- ---------- ---------- TTTAGTGTTG A--ATCTGAA TATATCT---
Panagrolaimus sp. Sourhope ED2    G-ATTG---- ---------- ---------- TTTAGTGTTG A--ATCTGAA TATATCT---
Panagrolaimus sp. Sourhope ED2    G-ATTG---- ---------- ---------- TTTAGTGTTG A--ATCTGAA TATATCT---
Panagrolaimus sp. Sourhope ED2    G-AATG---- ---------- ---------- TTTAGTGTTG A--ACCTGAA TATATCT---
Panagrolaimus sp. Sourhope ED2    G-AATG---- ---------- ---------- TTTAGTGTTG A--ACCTGAA TATATCT---
Steinernema_carpocapsae           --TCG----- ---------- --------TT TATGTTGGTG A--CTCTTAG TAACTTT---
Strongyloides_stercoralis         ---------- ---------- ---------G CTCCTTGGTG A--TTCATAA TAACTTC---
Strongyloides_ratti               ---------- ---------- ---------- -------TTG A--CTCAAAA TATCCTC---
Diploscapter_sp_PS1897            -GACG----- ---------- ---------- TATTGTGGCG A--CTCCAAA TAGCCCA---
Diploscapter_sp_PS2017            -GACG----- ---------- ---------- TATTGTGGCG A--CTCCAAA TAGCCCA---
Heterorhabditis_bacteriophora     --ACG----- ---------- ---------- TAGTTTGTTG A--CTCTGAA TAACGCA---
Heterorhabditis_hepialus          --ACG----- ---------- ---------- TAGTTTGTTG A--CTCTGAA TAACGCA---
Heterorhabditis_zelandica         --ACG----- ---------- ---------- TAGTTTGTTG A--CTCTGAA TAACGCA---
Parasitorhabditis_sp_SB281        --CG------ ---------- ---------- TAAAGTGATG A--ATCTGAA TATCTT----
Rhabditoides_inermiformis         --TCG----- ---------- ---------T TTGTTTGTTG A--CTCTGAA TAACTCA---
Rhabditoides_inermis_DF5001       --GAT----- ---------- ---------- ---ACTGGTG A--CTCTGAA TAACCCA---
Rhabditoides_regina_DF5012        ---------- ---------- ---------- TTGAGTGATG A--CTCTGAT TATCTTG---
Poikilolaimus_oxycerca_SB200      --CCG----- ---------- ---------- TTTGTTGTTG A--CTCTGAA TAACTTA---
Poikilolaimus_regenfussi_SB199    --CCG----- ---------- ---------- TTTGTTGTTG A--CTCTGAA TAACTCA---
Distolabrellus veechi DWF1604     --C-G----- ---------- ---------- TGTAGTGATG A--CTCTGAA TATCTC----
Distolabrellus veechi DF5024      --C-G----- ---------- ---------- TATAGTGATG A--CTCTGAA TATCTC----
Choriorhabditis_dudichi           --GAG----- ---------- ---------G ACGTTTGTTG A--CTCTGAA TAACCTA---
Protorhabditis_sp                 --ACG----- ---------- ---------- TATTGTGGCG A--CTCCAAA TAGCGCA---
Protorhabditis_sp_DF5055          --AGG----- ---------- ---------- TTTTGTGTTG A--ATCTGAG TAAAGTTC--
Cruznema_tripartitum_DF5015       --ACG----- ---------- ---------- TAGTTTGTTG A--CTCTGAG TAATGCA---
Mesorhabditis_sp_PS1179           ---CG----- ---------- ---------- TCAAGTGATG A--TTCTGAA TATCTT----
Mesorhabditis_spiculigera_SB15    --CAACG--- ---------- -----GTTGT TTCGGTGATG A--TTCTGAA TAACTC----
Mesorhabditis_anisomorpha_SB12    ---CG----- ---------- ---------- TTGAGTGATG A--TTCTGAA TGTCTT----
Teratorhabditis_palmarum_DF501    ---CG----- ---------- ---------- TTTTGTGTTG A--CTCTGAA TATTTT----
Teratorhabditis_synpapillata_S    ---CG----- ---------- ---------- TTTTGTGTTG A--CTCTGAA TATTTT----
Caenorhabditis_briggsae_PB102     --ACG----- ---------- ---------- TTGTTTGTTG A--CTCTGAA TAAAGCA---
Caenorhabditis_elegans_N2         --ACG----- ---------- ---------- TTGTTTGTTG A--CTCTGAA TAAAGCA---
Caenorhabditis_sp_CB5161          --ACG----- ---------- ---------- TTGTTTGTTG A--CTCTGAA TAAAGCA---
Caenorhabditis_sp_PS1010          --ACG----- ---------- ---------- TAGTTTGTTG A--CTCTGAA TAAAGCA---
Caenorhabditis_japonica           --ACG----- ---------- ---------- TTGTTTGTTG A--CTCTGAA TACCGTC---
Caenorhabditis_sp_DF5170          --ACG----- ---------- ---------- TAATTTGTTG A--CTCTGAA TAAAGCA---
Caenorhabditis_sp_SB341           --ACG----- ---------- ---------- TTGACTGTTG A--CTCTGAA TAATGCA---
Caenorhabditis_plicata            --ACG----- ---------- ---------- TTTTGTGTTG A--CTCTGAA CAATCCC---
Caenorhabditis_vulgaris           --ACG----- ---------- ---------- TTGTTTGTTG A--CTCTGAA TAAAGCA---
Caenorhabditis_sonorae            --ACG----- ---------- ---------- TTGACTGTTG A--CTCTGAA TAAAGCA---
Caenorhabditis_drosophilae        --ACG----- ---------- ---------- TAATTTGTTG A--CTCTGAA TAAAGCA---
Phasmarhabditis_hermaphrodita     --GCG----- ---------- ---------- TAGTTTGTTG A--CTCTGAA TACCTAG---
Phasmarhabditis_neopapillosa      --GCG----- ---------- ---------- TAGTTTGTTG A--ATCTAAA TACCTAG---
Phasmarhabditis_neopapillosa      --ACG----- ---------- ---------- TAGTTTGTTG A--CTCTGAA TACCGTA---
Pellioditis_mediterranea_SB173    --ACG----- ---------- ---------- TAGTTTGTTG A--CTCTGAA TACCGTA---
Pedllioditis marina               --ACG----- ---------- ---------- TAGTTTGTTG A--CTCTGAA TACCGTA---
Prodontorhabditis_wirthi          --CGG----- ---------- ---------- ACTGTG-TTG A--CACTGAA TAACGCTC--
Crustorhabditis_scanica           --GTW----- ---------- ---------- AAGTGATGAC T--CTGGATA TCTTGYA---
Dolichorhabditis_sp_CEW1          --ACG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TACC-CA---
Oscheius_sp_DF5000                --ACG----- ---------- ---------- TAGTTTGTTG A--CTCTGAA TACCCAG---
Oscheius_sp_BW282                 --ACG----- ---------- ---------- TTGTTTGTTG A--CTCTGAA TATCGCA---
Oscheius_myriophila_EM435         --ACG----- ---------- ---------- TTGTTTGTTG A--CTCTGAA TATCGCA---
Oscheius_insectivora              --ACG----- ---------- ---------- TTGTTTGTTG A--CTCTGAA TAACGTA---
Oscheius_dolichuroides            --ACG----- ---------- ---------- TAGTTTGTTG A--CTCTGAA TACCCA----
Rhabditis_blumi_DF5010            --GCG----- ---------- ---------- TTGTTTGTTG A--CTCTGAA TAACGTA---
Rhabditis_sp_PS1191               --ACG----- ---------- ---------- TAGTTTGTTG A--CTCTGAA TAACTCC---
Rhabditis_sp_PS1010               --ACG----- ---------- ---------- TAGTTTGTTG A--CTCTGAA TAAAGCA---
Rhabditis_myriophila_EM435        --ACG----- ---------- ---------- TTGTTTGTTG A--CTCTGAA TATCGCA---
Rhabditis_colombiana              --ACG----- ---------- ---------- TAGTTTGTTG A--CTCTGAA TAACGCT---
Rhabditella_axei_DF5006           --ACG----- ---------- ---------- AAGTTTGTTG A--CTCTGAA TATCGTA---
Rhabditella_sp_DF5044             --ACG----- ---------- ---------- AAGTTTGTTG A--CTCTGAA TATCGTA---
Cuticularia_sp_PS2083             --CCG----- ---------- ---------- TTTGTTGTTG A--CTCTGAA TAACTTA---
Necator_americanus                --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTAAA TAACGCT---
Kalicephalus_cristatus            --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCT---
Ancylostoma_caninum               --GTG----- ---------- ---------- TAGTTTGCTG A--CTCTAAA TAACGCT---
Angiostrongylus_cantonensis       --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Angiostrongylus_costaricensis     --ATG----- ---------- ---------- CAGTTTGCTG A--CTCTGAA TAACGCA---
Angiostrongylus_malaysiensis      --ATG----- ---------- ---------- CAGTTTGCTG A--CTCTGAA TAACGCA---
Angiostrongylus_dujardini         --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Angiostrongylus_vasorum           --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Aulurostrongylus_abstrusus        --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Didelphostrongylus_hayesi         --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Crenosoma_mephitidis              --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Crenosoma_vulpis                  --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Otostrongylus_circumlitus         --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
NUCLEOTIDES INCLUDED              ---------- ---------- ---------- -mmmmmmmmm m--mmmmmmm mmmmmm----
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         370        380        390        400        410        420
Troglostrongylus_wilsoni         --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Filaroides_martis                --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Oslerus_osleri                   --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Parafilaroides_decorus           --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Metastrongylus_salmi             --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Metastrongylus_elongatus         --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Skrjabingylus_chitwoodrum        --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Parelaphostrongylus_odocoilei    --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Muelerius_capillaris             --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Protostrongylus_rufescens        --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Halocercus_invaginatus           --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Pseudalius_inflexus              --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Stenurus_minor                   --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Torynurus_convolutus             --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Syngamus_trachea                 --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCC---
Stephanurus_dentatus             --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTAAA TAACGCT---
Nematodirus_battus               --GTG----- ---------- ---------- CTGTTTGCTG A--CTCTGAA TAATGCA---
Strongylus_equinus               --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTAAA TAACGCT---
Labiostrongylus_bipapillosus     --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTAAA TAACGCT---
Petrovinema_poculatum            --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTAAA TAACGCT---
Cylicocyclus_insignis            --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTAAA TAACGCT---
Chabartia_ovina                  --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTAAA TAACGCT---
Cyclodontostomum_purvisi         --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTAAA TAACGCT---
Zoniolaimus_mawsonae             --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTAAA TAACGCT---
Hypodontus_macropi               --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTAAA TAACGCT---
Deletrocephalus_dimidiatus       --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTAAA TAACGCT---
Dictyocaulus_eckerti_P7B8        --ATG----- ---------- --------TA TAGTTTGCTG A--CTCTGAA TAACGCA---
Dictyocaulus_capreolus_P3B2      --ATG----- ---------- --------TA TAGTTTGCTG A--CTCTGAA TAACGCA---
Dictyocaulus_sp._P6A1            --ATG----- ---------- --------TA TAGTTTGCTG A--CTCTGAA TAACGCA---
Dictyocaulus_filaria             --ATG----- ---------- -------CAA AAGTTTGCTG A--CTCTGAA TAACGCA---
Dictyocaulus_capreolus_P2C10     --ATG----- ---------- --------TA TAGTTTGCTG A--CTCTGAA TAACGCA---
Dictyocaulus_viviparus           --ATG----- ---------- --------TA TAGTTTGTTG A--CTCTGAA TAACGCA---
Haemonchus_sp._V3091             --GTG----- ---------- ---------- CAGTTTGCTG A--CTCTGAA TAACGCA---
Haemonchus_contortus             --GTG----- ---------- ---------- CAGTTTGCTG A--CTCTGAA TAACGCA---
Haemonchus_placei                --GTG----- ---------- ---------- CAGTTTGCTG A--CTCTGAA TAACGCA---
Haemonchus_similis               --GTG----- ---------- ---------- CAGTTTGCTG A--CTCTGAA TAACGCA---
Ostertagia_ostertagi             --ATG----- ---------- ---------- AAGTTTGCTG A--CTCTGAA TAACGCA---
Ostertagia_leptospicularis       --ATG----- ---------- ---------- AAGTTTGCTG A--CTCTGAA TAACGCA---
Nippostrongylus_brasileinsis     --ATG----- ---------- ---------- TTGTTTGCTG A--CTCTGAA TAACGCA---
Heligmosomoides_polygyrus        --ATG----- ---------- ---------- CTGTTTGCTG A--CTCTGAA TAACGCA---
Trichostrongylus_colubriformis   --GTG----- ---------- ---------- CTGTTTGCTG A--CTCTGAA TAACGCA---
Tetrabothriostrongylus mackerr   --GTG----- ---------- ---------- TTGTTTGCTG A--CTCTGAA TAACGCA---
Herpestrongylus_pythonis         --GTG----- ---------- ---------- CTGTTTGCTG A--CTCTGAA TAACGCA---
Nicollina_cameroni               --GTG----- ---------- ---------- CTGTTTGCTG A--CTCTGAA TAACGCA---
Filarimena_flagrifer             --GTG----- ---------- ---------- CTGTTTGCTG A--CTCTGAA TAACGCA---
Amidostomum_cygni                --GTG----- ---------- ---------- CTGTTTGCTG A--CTCTGAA TAACGCA---
Teratocephalus_lirellus          --CTC----- ---------- ---------- GCCGTTGGTG A--CTCTGAA TAACTCA---
Brumptaemilius_justini           C-CCG----- ---------- ---------- TCTCTTGGTG A--CTCTGAA TAGCTTCA--
Anguillicola_crassus             C-TCG----- ---------- ---------- TAAGTTGGTG A--CTCTGAA TAACTTAT--
Dracunculus_medinensis           C-TCGT---- ---------- ---------- CTAATTGGTG A--CTCTGAA TAGCTTA---
Dracunculus_oesophageus          T-TCG----- ---------- ---------- TTAATTGGTG A--CTCTGAA TAGCTTA---
Dracunculus_sp._V3104            C-TCG----- ---------- ---------- TTAATTGGTG A--CTCTGAA TAGCTTA---
Philonema_sp_A                   C-TCG----- ---------- ---------- TCAATTGGTG A--CTCTGAA TAGCTCA---
Philometra_obturans              TCTCG----- ---------- ---------T CAATTTGGTG A--CTCTGAA TAGCTTA---
Camallanus_oxycepahalus          ATTCGTGCTC GAAC------ ---TTCTCGT AACTTTGGTG A--CTCTGAA TAGCTTA---
Acanthocheilonema_viteae         ACCCG----- ---------- ---------- TAAATTGGTG A--CTCTGAA TAGCTATG--
Loa_loa                          C-CCG----- ---------- ---------- TTAATTGGTG A--CTCTGAA TAGCTATG--
Onchocerca_cervicalis            C-CCG----- ---------- ---------- TTAATTGGTG A--CTCTGAA TAGCTATG--
Dirofilaria_immitis              T-CCG----- ---------- ---------T TAATTTGGTG A--CTCTAAA TAGCTATA--
Brugia_malayi                    ATCCG----- ---------- ---------- TTAATTGGTG A--CTCTGAA TAGCTATG--
Wuchereria_bancrofti             --CCG----- ---------- ---------- TTAATTGGTG A--CTCTGAA TAGCTATG--
Litomosoides_sigmodontis         ACCCG----- ---------- --------TT CAGATTGGTG A--CTCTGAA TAGCTATT--
Setaria_digitata                 C-CCG----- ---------- ---------- TTAATTGGTG A--CTCTGAA TAGCTATG--
Gnathostoma_turgidum             C-TCG----- ---------- ---------- GTTGTTGGTG A--CTCTGAA TAACTACG--
Gnathostoma_neoprocyonis         C-TCG----- ---------- ---------- GTTGTTGGTG A--CTCTGAA TAACTACG--
Gnathostoma_binucleatum          C-TCG----- ---------- ---------- GTTGTTGGTG A--CTCTGAA TAACTACG--
Physaloptera_alata               C-CCG----- ---------- ---------- TCACTTGGTG A--CTCTGAA TAGCTATG--
Physaloptera_turgida             C-CCG----- ---------- ---------- TCATTTGGTG A--CTCTGAA TAGCTATG--
Ascarophis_arctica               C-TCG----- ---------- ---------- TCAATTGGTG A--CTCTGAA TAGCTATG--
Spinitectus_carolini             AACGGTTTGC CG-------- ---------- TTAATTGGTG A--CTCTGAA TAGCTCA---
Thelazia_lacrymalis              CAAATAAGCT CGCAAAAAA- ---------- AAAATTGGTG A--ATCTGAA TAGCTATA--
Aphelenchus_avenae               G-CCG----- ---------- ---------- TCTACCACTG A--CTTAAAG TAACTAA---
Aphelenchoides_fragariae         ---------- ---------- ---------- GTTTATGCTA A--CTCTGGG TAACACT---
Bursaphelelenchus_sp             ---------- ---------- ---------- CTGTTTGCTA A--CT-TGGA TAATTT----
Deladenus_sp                     --TCG----- ---------- ---------- TTTTTTGTTG A--CTCAGAA TAACTTA---
Criconema_sp                     --CCG----- ---------- ---------- -TTTTTGCTG A--CTCAGAA CAACTTA---
Hemicycliophora_conida           --TCG----- ---------- ---------- -TTCTTGCTG A--CTCAGAA TAACTAA---
Paratylenchus_dianthus           --CCG----- ---------- ---------- -TTTCTGTTG A--TTCAGAA TAACTAA---
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- -mmmmmmmmm m--mmmmmmm mmmmmm----
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                        370        380        390        400        410        420
Pratylenchus_thornei             --CCG----- ---------- ---------- TCCATTGTTG A--CTCAGAA TAACTAA---
Tylenchulus_semipentrans         --CCG----- ---------- ---------- -TTTTTGCTG A--CTCAGAA TAACTAA---
Ditylenchus_angustus             --CCG----- ---------- ---------- TGTTTTGTTG A--CTCAAAA TAACTCA---
Subanguina_radicola              --TCG----- ---------- ---------- TTTTTTGTTG A--CTCAGAA TAACTAA---
Tylenchorhynchus_maximus         --CCG----- ---------- ---------- TCCAATGTTG A--CTCAGAA TAACTAA---
Geocenamus_quadrifer             --CCG----- ---------- ---------- TCCGCAGTTG A--CTCAGAA TAACTAA---
Globodera_pallida                --GCG----- ---------- ---------- TCCAGTGTTG A--CTCAGAA CAACTAA---
Scutellonema_bradys              --TCG----- ---------- ---------- TTCAGTGTTG A--ACCAGAA CAACTAA---
Helicotylenhcus_dihystera        --GCG----- ---------- ---------- TCCATTGCTG A--ACCAGAA CAACTCA---
Rotylenchus_robustus             --GCG----- ---------- ---------- TTCAGTGTTG A--CTCAGAA TAACTAA---
Meloidogyne_arenaria             --CTG----- ---------- ---------- CTTCTTGTTG A--CTCAGAA TAACTTA---
Meloidogyne_incognita_KT         --CTG----- ---------- ---------- CTTCTTGTTG A--CTCAGAA TAACTTA---
Meloidogyne_javanica             --CTG----- ---------- ---------- CTTYTTGTTG A--CTCAGAA TAACTWA---
Meloidogyne_artiellia            --CTGTCAA- ---------- ---------- ACGTTTGTTG A--CTCAGAA TAACTAA---
Meloidogyne_duytsi               --CTG----- ---------- ---------- CTTCTTGTTG A--CTCAGAA TAACTAA---
Meloidogyne_exigua               --CTG----- ---------- ---------- CCTTTTGTTG A--CTCAGAA TAACTAA---
Meloidogyne_hapla                --CTG----- ---------- ---------- CTTCTTGTTG A--CTCAGAA TAACTAA---
Meloidogyne_ichinohei            --CTG----- ---------- ---------- TTCATTGTTG A--CTCAGAA TAACTCA---
Meloidogyne_maritima             --CTG----- ---------- ---------- CTTCTTGTTG A--CTCAGAA TAACTAA---
Meloidogyne_microtyla            --CTG----- ---------- ---------- CTTCTTGTTG A--CTCAGAA TAACTAA---
Nacobbus_aberrans                --CCG----- ---------- ---------- TCCACTGTTG A--ACCAGAA TAACTAA---
Pratylenchoides_ritteri          --CCG----- ---------- ---------- TTCGCAGTTG A--CTCAGAA TAACTAA---
Pratylenchoides_magnicauda       --CCG----- ---------- ---------- TTCGCAGTTG A--CTCAGAA TAACTAA---
Hirschmanniella_sp._JH_2003      --CCG----- ---------- ---------T CCATGAGTTG A--CTCAGAA TAACTAA---
Radopholus_similis               --GGG----- ---------- ---------- TTGAGTGTTG A--ATCAGAG CAACTAA---
Pratylenchus_goodeyi_VF          --CCG----- ---------- ---------- TCCATTGTTG A--CTCAGAA TAACTAA---
Boleodorus_thylactus_clone2      A-CGG-TGCT CG-------- ---------- TGATTTGTTG A--CTCAGAA TAACTAA---
Philippine Sequence 1            --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Philippine Sequence 2            --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Philippine Sequence 3            --ACG----- ---------- ---------- -CGGCTGTTG A--CTCTGAA TAACGCT---
Philippine Sequence 4            --ATG----- ---------- ---------- TTTTGTGTTG A--AACTGAA TATATCT---
Philippine Sequence 5            --GTG----- ---------- ---------- TAGTTTGCTG A--CTCTAAA TAACGCT---
Philippine Sequence 6            --ACG----- ---------- ---------- TTGTTTGTTG A--CTCTGAA TATCGTA---
Philippine Sequence 7            --ACG----- ---------- ---------- TTGTTTGTTG A--CTCTGAA TAAAGCA---
Tahiti Sequence 1                --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Tahiti Sequence 2                --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Thailand Sequence 1              ---CCTG--- ---------- ---------- TTCATTGGTG A--CTCTGAA TAGCTTA---
Ogasawara Sequence 1             --ATG----- ---------- ---------- TTTAGTGTTG A--AACTGAA TATATCT---
Ogasawara Sequence 2             --GCG----- ---------- ---------- TTGTTTGTTG A--CTCTGAA TACCAAG---
Ivory Coast Sequence 1           --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Ivory Coast Sequence 2           --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Ivory Coast Sequence 3           --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Ivory Coast Sequence 4           --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Ivory Coast Sequence 5           ---CCTG--- ---------- ---------- TTCATTGGTG A--CTCTGAA TAGCTTA---
Ivory Coast Sequence 6           --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Ivory Coast Sequence 7           --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Singapore Sequence 1             --ACG----- ---------- ---------- -CGGCTGTTG A--CTCTGAA TAACGCT---
Singapore Sequence 2             ---CCTG--- ---------- ---------- TTCATTGGTG A--CTCTGAA TAGCTTA---
Singapore Sequence 3             --ACG----- ---------- ---------- TTGTTTGTTG A--CTCTGAA TAAAGCA---
Singapore Sequence 4             --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Nigerian Sequence 1              --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
Nigerian Sequence 2              --GTG----- ---------- ---------- TAGTTTGCTG A--CTCTAAA TAACGCT---
Nigerian Sequence 3              --ATG----- ---------- ---------- TAGTTTGCTG A--CTCTGAA TAACGCA---
NUCLEOTIDES INCLUDED             ---------- ---------- ---------- -mmmmmmmmm m--mmmmmmm mmmmmm----
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                        430        440        450        460        470        480
Gordius_aquaticus                GCCGATCGCA --CGGTCTC- -GT-ACCGGC GACGTATCT- TTC--AAATG TCTGC-CTTA
Priapulus_caudatus               GCTGATCGCA --CGGTCTC- -GC-ACCGGC GACGTATCT- TTC--AAATG TCTGC-CTTA
Brachionus_plicatilis            GCTGATCGCA --TGGCCTA- -GA-GCCGGC GACGTATCT- TTC--AAGTG TCTGC-CCTA
Chordodes_morgani                GCCGATCGCA --TGGTCTC- -GT-ACCGGC GACGTATCT- TTC--AAATG TCTGC-CTTA
Paractinolaimus_macrolaimus      GCCAATCGCA --CAGTCCTA -GT-ACTGGC GATGTATCT- TTC--AAGTG TCTGC-CTTA
Aporcelaimellus_obtusicaudatus   GCCAATCGCA --CAGTCCTA -GT-ACTGGC GATGTATCT- TTC--AAGTG TCTGC-CTTA
Wilsonema_schuurmansstekhoveni   GCTGATCGCA --TGGTCTTT -GT-ACCGGC GACGTATCT- TTC--AAGTG TCTGC-CTTA
Mesodorylaimus_sp_cf_nigritul    GCCAATCGCA --CAGTCCTA -GC-ACTGGC GATGTATCT- TTC--AAGTG TCTGC-CTTA
Mesodorylaimus_bastiani          GCCAATCGCA --CAGTCCTA -GT-ACTGGC GATGTATCC- TTC--AAATG TCTGC-CTTA
Mesodorylaimus_japonicus         GCCAATCGCA --CAGTCCTA -GT-ACTGGC GATGTATCT- TTC--AAGTG TCTGC-CTTA
Pungentus_sp._PDL_2005           GCCAATCGCA --CAGTCCTA -GT-ACTGGC GATGTATCT- TTC--AAGTG TCTGC-CTTA
Allodorylaimus_sp                GCCAATCGCA --CAGTCCTA -GT-ACTGGC GATGTATCT- TTC--AAGTG TCTGC-CTTA
Eudorylaimus_carteri             GCCAATCGCA --CAGTCCTA -GT-ACTGGC GATGTATCT- TTC--AAGTG TCTGC-CTTA
Microdorylaimus_sp               GCCAATCGCA --CAGTCCTA -GT-ACTGGC GATGTATCT- TTC--AAGTG TCTGC-CTTA
Longidorus_elongatus             GCTGATCGCA --CGGTC-TA -GT-ACCGGC GAMGTATCT- TTC--AAGTG TCTGC-CTTA
Xiphinema_rivesi                 GCCGATCGCA --CGGTCCTA -GT-ACCGGC GACGTATCT- TTC--AAGTG TCTGC-CTTA
Tylencholaimus_sp                GCCAATCGCA --CGGTCCTA -GT-ACCGGC GATGTATCT- TTC--AAGTG TCTGC-CTTA
Anoplostoma_sp._BHMM_2005        G-TGATCGCA --CGGTCTTT -GT-ACCGGC GACATATCC- TTC--AAATG TCTGC-CTTA
Adoncholaimus_fuscus             GCTGATCGCA --CGGTCTAT -GC-ACCGGC GACATGTCT- TTC--AAACG TCTGC-CTTA
Enoplus_meridionalis             GTAGATCGCA --CGGTCCTC -GA-ACCGGC GACTCGTCA- TTC--AAATG TCTGC-CTTA
NUCLEOTIDES INCLUDED             mmmmmmmm-- ---------- ---------- ---------- -----mmmmm mmmmm-mmmm
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                        430        440        450        460        470        480
Enoplus_brevis_U88336            GCAGATCGCA --CGGTCCTC -GC-ACCGGC GACATGTCA- TTC--AAATG TCTGC-CTTA
Enoplus_communis                 GCAGATCGCA --CGGTCCTC -GC-ACCGGC GACATGTCA- TTC--AAATG TCTGC-CTTA
Enoploides_brunettii             GCTGATCGCA --CAGTCCTC -GT-ACTGGC GATGTATCT- TTC--AAATA TCTGC-CTTA
Syringolaimus_striatocaudatus    GCAGATCGCA --TGGTCTTT -GC-ACCGGC GACGTATCT- TTC--AAATG TCTGC-CTTA
Ironus_dentifurcatus             GCCGATCGAA --CGGTCTTT -GA-ACCGTC GACGTATCT- TTC--AAATG TCTGC-CTTA
Calyptronema_maxweberi           GCTGAACGAA --CGGTCTAA -GA-ACCGAC GTCATATCC- TTC--AAACG TCTGC-CTTA
Viscosia_sp._BHMM_2005           GCTGATCGCA --CGGTCCA- -GA-ACCGGC GACATATCC- TTC--AAATG TCTGC-CTTA
Viscosia_viscosa                 GCTGATCGCA --CGGTCTGA -GA-ACCGGC GACATATCC- TTC--AAATG TCTGC-CTTA
Pontonema_vulgare                NNNNAACGCA --CGGTCCGA -GT-ATTGGC GACATATCC- TTC--AAATG TCTGC-CTTA
Oncholaimus_sp._BHMM_2005        GCTGATCGCA --CGGTCTAA -GC-ACCGGC GACATATCC- TTC--AAATG TCTGC-CTTA
Alaimus_sp_PDL_2005              GCCGATCGCA ---GGTCCTC -GA-ACCGGC GACGTATCT- TTC--AAATG TCTGC-CTTA
Prismatolaimus_intermedius       GCAGATCGCA --CGGTCTC- -GT-ACCGGC GACGTATCT- TTC--AAATG TCTGC-CTTA
Tobrilus_gracilis                GCAGATCGCA --CGGTCTC- -GC-ACCGGC GACGCATCT- TTC--AAATG TCTGC-CTTA
Tripyla_cf_filicaudata_JH_2004   GCCGATCGCA --TGGTCTC- -GC-ACCGGC GACGCACCT- TTC--AAATG TCTGT-CTCA
Bathylaimus_sp                   GCAGATCGCA --CGGTCTA- -GC-ACCGGC GACGAATCT- TTC--AAATG TCTGC-CTTA
Bathylaimus_assimilis            GCAGATCGCA --CGGTCTA- -GC-ACCGGC GACGAATCT- TTC--AAATG TCTGC-CTTA
Bathylaimus_sp._BHMM_2005        GCAGATCGCA --CGGTCTA- -GT-ACCGGC GACGCATCT- TTC--AAATG TCTGC-CTTA
Tripyloides_sp._BHMM_2005        GCAGATCGCA --TGGTCTA- -GT-ACCGGC GACGCATCT- TTC--AAATG TCTGC-CTTA
Trischistoma_monohystera         GCCGATCGCA --TGGTCTAA -GT-ACCGGC GACGCATCT- TTC--AAATG TCTGC-CTTA
Mermis_nigrescens                GTTGATCGCA --CAGTCTC- -GC-ACTGGC GACGTATCT- TTC--AAATG TCTGC-CTTA
Mylonchulus_arenicolus           GTTGATCGCA --CAGTCTTA -GT-ACTGGC GACGTATCT- TTC--AAATG TCTGC-CTTA
Anatonchus_tridentacus           GTTGATCGCA --CAGTCTTA -GT-ACTGGC GACGTATCT- TTC--AAATG TCTGC-CTTA
Mononchus_truncatus              GTTGATCGCA --CAGTCTT- -GT-ACTGGC GACGTATCT- TTC--AAATG TCTGC-CTTA
Prionchulus_muscorum             GTCGATCGCA --CAGTCTTA -GT-ACTGGC GACGTATTT- TTC--AAATG TCTGC-CTTA
Clarkus_sp                       GTCGATCGCA --CAGTCTTA -GT-ACTGGC GACGTATTT- TTC--AAATG TCTGC-CTTA
Trichinella_spiralis             TCTGATCGCA --TGGTCTA- -GC-ACCGGC GACATCACT- TTC--AAGTG TCTGC-CTTA
Trichinella_papuae               TCTGATCGCA --TGGTCTA- -GC-ACCGGC GACATCACT- TTC--AAGTG TCTGC-CTTA
Trichinella_britovi              TCTGATCGCA --TGGTCTA- -GC-ACCGGC GACATCACT- TTC--AAGTG TCTGC-CTTA
Trichinella_murrelli             TCTGATCGCA --TGGTCTA- -GC-ACCGGC GACATCACT- TTC--AAGTG TCTGC-CTTA
Trichinella_pseudospiralis       TCTGATCGCA --TGGTCTA- -GC-ACCGGC GACATCACT- TTC--AAGTG TCTGC-CTTA
Trichinella_nativa               TCTGATCGCA --TGGTCTA- -GC-ACCGGC GACATCACT- TTC--AAGTG TCTGC-CTTA
Trichinella_zimbabwensis         TCTGATCGCA --TGGTCTA- -GC-ACCGGC GACATCACT- TTC--AAGTG TCTGC-CTTA
Trichinella_nelsoni              TCTGATCGCA --TGGTCTA- -GC-ACCGGC GACATCACT- TTC--AAGTG TCTGC-CTTA
Trichuris_suis                   GCTGATCGCA --CGGTCCA- -GC-ACCGGC GACGAACT-- TTG--AAATG ACTTG-CTCA
Trichuris_trichiura              GCTGATCGCA --CGGTCCA- -GT-ACCGGC GACGATGCT- TTG--AAACG ACTTG-CTCA
Trichuris_muris                  GCTGATCGCA --CGGTCCA- -GC-ACCGGC GACGAATCT- TTG--AAATG ACTTG-CTCA
Tylolaimophorus_minor            GCTGATCGCA --CGGTCTC- -GT-ACCGGC GACAAATCT- TTC--AAATG TCTGT-TTTA
Paratrichodorus_pachydermus      GCTGATCGCA --CAGTCTC- -GT-ACTGGC GACAAATCT- TTC--AAGTG TCTGC-CTTA
Paratrichodorus_anemones         GCTGATCGCA --CAGTCTC- -GT-ACTGGC GACAAATCC- TTC--AAGTG TCTGA-CTTA
Trichodorus_primitivus           GCTGATCGCA --CAGTCTC- -GT-ACTGGC GACAAATCT- TTC--AAGTG TCTGC-CTTA
Axonolaimus_helgolandicus        GTTGATCGCA --TGGTCTC- -GC-ACCGGC GACGTATCT- TCC--AAGTG TCTGC-CTTA
Ascolaimus_elongatus             GTTGATCGCA --TGGTCTC- -GC-ACCGGC GACGTATCT- TCC--AAGTG TCTGC-CTTA
Odontophora_rectangula           GCTGATCGCA --TGGTCTC- -GC-ACCGGC GACGTATCT- TCC--AAGTG TCTGC-CTTA
Cylindrolaimus_sp._202149        GCTGATCGCA --TGGTCTC- -GT-ACCGGC GACGTATCT- TCC--AAGTG TCTGC-CTTA
Tylocephalus_auriculatus         GCTGATCGCA --TGGTCTC- -GT-ACCGGC GACGTATCA- TTC--AAGTG TCTGC-CTTA
Plectus_acuminatus_BS9           GCTGATCGCA --TGGTCTTT -GT-ACCGGC GACGCATCT- TTC--AAGTG TCTGC-CTTA
Plectus_aquatilis                GCTGATCGCA --TGGTCTTT -GT-ACCGGC GACGCATCT- TTC--AAGTG TCTGC-CTTA
Anaplectus_sp                    GCTGATCGCA --TGGTCTTT -GT-ACCGGC GACGCATCT- TTC--AAGTG TCTGC-CTTA
Anisakis_sp_WKT                  GCTGATCGCA --TGGTCTT- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-C-TA
Anisakis_sp_Nadler               GCTGATCGCA --TGGTCTT- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Contracaecum_multipapillatum     GCTGATCGCA --TGGTCTT- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Pseudoterranova_decipiens        GCTGATCGCA --TGGTCTT- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Raphidascaris_acus               GCTGATCGCA --TGGTCTA- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Terranova_caballeroi             GCTGATCGCA --TGGTCTT- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Ascaris_suum                     GCTGATCGCA --TGGTCTC- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Ascaris_lumbricoides             GCTGATCGCA --TGGTCTC- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Baylisascaris_procyonis          GCTGATCGCA --TGGTCTC- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Baylisascaris_transfuga          GCTGATCGCA --TGGTCTC- -GA-ACCGGC GACATGTCT- ATC--AAGTG TCTGC-CTTA
Parascaris_equorum               GCTGATCGCA --TGGTCTC- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Porrocaecum_depressum            GCTGATCGCA --TGGTCTC- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Toxascaris_leonina               GCTGATCGCA --TGGTCTC- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Heterocheilus_tunicatus          GCTGATCGCA --TGGTCTC- -GC-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Goezia_pelagia                   GCTGATCGCA --TGGTCTC- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Hysterothylacium_fortalezae      GCTGATCGCA --TGGTCTC- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Hysterothylacium_pelagicum       GCTGATCGCA --TGGTCTA- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Hysterothylacium_reliquens       GCTGATCGCA --TGGTCTA- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Iheringascaris_inquies           GCTGATCGCA --TGGTCTA- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Toxocara_canis                   GCTGATCGCA --TGGTCCA- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Nemhelix_bakeri                  GCTGATCGCA --TGGTCTA- -GT-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Raillietnema_sp._V3060           GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Cruzia_americana                 GCTGATTGCA --TGGCCTC- -GC-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Heterakis_sp_14690               GCTGATCGCA --CGGTCTT- -GC-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Heterakis_gallinarum             GCTGATCGCA --TGGTCTT- -GA-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Paraspidodera_sp_21303           GCTGATCGCA --TGGTCTC- -GC-ACCGGC GACGYGTCT- ATC--AAGTG TCTGC-CTTA
Chromodora_nudicapitata          GCAGATCGCA --CGGTCTA- -GT-ACCGGC GACATATCC- TTC--ATGTG TCTGC-CTTA
Chromadora_sp._BHMM_2005         GCAGATCGCA --TGGGCTC- -GT-CCCGGC GACATATCC- TTC--AAGTG TCTGC-CTTA
Atrochromadora_microlaima        GCAGATCGCA --TGGGCTC- -GT-CCCGGC GACATATCC- TTC--AAGTG TCTGC-CTTA
Chromadorina_germanica           GCTGATCGCA --CGAGCTC- -GT-CTCGGC GACATATCC- TTC--AAGTG TCTGC-CTTA
NUCLEOTIDES INCLUDED             mmmmmmmm-- ---------- ---------- ---------- -----mmmmm mmmmm-mmmm
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                                         430        440        450        460        470        480
Chromadorita_tentabundum         GCTGATCGCA --CGGTCTC- -GT-ACCGGC GACGTATCC- TTC--AAGTG TCTGC-CTTA
Dichromadora_sp._BHMM_2005       GCAGATCGCA --TGGGCTC- -GT-CCCGGC GACATATCC- TTC--AAGTG TCTGC-CTTA
Neochromadora_BHMM_2005          GCTGATCGCA --CGGTCTC- -GT-ACCGGC GACGTATCC- TTC--AAGTG TCTGC-CTTA
Spilophorella_paradoxa           GCTGATCGCA --TGGGCTC- -GT-CCCGGC GACATATCC- TTC--AAGTG TCTGC-CTTA
Paracanthonchus_caecus           GTTGATCGCA --CAGTCCTC -GC-ACTGGC GACGTATCT- TTC--AAGTG TCTGC-CTTA
Paracyatholaimus_intermedius     GTGGATCGCA --CAGTCTC- -GT-ACTGGC GACGTATCT- TTC--AAGTG TCTGC-CTTA
Praeacanthonchus_punctatus       GTTGATCGCA --CAGTCCTC -GA-ACTGGC GACGTATCT- TTC--AAGTG TCTGC-CTTA
Praeacanthonchus_sp              GTTGATCGCA --CAGTCCTC -GA-ACTGGC GACGTATCT- TTC--AAGTG TCTGC-CTTA
Cyatholaimus_sp._BHMM_2005       GTTGATCGCA --CAGTCCTC -GC-ACTGGC GACGTATCT- TTC--AAGTG TCTGC-CTTA
Spirinia_parasitifera            GCTGATCACA --CGGTCCTA -GC-ACCGGT GACATATCT- TTC--AAGTG TCTGC-CCTA
Acanthopharynx_micans            GCTGATCACA --CGGTCCTC -GC-ACCGGT GACATATCT- TTC--AAGTG TCTGC-CCTA
Xyzzors_sp                       GCTGATCACA --CGGTCCTA -GC-ACCGGT GACATATCT- TTC--AAGTG TCTGC-CCTA
Metachromadora_sp                GCTGATCACA --CGGTCTA- -GC-ACCGGT GACATATCT- TTC--AAGTG TCTGC-CCTA
Metachromadora_remanei           GCTGATCACA --CGGTCTA- -GC-ACCGGT GACATATCT- TTC--AAGTG TCTGC-CCTA
Catanema_sp                      GCAGATCACA --CGGTCCTA -GC-ACCGGT GACATATCT- TTC--AAGTG TCTGC-CCTA
Eubostrichus_dianae              GCTGATCACA --TGGTCTC- -GT-ACCGGT GACATATCT- TTC--AAGTG TCTGC-CCTA
Eubostrichus_topiarus            GCTGATCACA --TGGTCCTA -GC-ACCGGT GACATATCT- TTC--AAGTG TCTGC-CCTA
Eubostrichus_parasitiferus       GCTGATCATA --CGGTCCTA -GT-ACCGAT GACATATCT- TTC--AAGTG TCTGC-CCTA
Laxus_oneistus                   GCTGATCACA --TGGTCCTA -GC-ACCGGT GACATATCT- TTC--AAGTG TCTGC-CCTA
Laxus_cosmopolitus               GCTGATCACA --CGGTCCTA -GC-ACCGGT GACATATCT- TTC--AAGTG TCTGC-CCTA
Leptonemella_sp                  GCTGATCACA --CAGTCCTA -GC-ACTGGT GACATATCT- TTC--AAGTG TCTGC-CCTA
Robbea_hypermnestra              GCTGATCGCA --TGGTCCTA -GC-ACCGGT GACATATCT- TTC--AAGTG TCTGC-CCTA
Stilbonema_majum                 GCTGATCACA --CGGTCTC- -GC-ACTGGT GACATATCT- TTC--AAGTG TCTGC-CCTA
Monoposthia_costata              ACGGATCGCA --CGGCCTTC -GT-GCCGGC GACGCATCA- TTC--AAATT TCTGC-CCTA
Nudora_bipapillata               GCAGATCGCA --TGGTCCA- -GT-ACCGGC GACACATTG- CAG--GAGGG AGTGC-CTTA
Calomicrolaimus_parahonestus     GCAGATCGCA --TGGTCTA- -GC-ACCGGC GACATATCT- TTC--AAGTG TCTGC-CTTA
Calomicrolaimus_sp._BHMM_2005    GCAGATCGCA --TGGTCTA- -GC-ACCGGC GACATATCT- TTC--AAGTG TCTGC-CTTA
Molgolaimus_demani               GCAGATCGCA --TGGTCTA- -GT-ACCGGC GACATATCT- TTC--AAGTG TCTGC-CTTA
Diplogaster_lethieri             GCGGATCGCA --TGGTCTT- -GT-ACCGGC GACGTACTG- GTC--GAGCG GGTGC-CCTA
Aduncospiculum_halicti           GCTGATCGCA --CGGTCTT- -GCAACCGGC GACGTATCG- TTC--GAGTG TCTGC-CTTA
Pristionchus_lheritieri          GCGGATCGCA --TGGTCTT- -GT-ACCGGC GACGTACTG- GTC--GAGCG GGTGC-CCTA
Pristionchus_pacificus           GCGGATCGTA --TGGTCTT- -GT-ACCGAC GACGTACTG- GTC--GAGTG GGTGC-CCTA
Pristionchus_pacificus           GCGGATCGTA --TGGTCTT- -GT-ACCGAC GACGTACTG- GTC--GAGTG GGTGC-CCTA
Sabatieria_punctata_STRAIN_343   GCCGATCGCA --CGGTCTC- -GC-ACCGGC GACGTATCT- TTC--AAGTG TCTGC-CTTA
Sabatieria_sp._355_BHMM_2005     GCCGATCGCA --CGGTCTC- -GC-ACCGGC GACGTATCT- TTC--AAGTG TCTGC-CTTA
Sabatieria_celtica               TCCGATCGCA --CGGTCTC- -GC-ACCGGC GACGCATCT- TTC--AAGTG TCTGC-CTTA
Sabatieria_punctata_STRAIN_200   GCCGATCGCA --CGGTCTC- -GT-ACCGGC GACGTATCT- TTC--AAGTG TCTGC-CTTA
Sabatieria_punctata_STRAIN_223   GCCGATCGCA --CGGTCTC- -GC-ACCGGC GACGCATCT- TTC--AAGTG TCTGC-CTTA
Sabatieria_sp._210_BHM_2005      GCCGATCGCA --CGGTCTC- -GT-ACCGGC GACGTATCT- TTC--AAGTG TCTGC-CTTA
Setosabatieria_hilarula          TCCGATCGCA --CGGTCTC- -GC-ACCGGC GACGCATCT- TTC--AAGTG TCTGC-CTTA
Desmolaimus_zeelandicus          GCCGATCGCA --CAGTCTT- -GT-ACTGGC GACGGACCA- TTC--GAGTG TCTGC-CTTA
Terschellingia_longicaudata      GCTGATCGCA --CGGTCTTT -GC-ACCGGC GACGCATCT- TTC--AAGTG TCTGC-CTTA
Cyartonema_elegans               GCCGATCGCA --CGGTCTTT -GC-ACCGGC GACGCATCT- TTC--AAGTG TCTGC-CTTA
Tridentulus_sp                   GCAAATCACA --TGGTCTC- -GT-ACCGGT GATGTATCT- TTC--AAGTG TCTGC-CTTA
Diplolaimelloides_meyli          GCAGATCGCA --TGGGCTC- -GT-CCCGGC GACAAATCT- TTC--AAGTG TCTGC-CTTA
Diplolaimella_diavengatensis     GCAGAGCACA --TGGGCTC- -GT-CCCGGT GCCAAATCT- TTC--AAGTG TCTGC-TCTA
Geomonhystera_disjuncta          GCTGATCGCA --CGGTCTA- -GT-GCCGGC GACATATCT- TTC--AAGTG TCTAC-CTTA
Sphaerolaimus_hirsutus           GCGGATTGCA C-TGGTCCTA -GT-ACCGGC GACATATCC- TTC--AAGTG TCTGC-CTTA
Theristus_acer                   GCTGATCGCT T-CGGTCTC- -GT-ACCGGC GACATGTCT- TTC--AAGTG TCTGC-CTTA
Daptonema_procerus               GCAGATCGCT --TGGTTTA- -AT-ACCGGC GACGTATCC- TTC--AAGTG TCTGC-CTTA
Daptonema_hirsutum               GCAGATCGCT T-CGGTTTC- -AC-ACCGGC GACATATCC- TTC--AAGTG TCTGC-TTTA
Daptonema_normandicum            GCAGATCGCT T-CGGTCTC- -GT-ACCGGC GATGTATCC- TTC--AAGTG TCTGC-CTTA
Daptonema_oxycerca               GCAGATCGCT T-CGGTTTA- -AT-ACCGGC GACGTATCC- TTC--AAGTG TCTGC-CTTA
Daptonema_setosum                GCAGATCGCT T-CGGTTTC- -AC-ACCGGC GACATATCC- TTC--AAGTG TCTGC-TTTA
Desmodora_communis               GCTGATCACA --CGGTCCT- CGC-ACCGGT GACATATCT- TTC--AAGTG TCTGC-CCTA
Desmodora_ovigera                GCTGATCACA --CAGTCCTA -GC-ACTGGT GACATATCT- TTC--AAGTG TCTGC-CCTA
Metadesmolaimus_sp               GCAGATCGCT T-CGGTTTC- -AC-ACCGGC GACATATCC- TTC--AAGTG TCTGC-TTTA
Dentostomella_sp                 GCTGATCCCA --CGGTTAA- -GC-ACCGGC GGCGTTTCT- ATC--AAGTA TCTGC-CTTA
Bunonema_franzi                  TCCGATCGCA --TGGTCTC- -GT-ACCGGC GACGTATCAT TTC--AAGAC TCTGC-CCTA
Bunonema_sp                      GCCGATCGCA --TGGCCTC- -GG-GCCGGC GACGCATCAT ATC--AAGTC TCTGC-CCTA
Seleborca_complexa               GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CGTA
Acrobeloides_nanus               GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CGTA
Acrobeloides_bodenheimeri        GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CGTA
Acrobeloides_sp_PS1146           GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CGTA
Acrobeles_ciliatus               GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--GAGTT TCTGC-CGTA
Acrobeles_sp_PS1156              GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--GAGTT TCTGC-CGTA
Acrobeles_complexus_WCUG2        GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--GAGTT TCTGC-CGTA
Cephaloboides_sp_SB227           GATAATCGAA ---GGTT--- -AA-TCCATC GATTTAAGC- ATT--AGGTG TCTGC-CCTA
Cephalobus_cubaensis             GCTGATCGCA --CGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CGTA
Cephalobus_sp._PS1143            GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CGTA
Cephalobus_sp._PS1196            GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CGTA
Cephalobus_oryzae_PS1165         GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CGTA
Cervidellus_alutus               GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CGTA
Pseudacrobeles_variabilis        GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CGTA
Triligulla_aluta                 GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CGTA
Zeldia_punctada                  GCTGATCGCA --TGGTCTT- -GT-ACCGGC -ACGTGTCT- TTC--AAGTA TCTGC-CGTA
Myolaimus_sp_U81585              GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACAGTTCT- TTC--AAGTT TCTGC-CTTA
Rhabditophanes_sp._KR3021        GCTGAAC--- -------TA- -CT-CACGTA GTCATGCCG- TAT--AAGTA TCTGC-TTTA
NUCLEOTIDES INCLUDED             mmmmmmmm-- ---------- ---------- ---------- -----mmmmm mmmmm-mmmm
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                                           430        440        450        460        470        480
Brevibucca_sp._SB261              ACAGCTGATC --GTATAGC- -CT-CGTGCT GACGATGTGT CATTCAAGTG TCTGC-CTTA
Halicephalobus_gingivalis         CGACCATACG --GATTAAT- -T--TCCGAT GGAAGGCCG- TAT--TTGTA TCTGC-CCTA
Panagrobelus_stammeri             GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACATGTCA- TTC--GAGTA TCTGG-CTTA
Plectonchus_sp._PDL0025           GCTGATCG-C A-TGGTCTT- -GT-ACCGGC GATATGTCA- TTC--GAGAA TCTGG-CTTA
Turbatrix_aceti                   GCTAATCGCG --TGGTCTC- -GT-ACCAGC GATGTAACT- TTC--AAGGG ACTGA-TCTA
Panagrellus_redivivus             GCTGATTGCA --TGGCCTTT -GT-GCCGGC AATGTGTCA- AAG--CTGTG TCTGCCNSKA
Panagrellus_redivivus_PS1163      GCTGATTGCA --TGGCCTTT -GT-GCCGGC AATGTGTCA- AAG--CTGTG TCTGC-CCTA
Panagrolaimus_subelongatus        GCTGATCGTA --TGGTCTT- -GT-ACCGAC GACATGTCA- TTC--AAGTG TCWGA-TCTA
Panagrolaimus_davidi              GCTGATCGTA --TGGTCTT- -GT-ACCGAC GACATGTCA- TTC--AAGTG TCTGA-TCTA
Panagrolaimus_cf_rigidus_AF40     GCTGATCGTA --TGGTCTT- -GT-ACCGAC GATATGTCA- TTC--AAGTG TCTGA-TCTA
Panagrolaimus sp. Sourhope ED2    GCTAATCGTA --TGGTCTT- -GT-ACCGAC GATATGTCA- TTC--AAGTG TCTGA-TCTA
Panagrolaimus sp. Sourhope ED2    GCTAATCGTA --TGGTCTT- -GT-ACCGAC GATATGTCA- TTC--AAGTG TCTGA-TCTA
Panagrolaimus sp. Sourhope ED2    GCTAATCGTA --TGGTCTT- -GT-ACCGAC GATATGTCA- TTC--AAGTG TCTGA-TCTA
Panagrolaimus sp. Sourhope ED2    GCTGATCGTA --TAGTCTT- -GT-ACTGAC GATATGTCA- TTC--AAGTG TCTGA-TCTA
Panagrolaimus sp. Sourhope ED2    GCTGATCGTA --TAGTCTT- -GT-ACTGAC GATATGTCA- TTC--AAGTG TCTGA-TCTA
Steinernema_carpocapsae           GTTAATCGCA --TGGACTT- -GT-TCCGGC GATACGTTT- ATC--AAGTT TCTGC-CCTA
Strongyloides_stercoralis         TCGAATCGCA --TGGCCTT- -GC-GCCGGC GATGCTTCA- TTC--AAATT TCTGC-CCTA
Strongyloides_ratti               GCTGATT--- -------TT- -GT-TACTAA AACATACCG- TAT--GTGTA TCTGG-TTTA
Diploscapter_sp_PS1897            GTCTATCG-T --CGGTTCT- -AT--CCGAC GAAGGCCGA- AAA--GGGTT TCTGC-CCTA
Diploscapter_sp_PS2017            GTCTATCG-T --CGGTTCT- -AT--CCGAC GAAGGCCGA- AAA--GGGTT TCTGC-CCTA
Heterorhabditis_bacteriophora     GCATATCG-G --CGGCTA-- -GT--CCGCT GATAATCCG- AGA--AAGTG TCTGC-CCTA
Heterorhabditis_hepialus          GCATATCG-G --CGGCTA-- -GT--CCGCT GATATTCCG- AGA--AAGTG TCTGC-CCTA
Heterorhabditis_zelandica         GCATATCG-G --CGGCTC-- -GT--CCGCT GATATTCCG- AAA--AAGTG TCTGC-CCTA
Parasitorhabditis_sp_SB281        GCAGACCG-C --ATGCGTA- -----AGCGG CGGCAATTC- ATGC-AATTA ACTGC-CCTA
Rhabditoides_inermiformis         GCTGATCGCA --TGGTCTT- -GA-GCCGGC GACGTGTCT- TTC--AAGTA TCTGC-CTTA
Rhabditoides_inermis_DF5001       GCCGATCGCT ----G-CTT- -C--GGCGGC GACGTCTCA- ATC--AAGTT TCTGC-CTTA
Rhabditoides_regina_DF5012        CAGACCGCAT ----G-CTT- -TT-GCAGCG GCGATTCAT- TCT--GATTG ACTGT-CCTA
Poikilolaimus_oxycerca_SB200      GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACATATCT- TTC--AAGTA TCTGC-CTTA
Poikilolaimus_regenfussi_SB199    GCTGATCGCA --TGGTCTT- -GA-ACCGGC GACATATCT- TTC--AAGTA TCTGC-CTTA
Distolabrellus veechi DWF1604     GCAGACCGCA --TGCGAAA- -GC-GGCGGC GATTCACGT- -----AATTA ACTGC-CCTA
Distolabrellus veechi DF5024      gcagaccgca --tgcgaaa- -gc-ggcggc gattcacgt- -----aatta actgc-ccta
Choriorhabditis_dudichi           GTTAATCG-T --CGGTTTA- -CC-GATGAT GTCCTCGRA- -----AAGTG TCTGC-CCTA
Protorhabditis_sp                 GTCTATCG-T --CGGTCAA- ----TCCGAC GAAGGCCGA- AAA--GGTTT TCTGC-CCTA
Protorhabditis_sp_DF5055          GTATCTCG-T --CGGTTTA- ----TCCGAC GAATAACGG- AAG--GCTTT TCTGC-CCTA
Cruznema_tripartitum_DF5015       GTGAATCG-T --CGGTCAA- ----TCCGAC GATGTCCGG- AAA--AAGTG TCTGC-CCTA
Mesorhabditis_sp_PS1179           GCAGACCG-C --ATGCGTA- -AG--CGGCG GCAATTCGC- -GA--AATTA ACTGC-CCTA
Mesorhabditis_spiculigera_SB15    GCAGACCG-C --ATGCGCA- -AG--CGGCG GCAATTCAC- -GC--AATCA ACTGC-CCTA
Mesorhabditis_anisomorpha_SB12    GCAGTCCG-C --GCTTGCG- CAAGCCGGCG GCGGTTCGT- -GC--GATTG ACTGT-CCTA
Teratorhabditis_palmarum_DF501    GCAGACCG-C --ATGCGAA- -AG--CGGCG GCGTGTCAT- -GC--GATTA ACTGC-CCTA
Teratorhabditis_synpapillata_S    GCAGACCG-C --ATGCGTA- -AG--CGGCG GCGTGTCAT- -GC--GATTA ACTGC-CCTA
Caenorhabditis_briggsae_PB102     GTTTACTG-T --CAGTTTC- -GA--CTGAC TCTATCCGA- AAA--GGGTG TCTGC-CCTT
Caenorhabditis_elegans_N2         GTTTACTG-T --CAGTTTC- -GA--CTGAC TCTATCCGG- AAA--GGGTG TCTGC-CCTT
Caenorhabditis_sp_CB5161          GTTTACTG-T --CAGTTTC- -GA--CTGAC TCTATCCGA- AAA--GGGTG TCTGC-CCTA
Caenorhabditis_sp_PS1010          GTTTAGTG-T --CAGTTTC- -GA--CTGAC TCTATCCGA- AAA--GAGTG TCTGC-CCTT
Caenorhabditis_japonica           GTTTACTG-T --CAGTTTC- -GA--CTGAC TCTATCCGA- GAA--GGGTG TCTGC-CCTT
Caenorhabditis_sp_DF5170          GTTTACTG-T --CGGTTTT- -A---CCGAC TCTATCCGG- GAA--AAGTG TCTGC-CCTT
Caenorhabditis_sp_SB341           GTTTATCG-T --CGGAGCA- -AT--CCGA- CGAAGGCCG- AAA-CTAGTG TCTGC-CCTA
Caenorhabditis_plicata            GCAAACTG-T --CGGCCTG- -GTG-CTGAC TCAGTCCGA- AAA--GAATA TCTGC-CCTT
Caenorhabditis_vulgaris           GTTTACTG-T --CGGTTTC- -GA--CTGAC TCTATCCGG- AAA--GGGTG TCTGC-CCTT
Caenorhabditis_sonorae            GTGTATCG-T --CGGAGCA- -AT--CCGAC GAAGGCCGA- AAC--GAGTG TCTGC-CCTA
Caenorhabditis_drosophilae        GTTTACTG-T --CGGTTTT- -CT--CCGAC TCTATCCGA- GAA--AAGTG TCTGC-CCTT
Phasmarhabditis_hermaphrodita     TT-TATCG-G --CGGTTC-- -AT--CCGCT GAAGTCCGG- AAT-TTTGTG TCTGC-CCTA
Phasmarhabditis_neopapillosa      TT-TATCG-G --TGGTTT-- -AT--CCGCT GAAGTCTGG- AAT-TTTGTG TCTGC-CCTA
Phasmarhabditis_neopapillosa      GCTTATCG-A --CGGTTT-- -AT--CCGTC GATAACCGA- AAG--AAGTG TCTGC-CCTA
Pellioditis_mediterranea_SB173    GCTTATCG-A --CGGTTT-- -TT--CCGTC GATAACCGA- AAG--AAGTG TCTGC-CCTA
Pellioditis_marina                GCTTATCG-A --CGGTTT-- -AT--CCGTC GATAACCGA- AAG--AAGTG TCTGC-CCTA
Prodontorhabditis_wirthi          GTTCATTG-T --CGGTTT-- -AT--CCGGC AAGGTCCAG- AAA--ACTTT TCTGC-CCTA
Crustorhabditis_scanica           GACCGCAT-G --TGAAA--- -----ACGGC GGCAATTCA- TGC--GATTA ACTGC-CCTA
Dolichorhabditis_sp_CEW1          GTATATCG-A --CGGTTT-- -AT--CCGTC GAAAGCTCG- GAA--TAGTG TCTGC-CCTA
Oscheius_sp_DF5000                TGTATCGA-C --GGTTT--- -AT--CTGTC GAAAACTCG- GAA--CAGTG TCTGC-CCTA
Oscheius_sp_BW282                 GTTTATCG-G --CAGGTA-- -AT--CTACC GATAACCGA- AAG--AAGTG TCTGC-CCTA
Oscheius_myriophila_EM435         GTTTATCG-G --CAGGTA-- -AT--CTACC GATAACCGA- AAG--AAGTG TCTGC-CCTA
Oscheius_insectivora              GTTTATCG-G --CAGGTA-- -AT--CTGCC GATAACCGA- AAG--AAGTG TCTGC-CCTA
Oscheius_dolichuroides            GTATATCG-A --CGGTTT-- -AT--CTGTC GAAAACTCG- GAA--CAGTG TCTGC-CCTA
Rhabditis_blumi_DF5010            GTTTATCG-G --TGGTTT-- -AT--CTGCC GAAGTCCGA- AAT--AGGTG TCTGC-CCTA
Rhabditis_sp_PS1191               GTGGATCG-A --CAGTGT-- -AT--CTGTC GACGTTCGA- AAT--AGGGT CCTGC-CCTA
Rhabditis_sp_PS1010               GTTTAGTG-T --CAGTTTC- -GA--CTGAC TCTATCCGA- AAA--GAGTG TCTGC-CCTT
Rhabditis_myriophila_EM435        GTTTATCG-G -CAGGTA--- -AT--CTACC GATAACCGA- AAG--AAGTG TCTGC-CCTA
Rhabditis_colombiana              GTTTACCG-G --CGGTTT-- -AT--CTGCC GGTAGCCGA- AAG--AAGTG TCTGC-CCTA
Rhabditella_axei_DF5006           GCTGATCG-A --CGGTTT-- -AC--CTGTC GACGATCGG- AGA--AGGAG TCTGC-CCTA
Rhabditella_sp_DF5044             GCTAATCG-A --CGGTTT-- -AC--CTGTC GATGATCGG- AGA--AGGAG TCTGC-CCTA
Cuticularia_sp_PS2083             GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACATATCT- TTC--AAGTA TCTGC-CTTA
Necator_americanus                GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Kalicephalus_cristatus            GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Ancylostoma_caninum               GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Angiostrongylus_cantonensis       GCATATCG-G --CGGCTT-- -GT--TCGCC GATAATCCG- AAA--AAGTG TCTGC-CCTA
Angiostrongylus_costaricensis     GCATATCG-G --CGGCTT-- -GT--TCGCT GATAATCCG- AAA--AAGTG TCTGC-CCTA
Angiostrongylus_malaysiensis      GCATATCG-G --CGGCTT-- -GT--TCGCT GATAATCCG- AAA--AAGTG TCTGC-CCTA
NUCLEOTIDES INCLUDED              mmmmmmmm-- ---------- ---------- ---------- -----mmmmm mmmmm-mmmm
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                                         430        440        450        460        470        480
Angiostrongylus_dujardini        GCATATCG-G --CGGCTT-- -GT--TCGCC GATAATCCG- AAA--AAGTG TCTGC-CCTA
Angiostrongylus_vasorum          GCATATCG-G --CGGCTT-- -GT--TCGCC GATAATCCG- AAA--AAGTG TCTGC-CCTA
Aulurostrongylus_abstrusus       GCATATCG-G --CGGCTT-- -GA--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Didelphostrongylus_hayesi        GCATATCG-G --CGGCTT-- -GT--TCGCC GATAATCCG- AAA--AAGTG TCTGC-CCTA
Crenosoma_mephitidis             GCATATCG-G --CGGCTT-- -GT--TCGCC GATAATCCG- AAA--AAGTG TCTGC-CCTA
Crenosoma_vulpis                 GCATATCG-G --CGGCTT-- -GT--TCGCC GATAATCCG- AAA--AAGTG TCTGC-CCTA
Otostrongylus_circumlitus        GCATATCG-G --CGGCTT-- -GT--TCGCC GATAATCCG- AAA--AAGTG TCTGC-CCTA
Troglostrongylus_wilsoni         GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Filaroides_martis                GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Oslerus_osleri                   GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Parafilaroides_decorus           GCATATCG-A --CGGCTT-- -GT--TCGTC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Metastrongylus_salmi             GCATATCG-G --CGGCTT-- -GT--TCGCC GATAATCCG- AAA--AAGTG TCTGC-CCTA
Metastrongylus_elongatus         GCATATCG-G --CGGCTT-- -GT--TCGCC GATAATCCG- AAA--AAGTG TCTGC-CCTA
Skrjabingylus_chitwoodrum        GCATATCG-G --CGGCTT-- -GA--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Parelaphostrongylus_odocoilei    GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Muelerius_capillaris             GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Protostrongylus_rufescens        GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Halocercus_invaginatus           GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AGA--AAGTG TCTGC-CCTA
Pseudalius_inflexus              GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Stenurus_minor                   GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Torynurus_convolutus             GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Syngamus_trachea                 GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AGGTG TCTGC-CCTA
Stephanurus_dentatus             GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Nematodirus_battus               GCATATCG-G --CGGCTT-- -GA--CCGCT GATAATCCG- AAA--AAGTG TCTGC-CCTA
Strongylus_equinus               GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Labiostrongylus_bipapillosus     GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Petrovinema_poculatum            GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Cylicocyclus_insignis            GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Chabartia_ovina                  GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Cyclodontostomum_purvisi         GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Zoniolaimus_mawsonae             GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Hypodontus_macropi               GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Deletrocephalus_dimidiatus       GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Dictyocaulus_eckerti_P7B8        GCATATCG-G --CGGCATA- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Dictyocaulus_capreolus_P3B2      GCATATCG-G --CGGCATA- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Dictyocaulus_sp._P6A1            GCATATCG-G --CGGCATA- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Dictyocaulus_filaria             GCATATCG-G --CGGCTTG- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Dictyocaulus_capreolus_P2C10     GCATATCG-G --CGGCATA- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Dictyocaulus_viviparus           GCATATCG-G --CGGCATA- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Haemonchus_sp._V3091             GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Haemonchus_contortus             GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Haemonchus_placei                GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Haemonchus_similis               GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Ostertagia_ostertagi             GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Ostertagia_leptospicularis       GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Nippostrongylus_brasileinsis     GCATATCG-G --CGGCTT-- -GT--CCGCT GATATTCCG- AAA--AAGTG TCTGC-CCTA
Heligmosomoides_polygyrus        GCATATCG-G --CGGCTT-- -GT--CCGCT GATATTCCG- AAA--AAGTG TCTGC-CCTA
Trichostrongylus_colubriformis   GCATATCG-G --CGGCTT-- -GT--YCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Tetrabothriostrongylus mackerr   GCATATCG-G --CGGCTT-- -GT--CCGCT GATATTCCG- AAA--AAGTG TCTGC-CCTA
Herpestrongylus_pythonis         GCATATCG-G --CGGCTT-- -GT--CCGCT GATATTCCG- AAA--AAGTG TCTGC-CCTA
Nicollina_cameroni               GCATATCG-G --CGGCTT-- -GT--CCGCT GATATTCCG- AAA--AAGTG TCTGC-CCTA
Filarimena_flagrifer             GCATATCG-G --CGGCTT-- -GT--CCGCC GATAATCCG- AAA--AAGTG TCTGC-CCTA
Amidostomum_cygni                GCATATCG-G --CGGCTT-- -GT--CCGCT GATATTCCG- AAA--AAGTG TCTGC-CCTA
Teratocephalus_lirellus          GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACTCATCT- TTC--AAGTG TCTGC-CTTA
Brumptaemilius_justini           GCTGATCGCA --TGGTCTT- -GA-ACCGGC GACGTGTCA- ATC--AAGTG TCTGC-CTTA
Anguillicola_crassus             GCTGATCGCA --TGGTCTT- -GA-ACCGGC GACATATCT- ATC--AAGTG TCTGC-CTTA
Dracunculus_medinensis           GCTGATCGCA --TGGTCTA- -GT-ACCGGC GACATATCT- ATC--AAGTA TCTGC-CTTA
Dracunculus_oesophageus          GCCGATCGTA --TGGTCTA- -GT-ACCGAC GACATATCT- ATC--AAGTA TCTGC-CTTA
Dracunculus_sp._V3104            GCTGATCGCA --TGGTCTA- -GT-ACCGGC GACATATCT- ATC--AAGTA TCTGC-CTTA
Philonema_sp_A                   GCTGATCGCA --CGGTCTT- -GC-ACCGGC GACATATCT- ATC--AAGTG TCTGC-CTTA
Philometra_obturans              GCTGATCGCA --TGGTCTC- -GT-ACCGGC GACTTATCT- ATC--AAGTA TCTGC-CTTA
Camallanus_oxycepahalus          GCTGATCGCA --TGGTCTC- -GT-ACCGGC GACGTATCT- ATC--AAGTG TCTGC-CTTA
Acanthocheilonema_viteae         GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACATATCT- ATC--AAGTG TCTGC-CTTA
Loa_loa                          GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACGTATCT- ATC--AAGTG TCTGC-CTTA
Onchocerca_cervicalis            GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACGTATCT- ATC--AAGTG TCTGC-CTTA
Dirofilaria_immitis              GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACATATCT- ATCTCAAGTG TCTGC-CTTA
Brugia_malayi                    GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACGTATCT- ATC--AAGTG TCTGC-CTTA
Wuchereria_bancrofti             GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACGTATCT- ATC--AAGTG TCTGC-CTTA
Litomosoides_sigmodontis         GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACATATCT- ATC--AAGTG TCTGC-CTTA
Setaria_digitata                 GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACGTATCT- ATC--AAGTG TCTGC-CTTA
Gnathostoma_turgidum             GCTGATCGCA --TGGTCTC- -GT-ACCGGC GACATGTCA- ATC--AAGTA TCTGC-CTTA
Gnathostoma_neoprocyonis         GCTGATCGCA --CGGTCTC- -GC-ACCGGC GACATGTCA- ATC--AAGTA TCTGC-CTTA
Gnathostoma_binucleatum          GCTGATCGCA --CGGTCTC- -GT-ACCGGC GACATGTCA- ATC--AAGTA TCTGC-CTTA
Physaloptera_alata               GCTGATCGCA --TGGTCTC- -GT-ACCGGC GACGTATCT- ATC--AAGTG TCTGC-CTTA
Physaloptera_turgida             GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACGTATCT- ATC--AAGTG TCTGC-CTTA
Ascarophis_arctica               GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACATGTCT- ATC--AAGTG TCTGC-CTTA
Spinitectus_carolini             GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACGTGTCT- ATC--AAGTA TCTGC-CTTA
Thelazia_lacrymalis              GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACGTATCT- CAC--AAGTG TCTGC-CTTA
NUCLEOTIDES INCLUDED             mmmmmmmm-- ---------- ---------- ---------- -----mmmmm mmmmm-mmmm
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                        430        440        450        460        470        480
Aphelenchus_avenae               GCTGATCGTA --TGGTCTT- -GT-ACCGAC GACGTATCT- TTC--AAGTA TCTGC-CTTA
Aphelenchoides_fragariae         GCTTATCGCA --CGACTTT- -AC-GTCGGC GAAATTACA- TTC--AAGTA TCTGC-CTTA
Bursaphelelenchus_sp             GCTTATCGCA --TGGTCTC- -GT-ACCGGC GAAGTTTCT- TTC--AAGTA T-TGC-TTTA
Deladenus_sp                     GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CTTA
Criconema_sp                     GCTGATCGCA --TGGGCTT- -GT-CCCGGC GACGTACCG- TCC--GAGTG TCTGC-CTTA
Hemicycliophora_conida           GCTGACCGCA --TGGGCTT- -GT-CCCGGC GGCGTGTCG- TTC--AAGTG TCTGC-CTTA
Paratylenchus_dianthus           GCTGATCGCA --TGGGCTT- -GT-CCCGGC GACGTGTCT- TTC--AAGTG TCTGC-CTTA
Pratylenchus_thornei             GCTGATCGTA --CGGTCTT- -GT-ACCGAC GACGTGTCT- TTC--AAGTT TCTGC-CTTA
Tylenchulus_semipentrans         GCTGATCGTA --TGGGCTT- -GT-CCCGAC GACGTGTCT- TTC--AAGTG TCTGC-CTTA
Ditylenchus_angustus             GCTGATCGCA --TGGTCTT- -GT-ACCGGC GATGTGTCA- TTC--AAGTA TCTGC-CTTA
Subanguina_radicola              GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CTTA
Tylenchorhynchus_maximus         GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CTTA
Geocenamus_quadrifer             GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CTTA
Globodera_pallida                GCTGATCGCA --CGGTCTT- -GT-ACCGGC GACGTGTCT- TTC--AAGTG TCTGC-CTTA
Scutellonema_bradys              GCTGATCGCA --CGGTCCT- GGT-ACCGGC GACGTGTCT- TTC--AAGTG TCTGC-CTTA
Helicotylenhcus_dihystera        GCTGATCGCA --CGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--AAGTG TCTGC-CTTA
Rotylenchus_robustus             GCTGATCGCA --CGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--AAGTG TCTGC-CTTA
Meloidogyne_arenaria             GCTGACCGCA --TGGCCTT- -GT-GCCGGC GGCGTGTCT- TTC--AAGCG TCCAC-TTTA
Meloidogyne_incognita_KT         GCTGACCGCA --TGGCCTT- -GT-GCCGGC GGCGTGTCT- TTC--AAGCG TCCAC-TTTA
Meloidogyne_javanica             GCTGACCGCA --TGGCCYT- -GT-GCCGSC GGCGTGTCT- TTC--AAGCG TCCAC-TTTA
Meloidogyne_artiellia            GCTGACCGCA --CGGCCTT- -GT-GCCGGC GGCGTGTCT- TTC--AAGCG TCCAC-TTTA
Meloidogyne_duytsi               GCTGACCGCA --TGGCCTT- -GT-GCCGGC GGCGTGTCT- TTC--AAGCG TCCAC-TTTA
Meloidogyne_exigua               GCTGACCGCA --TGGCCTCA -GT-GCCGGC GGCGTGTCT- TTC--AAGCG TCCAC-TTTA
Meloidogyne_hapla                GCTGACCGCA --TGGCCAA- -GT-GCCGGC GGCGAATCT- TTC--AAGCG TCCAC-TTTA
Meloidogyne_ichinohei            ACTGACCGCA --CGGCCCC- -GA-GCCGGC GGCGTGTCA- TTC--AAGTG TCTAC-TTTA
Meloidogyne_maritima             GCTGACCGCA --TGGCCTT- -GT-GCCGGC GGCGTGTCT- TTC--AAGCG TCCAC-TTTA
Meloidogyne_microtyla            GCTGACCGCA --TGGCCTA- -GT-GCCGGC GGCGTGTCT- TTC--AAGCG TCCAC-TTTA
Nacobbus_aberrans                GCTGACCGCA --TGGTCTT- -GT-ACCGGC GGCATGTCT- TTC--AAGTA TCTGC-CTTA
Pratylenchoides_ritteri          GCTGATCGCA --TGGTCTT- -GA-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CTTA
Pratylenchoides_magnicauda       GCTGATCGCA --TGGTCTT- -GA-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CTTA
Hirschmanniella_sp._JH_2003      GCTGATCGCA --TGGCCTT- -GC-GCCGGC GACGTGTCT- TTC--AAGTA TCTGC-CTTA
Radopholus_similis               GCTGAGCGCA --CGGTCTT- -GC-ACCGGC GCCGTATCA- TTC--GAGCT TCTGC-CCTA
Pratylenchus_goodeyi_VF          GCTGACCGCA --TGGTCTT- -GA-ACCGGC GGCGTGTCT- TTC--AAGCA TCTGC-ATTA
Boleodorus_thylactus_clone2      GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACGTGTCT- TTC--AAGTA TCTGC-CTTA
Philippine Sequence 1            GCATATCG-G --CGGCTT-- -GT--TCGCC GATAATCCG- AAA--AAGTG TCTGC-CCTA
Philippine Sequence 2            GCATATCG-G --CGGCTT-- -GT--TCGCC GATAATCCG- AAA--AAGTG TCTGC-CCTA
Philippine Sequence 3            GTTTATCG-T --CGGTTT-- -AT--CCGAC GAAAACCGA- AAG--AAGTG TCTGC-CCTA
Philippine Sequence 4            GCTGATCGTA --TGGTCTT- -GT-ACCGAC GACATGTCA- TTC--AAGTG TCTGA-TCTA
Philippine Sequence 5            GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Philippine Sequence 6            GCTTATCG-A --CGGTCT-- -AT--CCGTC GATGATCGA- AAA--ATGTG TCTGC-CCTA
Philippine Sequence 7            GTTTACTG-T --CAGTTTC- -GA--CTGAC TCTATCCGA- AAA--GGGTG TCTGC-CCTT
Tahiti Sequence 1                GCATATCG-G --CGGCTT-- -GT--TCGCC GATAATCCG- AAA--AAGTG TCTGC-CCTA
Tahiti Sequence 2                GCATATCG-G --CGGCTT-- -GT--TCGCC GATAATCCG- AAA--AAGTG TCTGC-CCTA
Thailand Sequence 1              GCTGATCGCA --TGGTCTT- -GT-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Ogasawara Sequence 2             GCTGATCGTA --TGGTCTT- -GT-ACCGAC GACATGTCA- TTC--AAGTG TCTGA-TCTA
Ogasawara Sequence 1             TCTATCGG-- --CGGTTT-- -AT--CCGCT GAAATCTGC- AAT-TTTGTG TCTGC-CCTA
Ivory Coast Sequence 1           GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Ivory Coast Sequence 2           GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Ivory Coast Sequence 3           GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Ivory Coast Sequence 4           GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Ivory Coast Sequence 5           GCTGATCGCA --TGGTCTT- -GC-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Ivory Coast Sequence 6           GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Ivory Coast Sequence 7           GCATATCG-G --CGGCAT-- -GA--CCGCT GATATTCCG- AAA--AAGTG TCTGC-CCTA
Singapore Sequence 1             GTTTATCG-T --CGGTTT-- -AT--CCGAC GAAAACCGA- AAG--AAGTG TCTGC-CCTA
Singapore Sequence 2             RCTGATCGCA --TGGTCTT- -GT-ACCGGC GACGTGTCT- ATC--AAGTG TCTGC-CTTA
Singapore Sequence 3             GTTTACTG-T --CAGTTTC- -GA--CTGAC TCTATCCGA- AAA--GGGTG TCTGC-CCTT
Singapore Sequence 4             GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Nigerian Sequence 1              GCATATCG-G --CGACTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Nigerian Sequence 2              GCATATCG-G --CGGCTT-- -GT--CCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
Nigerian Sequence 3              GCATATCG-G --CGGCTT-- -GT--TCGCC GATATTCCG- AAA--AAGTG TCTGC-CCTA
NUCLEOTIDES INCLUDED             mmmmmmmm-- ---------- ---------- ---------- -----mmmmm mmmmm-mmmm


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                                        490        500        510        520        530        540
Gordius_aquaticus                TCA-ACTGTC GATGGTAGGT TATGCGCCT- ACCATGGTCG TAACGGG-TA ACGGAGAATC
Priapulus_caudatus               TCA-ACTTTC GATGGTAGAT TATGTGCCT- ACCATGGCTG TAACGGG-TA ACGGGGAATC
Brachionus_plicatilis            TCA-ACTTTC GATGGTAAGC GATTTGCCT- ACCATGGTTG TAACGGG-TA ACGGGGAATC
Chordodes_morgani                TCA-ACTGTC GATGGTAGGT TATATGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATC
Paractinolaimus_macrolaimus      TCA-ACTTTC GATGGTAGGT TATACGCCT- ACCATGGTAG TAACGGG-TA ACGGAGAATA
Aporcelaimellus_obtusicaudatus   TCA-ACTTTC GATGGTAGGT TATACGCCT- ACCATGGTAG TAACGGG-TA ACGGAGAATA
Wilsonema_schuurmansstekhoveni   TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Mesodorylaimus_sp_cf_nigritul    TCA-ACTTTC GATGGTAGGT TATACGCCT- ACCATGGTAG TAACGGG-TA ACGGAGAATA
Mesodorylaimus_bastiani          TCA-ACTTTC GATGGTAGGT TATACGCCT- ACCATGGTAT TAACGGG-TA ACGGAGAATA
Mesodorylaimus_japonicus         TCA-ACTTTC GATGGTAGGT TCTACGCCT- ACCATGGTAG TAACGGG-TA ACGGAGAATA
Pungentus_sp._PDL_2005           TCA-ACTTTC GATGGTACGC TATACGCCT- ACCATGGTAG TAACGGG-TA ACGGAGAATA
Allodorylaimus_sp                TCA-ACTTTC GATGGTACGC TATACGCCT- ACCATGGTAG TAACGGG-TA ACGGAGAATA
Eudorylaimus_carteri             TCA-ACTTTC GATGGTACGC TATACGCCT- ACCATGGTAG TAACGGG-TA ACGGAGAATA
NUCLEOTIDES INCLUDED             mmm-mmm--m mmmmmmmmmm mmmmmmmmm- mmmmmmmmmm mmmmmmm-mm mmmmmmmmmm
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                                        490        500        510        520        530        540
Microdorylaimus_sp               TCA-ACTTTC GATGGTACGC TATACGCCT- ACCATGGTAG TAACGGG-TA ACGGAGAATA
Longidorus_elongatus             TCA-ACTTTC GATGGTAGGT TATACGCCT- ACCATGGTAG TAACGGG-TA ACGGAGAATA
Xiphinema_rivesi                 TCC-ACTTTC GATGSTAGGT TATACGCCT- ACCATGGTAG TAACGGG-TA ACGGAGAATA
Tylencholaimus_sp                TCA-ACTTTC GATGGTAGGT TATACGCCT- ACCATGGTAG TAACGGG-TA ACGGAGAATA
Anoplostoma_sp._BHMM_2005        TCA-ACCGTC GATGGTAGTT TATGCGCCT- ACCATGGTTG TTACGGG-TA ACGGAGAATT
Adoncholaimus_fuscus             TCA-ACTTTC GATGGTAGAT TATGCGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATC
Enoplus_meridionalis             TCA-ACTGTC GATGGTAGTT TATGCGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Enoplus_brevis_U88336            TCA-ACTTTC GATGGTAGTT TATGCGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATT
Enoplus_communis                 TCA-ACTTTC GATGGTAGTT TATGCGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATT
Enoploides_brunettii             TCA-ACTGTC GATGGTAGCT TACACGACT- ACCATGGTTG TTACGGG-TA ACGGAGAATT
Syringolaimus_striatocaudatus    TCA-ACTTTC GATGGTAGTT TATGCGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Ironus_dentifurcatus             TCA-ACTTTC GATGGTAGTA TATAGGACT- ACCATTGTGA TAACGGG-TA ACGGAGAATT
Calyptronema_maxweberi           TCA-ACTTTC GACGGTAAGC TATAAGCCT- ACGGTGGTTA TAACGGG-TA ACGGAGAATC
Viscosia_sp._BHMM_2005           TCA-ACTGTC GATGGTAGAT TATGCGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATT
Viscosia_viscosa                 TCA-ACTTTC GATGGTAGAT TACGCGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATC
Pontonema_vulgare                TCA-ACTTTC GATGGTAGAT TATGCGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATT
Oncholaimus_sp._BHMM_2005        TCA-ACTTTC GATGGTAGAT TATGCGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATC
Alaimus_sp_PDL_2005              TCA-ACTTTC GATGGTAGTT TATGCGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Prismatolaimus_intermedius       TCA-ACTTTA GATGGTAGTT TACACGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Tobrilus_gracilis                TCA-ACTTTC GATGGTAGTT TATACGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Tripyla_cf_filicaudata_JH_2004   TCA-CCTTTC GATGGTAGTT TAAGTGCCT- ACCATGGGTT TTACGGG-TA ACGGAGAATC
Bathylaimus_sp                   TCA-ACTGTC GATGGTAGTT TACATGCCT- ACCATGGTGA TAACGGG-TA ACAGAGAATA
Bathylaimus_assimilis            TCA-ACTGTC GATGGTAGTT TACATGCCT- ACCATGGTGA TAACGGG-TA ACAGAGAATA
Bathylaimus_sp._BHMM_2005        TCA-ACTTTC GATGGTAGTT TACATGCCT- ACCATGGTGA TAACGGG-TA ACAGAGAATA
Tripyloides_sp._BHMM_2005        TCA-ACTGTC GATGGTAGTT TACATGCCT- ACCATGGTGA TAACGGG-TA ACAGAGAATA
Trischistoma_monohystera         TCA-ACTTTC GATGGTAGTT TATGCGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Mermis_nigrescens                TCA-ACTTTC GATGGTAGGT TATATGCCT- ACCATGGTTA TAACGGG-TA ACGGAGAATA
Mylonchulus_arenicolus           TCA-ACTTTC GATGGTAGGT TATACGCCT- ACCATGGTTA TAACGGG-TA ACGGAGAATT
Anatonchus_tridentacus           TCA-ACTTTC GATGGTAGGT TATACGCCT- ACCATGGTTA TAACGGG-TA ACGGAGAATA
Mononchus_truncatus              TCA-ACTTTC GATGGTAGGT TATACGCCT- ACCATGGTTA TAACGGG-TA ACGGAGAATA
Prionchulus_muscorum             TCA-ACTTTC GATGGTAGGT TATACGCCT- ACCATGGTTA TAACGGG-TA ACGGAGAATA
Clarkus_sp                       TCA-ACTTTC GATGGTAGGT TATACGCCT- ACCATGGTTA TAACGGG-TA ACGGAGAATT
Trichinella_spiralis             TCA-ACCTTC GATGGTAGCC TATGCGACT- ACCATGGTGA TAACGGG-TA ACGGAGAATC
Trichinella_papuae               TCA-ACCTTC GATGGTAGTC TATGCGACT- ACCATGGTGA TAACGGG-TA ACGGAGAATC
Trichinella_britovi              TCA-ACCTTC GATGGTAGTC TATGCGACT- ACCATGGTGA TAACGGG-TA ACGGAGAATC
Trichinella_murrelli             TCA-ACCTTC GATGGTAGTC TATGCGACT- ACCATGGTGA TAACGGG-TA ACGGAGAATC
Trichinella_pseudospiralis       TCA-ACCTTC GATGGTAGTC TATGCGACT- ACCATGGTGA TAACGGG-TA ACGGAGAATC
Trichinella_nativa               TCA-ACCTTC GATGGTAGTC TATGCGACT- ACCATGGTGA TAACGGG-TA ACGGAGAATC
Trichinella_zimbabwensis         TCA-ACCTTC GATGGTAGTC TATGCGACT- ACCATGGTGA TAACGGG-TA ACGGAGAATC
Trichinella_nelsoni              TCA-ACCTTC GATGGTAGTC TATGCGACT- ACCATGGTGA TAACGGG-TA ACGGAGAATC
Trichuris_suis                   TCA-ACTTTC GATGGTACGC TACGTGCTT- ACCATGGTGA CAACGGT-TA ACGGAGAATC
Trichuris_trichiura              TCA-ACTTTC GATGGTACGC TACGTGCTT- ACCATGGTGA CAACGGT-TA ACGGAGAATC
Trichuris_muris                  TCA-ACTTTC GATGGTACGC TACGTGCTT- ACCATGGTGA CAACGGT-TA ACGGAGAATC
Tylolaimophorus_minor            TCA-ACTTTC GATGGTAGTT TATACGACT- ACCATGGTTG TAACGGA-TA ACGGAGAATA
Paratrichodorus_pachydermus      TCA-ACTTTC GATGGTAGTT TATACGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Paratrichodorus_anemones         TCA-ACTTTC GATGGTAGTT TATACGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Trichodorus_primitivus           TCA-ACTTTC GATGGTAGTT TATACGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Axonolaimus_helgolandicus        TCA-ACTTTT GATGGTAGTT TATGCGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Ascolaimus_elongatus             TCA-ACTTTT GATGGTAGTT TATGCGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Odontophora_rectangula           TCA-ACTTTT GATGGTAGTT TATGCGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Cylindrolaimus_sp._202149        TCA-ACTTTT GATGGTAGTT TATGCGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Tylocephalus_auriculatus         TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Plectus_acuminatus_BS9           TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Plectus_aquatilis                TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Anaplectus_sp                    TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Anisakis_sp_WKT                  TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Anisakis_sp_Nadler               TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Contracaecum_multipapillatum     TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Pseudoterranova_decipiens        TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Raphidascaris_acus               TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Terranova_caballeroi             TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Ascaris_suum                     TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Ascaris_lumbricoides             TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Baylisascaris_procyonis          TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Baylisascaris_transfuga          TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Parascaris_equorum               TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Porrocaecum_depressum            TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Toxascaris_leonina               TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Heterocheilus_tunicatus          TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Goezia_pelagia                   TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Hysterothylacium_fortalezae      TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Hysterothylacium_pelagicum       TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Hysterothylacium_reliquens       TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Iheringascaris_inquies           TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Toxocara_canis                   TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Nemhelix_bakeri                  TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Raillietnema_sp._V3060           TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Cruzia_americana                 TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
NUCLEOTIDES INCLUDED             mmm-mmm--m mmmmmmmmmm mmmmmmmmm- mmmmmmmmmm mmmmmmm-mm mmmmmmmmmm
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                                        490        500        510        520        530        540
Heterakis_sp_14690               TCA-ACTTTC GATGGTAGTT TAAATGCCT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Heterakis_gallinarum             TCA-ACTTTC GATGGTAGTT TAACTGCCT- ACCATGGTCG TAACGGG-TA ACGGAGAATA
Paraspidodera_sp_21303           TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Chromodora_nudicapitata          TCA-ACTGTC GATGGTAGTT TATTGGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATT
Chromadora_sp._BHMM_2005         TCA-ACTGTC GATGGTAGTT TATTGGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATT
Atrochromadora_microlaima        TCA-ACTGTC GATGGTAGTT TATTGGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATT
Chromadorina_germanica           TCA-ACTGTC GATGGTAGTT TATTGGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATT
Chromadorita_tentabundum         TCA-ACTTTC GATGGTAGTC TATAAGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Dichromadora_sp._BHMM_2005       TCA-ACTGTC GATGGTAGTT TATTGGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATT
Neochromadora_BHMM_2005          TCA-ACTTTC GATGGTAGTT TACATGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Spilophorella_paradoxa           TCA-ACTTTC GATGGTAGTT TACATGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Paracanthonchus_caecus           TCA-ACTTTC GATGGTAGTT TATATGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Paracyatholaimus_intermedius     TCA-ACTGTC GATGGTAGTT TATATGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATC
Praeacanthonchus_punctatus       TCA-ACTTTC GATGGTAGTT TACATGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Praeacanthonchus_sp              TCA-ACTTTC GATGGTAGTT TACATGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Cyatholaimus_sp._BHMM_2005       TCA-ACTTTC GATGGTAGTT TATATGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Spirinia_parasitifera            TCA-ACTTTC GATGGTAGTT TACGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Acanthopharynx_micans            TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTCG TAACGGG-TA ACGGAGAATA
Xyzzors_sp                       TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTGT TAACGAG-TA ACGGAGAATA
Metachromadora_sp                TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Metachromadora_remanei           TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Catanema_sp                      TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTCG TAACGGG-TA ACGGAGAATA
Eubostrichus_dianae              TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTA TAACGGG-TA ACGGAGAATA
Eubostrichus_topiarus            TCA-ACTTTC GATGGTAGTT TATATGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Eubostrichus_parasitiferus       TCA-ACTTTC GATGGTAGTT TATATGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Laxus_oneistus                   TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Laxus_cosmopolitus               TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ATGGAGAATA
Leptonemella_sp                  TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Robbea_hypermnestra              TCA-ACTTAC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Stilbonema_majum                 TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Monoposthia_costata              TCA-ACTTTC GATGGTAGGA TAGGGGCCT- ACCATGGTGG TGACGGA-TG ACGGAGAATT
Nudora_bipapillata               TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTA TCACGGG-TA ACGGAGAATT
Calomicrolaimus_parahonestus     TCA-ACTTTC GATGGTAGTT TATGTGACT- ACCATGGTTG TTACGGG-TA ACGGAGAATT
Calomicrolaimus_sp._BHMM_2005    TCA-ACTTTC GATGGTAGTT TATGTGACT- ACCATGGTTG TTACGGG-TA ACGGAGAATT
Molgolaimus_demani               TCA-ACTTTC GATGGTAGTT TATATGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATT
Diplogaster_lethieri             TCA-ACTATT GATGGAAGTC TATGTGTCT- TCCATGGTTG TAACGGG-TA ACGGAGAATA
Aduncospiculum_halicti           TCA-ACTTTC GATGGAAGTC TATGTGACT- ACCATGGTTG TAACAGG-TA ACGGAGAATA
Pristionchus_lheritieri          TCA-ACTATT GATGGAAGTC TATGTGTCT- TCCATGGTTG TAACGGG-TA ACGGAGAATA
Pristionchus_pacificus           TCA-ACTATT GATGGAAGTC TATGTGTCT- TCCATGGTTG TAACGGG-TA ACGGAGAATA
Pristionchus_pacificus           TCA-ACTATT GATGGAAGTC TATGTGTCT- TCCATGGTTG TAACGGG-TA ACGGAGAATA
Sabatieria_punctata_STRAIN_343   TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Sabatieria_sp._355_BHMM_2005     TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Sabatieria_celtica               TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Sabatieria_punctata_STRAIN_200   TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Sabatieria_punctata_STRAIN_223   TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Sabatieria_sp._210_BHM_2005      TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Setosabatieria_hilarula          TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Desmolaimus_zeelandicus          TCA-ACTGTT GATTGTAGTT TATGTGACT- ACAATGGTTG CAACGGG-TA ACGGAGAATC
Terschellingia_longicaudata      TCA-ACTTTC GATGGTAGTT TATGTGACT- ACCATGGTTA TAACGGG-TA ACGGAGAATA
Cyartonema_elegans               TCA-ACTTTC GATGGTAGTT TATGTGACT- ACCATGGTTA TAACGGG-TA ACGGAGAATA
Tridentulus_sp                   TCA-ACTTTC GATGGTAGTT TATGTGACT- ACCATGGTTG TTACGGG-TA ACGGAGAATC
Diplolaimelloides_meyli          TCA-ACTTTC GATGGTAGTT TCTGTGACT- ACCATGGTTG TGACGGG-TA ACGGAGGATC
Diplolaimella_diavengatensis     TCA-ACTTTC GATGGTAGTT TATGTGACT- ACCATGGTTG TGACGGG-TA ACGGAGGATT
Geomonhystera_disjuncta          TCA-ACTGTC GATGGTAGTT TATGTGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATC
Sphaerolaimus_hirsutus           TCA-ACTTTC GATGGTAGTT TATATGCCT- ACCATGGTTG TAACGGG-TA ACGGAAAATC
Theristus_acer                   TCA-ACTTTC GATGGTAGTT TATGTGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATC
Daptonema_procerus               TCA-ACTTTC GATGGTAGTT TCTACGCCT- ACCATGGTTT CGACGGG-TA ACGGAGAATT
Daptonema_hirsutum               TCA-ACTTTC GTTGGTAGTT TATACGCCT- ACCAAGGTTT TAACGGA-TA ACGGAGAATC
Daptonema_normandicum            TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATT
Daptonema_oxycerca               TCA-ACTTTC GATGGTAGTT TCTACGCCT- ACCATGGTTT CGACGGG-TA ACGGAGAATT
Daptonema_setosum                TCA-ACTTTC GTTGGTAGTT TATACGCCT- ACCAAGGTTT TAACGGA-TA ACGGAGAATC
Desmodora_communis               TCA-ACTGTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Desmodora_ovigera                TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTGG TAACGGG-TA ACGGAGAATA
Metadesmolaimus_sp               TCA-ACTTTC GTTGGTAGTT TATACGCCT- ACCAAGGTTT TAACGGA-TA ACGGAGAATC
Dentostomella_sp                 TCA-ACTTTC GATGGTTGGT TATGTGCCT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Bunonema_franzi                  TCA-ACTTCC GATGGGAGGT CATGTGCCT- CCCATGGTTG TGACGGG-TA ACGGAGAATA
Bunonema_sp                      TCA-ACTTCC GATGGGAGAT TATGTGCCT- CCCATGGTTG TGACGGG-TA ACGGAGGATC
Seleborca_complexa               TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGA TCACGCG-TA ACGGAGAATA
Acrobeloides_nanus               TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGA TCACGCG-TA ACGGAGAATA
Acrobeloides_bodenheimeri        TCA-ACTTTC GATGGTGGTG TTTCTGACT- ACCATGGTGA TCACGCC-TA ACGGAGAATA
Acrobeloides_sp_PS1146           TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGA TCACGCG-TA ACGGAGAATA
Acrobeles_ciliatus               TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGA TCACGCG-TA ACGGAGAATA
Acrobeles_sp_PS1156              TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGA TCACGCG-TA ACGGAGAATA
Acrobeles_complexus_WCUG2        TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGA TCACGCG-TA ACGGAGAATA
Cephaloboides_sp_SB227           TCA-ACC--T GATGGTAGTT TATTAGACT- ACCATGGTGA TTACGGG-TA ACGGAGAATC
Cephalobus_cubaensis             TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGA TCACGCG-TA ACGGAGAATA
Cephalobus_sp._PS1143            TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGA TCACGCG-TA ACGGAGAATA
Cephalobus_sp._PS1196            TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGA TCACGCG-TA ACGGAGAATA
NUCLEOTIDES INCLUDED             mmm-mmm--m mmmmmmmmmm mmmmmmmmm- mmmmmmmmmm mmmmmmm-mm mmmmmmmmmm
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                                        490        500        510        520        530        540
Cephalobus_oryzae_PS1165         TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGA TCACGCG-TA ACGGAGAATA
Cervidellus_alutus               TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGA TCACGCG-TA ACGGAGAATA
Pseudacrobeles_variabilis        TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGA TCACGCG-TA ACGGAGAATA
Triligulla_aluta                 TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGA TCACGCG-TA ACGGAGAATA
Zeldia_punctada                  TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGA TCACGCG-TA ACGGAGAATA
Myolaimus_sp_U81585              TCA-ACTTTC GATGGTAGTT TATGTGACT- ACCATGGTGA TCACGGG-TA ACGGAGGATA
Rhabditophanes_sp._KR3021        TCA-ACTTTC GATGGTAGGG TATTGGCCT- ACCATGGTGT TGACGGA-TA ACGGAGAATC
Brevibucca_sp._SB261             TCA-ACTGTT GACTGTATGC TATCGGCTT- ACAGTGGTTG TAACGGG-TA ACGGAGAATA
Halicephalobus_gingivalis        TCA-ACTAT- -ATAACCGTG TATTGAACG- GTTATGGTGT TGCCGGG-TA ACGGAGAATT
Panagrobelus_stammeri            TCA-ACTGTC GATGGTAGTT TATTGCACT- GCCATGGTGT TGACGGG-TA ACGGAGAATT
Plectonchus_sp._PDL0025          TCA-ACTGTC GATGGTAGTT TATTGCACT- GCCATGGTGT TGACGGG-TA ACGGAGAATT
Turbatrix_aceti                  TCA-ACTT-C GACATTAGTG TATTGAACT- AATGTGGTGT TGACGGA-TA ACGGAGAATT
Panagrellus_redivivus            TCACACTTCC AACGGCAGTG TATTGTCCT- GACGTGGTTG TGACGGG-TA ACTGATAATT
Panagrellus_redivivus_PS1163     TCACACTTCC AACGGCAGTG TATTGTCCT- GACGTGGTTG TGACGGG-TA ACGGAGAATT
Panagrolaimus_subelongatus       TCA-ACTTTC TATATAAGTA TATAGTACT- TATATGGTTT TGACGGA-TA ACGGGGTATT
Panagrolaimus_davidi             TCA-ACTTTC TATATAAGTA TATAGTACT- TATATGGTTT TGACGGA-TA ACGGGGTATT
Panagrolaimus_cf_rigidus_AF40    TCA-ACTTTC TATATAAGTA TATAGTACT- TATATGGTTT TGACGGA-TA ACGGAGTATT
Panagrolaimus sp. Sourhope ED2   TCA-ACTTTC TATATAAGTA TATAGTACT- TATATGGTTT TGACGGA-TA ACGGAGTATT
Panagrolaimus sp. Sourhope ED2   TCA-ACTTTC TATATAAGTA TATAGTACT- TATATGGTTT TGACGGA-TA ACGGAGTATT
Panagrolaimus sp. Sourhope ED2   TCA-ACTTTC TATATAAGTA TATAGTACT- TATATGGTTT TGACGGA-TA ACGGAGTATT
Panagrolaimus sp. Sourhope ED2   TCA-ACTTTC TATATAAGTA TATAGTACT- TATATGGTTT TGACGGA-TA ACGGGGTATT
Panagrolaimus sp. Sourhope ED2   TCA-ACTTTC TATATAAGTA TATAGTACT- TATATGGTTT TGACGGA-TA ACGGGGTATT
Steinernema_carpocapsae          TCA-ACTTTT GATGGTTGTG TATTTGACA- ACCATGGTGG TGACGGG-TA ACGGAGAATT
Strongyloides_stercoralis        TCA-ACTTTC GATGGTAGGA TAGTGGCCT- ACCATGGTAT CAACGGG-TA ACGGGGAATT
Strongyloides_ratti              TCA-ACTTTC GATGGTAGGG TATTGGCCT- ACCATGGTTG TGACGGA-TA ACGGAGAATT
Diploscapter_sp_PS1897           TCA-ACT--A GACGGTAGCC CAGTAGACT- ACCGTGGTTG TCACGGG-TA CCGGAGAATT
Diploscapter_sp_PS2017           TCA-ACT--A GACGGTAGCC CAGTAAACT- ACCGTGGTTG TCACGGG-TA CCGGAGAATT
Heterorhabditis_bacteriophora    TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TCACGGG-TA ACGGAGAATA
Heterorhabditis_hepialus         TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TCACGGG-TA ACGGAGAATA
Heterorhabditis_zelandica        TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TCACGGG-TA ACGGAGAATA
Parasitorhabditis_sp_SB281       TCA-ACTTTT GATGGTAGTT TAGTTGTCT- ACCATGGTGA TAACGGG-TA ACGGAGGATA
Rhabditoides_inermiformis        TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATC
Rhabditoides_inermis_DF5001      TCA-ACTTTC GATGGTAGTT TATGTGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Rhabditoides_regina_DF5012       TCA-ACTTTC --TAGTAGAG TAGCGGTCT- ACTAGGGTGA TTACGGG-TA ACGGAGGATT
Poikilolaimus_oxycerca_SB200     TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG CAACGGG-TA ACGGAAAATA
Poikilolaimus_regenfussi_SB199   TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG CAACGGG-TA ACGGAAAATA
Distolabrellus veechi DWF1604    TCA-ACTTTT GATGGTAGTT TCGTTGTCT- ACCATGGTGA TAACGGG-TA ACGGAGGATA
Distolabrellus veechi DF5024     TCA-ACTTTT GATGGTAGTT TCGTTGTCT- ACCATGGTGA TAACGGG-TA ACGGAGGATA
Choriorhabditis_dudichi          TCA-ACC--T GGTGGTAGTC TATTAGTCT- ACCATGGTTA TAACGGG-TA ACGGAGAATC
Protorhabditis_sp                TCA-ACT--A GATGGTAGCC TAGTAGACT- ACCATGGTTG TCACGGG-TA CCGGAGAATC
Protorhabditis_sp_DF5055         TCA-ACT--A GATGGCAGTT TAGAGGACT- GCCATGGTTG TAACGGG-TA CCGGAGAATC
Cruznema_tripartitum_DF5015      TCA-ACT--T GATGGTAGTG TATTGGACT- ACCATGGTTA TCACGGG-TA ACGGAGAATC
Mesorhabditis_sp_PS1179          TCA-ACTTTT GATGGTAGTT TAGTTGACT- ACCATGGTCG TAACGGG-TA ACGGAGGATC
Mesorhabditis_spiculigera_SB15   TCA-ACTT-T GATGGTAGTT TAGTTGGCT- ACCATGGTGA TAACGGG-TA ACGGAGGATC
Mesorhabditis_anisomorpha_SB12   TCA-ACTTTT GATGGTAGTT CAGTTGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATC
Teratorhabditis_palmarum_DF501   TCA-ACTTTT GATGGTAGTT TAGTTGACT- ACCATGGTGA TAACGGG-TA ACGGAGGATC
Teratorhabditis_synpapillata_S   TCA-ACTTTT GATGGTAGTT TAGTTGACT- ACCATGGTGA TAACGGG-TA ACGGAGGATC
Caenorhabditis_briggsae_PB102    TCA-ACT--A GATGGTAGTT TATTGGACT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Caenorhabditis_elegans_N2        TCA-ACT--A GATGGTAGTT TATTGGACT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Caenorhabditis_sp_CB5161         TCA-ACT--A GATGGTAGTC TATTGGACT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Caenorhabditis_sp_PS1010         TCA-ACT--A GATGGTAGTT CATTGGACT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Caenorhabditis_japonica          TCA-ACT--A GATGGTAATC TATTGGACT- ACCATGGTTG TTACGGG-TA ACGGAGAATT
Caenorhabditis_sp_DF5170         TCA-ACT--A GATGGTAGTT TATTGGACT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Caenorhabditis_sp_SB341          TCA-ACT--A GATGGTAGTC TATTAGTCT- ACCATGGTTA TCACGGG-TA ACGGAGAATA
Caenorhabditis_plicata           TCA-ACT--A GATGGCAGTC TATTGGATT- GCTATGGTTG TTACGGG-TA ACGGAGAATA
Caenorhabditis_vulgaris          TCA-ACT--A GATGGTAGTT CATTGGACT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Caenorhabditis_sonorae           TCA-ACT--A GATGGTAGTC TATTAGTCT- ACCATGGTTA TCACGGG-TA ACGGAGAATA
Caenorhabditis_drosophilae       TCA-ACT--A GATGGTAGTT TATTGGACT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Phasmarhabditis_hermaphrodita    TCA-ACT--A GATGATAGTC TATTGGCCT- ATCATGGTTG TAACGGG-TA ACGGAGAATC
Phasmarhabditis_neopapillosa     TCA-ACT--A GATGATAGTC TATTGGCCT- ATCATGGTTG TAACGGG-TA ACGGAGAATC
Phasmarhabditis_neopapillosa     TCA-ACC--A GATGGTAGTC TATTAGTCT- ACCATGGTTA TCACGGG-TA ACGGAGAATA
Pellioditis_mediterranea_SB173   TCA-ACC--A GATGGTAGTC TATTAGTCT- ACCATGGTTA TAACGGG-TA ACGGAGAATA
Pellioditis_marina               TCA-ACC--A GATGGTAGTC TATTAGTCT- ACCATGGTTA TCACGGG-TA ACGGAGAATA
Prodontorhabditis_wirthi         TCA-ACT--A GACGTCAGAG TCGTGACCT- GACGTGGTTG CCACGGG-TA ACGGAGAATT
Crustorhabditis_scanica          TCA-ACTTTG -ATGGTAGTT TCGTTGTCT- ACCATGGTGA TAACGGG-TA ACGGAGGATC
Dolichorhabditis_sp_CEW1         TCA-ACT--A GATGGTAGTC TATTAGACT- ACCATGGTGA TAACGGG-TA ACGGAGAATA
Oscheius_sp_DF5000               TCA-ACT--A GATGGTAGTC TATTAGACT- ACCATGGTGA TAACGGG-TA ACGGAGAATA
Oscheius_sp_BW282                TCA-ACC--A GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Oscheius_myriophila_EM435        TCA-ACC--A GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Oscheius_insectivora             TCA-ACC--A GATGGTAGTC TATTAGTCT- ACCATGGTTA TCACGGG-TA ACGGAGAATA
Oscheius_dolichuroides           TCA-ACT--A GATGGTAGTA TATTTGACT- ATCATGGTGA TAACGGG-TA ACGGAGAATA
Rhabditis_blumi_DF5010           TCA-AC---T GACGGTAGTC TATTAGTCT- ACCGAGGTTA TCACGGG-TA ACGGAGAATA
Rhabditis_sp_PS1191              TCA-ACT--A GATGGTAGTC TATTAGTCT- ACCATGGTTA TCACGGG-TA ACGGAGAATA
Rhabditis_sp_PS1010              TCA-ACT--A GATGGTAGTT CATTGGACT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Rhabditis_myriophila_EM435       TCA-ACC--A GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Rhabditis_colombiana             TCA-ACC--A GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Rhabditella_axei_DF5006          TCA-ACC--A GATGGTAGTC TATTAGTCT- ACCATGGTGA TCACGGG-TA ACGGAGAATC
Rhabditella_sp_DF5044            TCA-ACC--A GATGGTAGTC TATTAGTCT- ACCATGGTGA TCACGGG-TA ACGGAGAATC
NUCLEOTIDES INCLUDED             mmm-mmm--m mmmmmmmmmm mmmmmmmmm- mmmmmmmmmm mmmmmmm-mm mmmmmmmmmm
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                                        490        500        510        520        530        540
Cuticularia_sp_PS2083            TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG CAACGGG-TA ACGGAAAATA
Necator_americanus               TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Kalicephalus_cristatus           TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Ancylostoma_caninum              TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Angiostrongylus_cantonensis      TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Angiostrongylus_costaricensis    TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Angiostrongylus_malaysiensis     TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Angiostrongylus_dujardini        TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Angiostrongylus_vasorum          TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Aulurostrongylus_abstrusus       TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Didelphostrongylus_hayesi        TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Crenosoma_mephitidis             TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Crenosoma_vulpis                 TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Otostrongylus_circumlitus        TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Troglostrongylus_wilsoni         TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Filaroides_martis                TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Oslerus_osleri                   TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Parafilaroides_decorus           TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Metastrongylus_salmi             TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Metastrongylus_elongatus         TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Skrjabingylus_chitwoodrum        TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Parelaphostrongylus_odocoilei    TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Muelerius_capillaris             TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Protostrongylus_rufescens        TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Halocercus_invaginatus           TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Pseudalius_inflexus              TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Stenurus_minor                   TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Torynurus_convolutus             TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Syngamus_trachea                 TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TAACGGG-TA ACGGAGAATA
Stephanurus_dentatus             TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Nematodirus_battus               TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Strongylus_equinus               TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Labiostrongylus_bipapillosus     TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Petrovinema_poculatum            TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Cylicocyclus_insignis            TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Chabartia_ovina                  TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Cyclodontostomum_purvisi         TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Zoniolaimus_mawsonae             TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Hypodontus_macropi               TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Deletrocephalus_dimidiatus       TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Dictyocaulus_eckerti_P7B8        TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Dictyocaulus_capreolus_P3B2      TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Dictyocaulus_sp._P6A1            TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Dictyocaulus_filaria             TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Dictyocaulus_capreolus_P2C10     TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Dictyocaulus_viviparus           TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Haemonchus_sp._V3091             TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Haemonchus_contortus             TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Haemonchus_placei                TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Haemonchus_similis               TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Ostertagia_ostertagi             TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Ostertagia_leptospicularis       TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Nippostrongylus_brasileinsis     TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Heligmosomoides_polygyrus        TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Trichostrongylus_colubriformis   TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Tetrabothriostrongylus mackerr   TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Herpestrongylus_pythonis         TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Nicollina_cameroni               TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Filarimena_flagrifer             TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Amidostomum_cygni                TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Teratocephalus_lirellus          TCA-ACTTTC GATGGTAGAT TATGTGTCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Brumptaemilius_justini           TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Anguillicola_crassus             TCA-ACTGTC GATGGTAGTT TATATGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Dracunculus_medinensis           TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Dracunculus_oesophageus          TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Dracunculus_sp._V3104            TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Philonema_sp_A                   TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Philometra_obturans              TCA-ACTTTC GATGGTAGTT TATACGACT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Camallanus_oxycepahalus          TCA-ACTTTC GATGGTAGTT TATATGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Acanthocheilonema_viteae         TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Loa_loa                          TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Onchocerca_cervicalis            TCA-ACTTTC GATGGTAATT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Dirofilaria_immitis              TCA-ACTTTC GATGGTAGTT TATGTGCCTA ACCATNGTTG TAACGGG-TA ACGGAGAATA
Brugia_malayi                    TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Wuchereria_bancrofti             TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Litomosoides_sigmodontis         TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGWGAATA
Setaria_digitata                 TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Gnathostoma_turgidum             TCA-ACTTTC GATGGTAGGT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
NUCLEOTIDES INCLUDED             mmm-mmm--m mmmmmmmmmm mmmmmmmmm- mmmmmmmmmm mmmmmmm-mm mmmmmmmmmm
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                                         490        500        510        520        530        540
Gnathostoma_neoprocyonis         TCA-ACTTTC GATGGTAGGT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Gnathostoma_binucleatum          TCA-ACTTTC GATGGTAGGT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Physaloptera_alata               TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAGTA
Physaloptera_turgida             TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Ascarophis_arctica               TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Spinitectus_carolini             TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Thelazia_lacrymalis              TCA-ACTTTC GATGGTAGTT TATGTGCCT- ACCATGGTTG TAACGGG-TA ACGGAGAATA
Aphelenchus_avenae               TCA-ACTTTC GATGGTAGTG TAGTGGACT- ACCATGGTTG TGACGGG-TA ACGGAGGATA
Aphelenchoides_fragariae         TCA-ACTTTC GATGGTAGTG TATTGGACT- GCCATGGTGT TGACGGG-TA ACGGAGAATC
Bursaphelelenchus_sp             TCA-ACTATC GTTGGTAGTT TATTGGACT- ACCATGGTGT TGACGGG-TA ACGGAGAATC
Deladenus_sp                     TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGG TGACGGG-TA ACGGGGGATA
Criconema_sp                     TCA-ACTTTC GATGGTAGTG TACGTGACT- ACCATGGTTG TGACGGG-TA ACGGAGGATA
Hemicycliophora_conida           TCA-ACTTTC GATGGTAGTG TACGTGACT- ACCATGGTTG TGACGGG-TA ACGGAGGATA
Paratylenchus_dianthus           TCA-ACTTTC GATGGTAGTG TACGTGACT- ACCATGGTGT TGACGGG-TA ACGGAGGATA
Pratylenchus_thornei             TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGG TGACGGG-TA ACGGAGGATA
Tylenchulus_semipentrans         TCA-ACTTTC GATGGTAGTG TACGTGACT- ACCATGGTGT TGACGGG-TA ACGGAGGATA
Ditylenchus_angustus             TCA-ACTTTC GACGGTAGTG TATTGGACT- ACCGTGGTGG TGACGGG-TA ACGGAGGATA
Subanguina_radicola              TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGG TGACGGG-TA ACGGAGGATA
Tylenchorhynchus_maximus         TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGA TGACGGG-TA ACGGAGGATA
Geocenamus_quadrifer             TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGG TGACGGG-TA ACGGAGGATA
Globodera_pallida                TCA-ACTTTC GATGGTAGTG TACCTGACT- ACCATGGTGA TGACGGG-TA ACGGAGGATA
Scutellonema_bradys              TCA-ACTTTC GATGGTAGTG TACCTGACT- ACCATGGTTG TGACGGG-TA ACGGAGGATC
Helicotylenhcus_dihystera        TCA-ACTTTC GATGGTAGTG TACCTGACT- ACCATGGTTG TGACGGG-TA ACGGAGGATA
Rotylenchus_robustus             TCA-ACTTTC GATGGTAGTG TACCTGACT- ACCATGGTGA TGACGGG-TA ACGGAGGATA
Meloidogyne_arenaria             TCA-ACTT-- GACGGGAGCA TAATCGACT- CCCGTGGTGG TGACGGA-TA ACGGAGGATC
Meloidogyne_incognita_KT         TCA-ACTT-- GACGGGAGCA TAATCGACT- CCCGTGGTGG TGACGGA-TA ACGGAGGATC
Meloidogyne_javanica             TCA-AMTT-- GACGGGAGCA TAATCGACT- CCCGTGGTGG TGACGGA-TA ACGGAGGATC
Meloidogyne_artiellia            TCA-ACTT-- GACGGGAGTA TAATCGACT- CCCGTGGTGG TGACGGA-TA ACGGAGAATC
Meloidogyne_duytsi               TCA-ACTT-- GACGGGAGCA TAACCGACT- CCCGTGGTGG TGACGGA-TA ACGGAGGATC
Meloidogyne_exigua               TCA-ACTT-- GACGGGAGCA TAATCGACT- CCCGTGGTTG TGACGGA-TA ACGGAGGATC
Meloidogyne_hapla                TCA-ACTT-- GACGGGAGCA TAATCGACT- CCCGTGGTGG TGACGGA-TA ACGGAGGATC
Meloidogyne_ichinohei            TCATACTT-- GATGTTAGTA TCAGTGGCT- AACATGGTGG TGACGGA-TA ACGGAGGATC
Meloidogyne_maritima             TCA-ACTT-- GACGGGAGCA TAATCGACT- CCCGTGGTGG TGACGGA-TA ACGGAGGATC
Meloidogyne_microtyla            TCA-ACTT-- GACGGGAGCA TAATTGACT- CCCGWGGTGA TGACGGA-TA ACGGAGGATC
Nacobbus_aberrans                TCA-ACTTTC GATGGTAGCG TATCTGCCT- ACCATGGTGA TGACGGG-TA ACGGAGGATA
Pratylenchoides_ritteri          TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGG TGACGGG-TA ACGGAGGATA
Pratylenchoides_magnicauda       TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGG TGACGGG-TA ACGGAGGATA
Hirschmanniella_sp._JH_2003      TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTGG TGACGGG-TA ACGGAGGATA
Radopholus_similis               TCA-ACTTTC GACGGTAGTG TCTCTGGCT- ACCGTGGTGG TGACGGG-TA ACGGAGGATC
Pratylenchus_goodeyi_VF          TCA-ACTTTC GATGGTAGTG TCAGTGACT- ACCATGGTGG TGACGGT-TA ACGGAGGATC
Boleodorus_thylactus_clone2      TCA-ACTTTC GATGGTAGTG TATCTGACT- ACCATGGTTG TGACGGG-TA ACGGAGGATA
Philippine Sequence 1            TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Philippine Sequence 2            TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Philippine Sequence 3            TCA-ACC--A GATGGTAGCC TATTAGACT- ACCATGGTTA TAACGGG-TA ACGGAGAATC
Philippine Sequence 4            TCA-ACTTTC TATATAAGTA TATAGTACT- TATATGGTTT TGACGGA-TA ACGGAGTATT
Philippine Sequence 5            TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Philippine Sequence 6            TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TCACGGG-TA ACGGAGAATA
Philippine Sequence 7            TCA-ACT--A GATGGTAGTT TATTGGACT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Tahiti Sequence 1                TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Tahiti Sequence 2                TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Thailand Sequence 1              TCA-ACTTTC GATGGTAGTT TAAATGCCT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Ogasawara Sequence 1             TCA-ACTTTC TATATAAGTA TATAGTACT- TATATGGTTT TGACGGA-TA ACGGAGTATT
Ogasawara Sequence 2             TCA-ACT--A GATGTTAGTC TATTAGTCT- AACATGGTTG TAACGGG-TA ACGGAGAATC
Ivory Coast Sequence 1           TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Ivory Coast Sequence 2           TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Ivory Coast Sequence 3           TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Ivory Coast Sequence 4           TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Ivory Coast Sequence 5           TCA-ACTTTC GATGGTAGTT TAAATGCCT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Ivory Coast Sequence 6           TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Ivory Coast Sequence 7           TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Singapore Sequence 1             TCA-ACC--A GATGGTAGCC TATTAGACT- ACCATGGTTA TAACGGG-TA ACGGAGAATC
Singapore Sequence 2             TCA-ACTTTC GATGGTAGTT TAAATGCCT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Singapore Sequence 3             TCA-ACT--A GATGGTAGTT TATTGGACT- ACCATGGTTG TTACGGG-TA ACGGAGAATA
Singapore Sequence 4             TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Nigerian Sequence 1              TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TG ACGGAGAATA
Nigerian Sequence 2              TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
Nigerian Sequence 3              TCA-ACC--T GATGGTAGTC TATTAGTCT- ACCATGGTTA TTACGGG-TA ACGGAGAATA
NUCLEOTIDES INCLUDED             mmm-mmm--m mmmmmmmmmm mmmmmmmmm- mmmmmmmmmm mmmmmmm-mm mmmmmmmmmm


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                                         550        560        570        580        590        600
Gordius_aquaticus                AGGGTT-CG- ATTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Priapulus_caudatus               AGGGTT-CG- ATTCC--GGA GAGGGAGCAT GAGAAACGGC TACCACATCC AAGGAAGGCA
Brachionus_plicatilis            AGGGTT-CG- ATTCC--GGA GAGGGAGCAT GAGAAACGGC TACCACATCT ACGGAAGGCA
Chordodes_morgani                AGGGTT-CG- ATTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Paractinolaimus_macrolaimus      AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Aporcelaimellus_obtusicaudatus   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
NUCLEOTIDES INCLUDED             mmmmmm-mm- mmmmm--mmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                        550        560        570        580        590        600
Wilsonema_schuurmansstekhoveni   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Mesodorylaimus_sp_cf_nigritul    AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Mesodorylaimus_bastiani          AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Mesodorylaimus_japonicus         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Pungentus_sp._PDL_2005           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Allodorylaimus_sp                AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Eudorylaimus_carteri             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Microdorylaimus_sp               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Longidorus_elongatus             AGGGTT-YG- ACTCC--GGA GAGGGAGCCT GWGAAACGGC TACCACATCC AAGGAAGGCA
Xiphinema_rivesi                 AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Tylencholaimus_sp                AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Anoplostoma_sp._BHMM_2005        AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Adoncholaimus_fuscus             AGGGTT-TG- ATTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Enoplus_meridionalis             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Enoplus_brevis_U88336            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Enoplus_communis                 AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Enoploides_brunettii             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Syringolaimus_striatocaudatus    AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Ironus_dentifurcatus             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Calyptronema_maxweberi           AGGGTT-TG- ATTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Viscosia_sp._BHMM_2005           AGGGTT-TG- ATTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Viscosia_viscosa                 AGGGTT-TG- ATTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Pontonema_vulgare                AGGGTT-TG- ATTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Oncholaimus_sp._BHMM_2005        AGGGTT-TG- ATTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Alaimus_sp_PDL_2005              AGGGTT-CG- ATACC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Prismatolaimus_intermedius       AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Tobrilus_gracilis                AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Tripyla_cf_filicaudata_JH_2004   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAKCGGC TACCACATCC AAGGAAGGCA
Bathylaimus_sp                   AGGGTT-TG- ACTCT--GGA GAGGCAGCCT GAGAGACGGC TACCACATCC AAGGAAGGCA
Bathylaimus_assimilis            AGGGTT-TG- ACTCT--GGA GAGGCAGCCT GAGAGACGGC TACCACATCC AAGGAAGGCA
Bathylaimus_sp._BHMM_2005        AGGGTT-TG- ACTCT--GGA GAGGGAGCCT GAGAGACGGC TACCACATCC AAGGAAGGCA
Tripyloides_sp._BHMM_2005        AGGGTT-TG- ACTCT--GGA GAGGGAGCCT GAGAGACGGC TACCACATCC AAGGAAGGCA
Trischistoma_monohystera         AGGGTT-CG- ATTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Mermis_nigrescens                AGG-TT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Mylonchulus_arenicolus           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Anatonchus_tridentacus           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Mononchus_truncatus              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Prionchulus_muscorum             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Clarkus_sp                       AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Trichinella_spiralis             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Trichinella_papuae               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Trichinella_britovi              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Trichinella_murrelli             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Trichinella_pseudospiralis       AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Trichinella_nativa               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Trichinella_zimbabwensis         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Trichinella_nelsoni              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Trichuris_suis                   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Trichuris_trichiura              AGGGTT-CG- GCTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Trichuris_muris                  AGGGTTTCG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Tylolaimophorus_minor            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Paratrichodorus_pachydermus      AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Paratrichodorus_anemones         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Trichodorus_primitivus           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Axonolaimus_helgolandicus        AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Ascolaimus_elongatus             AGGGTT-CG- ACTCC--GGA RAGGGAGCCT GAAAAATGGC TACCACATCC AAGGAAGGCA
Odontophora_rectangula           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Cylindrolaimus_sp._202149        AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Tylocephalus_auriculatus         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Plectus_acuminatus_BS9           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Plectus_aquatilis                AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Anaplectus_sp                    AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Anisakis_sp_WKT                  AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Anisakis_sp_Nadler               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Contracaecum_multipapillatum     AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Pseudoterranova_decipiens        AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Raphidascaris_acus               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Terranova_caballeroi             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Ascaris_suum                     AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Ascaris_lumbricoides             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Baylisascaris_procyonis          AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Baylisascaris_transfuga          AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Parascaris_equorum               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Porrocaecum_depressum            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Toxascaris_leonina               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Heterocheilus_tunicatus          AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Goezia_pelagia                   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Hysterothylacium_fortalezae      AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
NUCLEOTIDES INCLUDED             mmmmmm-mm- mmmmm--mmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                         550        560        570        580        590        600
Hysterothylacium_pelagicum       AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Hysterothylacium_reliquens       AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Iheringascaris_inquies           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Toxocara_canis                   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Nemhelix_bakeri                  AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Raillietnema_sp._V3060           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Cruzia_americana                 AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Heterakis_sp_14690               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Heterakis_gallinarum             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAAAAACGGC TACCACATCC AAGGAAGGCA
Paraspidodera_sp_21303           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Chromodora_nudicapitata          AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGATACGGC TACCACATCC AAGGAAGGCA
Chromadora_sp._BHMM_2005         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGATACGGC TACCACATCC AAGGAAGGCA
Atrochromadora_microlaima        AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGATACGGC TACCACATCC AAGGAAGGCA
Chromadorina_germanica           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGATACGGC TACCACATCC AAGGAAGGCA
Chromadorita_tentabundum         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACTTCC AAGGAAGGCA
Dichromadora_sp._BHMM_2005       AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGATACGGC TACCACATCC AAGGAAGGCA
Neochromadora_BHMM_2005          AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Spilophorella_paradoxa           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Paracanthonchus_caecus           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Paracyatholaimus_intermedius     AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Praeacanthonchus_punctatus       agggtt-cg- actcc--gga gagggagcct gagaaacggc taccacatcc aaggaaggca
Praeacanthonchus_sp              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Cyatholaimus_sp._BHMM_2005       AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Spirinia_parasitifera            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Acanthopharynx_micans            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Xyzzors_sp                       AGGGTT-TG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Metachromadora_sp                AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Metachromadora_remanei           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Catanema_sp                      AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCG
Eubostrichus_dianae              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Eubostrichus_topiarus            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Eubostrichus_parasitiferus       AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Laxus_oneistus                   AGGGTT-CG- GCTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Laxus_cosmopolitus               AGGGTT-CG- ACTCC--GGA GAGGGATCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Leptonemella_sp                  AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Robbea_hypermnestra              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Stilbonema_majum                 AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Monoposthia_costata              AGGGTT-CG- ATTCC--GGA GAGGGAGCCT GAGAAACGGA TACCACATCC AAGGAAGGCA
Nudora_bipapillata               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAAAAACGGC TACCACATCC AAGGAAGGCA
Calomicrolaimus_parahonestus     AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Calomicrolaimus_sp._BHMM_2005    AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Molgolaimus_demani               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Diplogaster_lethieri             AGGGTT-CG- ACTCC--GGA GAGCTAGCCT TAGAAACGGC TATCACATCC AAGGAAGGCA
Aduncospiculum_halicti           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGATGGCA
Pristionchus_lheritieri          AGGGTT-CG- ACTCC--GGA GAGCTAGCCT TAGAAACGGC TATCACATCC AAGGAAGGCA
Pristionchus_pacificus           AGGGTT-CG- ACTCC--GGA GAGCTAGCCT TAGAAACGGC TATCACATCC AAGGAAGGCA
Pristionchus_pacificus           AGGGTT-CG- ACTCC--GGA GAGCTAGCCT TAGAAACGGC TATCACATCC AAGGAAGGCA
Sabatieria_punctata_STRAIN_343   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Sabatieria_sp._355_BHMM_2005     AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Sabatieria_celtica               AGGGTT-CG- ACTCC--GGA GAGGGAGCCC GAGAAACGGC TACCACATCC AAGGAAGGCA
Sabatieria_punctata_STRAIN_200   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Sabatieria_punctata_STRAIN_223   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Sabatieria_sp._210_BHM_2005      AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Setosabatieria_hilarula          AGGGTT-CG- ACTCC--GGA GAGGGAGCCC GAGAAACGGC TACCACATCC AAGGAAGGCA
Desmolaimus_zeelandicus          AGGGTT-CG- ACTCC--GGA GAGGCAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Terschellingia_longicaudata      AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Cyartonema_elegans               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Tridentulus_sp                   AGGGTT-TG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACTTCT AAGGAAGGCA
Diplolaimelloides_meyli          AGGGTC-TG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACTTCT AAGGAAGGCA
Diplolaimella_diavengatensis     AGGGTC-TG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACTTCT AAGGAAGGCA
Geomonhystera_disjuncta          AGGGTT-TG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACTTCT AAGGAAGGCA
Sphaerolaimus_hirsutus           AGGGTT-TG- ATTCC--GGA GAGGGCGCCC GAGAAATGGC GACCACTTCC AAGGAAGGCA
Theristus_acer                   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACTTCT AAGGAAGGCA
Daptonema_procerus               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACTTCT AAGGAAGGCA
Daptonema_hirsutum               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACTTCC AAGGAAGGCA
Daptonema_normandicum            AGGGTT-CG- ATTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACTTCC AAGGAAGGCA
Daptonema_oxycerca               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACTTCC AAGGAAGGCA
Daptonema_setosum                AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACTTCC AAGGAAGGCA
Desmodora_communis               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Desmodora_ovigera                AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAATGGC TACCACATCC AAGGAAGGCA
Metadesmolaimus_sp               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACTTCT AAGGAAGGCA
Dentostomella_sp                 AAGGTT-CG- ACTCC--GGA GAAGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Bunonema_franzi                  AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Bunonema_sp                      AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Seleborca_complexa               AGGGTT-CG- GCTCC--GGA GAGTTCGCCT GAGAAATCGC GAACACATCT AAGGAAGGCA
Acrobeloides_nanus               AGGGTT-CG- GCTCC--GGA GAGTTCGCCT GAGAAATCGC GAACACATCT AAGGAAGGCA
Acrobeloides_bodenheimeri        AGGGTT-CG- GCTCC--GGA GAGTTCGCCT GAGAAATCGC GAACACATCT AAGGAAGGCA
Acrobeloides_sp_PS1146           AGGGTT-CG- GCTCC--GGA GAGTTCGCCT GAGAAATCGC GAACACATCT AAGGAAGGCA
NUCLEOTIDES INCLUDED             mmmmmm-mm- mmmmm--mmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                        550        560        570        580        590        600
Acrobeles_ciliatus              AGGGTT-CG- ACTCC--GGA GAGTTCGCCT GAGAAATCGC GAACACATCT AAGGAAGGCA
Acrobeles_sp_PS1156             AGGGTT-CG- ACTCC--GGA GAGTTCGCCT GAGAAATCGC GAACACATCT AAGGAAGGCA
Acrobeles_complexus_WCUG2       AGGGTT-CG- ACTCC--GGA GAGTTCGCCT GAGAAATCGC GAACACATCT AAGGAAGGCA
Cephaloboides_sp_SB227          AGGGTT-CG- TCTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Cephalobus_cubaensis            AGGGTT-CG- GCTCC--GGA GAGTTCGCCT GAGAAATCGC GAACACATCT AAGGAAGGCA
Cephalobus_sp._PS1143           AGGGTT-CG- GCTCC--GGA GAGTTCGCCT GAGAAATCGC GAACACATCT AAGGAAGGCA
Cephalobus_sp._PS1196           AGGGTT-CG- GCTCC--GGA GAGTTCGCCT GAGAAATCGC GAACACATCT AAGGAAGGCA
Cephalobus_oryzae_PS1165        AGGGTT-CG- GCTCC--GGA GAGTTCGCCT GAGAAATCGC GAACACATCT AAGGAAGGCA
Cervidellus_alutus              AGGGTT-CG- GCTCC--GGA GAGTTCGCCT GAGAAATCGC GAACACATCT AAGGAAGGCA
Pseudacrobeles_variabilis       AGGGTT-CG- GCTCC--GGA GAGTTCGCCT GAGAAATCGC GAACACATCT AAGGAAGGCA
Triligulla_aluta                AGGGTT-CG- GCTCC--GGA GAGTTCGCCT GAGAAATCGC GAACACATCT AAGGAAGGCA
Zeldia_punctada                 AGGGTT-CG- GCTCC--GGA GAGTTCGCCT GAGAAATCGC GAACACATCT AAGGAAGGCA
Myolaimus_sp_U81585             AGGGTT-TG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Rhabditophanes_sp._KR3021       AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Brevibucca_sp._SB261            AGGGTT-CG- ACTCC--GGA GAGGCAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Halicephalobus_gingivalis       AGGGTT-CG- TCTCC--GGA GAGAATGCCT TAAAAACGGC TTTCACATCC AAGGAAGGCA
Panagrobelus_stammeri           AGGGTT-CG- ACTCC--GGA GAAATCGCCT GAGAAACGGC GTTTACATCC AAGGAAGGCA
Plectonchus_sp._PDL0025         AGGGTT-CG- ACTCC--GGA GAAATCGCCT GAGAAACGGC GTTTACATCC AAGGAAGGCA
Turbatrix_aceti                 AGGGTT-CG- ACTCC--GGA GAAAACGCCT GAGAAACGGC GGTTACATCC AAGGAAGGCA
Panagrellus_redivivus           ATGGTT-CG- ACTCC--GGA GAAATAGCCT GAGAAACGGC TTTTACATCC AAGGAAGGCA
Panagrellus_redivivus_PS1163    AGGGTT-CG- ACTCC--GGA GAAATAGCCT GAGAAACGGC TTTTACATCC AAGGAAGGCA
Panagrolaimus_subelongatus      AGGGTA-CG- ACTCC--GGA GAAAATGCCT GAGAAACGGC GTTTACATCC AAGGAAGGCA
Panagrolaimus_davidi            AGGGTA-CG- ACTCC--GGA GAAAATGCCT GAGAAACGGC GTTTACATCC AAGGAAGGCA
Panagrolaimus_cf_rigidus_AF40   AGGGTA-CG- ACTCC--GGA GAAAATGCCT GAGAAACGGC GTTTACATCC AAGGAAGGCA
Panagrolaimus sp. Sourhope ED2  AGGGTA-CG- ACTCC--GGA GAAAATGCCT GAGAAACGGC GTTTACATCC AAGGAAGGCA
Panagrolaimus sp. Sourhope ED2  AGGGTA-CG- ACTCC--GGA GAAAATGCCT GAGAAACGGC GTTTACATCC AAGGAAGGCA
Panagrolaimus sp. Sourhope ED2  AGGGTA-CG- ACTCC--GGA GAAAATGCCT GAGAAACGGC GTTTACATCC AAGGAAGGCA
Panagrolaimus sp. Sourhope ED2  AGGGTA-CG- ACTCC--GGA GAAAATGCCT GAGAAACGGC GTTTACATCC AAGGAAGGCA
Panagrolaimus sp. Sourhope ED2  AGGGTA-CG- ACTCC--GGA GAAAATGCCT GAGAAACGGC GTTTACATCC AAGGAAGGCA
Steinernema_carpocapsae         AGGGTT-TG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Strongyloides_stercoralis       AGGGTT-CG- ATTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Strongyloides_ratti             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Diploscapter_sp_PS1897          GGGGTT-TG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Diploscapter_sp_PS2017          GGGGTT-TG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Heterorhabditis_bacteriophora   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Heterorhabditis_hepialus        AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Heterorhabditis_zelandica       AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Parasitorhabditis_sp_SB281      AGGGTT-TG- ACTCC--GGA GAGGATGCCT TAGAAACGGC AACCACATCT AAGGAAGGCA
Rhabditoides_inermiformis       AGGGTT-CG- ACTCC--GTA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Rhabditoides_inermis_DF5001     AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Rhabditoides_regina_DF5012      AGGGTT-TG- ACTCC--GGA GAAGATGCCT TAGAAACGGC AACTACATCC AAGGAAGGCA
Poikilolaimus_oxycerca_SB200    AGGGTT-TG- ATTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCT AAGGAAGGCA
Poikilolaimus_regenfussi_SB199  AGGGTT-TG- ATTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCT AAGGAAGGCA
Distolabrellus veechi DWF1604   AGGGTT-TG- ACTCC--GGA GAGGATGCCT TAGAAACGGC AACCACATCT AAGGAAGGCA
Distolabrellus veechi DF5024    AGGGTT-TG- ACTCC--GGA GAGGATGCCT TAGAAACGGC AACCACATCT AAGGAAGGCA
Choriorhabditis_dudichi         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Protorhabditis_sp               GGGGTT-TG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Protorhabditis_sp_DF5055        GGGGTT-CG- ACTCC--GGA GAGGCAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Cruznema_tripartitum_DF5015     AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Mesorhabditis_sp_PS1179         AGGGTT-TG- ACTCC--GGA GAGGATGCCT GAGAAACGGC AACCACATCT AAGGAAGGCA
Mesorhabditis_spiculigera_SB15  AGGGTT-TG- ACTCC--GGA GAGGATGCCT GAGAAACGGC AACCACATCT AAGGAAGGCA
Mesorhabditis_anisomorpha_SB12  AGGGTT-TG- ACTCC--GGA GAGGATGCCT GAGACACGGC AACCACATCT AAGGAAGGCA
Teratorhabditis_palmarum_DF501  AGGGTT-TG- ACTCC--GGA GA-GTATCCT GAGAGACGGC AAACACATCT AAGGAAGGCA
Teratorhabditis_synpapillata_S  AGGGTT-TG- ACTCC--GGA GAGTATGCCT GAGAGACGGC AAACACATCT AAGGAAGGCA
Caenorhabditis_briggsae_PB102   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACGTCC AAGGAAGGCA
Caenorhabditis_elegans_N2       AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACGTCC AAGGAAGGCA
Caenorhabditis_sp_CB5161        AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACGTCC AAGGAAGGCA
Caenorhabditis_sp_PS1010        AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACGTCC AAGGAAGGCA
Caenorhabditis_japonica         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACGTCC AAGGAAGGCA
Caenorhabditis_sp_DF5170        AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACGTCC AAGGAAGGCA
Caenorhabditis_sp_SB341         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Caenorhabditis_plicata          AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACGTCC AAGGAAGGCA
Caenorhabditis_vulgaris         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACGTCC AAGGAAGGCA
Caenorhabditis_sonorae          AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Caenorhabditis_drosophilae      AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACGTCC AAGGAAGGCA
Phasmarhabditis_hermaphrodita   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Phasmarhabditis_neopapillosa    AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Phasmarhabditis_neopapillosa    AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Pellioditis_mediterranea_SB173  AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Pellioditis_marina              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Prodontorhabditis_wirthi        ATG-TT-CG- TCTCC--GGA GAGGCCGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Crustorhabditis_scanica         AGGGTT-TG- ACTCC--GGA GAGGATGCCT KAGAAACGGC AGCCACATCT AAGGAAGGCA
Dolichorhabditis_sp_CEW1        AGGGTT-CG- GCTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Oscheius_sp_DF5000              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Oscheius_sp_BW282               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Oscheius_myriophila_EM435       AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Oscheius_insectivora            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Oscheius_dolichuroides          AGGGTT-CG- GCTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
NUCLEOTIDES INCLUDED            mmmmmm-mm- mmmmm--mmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                         550        560        570        580        590        600
Rhabditis_blumi_DF5010           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Rhabditis_sp_PS1191              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Rhabditis_sp_PS1010              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACGTCC AAGGAAGGCA
Rhabditis_myriophila_EM435       AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Rhabditis_colombiana             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Rhabditella_axei_DF5006          AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Rhabditella_sp_DF5044            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Cuticularia_sp_PS2083            AGGGTT-TG- ATTCC--GGN GAGGGAGCCT GAGAAACGGC TACCACATCT AAGGAAGGCA
Necator_americanus               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Kalicephalus_cristatus           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Ancylostoma_caninum              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Angiostrongylus_cantonensis      AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Angiostrongylus_costaricensis    AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Angiostrongylus_malaysiensis     AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Angiostrongylus_dujardini        AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Angiostrongylus_vasorum          AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Aulurostrongylus_abstrusus       AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Didelphostrongylus_hayesi        AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Crenosoma_mephitidis             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Crenosoma_vulpis                 AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Otostrongylus_circumlitus        AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Troglostrongylus_wilsoni         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Filaroides_martis                AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Oslerus_osleri                   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Parafilaroides_decorus           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Metastrongylus_salmi             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Metastrongylus_elongatus         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Skrjabingylus_chitwoodrum        AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Parelaphostrongylus_odocoilei    AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Muelerius_capillaris             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Protostrongylus_rufescens        AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Halocercus_invaginatus           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Pseudalius_inflexus              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Stenurus_minor                   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Torynurus_convolutus             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Syngamus_trachea                 AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Stephanurus_dentatus             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Nematodirus_battus               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Strongylus_equinus               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Labiostrongylus_bipapillosus     AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Petrovinema_poculatum            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Cylicocyclus_insignis            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Chabartia_ovina                  AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Cyclodontostomum_purvisi         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Zoniolaimus_mawsonae             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Hypodontus_macropi               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Deletrocephalus_dimidiatus       AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Dictyocaulus_eckerti_P7B8        AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Dictyocaulus_capreolus_P3B2      AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Dictyocaulus_sp._P6A1            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Dictyocaulus_filaria             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Dictyocaulus_capreolus_P2C10     AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Dictyocaulus_viviparus           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Haemonchus_sp._V3091             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Haemonchus_contortus             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Haemonchus_placei                AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Haemonchus_similis               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Ostertagia_ostertagi             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Ostertagia_leptospicularis       AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Nippostrongylus_brasileinsis     AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Heligmosomoides_polygyrus        AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Trichostrongylus_colubriformis   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Tetrabothriostrongylus mackerr   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Herpestrongylus_pythonis         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Nicollina_cameroni               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Filarimena_flagrifer             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Amidostomum_cygni                AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Teratocephalus_lirellus          AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Brumptaemilius_justini           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GRGAAACGGC TACCACATCC AAGGAAGGCA
Anguillicola_crassus             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Dracunculus_medinensis           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACTTCC AAGGAAGGCA
Dracunculus_oesophageus          AGGGTT-TG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACTTCC AAGGAAGGCA
Dracunculus_sp._V3104            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACTTCC AAGGAAGGCA
Philonema_sp_A                   AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACTTCC AAGGAAGGCA
Philometra_obturans              AGGGTT-CG- ACTCCCAGGA GAGGGAGCCT GAGAAACGGC TACCACTTCC AAGGAAGGCA
Camallanus_oxycepahalus          AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Acanthocheilonema_viteae         AGGGTT-TG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCa
Loa_loa                          AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
NUCLEOTIDES INCLUDED             mmmmmm-mm- mmmmm--mmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                         550        560        570        580        590        600
Onchocerca_cervicalis            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Dirofilaria_immitis              AGGGTT-CG- ACNCA--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Brugia_malayi                    AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Wuchereria_bancrofti             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Litomosoides_sigmodontis         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Setaria_digitata                 AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Gnathostoma_turgidum             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Gnathostoma_neoprocyonis         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Gnathostoma_binucleatum          AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Physaloptera_alata               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Physaloptera_turgida             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Ascarophis_arctica               AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Spinitectus_carolini             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Thelazia_lacrymalis              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT GAGAAACGGC TACCACATCC AAGGAAGGCA
Aphelenchus_avenae               AGGGTT-CG- ACTCC--GGA GAGGGAGCTT GAGACACGGC TACCATGTCT AAGGACAGCA
Aphelenchoides_fragariae         AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCATGTCT AAGGACAGCA
Bursaphelelenchus_sp             AGGGTT-TG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCATGT-T AAGGATAGCA
Deladenus_sp                     AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Criconema_sp                     AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Hemicycliophora_conida           AGGGTT-CG- ACTCC--GGA GAAGGCGCCT GAGAAATGGC GACTACGTCT AAGGATGGCA
Paratylenchus_dianthus           AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Pratylenchus_thornei             AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Tylenchulus_semipentrans         AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Ditylenchus_angustus             AGGGTT-TG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Subanguina_radicola              AGGGTT-TG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Tylenchorhynchus_maximus         AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Geocenamus_quadrifer             AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Globodera_pallida                AGGGTT-TG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Scutellonema_bradys              AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Helicotylenhcus_dihystera        AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Rotylenchus_robustus             AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Meloidogyne_arenaria             AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Meloidogyne_incognita_KT         AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Meloidogyne_javanica             AGGGTT-CG- ACTCC--GGT GAAGGGGCCT GAGAAATCGC CACTACGTCT AAGGATGGCA
Meloidogyne_artiellia            AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Meloidogyne_duytsi               AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Meloidogyne_exigua               AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Meloidogyne_hapla                AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Meloidogyne_ichinohei            AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Meloidogyne_maritima             AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Meloidogyne_microtyla            AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Nacobbus_aberrans                AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Pratylenchoides_ritteri          AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Pratylenchoides_magnicauda       AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Hirschmanniella_sp._JH_2003      AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Radopholus_similis               AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTATGTCT AAGGATAGCA
Pratylenchus_goodeyi_VF          AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Boleodorus_thylactus_clone2      AGGGTT-CG- ACTCC--GGA GAAGGGGCCT GAGAAATGGC CACTACGTCT AAGGATGGCA
Philippine Sequence 1            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Philippine Sequence 2            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Philippine Sequence 3            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Philippine Sequence 4            AGGGTA-CG- ACTCC--GGA GAAAATGCCT GAGAAACGGC GTTTACATCC AAGGAAGGCA
Philippine Sequence 5            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Philippine Sequence 6            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Philippine Sequence 7            AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACGTCC AAGGAAGGCA
Tahiti Sequence 1                AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Tahiti Sequence 2                AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGS TACCACATCC AAGGAAGGCA
Thailand Sequence 1              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Ogasawara Sequence 1             AGGGTA-CG- ACTCC--GGA GAAAATGCCT GAGAAACGGC GTTTACATCC AAGGAAGGCA
Ogasawara Sequence 2             AGGGTT-CG- TCTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Ivory Coast Sequence 1           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Ivory Coast Sequence 2           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Ivory Coast Sequence 3           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Ivory Coast Sequence 4           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Ivory Coast Sequence 5           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Ivory Coast Sequence 6           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Ivory Coast Sequence 7           AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Singapore Sequence 1             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Singapore Sequence 2             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Singapore Sequence 3             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACGTCC AAGGAAGGCA
Singapore Sequence 4             AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Nigerian Sequence 1              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Nigerian Sequence 2              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
Nigerian Sequence 3              AGGGTT-CG- ACTCC--GGA GAGGGAGCCT TAGAAACGGC TACCACATCC AAGGAAGGCA
NUCLEOTIDES INCLUDED             mmmmmm-mm- mmmmm--mmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                        610        620        630        640        650        660
Gordius_aquaticus                GCAG-GCGCG CAAA-TTACC CA----CTCC GGC---ACG- --GGGAGG-- -TAGTG-ACG
Priapulus_caudatus               GCAG-GCACG CAAA-TTACC CA----TTCC GGC---ACG- --GGGAGG-- -TAGTG-ACG
Brachionus_plicatilis            GCAG-GCGCG CAAA-TTACC CAC---TCCT AGA---ACG- --GGGAGG-- -TAGTG-ACG
Chordodes_morgani                GCAG-GCGCG CAAA-TTACC CAC---TCCC GGC---TCG- --GGGAGG-- -TAGTG-ACG
Paractinolaimus_macrolaimus      GCAG-GCGCG CAAA-TTACC CAC---TTCC AGA---ACG- --GAGAGG-- -TAGTG-ACG
Aporcelaimellus_obtusicaudatus   GCAG-GCGCG CAAA-TTACC CAC---TTCC AGA---ACG- --GAGAGG-- -TAGTG-ACG
Wilsonema_schuurmansstekhoveni   GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Mesodorylaimus_sp_cf_nigritul    GCAG-GCGCG CAAA-TTACC CAC---TTCC AGA---ACG- --GAGAGG-- -TAGTG-ACG
Mesodorylaimus_bastiani          GCAG-GCGCG CAAA-TTACC CAC---TTTC AGA---ACG- --AAGAGG-- -TAGTG-ACG
Mesodorylaimus_japonicus         GCAG-GCGCG CAAA-TTACC CAC---TTCC AGA---ACG- --GAGAGG-- -TAGTG-ACG
Pungentus_sp._PDL_2005           GCAG-GCGCG CAAA-TTACC CAC---TTCC AGA---ACG- --GAGAGG-- -TAGTG-ACG
Allodorylaimus_sp                GCAG-GCGCG CAAA-TTACC CAC---TTCC AGA---ACG- --GAGAGG-- -TAGTG-ACG
Eudorylaimus_carteri             GCAG-GCGCG CAAA-TTACC CAC---TTCC AGA---ACG- --GAGAGG-- -TAGTG-ACG
Microdorylaimus_sp               GCAG-GCGCG CAAA-TTACC CAC---TTCC AGA---ACG- --GAGAGG-- -TAGTG-ACG
Longidorus_elongatus             GCAG-GCGCG CAAA-TTACC CAC---TTCC AGA---ACG- --GAGAGG-- -TAGTG-ACG
Xiphinema_rivesi                 GCAG-GCGCG CAAA-TTACC CAC---TTCC AGA---ACG- --GAGAGG-- -TAGTG-ACG
Tylencholaimus_sp                GCAG-GCGCG CAAA-TTACC CAC---TTCC AGA---ACG- --GAGAGG-- -TAGTG-ACG
Anoplostoma_sp._BHMM_2005        GCAG-GCACG CAAA-TTACC CAC---TCTT GGT---ACG- --AGGAGG-- -TAGTG-ACG
Adoncholaimus_fuscus             GCAG-GCACG CAAA-TTACC CAC---TCCC GGC---ACG- --GGGAGG-- -TAGTG-ACG
Enoplus_meridionalis             GCAG-GCACG CAAA-TTACC CAC---TCCC AAC---ACG- --GGGAGG-- -TAGTG-ACG
Enoplus_brevis_U88336            GCAG-GCACG CAAA-TTACC CAC---TCCC AAT---ACG- --GGGAGG-- -TAGTG-ACG
Enoplus_communis                 GCAG-GCACG CAAA-TTACC CAC---TCCC AAT---ACG- --GGGAGG-- -TAGTG-ACG
Enoploides_brunettii             GCAG-GCACG CAAA-TTACC CAC---TCCC GGA---AAG- --GGGAGG-- -TAGTG-ACG
Syringolaimus_striatocaudatus    GCAG-GCACG CAAA-TTACC CAA---TCCC CGA---ACG- --GGGAGG-- -TAGTG-ACG
Ironus_dentifurcatus             GCAG-GCACG CAAA-TTACC CAC---TCCC GGC---AAG- --GGGAGG-- -TAGTG-ACG
Calyptronema_maxweberi           GCAG-GCACG CAAA-TTACC CAC---TCCC GGC---ACG- --GGGAGG-- -TAGTG-ACG
Viscosia_sp._BHMM_2005           GCAG-GCACG CAAA-TTACC CAC---TCCC GGC---ACG- --GGGAGG-- -TAGTG-ACG
Viscosia_viscosa                 GCAG-GCACG CAAA-TTACC CAC---TCCC GGC---ACG- --GGGAGG-- -TAGTG-ACG
Pontonema_vulgare                GCAG-GCACG CAAA-TTACC CAC---TCCG GCA---CGG- ---GGAGG-- -TAGTG-ACG
Oncholaimus_sp._BHMM_2005        GCAG-GCACG CAAA-TTACC CAC---TCCC GGC---ACG- --GGGAGG-- -TAGTG-ACG
Alaimus_sp_PDL_2005              GCAG-GCACG CAAA-TTACC CAC---TCCC GGC---ACG- --GTGAGG-- -TAGTG-ACG
Prismatolaimus_intermedius       GCAG-GCACG CAAA-TTACC CAC---TCCC GGC---ACG- --GGGAGG-- -TAGTG-ACG
Tobrilus_gracilis                GCAG-GCACG CAAA-TTACC CAC---TCCC GGC---ACG- --GGGAGG-- -TAGTG-ACG
Tripyla_cf_filicaudata_JH_2004   GCAG-GCACG CAAA-TTACC CAC---TCCC GGC---ACG- --GGGAGG-- -TAGTG-ACG
Bathylaimus_sp                   GCAG-GCACG CAAA-TTACC CAC---TCTC AGA---ACG- --AGGAGG-- -TAGTG-ACG
Bathylaimus_assimilis            GCAG-GCACG CAAA-TTACC CAC---TCTC AGA---ACG- --AGGAGG-- -TAGTG-ACG
Bathylaimus_sp._BHMM_2005        GCAG-GCACG CAAA-TTACC CAC---TCCC GGC---TCG- --GGGAGG-- -TAGTG-ACG
Tripyloides_sp._BHMM_2005        GCAG-GCACG CAAA-TTACC CAC---TCCC GGC---ACG- --GGGAGG-- -TAGTG-ACG
Trischistoma_monohystera         GCAG-GCACG CAAA-TTACC CAC---TCCC GGC---ACG- --GGGAGG-- -TAGTG-ACG
Mermis_nigrescens                GCACTGCGCG CAAAATTACC CAA---TCCC AGT---ACG- --GGGAG--- -TAGTG-ACG
Mylonchulus_arenicolus           GCAG-GCGCG CAAA-TTACC CAA---TCTC AGA---ACG- --AGGAGG-- -TAGTG-ACG
Anatonchus_tridentacus           GCAG-GCGCG CAAA-TTACC CAA---TCCC AGA---ACG- --GGGAGG-- -TAGTG-ACG
Mononchus_truncatus              GCAG-GCGCG CAAA-TTACC CAA---TCCC AGA---ATG- --GGGAGG-- -TAGTG-ACG
Prionchulus_muscorum             GCAG-GCGCG CAAA-TTACC CAA---TCCC AGA---ACG- --GGGAGG-- -TAGTG-ACG
Clarkus_sp                       GCAG-GCGCG CAAA-TTACC CAA---TCCC AGA---ACG- --GGGAGG-- -TAGTG-ACG
Trichinella_spiralis             GCAG-GCGCG CAAA-TTACC CAC---TCCC AGC---TTG- --GGGAGG-- -TAGTG-ACG
Trichinella_papuae               GCAG-GCGCG CAAA-TTACC CAC---TCCC AGC---TTG- --GGGAGG-- -TAGTG-ACG
Trichinella_britovi              GCAG-GCGCG CAAA-TTACC CAC---TCCC AGC---TTG- --GGGAGG-- -TAGTG-ACG
Trichinella_murrelli             GCAG-GCGCG CAAA-TTACC CAC---TCCC AGC---TTG- --GGGAGG-- -TAGTG-ACG
Trichinella_pseudospiralis       GCAG-GCGCG CAAA-TTACC CAC---TCCC AGC---TTG- --GGGAGG-- -TAGTG-ACG
Trichinella_nativa               GCAG-GCGCG CAAA-TTACC CAC---TCCC AGC---TTG- --GGGAGG-- -TAGTG-ACG
Trichinella_zimbabwensis         GCAG-GCGCG CAAA-TTACC CAC---TCCC AGC---TTG- --GGGAGG-- -TAGTG-ACG
Trichinella_nelsoni              GCAG-GCGCG CAAA-TTACC CAC---TCCC AGC---TTG- --GGGAGG-- -TAGTG-ACG
Trichuris_suis                   GCAG-GCACG CAAA-TTACC CAC---TCCC AGA---TCG- --GGGAGG-- -TAGTG-ACG
Trichuris_trichiura              GCAG-GCACG CAAA-TTACC CAC---TCCC AGA---TCG- --GGGAGG-- -TAGTG-ACG
Trichuris_muris                  GCAG-GCACG CAAA-TTACC CAC---TCCC AGA---TCG- --GGGAGG-- -TAGTG-ACG
Tylolaimophorus_minor            GCAG-GCGCG TAAA-TTACC CAT---TCCC GGT---TCG- --GGGAGG-- -TAGTG-ACG
Paratrichodorus_pachydermus      GCAG-GCGCG CAAA-TTACC CAC---T-TC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Paratrichodorus_anemones         GCAG-GCGCG CAAA-TTACC CAT---TCTC AGT---TCG- --AGGAGG-- -TAGTG-ACG
Trichodorus_primitivus           GCAG-GCGCG CAAA-TTACC CAC---TCGC AGA---ACG- --CGGAGG-- -TAGTG-ACG
Axonolaimus_helgolandicus        GCAG-GCGCG CAAA-TTACC CAA---TCTC GGA---ACG- --AGGAGG-- -TAGTG-ACG
Ascolaimus_elongatus             GCAG-GCGCG CAAA-TTACC CAA---TCTC GGA---ACG- --AGGAGG-- -TAGTG-ACG
Odontophora_rectangula           GCAG-GCGCG CAAA-TTACC CAA---TCTC GGA---ACG- --AGGAGG-- -TAGTG-ACG
Cylindrolaimus_sp._202149        GCAG-GCGCG CAAA-TTACC CAA---TCTC AGT---ACG- --AGGAGG-- -TAGTG-ACG
Tylocephalus_auriculatus         GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Plectus_acuminatus_BS9           GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Plectus_aquatilis                GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Anaplectus_sp                    GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Anisakis_sp_WKT                  GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Anisakis_sp_Nadler               GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Contracaecum_multipapillatum     GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Pseudoterranova_decipiens        GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Raphidascaris_acus               GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Terranova_caballeroi             GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Ascaris_suum                     GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Ascaris_lumbricoides             GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Baylisascaris_procyonis          GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Baylisascaris_transfuga          GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
NUCLEOTIDES INCLUDED             mmmm-mmmmm mmmm-mmmmm mmm---mmmm mmm------- --mmmmmm-- -mmmmm-mmm
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                        610        620        630        640        650        660
Parascaris_equorum               GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Porrocaecum_depressum            GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Toxascaris_leonina               GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Heterocheilus_tunicatus          GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Goezia_pelagia                   GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Hysterothylacium_fortalezae      GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Hysterothylacium_pelagicum       GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Hysterothylacium_reliquens       GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Iheringascaris_inquies           GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Toxocara_canis                   GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Nemhelix_bakeri                  GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Raillietnema_sp._V3060           GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Cruzia_americana                 GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Heterakis_sp_14690               GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Heterakis_gallinarum             GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---ATG- --AGGAGG-- -TAGTG-ACG
Paraspidodera_sp_21303           GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Chromodora_nudicapitata          GCAG-GCGCG CAAA-TTACC CAC---TCTC AGT---GCG- --AGGAGG-- -TAGTG-ACG
Chromadora_sp._BHMM_2005         GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---TCG- --AGGAGG-- -TAGTG-ACG
Atrochromadora_microlaima        GCAG-GCGCG CAAA-TTACC CAC---TCTC AGT---TCG- --AGGAGG-- -TAGTG-ACG
Chromadorina_germanica           GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ACG- --AGGAGG-- -TAGTG-ACG
Chromadorita_tentabundum         GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ACG- --AGGAGG-- -TAGTG-ACG
Dichromadora_sp._BHMM_2005       GCAG-GCGCG CAAA-TTACC CAC---TCTC AGT---TCG- --AGGAGG-- -TAGTG-ACG
Neochromadora_BHMM_2005          GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ACG- --AGGAGG-- -TAGTG-ACG
Spilophorella_paradoxa           GCAG-GCGCG CAAA-TTACC CAC---TCTC AGT---TCG- --AGGAGG-- -TAGTG-ACG
Paracanthonchus_caecus           GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---TCG- --AGGAGG-- -TAGTG-ACG
Paracyatholaimus_intermedius     GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---TCG- --AGGAGG-- -TAGTG-ACG
Praeacanthonchus_punctatus       GCAG-GCGCG CAAA-TTACC CAC---TCTC AGT---ACG- --AGGAGG-- -TAGTC-ACG
Praeacanthonchus_sp              GCAG-GCGCG CAAA-TTACC CAC---TCTC AGT---ACG- --AGGAGG-- -TAGTG-ACG
Cyatholaimus_sp._BHMM_2005       GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---TCG- --AGGAGG-- -TAGTG-ACG
Spirinia_parasitifera            GCAG-GCGCG CAAA-TTACC CAC---TCTC AGT---ACG- --AGGAAG-- -TAGTG-ACG
Acanthopharynx_micans            GCTG-GCGCG CAAA-TTACC CAC---TCTC AGC---TCG- --AGGAGG-- -TAGTG-ACG
Xyzzors_sp                       GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ACG- --AGGAGG-- -TAGTG-ACG
Metachromadora_sp                GCAG-GCGCG CAAA-TTACC CAA---TCTC AGT---TTG- --AGGAGG-- -TAGTG-ACG
Metachromadora_remanei           GCAG-GCGCG CAAA-TTACC CAA---TCTC AGT---TTG- --AGGAGG-- -TAGTG-ACG
Catanema_sp                      GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---CCG- --AGGAGG-- -TAGTG-ACG
Eubostrichus_dianae              GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---TCG- --AGGAGG-- -TAGTG-ACG
Eubostrichus_topiarus            GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---TCG- --AGGAGG-- -TAGTG-ACG
Eubostrichus_parasitiferus       GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---TCG- --AGGAGG-- -TAGTG-ACG
Laxus_oneistus                   GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ACG- --AGGAGG-- -TAGTG-ACG
Laxus_cosmopolitus               GCAG-GCACG CAAA-TTACC CAC---TCTC AGA---ACG- --AGGAGG-- -TAGTG-ACG
Leptonemella_sp                  GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---TCG- --AGGAGG-- -TAGTG-ACG
Robbea_hypermnestra              GCAG-GCGCG CAAA-TTACC CAC---TCTC AGT---ACG- --AGGAGG-- -TAGTG-ACG
Stilbonema_majum                 GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---TCG- --AGGAGG-- -TAGTG-ACG
Monoposthia_costata              GCAG-GCGCG CAAA-TTACA CAA---TGAC AGCAAATTG- --TTGATG-- -TAGTG-ACA
Nudora_bipapillata               GCAG-GCGCG CAAA-TTACA CAA---TGAC AGCAAAATG- --TTGATG-- -TAGTG-ACA
Calomicrolaimus_parahonestus     GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Calomicrolaimus_sp._BHMM_2005    GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Molgolaimus_demani               GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Diplogaster_lethieri             GCAG-GCGCG TAAA-TTACC CAC---TCTC AAT---TCG- --AGGAGG-- -TAGTG-ACT
Aduncospiculum_halicti           GCAG-GCGCG TAAA-TTACC CAC---TCTC AAT---GCG- --AGGAGG-- -TAGTA-ACT
Pristionchus_lheritieri          GCAG-GCGCG TAAA-TTACC CAC---TCTC AAT---TCG- --AGGAGG-- -TAGTG-ACT
Pristionchus_pacificus           GCAG-GCGCG TAAA-TTACC CAC---TCTC AAT---TCG- --AGGAGG-- -TAGTG-ACT
Pristionchus_pacificus           GCAG-GCGCG TAAA-TTACC CAC---TCTC AAT---TCG- --AGGAGG-- -TAGTG-ACT
Sabatieria_punctata_STRAIN_343   GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Sabatieria_sp._355_BHMM_2005     GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Sabatieria_celtica               GCAG-GCGCG CAAA-TTACC CAT---TCTC AGT---ACG- --AGGAGG-- -TAGTG-ACG
Sabatieria_punctata_STRAIN_200   GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Sabatieria_punctata_STRAIN_223   GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Sabatieria_sp._210_BHM_2005      GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Setosabatieria_hilarula          GCAG-GCGCG CAAA-TTACC CAT---TCTC AGT---ACG- --AGGAGG-- -TAGTG-ACG
Desmolaimus_zeelandicus          GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Terschellingia_longicaudata      GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Cyartonema_elegans               GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---ACG- --AGAAGG-- -TAGTG-ACG
Tridentulus_sp                   GCAG-GCGCG CAAA-TTACC CAT---TCTC GGT---ATG- --AGGAGG-- -TAGTG-ACG
Diplolaimelloides_meyli          GCAG-GCGCG CAAA-TTACC CAT---TCTC AGA---ACG- --AGGAGG-- -TAGTG-AAG
Diplolaimella_diavengatensis     GCAG-GCGCG CAAA-TTACC CAT---TCTC AGT---ACG- --AGGAGG-- -TAGTG-ACG
Geomonhystera_disjuncta          GCAG-GCGCG CAAA-TTACA CAA---TCTC AGC---ACG- --AGGATG-- -TAGTG-ACG
Sphaerolaimus_hirsutus           GCAG-GCGCG TAAC-TTACC CAC---TCTC AGA---TTG- --AGGAGG-- -TAGTG-ACG
Theristus_acer                   GCAG-GCGCG CAAA-TTACC CAC---TCTC AGT---ACG- --AGGAGG-- -TAGTG-ACG
Daptonema_procerus               GCAG-GCACG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Daptonema_hirsutum               GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Daptonema_normandicum            GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Daptonema_oxycerca               GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Daptonema_setosum                GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Desmodora_communis               GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---TCG- --AGGAGG-- -TAGTG-ACG
Desmodora_ovigera                GCAG-GCGCG CAAA-TTACC CAC---TCTC AAC---TCG- --AGGAGG-- -TAGTG-ACG
Metadesmolaimus_sp               GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Dentostomella_sp                 GCAG-GCGCG CAAA-TTACC CAC---TNTC GGC---ATG- --AGGAGT-- -TAGTG-ACG
NUCLEOTIDES INCLUDED             mmmm-mmmmm mmmm-mmmmm mmm---mmmm mmm------- --mmmmmm-- -mmmmm-mmm
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         610        620        630        640        650        660
Bunonema_franzi                  GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-AAT
Bunonema_sp                      GCAG-GCGCG CAAA-TTACC CAC---TCTC AGT---ACG- --AGGAGG-- -TAGTG-AAT
Seleborca_complexa               GCAG-GCGCG AAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Acrobeloides_nanus               GCAG-GCGCG AAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Acrobeloides_bodenheimeri        GCAG-GCGCG AAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Acrobeloides_sp_PS1146           GCAG-GCGCG AAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Acrobeles_ciliatus               GCAG-GCGCG AAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Acrobeles_sp_PS1156              GCAG-GCGCG AAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Acrobeles_complexus_WCUG2        GCAG-GCGCG AAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Cephaloboides_sp_SB227           GCAG-GCGCG TAAC-TTATC CAC---TACT TTA------- --GTGAGA-- -TAGTG-ACT
Cephalobus_cubaensis             GCAG-GCGCG NAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Cephalobus_sp._PS1143            GCAG-GCGCG AAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Cephalobus_sp._PS1196            GCAG-GCGCG AAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Cephalobus_oryzae_PS1165         GCAG-GCGCG AAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Cervidellus_alutus               GCAG-GCGCG AAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Pseudacrobeles_variabilis        GCAG-GCGCG AAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Triligulla_aluta                 GCAG-GCGCG AAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Zeldia_punctada                  GCAG-GCGCG AAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Myolaimus_sp_U81585              GCAG-GCGCG CAAA-TTATC CAC---TCTC GGC---ACG- --AGGAGA-- -TAGTG-ACG
Rhabditophanes_sp._KR3021        GCAG-GCGCG AAAA-TTACC CAA---TTTT AGT---TAA- --AAGAGG-- -TAGTG-ACG
Brevibucca_sp._SB261             GCAG-GCGCG TAAA-TTACC CAC---TCTC AGT---TCG- --AGGAGG-- -TAGTG-ACG
Halicephalobus_gingivalis        GCAG-GCGCG AAAA-TTACC CAC---TCTC AGT---GCG- --AGGAGG-- -TAGTG-ACG
Panagrobelus_stammeri            GCAGG-CGCG AAAA-TTACC CAC---TCTT AGT---ACG- --AGGAGG-- -TAGTG-ACG
Plectonchus_sp._PDL0025          GCAG-GCGCG AAAA-TTACC CAC---TCTT AGT---ACG- --AGGAGG-- -TAGTG-ACG
Turbatrix_aceti                  GCAG-GCGCG AAAA-TTACC CAC---TCTC GGT---TCG- --AGGAGG-- -TAGTG-ACG
Panagrellus_redivivus            GCAG-GCGCG AAAA-TTACC CAC---TCTT AGT---ACG- --AGGAGG-- -TAGTG-ACG
Panagrellus_redivivus_PS1163     GCAG-GCGCG AAAA-TTACC CAC---TCTT AGT---ACG- --AGGAGG-- -TAGTG-ACG
Panagrolaimus_subelongatus       GCAG-GCGCG AAAA-TTACC CAC---TCTC AGT---ACG- --AGGAGG-- -TAGTG-ACG
Panagrolaimus_davidi             GCAG-GCGCG AAAA-TTACC CAC---TCTC AGT---ACG- --AGGAGG-- -TAGTG-ACG
Panagrolaimus_cf_rigidus_AF40    GCAG-GCGCG AAAA-TTACC CAC---TCTC AGT---TCG- --AGGAGG-- -TAGTG-ACG
Panagrolaimus sp. Sourhope ED2   GCAG-GCGCG AAAA-TTACC CAC---TCTC AGT---ACG- --AGGAGG-- -TAGTG-ACG
Panagrolaimus sp. Sourhope ED2   GCAG-GCGCG AAAA-TTACC CAC---TCTC AGT---ACG- --AGGAGG-- -TAGTG-ACG
Panagrolaimus sp. Sourhope ED2   GCAG-GCGCG AAAA-TTACC CAC---TCTC AGT---ACG- --AGGAGG-- -TAGTG-ACG
Panagrolaimus sp. Sourhope ED2   GCAG-GCGCG AAAA-TTACC CAC---TCTC AGT---TCG- --AGGAGG-- -TAGTG-ACG
Panagrolaimus sp. Sourhope ED2   GCAG-GCGCG AAAA-TTACC CAC---TCTC AGT---TCG- --AGGAGG-- -TAGTG-ACG
Steinernema_carpocapsae          GCAG-GCGCG AAAA-TTACC CAC---TCTC AGT---TCG- --AGGAGG-- -TAGTG-ACG
Strongyloides_stercoralis        GCAG-GCGCG AAAA-TTACC CAA---TTTT AGT---TAA- --AAGAGG-- -TAGTG-ACG
Strongyloides_ratti              GCAG-GCGCG AAAA-TTACC CAA---TTTT AGT---TAA- --AAGAGG-- -TAGTG-ACG
Diploscapter_sp_PS1897           GCAG-GCGCG AAAC-TTATC CAC---TGTC AAA---A--- --ATGAGA-- -TAGTG-ACT
Diploscapter_sp_PS2017           GCAG-GCGCG AAAC-TTATC CAC---TGTC AAA---A--- --ATGAGA-- -TAGTG-ACT
Heterorhabditis_bacteriophora    GCAG-GCGCG TAAC-TTATC CAC---TC-C TAA---TCG- --GTGAGA-- -TAGTG-ACT
Heterorhabditis_hepialus         GCAG-GCGCG TAAC-TTATC CAC---TC-C TAA---TCG- --GTGAGA-- -TAGTG-ACT
Heterorhabditis_zelandica        GCAG-GCGCG TAAC-TTATC CAC---TC-C TAA---TCG- --GTGAGA-- -TAGTG-ACT
Parasitorhabditis_sp_SB281       GCAG-GCGCG CAAA-TTACC CAC---TCTC AAT---KCG- --AGGAGG-- -TAGTG-AAA
Rhabditoides_inermiformis        GCAG-GCGCG CAAA-TTACC CAC---TCTC AGT---ACG- --AGGAGG-- -TAGTA-ACA
Rhabditoides_inermis_DF5001      GCAG-GCGCG CAAA-TTACC CAC---TCTC AAT---ACG- --AGGAGG-- -TAGTG-ACT
Rhabditoides_regina_DF5012       GCAG-GCGCG TAAA-TTACC CAC---TCTC AGT---TCG- --AGGAGG-- -TAGTG-ACA
Poikilolaimus_oxycerca_SB200     GCAG-GCGCG CAAA-TTACC CAC---TGGA GGT---GCT- --CCGAGG-- -TAGTG-ACT
Poikilolaimus_regenfussi_SB199   GCAG-GCGCG CAAA-TTACC CAC---TCTC AGT---ACG- --AGGAGG-- -TAGTG-ACT
Distolabrellus veechi DWF1604    GCAG-GCGCG CAAA-TTACC CAC---TCTC AAT---TCG- --AGGAGG-- -TAGTG-ACA
Distolabrellus veechi DF5024     GCAG-GCGCG CAAA-TTACC CAC---TCTC AAT---TCG- --AGGAGG-- -TAGTG-ACA
Choriorhabditis_dudichi          GCAG-GCGTG AAAC-TTATC CAC---TGCA TAT---AG-- ---TGAGA-- -TAGTG-ACT
Protorhabditis_sp                GCAG-GCGCG AAAC-TTATC CAC---TGTA TCA---AA-- ---TGAGA-- -TAGTG-ACT
Protorhabditis_sp_DF5055         gcag-gcgcg aaac-ttatc cac---tgtt gaa---aa-- ---tgaga-- -tagtg-act
Cruznema_tripartitum_DF5015      GCAG-GCGCG TAAC-TTATC CAT---TATA AAT---T--- --ATGAGA-- -TAGTG-ACT
Mesorhabditis_sp_PS1179          GCAG-GCGCG CAAA-TTACC CAC---TCTC AAT---TCG- --AGGAGG-- -TAGTG-ACA
Mesorhabditis_spiculigera_SB15   GCAG-GCGCG CAAA-TTACC CAC---TCTC AAT---GCG- --AGGAGG-- -TAGTG-ACA
Mesorhabditis_anisomorpha_SB12   GCAG-GCGCG CAAA-TTACC CAC---TCTC AGT---GCG- --AGGAGG-- -TAGTA-ACA
Teratorhabditis_palmarum_DF501   GCAG-GCGCG CAAA-TTACC CAC---TCTC AAT---TCG- --AGGAGG-- -TAGTG-ACA
Teratorhabditis_synpapillata_S   GCAG-GCGCG CAAA-TTACC CAC---TCTC AAT---TCG- --AGGAGG-- -TAGTG-ACA
Caenorhabditis_briggsae_PB102    GCAG-GCGCG AAAC-TTATC CAC---TGTT GAG---T--- --ATGAGA-- -TAGTG-ACT
Caenorhabditis_elegans_N2        GCAG-GCGCG AAAC-TTATC CAC---TGTT GAG---T--- --ATGAGA-- -TAGTG-ACT
Caenorhabditis_sp_CB5161         GCAG-GCGCG AAAC-TTATC CAC---TGTT GAG---T--- --ATGAGA-- -TAGTG-ACT
Caenorhabditis_sp_PS1010         GCAG-GCGCG AAAC-TTATC CAC---TGTT GAT---T--- --ATGAGA-- -TAGTG-ACT
Caenorhabditis_japonica          GCAG-GCGCG AAAC-TTATC CAC---TGTT GAG---T--- --ATGAGA-- -TAGTG-ACT
Caenorhabditis_sp_DF5170         GCAG-GCGCG AAAC-TTATC CAC---TGTT GTG---T--- --ATGAGA-- -TAGTG-ACT
Caenorhabditis_sp_SB341          GCAG-GCGCG AAAC-TTATC CAC---TGTT GAC---A--- --ATGAGA-- -TAGTG-ACT
Caenorhabditis_plicata           GCAG-GCGCG AAAC-TTATC CAC---TGTT GGG---T--- --ATGAGA-- -TAGTG-ACT
Caenorhabditis_vulgaris          GCAG-GCGCG AAAC-TTATC CAC---TGTT GAG---T--- --ATGAGA-- -TAGTG-ACT
Caenorhabditis_sonorae           GCAG-GCGCG AAAC-TTATC CAC---TGTT GAC---A--- --ATGAGA-- -TAGTG-ACT
Caenorhabditis_drosophilae       GCAG-GCGCG AAAC-TTATC CAC---TGTT GTG---T--- --ATGAGA-- -TAGTG-ACT
Phasmarhabditis_hermaphrodita    GCAG-GCGCG TAAC-TTATC CAC---TACT CTT---T--- --GTGAGA-- -TAGTG-ACT
Phasmarhabditis_neopapillosa     ACAG-GCGCG TAAC-TTATC CAC---TACT CTT---T--- --GTGAGA-- -TAGCA-ACT
Phasmarhabditis_neopapillosa     GCAG-GCGCG TAAC-TTATC CAC---TACT TCA------- --GTGAGA-- -TAGTG-ACT
Pellioditis_mediterranea_SB173   GCAG-GCGCG TAAC-TTATC CAC---TACT ACA------- --GTGAGA-- -TAGTG-ACT
Pellioditis_marina               GCAG-GCGCG TAAC-TTATC CAC---TACT TCA------- --GTGAGA-- -TAGTG-ACT
Prodontorhabditis_wirthi         GCAG-GCGCG AAAC-TTACT CAC---TATN ATA---G--- --ATGAAG-- -TAGTA-ACT
Crustorhabditis_scanica          GCAG-GCGCG CAAA-TTACC CAC---TCTC AAT---TCG- --AGGAGG-- -TAGTG-ACA
NUCLEOTIDES INCLUDED             mmmm-mmmmm mmmm-mmmmm mmm---mmmm mmm------- --mmmmmm-- -mmmmm-mmm
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                                        610        620        630        640        650        660
Dolichorhabditis_sp_CEW1         GCAG-GCGCG TAAC-TTATC CAC---TACC ACA------- --GTGAGA-- -TAGTG-ACT
Oscheius_sp_DF5000               GCAG-GCGCG TAAC-TTATC CAC---TACT TCA------- --GTGAGA-- -TAGTG-ACT
Oscheius_sp_BW282                GCAG-GCGCG TAAC-TTATC CAC---TACT TCA------- --GTGAGA-- -TAGTG-ACT
Oscheius_myriophila_EM435        GCAG-GCGCG TAAC-TTATC CAC---TACT TCA------- --GTGAGA-- -TAGTG-ACT
Oscheius_insectivora             GCAG-GCGCG TAAC-TTATC CAC---TACT TCA------- --GTGAGA-- -TAGTA-ACT
Oscheius_dolichuroides           GCAG-GCGCG TAAC-TTATC CAC---TACT TCA------- --GTGAGA-- -TAGTG-ACT
Rhabditis_blumi_DF5010           GCAG-GCGCG TAAC-TTATC CAC---TACC AAT---A--- --GTGAGA-- -TAGCG-ACA
Rhabditis_sp_PS1191              GCAG-GCGCG TAAC-TTATC CAC---TACC GAC---A--- --GTGAGA-- -TAGTG-ACA
Rhabditis_sp_PS1010              GCAG-GCGCG AAAC-TTATC CAC---TGTT GAT---T--- --ATGAGA-- -TAGTG-ACT
Rhabditis_myriophila_EM435       GCAG-GCGCG TAAC-TTATC CAC---TACT TCA------- --GTGAGA-- -TAGTG-ACT
Rhabditis_colombiana             GCAG-GCGCG TAAC-TTATC CAC---TACT TCA------- --GTGAGA-- -TAGTG-ACT
Rhabditella_axei_DF5006          GCAG-GCGCG TAAC-TTATC CAC---TACC TTA------- --GTGAGA-- -TAGTG-ACT
Rhabditella_sp_DF5044            GCAG-GCGCG TAAC-TTATC CAC---TACC TTA------- --GTGAGA-- -TAGTG-ACT
Cuticularia_sp_PS2083            GCAG-GCGCG CAAA-TTACC CAC---TGGA GGT---GCT- --CCAAGG-- -TAGTG-ACT
Necator_americanus               GCAG-GCGCG TAAC-TTATC CAC---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Kalicephalus_cristatus           GCAG-GCGCG TAAC-TTATC CAC---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Ancylostoma_caninum              GCAG-GCGCG TAAC-TTATC CAC---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Angiostrongylus_cantonensis      GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Angiostrongylus_costaricensis    GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Angiostrongylus_malaysiensis     GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Angiostrongylus_dujardini        GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Angiostrongylus_vasorum          GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Aulurostrongylus_abstrusus       GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Didelphostrongylus_hayesi        GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Crenosoma_mephitidis             GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Crenosoma_vulpis                 GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Otostrongylus_circumlitus        GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Troglostrongylus_wilsoni         GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Filaroides_martis                GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Oslerus_osleri                   GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Parafilaroides_decorus           GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Metastrongylus_salmi             GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Metastrongylus_elongatus         GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Skrjabingylus_CHITWOODRUM        GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Parelaphostrongylus_odocoilei    GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Muelerius_capillaris             GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Protostrongylus_rufescens        GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Halocercus_invaginatus           GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Pseudalius_inflexus              GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Stenurus_minor                   GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Torynurus_convolutus             GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Syngamus_trachea                 GCAG-GCGCG TAAC-TTATC CAC---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Stephanurus_dentatus             GCAG-GCGCG TAAC-TTATC CAC---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Nematodirus_battus               GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Strongylus_equinus               GCAG-GCGCG TAAC-TTATC CAC---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Labiostrongylus_bipapillosus     GCAG-GCGCG TAAC-TTATC CAC---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Petrovinema_poculatum            GCAG-GCGCG TAAC-TTATC CAC---TCTT AAA---GAG- --ATGAGA-- -TAGTG-ACT
Cylicocyclus_insignis            GCAG-GCGCG TAAC-TTATC CAC---TCTT AAA---GAG- --ATGAGA-- -TAGTG-ACT
Chabartia_ovina                  GCAG-GCGCG TAAC-TTATC CAC---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Cyclodontostomum_purvisi         GCAG-GCGCG TAAC-TTATC CAC---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Zoniolaimus_mawsonae             GCAG-GCGCG TAAC-TTATC CAC---TCTT GAA---GAG- --WTGAGA-- -TAGTG-ACT
Hypodontus_macropi               GCAG-GCGCG TAAC-TTATC CAC---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Deletrocephalus_dimidiatus       GCAG-GCGCG TAAC-TTATC CAC---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Dictyocaulus_eckerti_P7B8        GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Dictyocaulus_capreolus_P3B2      GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Dictyocaulus_sp._P6A1            GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Dictyocaulus_filaria             GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Dictyocaulus_capreolus_P2C10     GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Dictyocaulus_viviparus           GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Haemonchus_sp._V3091             GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---CAG- --ATGAGA-- -TAGTG-ACT
Haemonchus_contortus             GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---CAG- --ATGAGA-- -TAGTG-ACT
Haemonchus_placei                GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---CAG- --ATGAGA-- -TAGTG-ACT
Haemonchus_similis               GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---CAG- --ATGAGA-- -TAGTG-ACT
Ostertagia_ostertagi             GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Ostertagia_leptospicularis       GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Nippostrongylus_brasileinsis     GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Heligmosomoides_polygyrus        GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Trichostrongylus_colubriformis   GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Tetrabothriostrongylus mackerr   GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Herpestrongylus_pythonis         GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Nicollina_cameroni               GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Filarimena_flagrifer             GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Amidostomum_cygni                GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Teratocephalus_lirellus          GCAG-GCGCG TAAA-TTACC CAA---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Brumptaemilius_justini           GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Anguillicola_crassus             GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ACG- --AGGAGG-- -TAGTG-ACG
Dracunculus_medinensis           GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC--TAAG- --AGGAGG-- -TAGTGAACG
Dracunculus_oesophageus          GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---AAG- --AGGAGG-- -TAGTG-ACG
NUCLEOTIDES INCLUDED             mmmm-mmmmm mmmm-mmmmm mmm---mmmm mmm------- --mmmmmm-- -mmmmm-mmm
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                                        610        620        630        640        650        660
Dracunculus_sp._V3104            GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---AAG- --AGGAGG-- -TAGTG-ACG
Philonema_sp_A                   GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---GTG- --AGGANG-- -TAGTG-ACG
Philometra_obturans              GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC--ACAG- --AGGAGG-- -TAGTG-ACG
Camallanus_oxycepahalus          GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---ACG- --AGGAGG-- -TAGTG-ACG
Acanthocheilonema_viteae         GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ATG- --AGGAGG-- -TAGTG-ACG
Loa_loa                          GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ATG- --AGGAGG-- -TAGTG-ACG
Onchocerca_cervicalis            GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ATG- --AGGAGG-- -TAGTG-ACG
Dirofilaria_immitis              GCAG-GCGCG CAAA-TTACC CA----TCTC AGA---ATG- --AGGATG-- -TAGTG-ACG
Brugia_malayi                    GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ATG- --AGGAGG-- -TAGTG-ACG
Wuchereria_bancrofti             GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ATG- --AGGAGG-- -TAGTG-ACG
Litomosoides_sigmodontis         GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ATG- --AGGAGG-- -TAGTG-ACG
Setaria_digitata                 GCAG-GCGCG CAAA-TTACC CAC---TCTC GGA---ATG- --AGGAGG-- -TAGTG-ACG
Gnathostoma_turgidum             GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Gnathostoma_neoprocyonis         GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Gnathostoma_binucleatum          GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Physaloptera_alata               GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Physaloptera_turgida             GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Ascarophis_arctica               GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Spinitectus_carolini             GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Thelazia_lacrymalis              GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Aphelenchus_avenae               GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ACG- --AGGAGG-- -TAGTG-ACG
Aphelenchoides_fragariae         GCAG-GCGCG CAAC-TTATC CAC---TGTT CAT---TGA- --ACGAGA-- -TAGTG-ACG
Bursaphelelenchus_sp             GCAG-GCGCG AAAA-TTACC CAA---TATC AAA---ACG- --ATGAGG-- -TAGTG-ACG
Deladenus_sp                     GCAG-GCGCG CAAA-TTACC CAC---TCTC GGA---ACG- --AGGAGG-- -TAGTG-AAG
Criconema_sp                     GCAG-GCGCG CAAA-TTACC CAC---TCTC GGT---TCG- --AGGAGG-- -TAGTG-ACG
Hemicycliophora_conida           GCAG-GCGCG CAAA-TTACC CAC---TCTC GGT---TCG- --AGGAGG-- -TAGTG-ACG
Paratylenchus_dianthus           GCAG-GCGCG CAAA-TTACC CAC---TCTC AGT---TCG- --AGGAGG-- -TAGTG-ACG
Pratylenchus_thornei             GCAG-GCGCG CAAA-TTACC CAC---TCTC AAT---GCG- --AGGAGG-- -TAGTG-ACG
Tylenchulus_semipentrans         GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Ditylenchus_angustus             GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ATG- --AGGAGG-- -TAGTG-ACG
Subanguina_radicola              GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ACG- --AGGAGG-- -TAGTG-ACG
Tylenchorhynchus_maximus         GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ACG- --AGGAGG-- -TAGTG-ACG
Geocenamus_quadrifer             GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ATG- --AGGAGG-- -TAGTG-ACG
Globodera_pallida                GCAG-GCGCG CAAA-TTACC CAC---TCTC AAC---ATG- --AGGAGG-- -TAGTG-ACG
Scutellonema_bradys              GCAG-GCGCG CAAA-TTACC CAC---TCTC AAC---ACGC GGAGGAGG-- -TAGTG-ACG
Helicotylenhcus_dihystera        GCAG-GCGCG CAAA-TTACC CAC---TCTC AAC---GCG- --AGGAGG-- -TAGTG-ACG
Rotylenchus_robustus             GCAG-GCGCG CAAA-TTACC CAC---TCTC AAT---TCG- --AGGAGG-- -TAGTG-ACG
Meloidogyne_arenaria             GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---TCG- --AGGAGG-- -TAGTG-ACG
Meloidogyne_incognita_KT         GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---TCG- --AGGAGG-- -TAGTG-ACG
Meloidogyne_javanica             GCAG-GCGCG CAAA-TTACC MAC---TTTC GGC---TCC- --AGGAGG-- -TAGTG-ACG
Meloidogyne_artiellia            GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ACG- --AGGAGG-- -TAGTG-ACG
Meloidogyne_duytsi               GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---TCG- --AGGAGG-- -TAGTG-ACG
Meloidogyne_exigua               GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---TCG- --AGGAGG-- -TAGTG-ACG
Meloidogyne_hapla                GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---TCG- --AGGAGG-- -TAGTG-ACG
Meloidogyne_ichinohei            GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---ATG- --AGGAGG-- -TAGTG-ACG
Meloidogyne_maritima             GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---TCG- --AGGAGG-- -TAGTG-ACG
Meloidogyne_microtyla            GCAG-GCGCG CAAA-TTACC CAC---TCTC GGC---TCG- --AGGAGG-- -TAGTG-ACG
Nacobbus_aberrans                GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ATG- --AGGAGG-- -TAGTG-ACG
Pratylenchoides_ritteri          GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ATG- --AGGAGG-- -TAGTG-ACG
Pratylenchoides_magnicauda       GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ATG- --AGGAGG-- -TAGTG-ACG
Hirschmanniella_sp._JH_2003      GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ACG- --CGGAGGAG GTAGTG-ACG
Radopholus_similis               GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---ATG- --AGGAGG-- -TAGTG-ACG
Pratylenchus_goodeyi_VF          GCAG-GCGCG CAAA-TTACC CAC---TCTC AAT---TCG- --AGGAGG-- -TAGTG-ACG
Boleodorus_thylactus_clone2      GCAG-GCGCG CAAA-TTACC CAC---TCTC AGA---ACAC TGAGGAGG-- -TAGTG-ACG
Philippine Sequence 1            GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Philippine Sequence 2            GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Philippine Sequence 3            GCAG-GCGCG TAAC-TTATC CAC---TACA TTT------- --GTGAGA-- -TAGAG-ACG
Philippine Sequence 4            GCAG-GCGCG AAAA-TTACC CAC---TCTC AGT---TCG- --AGGAGG-- -TAGTG-ACG
Philippine Sequence 5            GCAG-GCGCG TAAC-TTATC CAC---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Philippine Sequence 6            GCAG-GCGCG TAAC-TTATC CAC---TACT TCA------- --GTGAGA-- -TAGTA-ACT
Philippine Sequence 7            GCAG-GCGCG AAAC-TTATC CAC---TGTT GAG---T--- --ATGAGA-- -TAGTG-ACT
Tahiti Sequence 1                GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Tahiti Sequence 2                GCAG-GCGCG AAAC-TTATC TAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Thailand Sequence 1              GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---ATG- --AGGAGG-- -TAGTG-ACG
Ogasawara Sequence 1             GCAG-GCGCG AAAA-TTACC CAC---TCTC AGT---TCG- --AGGAGG-- -TAGTG-ACG
Ogasawara Sequence 2             GCAG-GCGCG TAAC-TTATC CAC---TACT CCT---T--- --GTGAGA-- -TAGGG-ACA
Ivory Coast Sequence 1           GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Ivory Coast Sequence 2           GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Ivory Coast Sequence 3           GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Ivory Coast Sequence 4           GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Ivory Coast Sequence 5           GCAG-GCGCG CAAA-TTACC CAC---TCTC AGC---ATG- --AGGAGG-- -TAGTG-ACG
Ivory Coast Sequence 6           GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Ivory Coast Sequence 7           GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Singapore Sequence 1             GCAG-GCGCG TAAC-TTATC CAC---TACA TTT------- --GTGAGA-- -TAGAG-ACG
Singapore Sequence 2             GCAG-GCGCG CAAA-TTACC CAC---TCTC AGT---ATG- --AGGAGG-- -TAGTG-ACG
Singapore Sequence 3             GCAG-GCGCG AAAC-TTATC CAC---TGTT GAG---T--- --ATGAGA-- -TAGTG-ACT
Singapore Sequence 4             GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
Nigerian Sequence 1              GCAG-GCGCG AAAC-TTATC CAA---TATT GAA---TAG- --ATGAGA-- -TAGTG-ACT
NUCLEOTIDES INCLUDED             mmmm-mmmmm mmmm-mmmmm mmm---mmmm mmm------- --mmmmmm-- -mmmmm-mmm
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         610        620        630        640        650        660
Nigerian Sequence 2              GCAG-GCGCG TAAC-TTATC CAC---TCTT GAA---GAG- --ATGAGA-- -TAGTG-ACT
Nigerian Sequence 3              GCAG-GCGCG AAAC-TTATC CAA---TCTT GAA---TAG- --ATGAGA-- -TAGTG-ACT
NUCLEOTIDES INCLUDED             mmmm-mmmmm mmmm-mmmmm mmm---mmmm mmm------- --mmmmmm-- -mmmmm-mmm


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                                         670        680        690        700        710        720
Gordius_aquaticus                ATAAATAACA AT-GCAGGTC TCTTTC--GA GACCCTGTAA TT-GGAATGA GAT-CACTTT
Priapulus_caudatus               ATAAATAACA AT-ACGGGAC TCTTTC--GA GGACCCGTAA TT-GGAATGA GTA-CACTTT
Brachionus_plicatilis            AAAAATAACA AT-ACCGGAC TCAAT---GA GGCTCGGTAA TT-GAAATGA GTA-CAGTTT
Chordodes_morgani                ATAAATAACA AC-GCAGGTC TCAAAC--GA GACCCTGTAA TT-GGAATGC GAT-CACTTT
Paractinolaimus_macrolaimus      AAAAATAACG AG-ACAGTCC TCTTC---GA GGTCT-GTCA TC-GGAATGG GTA-CAATTT
Aporcelaimellus_obtusicaudatus   AAAAATAACG AG-ACAGTCC TCTTC---GA GGTCT-GTCA TC-GGAATGG GTA-CAATTT
Wilsonema_schuurmansstekhoveni   AAAAATAACG AG-GCGGTTC TCTAT---GA GGCCC-GCTA TC-GGAATGA GTA-CAATTT
Mesodorylaimus_sp_cf_nigritul    AAAAATAACG AG-ACAGTCC TCTTC---GA GGTCT-GTCA TC-GGAATGG GTA-CAATTT
Mesodorylaimus_bastiani          AAAAATAACG AG-ACAGTCC TCTTC---GA GGTCT-GTCA TC-GGAATGG GTA-CAATTT
Mesodorylaimus_japonicus         AAAAATAACG AG-ACAGTCC TCTTC---GA GGTCT-GTCA TC-GGAATGG GTA-CAATTT
Pungentus_sp._PDL_2005           AAAAATAACG AG-ACAGTCC TCTTC---GA GGTCT-GTCA TC-GGAATGG GTA-CAATTT
Allodorylaimus_sp                AAAAATAACG AG-ACAGACC TCTTC---GA GGTCT-GTCA TC-GGAATGG GTA-CAATTT
Eudorylaimus_carteri             AAAAATAACG AG-ACAGTCC TCTTC---GA GGTCT-GTCA TC-GGAATGG GTA-CAATTT
Microdorylaimus_sp               AAAAATAACG AG-ACAGTCC TCTTC---GA GGTCT-GTCA TC-GGAATGG GTA-CAATTT
Longidorus_elongatus             AAAAATAACG AG-ACAGTCC TCTCT---GA GGTCT-GTCA TC-GGAATGG GTA-CAATTT
Xiphinema_rivesi                 AAAAATAACG AG-ACAGTCC TCTTC---GA GGTCT-GTCA TC-GGAATGG GTA-CAATTT
Tylencholaimus_sp                AAAAATAACG AG-ACAGTCC TCTTC---GA GGTCT-GTCA TC-GGAATGG GTA-CAATTT
Anoplostoma_sp._BHMM_2005        AAGAATAACA GG-ACGGCCT CTTATT--GA GGCCC-GTCA CT-GGAATGA GTA-CAGTTT
Adoncholaimus_fuscus             AAAAATAACA AG-CTGGT-C TCTAT---GA GTTCC-GGCA TT-GTAATGG GAA-CAATTT
Enoplus_meridionalis             AAAAATAACG AG-ACGGTTC TCTAA---GA GGCCC-GTCA TC-GGAATGG GTA-CAATCT
Enoplus_brevis_U88336            AAAAATAACG AG-ACGGTTC TCAAA---GA GGCCC-GTCA TC-GGAATGG GTA-CAATTT
Enoplus_communis                 AAAAATAACG AG-ACGGTTC TCAAA---GA GGCCC-GTCA TC-GGAATGG GTA-CAATTT
Enoploides_brunettii             AAAAATAACG AG-ACGGTTC TCTTT---GA GGCCC-GTCA TC-GAAATGG GTA-CAATTT
Syringolaimus_striatocaudatus    AAAAATAACG AG-ACGGTTC TCTAC---GA GGTCC-GTCA TC-GGAATGA GTA-CAATTT
Ironus_dentifurcatus             AAAAATAACG AG-GCAGTTC TCTAC---GA GGCCT-GTCA TC-GGAATGA ACA-CAATTT
Calyptronema_maxweberi           AAAAATAACG AG-CAGGTCT TTTTAT--GA GTTCC-TGCA TT-GTAATGG GAA-CAAGTT
Viscosia_sp._BHMM_2005           AAAAATAACA AG-TTGGT-C TCAAT---GA GTTCC-GACA TT-GTAATGG GAA-CAATTT
Viscosia_viscosa                 AAAAATAACA AG-CTGGT-C TCAAT---GA GTTCC-GGCA TT-GTAATGG GAA-CAATTT
Pontonema_vulgare                AAAAATAACA AG-CTGGT-C TCTAT---GA GTTCC-GGCA TT-GTAATGG GAA-CAATTT
Oncholaimus_sp._BHMM_2005        AAAAATAACA AG-CTGGT-C TCTTT---GA GTTCC-GGCA TT-GTAATGG GAA-CAACTT
Alaimus_sp_PDL_2005              AAAAATAACG AG-ATGATTC TCTCA---GA GGCTC-ATCA TC-GGAATGA GTA-CAATTT
Prismatolaimus_intermedius       AAAAATAACG AG-GCGGTTC TCTAC---GA GGCCC-GCCA TC-GGAATGG GTA-CAATTT
Tobrilus_gracilis                AAAAATAACG AG-GCGGTTC TCTAC---GA GGCCC-GCCA TC-GGAATGG GTA-CAATTT
Tripyla_cf_filicaudata_JH_2004   AAGAATAACG AG-GCGGTTC TCTTT---GA GGCCC-GCCA TC-GGAATGG -TA-CAATCT
Bathylaimus_sp                   AAAAATAACG AG-GTCGTTT CCTTAT--GG AGCCG-ACCA TC-GGAATGG GTA-CAATCT
Bathylaimus_assimilis            AAAAATAACG AG-GTCGTTT CCTTAT--GG AGCCG-ACCA TC-GGAATGG GTA-CAATCT
Bathylaimus_sp._BHMM_2005        AAAAATAACG AG-GTCGTTT CCTTAT--GG AGCCG-ACCA TC-GGAATGG GTA-CAATCT
Tripyloides_sp._BHMM_2005        AAAAATAACG AG-GTCGTTT CCAAAT--GG AGCCG-ACCA TC-GGAATGG GTA-CAATTT
Trischistoma_monohystera         AAAAATAACG AG-ACGGTTC TCTAT---GA GGCCC-GTCA TC-GGAATGG GTA-CAATTT
Mermis_nigrescens                AAAAATAACG AG-ATAGTCC ACTTT---TG TGGCC-GTCA TC-GGAATGG GTA-CAATTT
Mylonchulus_arenicolus           AAAAATAACA AA-ACAGTCC ACTCT---GT GGTCT-GTTA TC-GGAATGG GTA-CAATTT
Anatonchus_tridentacus           AAAAATAACG AG-ACAGTCC ACTAT---GT GGCCT-GTCA TC-GGAATGG GTA-CAATTT
Mononchus_truncatus              AAAAATAACG AG-ACGGTCC TCTTT---GA GGCCT-GTCA TC-GGAATGG GTA-CAATTT
Prionchulus_muscorum             AAAAATAACG AG-GTAGTCC ACTTT---GT GGCCT-GCCA TC-GGAATGG GTA-CAATTT
Clarkus_sp                       AAAAATAACG AG-GTAATCC ACTTT---GT GGCTT-GCCA TC-GGAATGG GCA-CAATAT
Trichinella_spiralis             AAAAATAACG AG-ACGATTC TCGTTT--GA GAAAC-GTTA TC-GAAATGA GTA-CGCTTT
Trichinella_papuae               AAAAATAACG AG-ACGATTC TCGTTT--GA GAAAC-GTTA TC-GAAATGA GTA-CGCTTT
Trichinella_britovi              AAAAATAACG AG-ACGATTC TCGTTT--GA GAAAC-GTTA TC-GAAATGA GTA-CGCTTT
Trichinella_murrelli             AAAAATAACG AG-ACGATTC TCGTTT--GA GAAAC-GTTA TC-GAAATGA GTA-CGCTTT
Trichinella_pseudospiralis       AAAAATAACG AG-ACGATTC TCGTTT--GA GAAAC-GTTA TC-GAAATGA GTA-CGCTTT
Trichinella_nativa               AAAAATAACG AG-ACGATTC TCGTTT--GA GAAAC-GTTA TC-GAAATGA GTA-CGCTTT
Trichinella_zimbabwensis         AAAAATAACG AG-ACGATTC TCGTTT--GA GAAAC-GTTA TC-GAAATGA GTA-CGCTTT
Trichinella_nelsoni              AAAAATAACG AG-ACGATTC TCGTTT--GA GAAAC-GTTA TC-GAAATGA GTA-CGCTTT
Trichuris_suis                   AAAAATAACG GA-ACGTATC TCCAT---GA GACGC-GTTA CC-GGAACGA CTG-AGCCGT
Trichuris_trichiura              AAAAATAACG GA-ACGTTTC TCCAT---GA GACGC-GTTA CC-GGAACGA TCG-AGCCGT
Trichuris_muris                  AAAAATAACG GA-ACGATAT CTCCAT--GA GACGC-GTTA CC-GGAACGA CCG-AGCCGT
Tylolaimophorus_minor            AAAAATAACG AG-GCGGTTC TCTTT---GA GGCCC-GCCA TC-GGAATGA GAA-CAATTT
Paratrichodorus_pachydermus      AAAAATAACG AG-GTGGCTC TCTAC---GA GGTCC-GCCA TC-GGAATGG GTA-CAATTT
Paratrichodorus_anemones         AAAAATAACG AG-TCGGCTC TCTAC---GA GGTCC-GACA TC-GGAATGA ATA-CAATTT
Trichodorus_primitivus           AAAAATAACG AG-GTGGCTC TCTAT---GA GGTCC-ATCA TC-GGAATGG GTA-CAATTT
Axonolaimus_helgolandicus        AAAAATAACG AG-ATGGTTC TCTAT---GA GGCCC-ATTA TC-GGAATGA GTA-CAATTC
Ascolaimus_elongatus             AAAAATAACG AG-ATGGTTC TCTAT---GA GGCCC-ATTA TC-GGAATGA GTA-CAATTC
Odontophora_rectangula           AAAAATAACG AG-ACGGTTC TCTAT---GA GGCCC-GTTA TC-GGAATGA GTA-CAATTC
Cylindrolaimus_sp._202149        AAAAATAACG AG-ACGGTTC TCATT---GA GGCCC-GTTA TC-GGAATGA GTA-CAATTC
Tylocephalus_auriculatus         AAAAATAACG AG-GCGGTTC TCTAT---GA GGCCC-GCTA TC-GGAATGA GTA-CAATTT
Plectus_acuminatus_BS9           AAAAATAACG AG-GCGGTTC TCTAA---GA GGCCCTGCTA TC-GGAATGG GTA-CAATTT
Plectus_aquatilis                AAAAATAACG AG-GCGGTTC TCTAA---GA GGCCC-GCTA TC-GGAATGG GTA-CAATTT
Anaplectus_sp                    AAAAATAACG AG-GCGGTTC TCTAA---GA GGCCC-GCTA TC-GGAATGG GTA-CAATTT
Anisakis_sp_WKT                  AAAAATAACG AG-ACCGTTC TCTCT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Anisakis_sp_Nadler               AAAAATAACG AG-ACCGTTC TCTCT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Contracaecum_multipapillatum     AAAAATAACG AG-ACCGTAC TCTTT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
NUCLEOTIDES INCLUDED             mmmmmmmmmm mm-mmmmmmm mmmm-----m mmmmm-mmmm mm-mmmmmmm mmm-mmmmmm
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                        670        680        690        700        710        720
Pseudoterranova_decipiens        AAAAATAACG AG-ACCGTTC TCTCT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Raphidascaris_acus               AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Terranova_caballeroi             AAAAATAACG AG-ACCGTTC TCTCT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Ascaris_suum                     AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Ascaris_lumbricoides             AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Baylisascaris_procyonis          AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Baylisascaris_transfuga          AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Parascaris_equorum               AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Porrocaecum_depressum            AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Toxascaris_leonina               AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Heterocheilus_tunicatus          AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Goezia_pelagia                   AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Hysterothylacium_fortalezae      AAAAATAACG AG-ACCGTTC TCTTT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Hysterothylacium_pelagicum       AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Hysterothylacium_reliquens       AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Iheringascaris_inquies           AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Toxocara_canis                   AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Nemhelix_bakeri                  AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Raillietnema_sp._V3060           AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Cruzia_americana                 AAAAATAACG AG-GCCGTTC TCTAT---GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Heterakis_sp_14690               AAAAATAACA AG-ACCGTTC TCTTT--AGA GGCCG-GTTA TT-GGAATGA GTA-CAGTTT
Heterakis_gallinarum             AAAAATAACA AG-ACCGTTC TCTAT---GA GGCCG-GTTA TT-GGAATGA GTA-CAATTT
Paraspidodera_sp_21303           AAAAATAACG AG-GCCGTTC TCTAT---GA GGCCG-GCCA TC-GGAATGG GTA-CAATTT
Chromodora_nudicapitata          AAAAATAACG AG-ACAGTCT TCTAT---GA GGTCT-GTCA TC-GGAATGG GTA-CAACTT
Chromadora_sp._BHMM_2005         AAAAATAACG AG-ACAGTCT TCTAT---GA GGTCT-GTCA TC-GGAATGG GTA-CAATTT
Atrochromadora_microlaima        AAAAATAACG AG-ACAGTCT TCTAT---GA GGTCT-GTCA TC-GGAATGG GTA-CAATTT
Chromadorina_germanica           AAAAATAACG AG-ACAGTCT TCTAT---GA GGTCT-GTCA TC-GGAATGG GTA-CAATTT
Chromadorita_tentabundum         AAAAATAACG AG-ACAGTTC TCTAT---GA GGTCT-GTCA TC-GGAATGG GTA-CAATCT
Dichromadora_sp._BHMM_2005       AAAAATAACG AG-ACAGTCT TCTAT---GA GGTCT-GTCA TC-GGAATGG GTA-CAATTT
Neochromadora_BHMM_2005          AAAAATAACG AG-ACAGTTC TCTAT---GA GGTCT-GTCA TC-GGAATGG GTA-CAATCT
Spilophorella_paradoxa           AAAAATAACG AG-ACAGTTC TCTAT---GA GGTCT-GTCA TC-GGAATGG GTA-CAATCT
Paracanthonchus_caecus           AAAAATAACA AG-ATGGTTC TCTAT---GA GGTCC-ATCA TT-GGAATGG GTA-CAATTT
Paracyatholaimus_intermedius     AAAAATAACG AG-ACGGTTC TCTAT---GA GGTCC-GTCA TC-GGAATGG GTA-CAATTT
Praeacanthonchus_punctatus       AAAAATAACG AG-ACGGTTC TCTAT---GA GGTCC-GTCA TC-GGAATGG GTA-CAATTT
Praeacanthonchus_sp              AAAAATAACG AG-ACGGTTC TCTAT---GA GGTCC-GTCA TC-GGAATGG GTA-CAATTT
Cyatholaimus_sp._BHMM_2005       AAAAATAACA AG-ATGGTTC TCTAT---GA GGTCC-GTCA TT-GGAATGG GTA-CAATTT
Spirinia_parasitifera            AAAAATAACG AG-ATGGTTC TCTAT---GA GGCCC-ATCA TC-GGAATGG GTA-CAATTT
Acanthopharynx_micans            AAAAATAACG AG-ACGGTTC TCTTT---GA GGCCC-GTCA TC-GGAATGG GTA-CAATCT
Xyzzors_sp                       AAAAATAACG AG-ATGGTTC TCTAT---GA GGCCC-ATCA TC-GGAATGG GTA-CAATTT
Metachromadora_sp                AAAAATAACG AG-ACGGTTC TCTAT---GA GGCCC-GTCA TC-GGAATGA GTA-CAATTT
Metachromadora_remanei           AAAAATAACG AG-ACGGTTC TCTAT---GA GGCCC-GTCA TC-GGAATGA GTA-CAATTT
Catanema_sp                      AAAAATAACG AG-ACGGTTC TCTTT---GA GGCCC-GTCA TC-GGAATGG GTA-CAATTT
Eubostrichus_dianae              AAAAATAACG AG-ACGGTTC TCTTT---GA GGCCC-GTCA TC-GGAATGG GTA-CAATTT
Eubostrichus_topiarus            AAAAATAACG AG-ACGGTTC TCTTT---GA GGCCC-GTCA TC-GGAATGG GTA-CAATTT
Eubostrichus_parasitiferus       AAAAATAACA AG-ACGGTTC TCTTT---GA GGCCC-GTCA TT-GGAATGG GTA-CAATTT
Laxus_oneistus                   AAAAATAACG AG-ACGGTTC TCTTT---GA GGCCC-GTCA TC-GGAATGG GTA-CAATTT
Laxus_cosmopolitus               AAAAATAACG AG-ACGGTTC TCTTT---GA GGCCC-GTCA TC-GGAATGG GTA-CAATTT
Leptonemella_sp                  AAAAATAACG AG-ACGGTTC TCTTT---GA GGCCC-GTCA TT-GGAATGG GTA-CAATTT
Robbea_hypermnestra              AAAAATAACG AG-ACGGTTC TCTTT---GA GGCCC-GTCA TC-GGAATGG GTA-CAATTT
Stilbonema_majum                 AAAAATAACG AG-ACGGCTC TCTTT---GA GGTCC-GTCA TC-GGAATGA GTA-CAATTT
Monoposthia_costata              AGAGGTAACG AG-GCGGTCC TCTGT---GA GGTCC-GTCA TC-GTATCGA GTA-CAACTC
Nudora_bipapillata               AGAAATAACG AG-ACGGTTC TCTAT---GA GGCCC-GTCA TC-GGAATGG GTA-CAACTT
Calomicrolaimus_parahonestus     AAAAATAACG AG-ACAGTTC TCTTT---GA GGTCT-GTCA TC-GGAATGG GTA-CAACCC
Calomicrolaimus_sp._BHMM_2005    AAAAATAACG AG-ACAGTTC TCTTT---GA GGTCT-GTCA TC-GGAATGG GTA-CAACCC
Molgolaimus_demani               AAAAATAACG AG-ACAGTTC TCTAT---GA GGTCT-GTCA TC-GGAATGG GTA-CAACCC
Diplogaster_lethieri             ATCAATAACG AG-ACAGATC TCTTT---GA GGTCT-GTCA TT-GAAATGA GCA-CAACTT
Aduncospiculum_halicti           ATCAATAACG AG-ACAGATC TCTTT---GA GGCCT-GTCA TC-GTAATGG GTG-TATATT
Pristionchus_lheritieri          ATCAATAACG AG-ACAGATC TCTTT---GA GGTCT-GTCA TT-GAAATGA GCA-CAACTT
Pristionchus_pacificus           ATCAATAACG AG-ACAGATC TCTTT---GA GGTCT-GTCA TT-GCAATGA GCA-CAACTT
Pristionchus_pacificus           ATCAATAACG AG-ACAGATC TCTTT---GA GGTCT-GTCA TT-GCAATGA GCA-CAACTT
Sabatieria_punctata_STRAIN_343   AAAAATAACA AG-ACGGATC TCTTT---GA GGCCC-GTTA TT-GGAATGA GAA-CAATTC
Sabatieria_sp._355_BHMM_2005     AAAAATAACA AG-ACGGATC TCTTT---GA GGCCC-GTTA TT-GGAATGA GAA-CAATTC
Sabatieria_celtica               AAAAATAACG AG-ACGGATC TCTTT---GA GGCCC-GTTA TC-GGAATGA GAA-CAATTC
Sabatieria_punctata_STRAIN_200   AAAAATAACG AG-ACGGATC TCTTT---GA GGCCC-GTTA TC-GGAATGA GAA-CAATTC
Sabatieria_punctata_STRAIN_223   AAAAATAACG AG-ACGGATC TCTTT---GA GGCCC-GTTA TC-GGAATGA GAA-CAATTC
Sabatieria_sp._210_BHM_2005      AAAAATAACG AG-ACGGATC TCTTT---GA GGCCC-GTTA TC-GGAATGA GAA-CAATTC
Setosabatieria_hilarula          AAAAATAACG AG-ACGGATC TCTTT---GA GGCCC-GTTA TC-GGAATGA GAA-CAATTC
Desmolaimus_zeelandicus          AGAAATAACG AG-GCGTCTC TCTTT---GA GGGTC-GCCA TC-GGAATGA GGA-CAATGC
Terschellingia_longicaudata      AAAAATAACG AG-GCGGTTC TCTAT---GA GGCCC-GCTA TC-GGAATGA GAA-CAATAT
Cyartonema_elegans               AAAAATAACG AG-GCGGTTC TCTTT---GA GGCCC-GCTA TC-GGAATGA GAA-CAACAC
Tridentulus_sp                   AAAAATACCA AG-CCGAGGC TCATT---GA GTTTC-GGCA TT-GGAATGA GAA-CAATCT
Diplolaimelloides_meyli          AAAAATACCA AG-AGGAGGC TCATT---GA GTTTC-CTCA TT-GGAATGA GTA-CAATCT
Diplolaimella_diavengatensis     AAAAATACCA AG-GTGAGGC CCTAT---GG GTTTC-GCCA TT-GGAATGA GAA-CAATAT
Geomonhystera_disjuncta          AAACATACCG AG-GCGATGC CCTTTC--GG GTGTC-GTCA TT-GGAATGA GTC-GAATCT
Sphaerolaimus_hirsutus           AAAAATATCG AG-CTGGTAG TCTTTC--GA TTATC-AGCA TC-GGAATGA GAA-CAATAT
Theristus_acer                   AAAAATAACG AG-ATGGGAC TCTATC--GA GTACC-ATCA TC-GGAATGA GAA-CAATCT
Daptonema_procerus               AAAAATAACG AG-ATAACCC GCTAT---GC GAGTT-ATCA TC-GGAATGA GTA-CAATTT
Daptonema_hirsutum               AAAAATAACG AG-ATAACCC GCTCTA--GC GAGTT-ATCA TC-GGAATGA GTA-CAATCT
NUCLEOTIDES INCLUDED             mmmmmmmmmm mm-mmmmmmm mmmm-----m mmmmm-mmmm mm-mmmmmmm mmm-mmmmmm
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                                        670        680        690        700        710        720
Daptonema_normandicum            AAAAATAACG AG-ACGATTC TCTTTT--GA GTATC-GTCA TC-GGAATGA GAA-CAATCC
Daptonema_oxycerca               AAAAATAACG AG-ATAACCC GCTATC--GC GAGTT-ATCA TC-GGAATGA GTA-CAATTT
Daptonema_setosum                AAAAATAACG AG-ATAACCC GCTCTA--GC GAGTT-ATCA TC-GGAATGA GTA-CAATCT
Desmodora_communis               AAAAATAACG AG-ACGGTTC TCTTT---GA GGCCC-GTCA TC-GGAATGG GTA-CAATCT
Desmodora_ovigera                AAAAATAACG AG-ACGGTTC TCTAT---GA GGCCC-GTCA TC-GGAATGG GTA-CAACTT
Metadesmolaimus_sp               AAAAATAACG AG-ATAACCC GCTCTA--GC GAGTT-ATCA TC-GGAATGA GTA-CAATCT
Dentostomella_sp                 AAAAATAACG AG-ACCGTTC TCAAT---GA GGCCG-GTTA TC-GGAATGA ATA-CAATTT
Bunonema_franzi                  AGAAATAACA AA-GTAGATG TCTTT---GA TGTCT-ACTA TT-GGAATGG GTA-CAATTT
Bunonema_sp                      AGAAATAACA AA-GCAGATG TCTCT---GA TGTCT-GCTA TT-GGAATGG GTA-CAATTC
Seleborca_complexa               AAAAATAACG AG-ACCGTTC TCTTT---GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Acrobeloides_nanus               AAAAATAACG AG-ACCGTTC TCTTAT--GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Acrobeloides_bodenheimeri        AAAAATAACG AG-ACCGTTC TCTTAT--GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Acrobeloides_sp_PS1146           AAAAATAACG AG-ACCGTTC TCTTT---GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Acrobeles_ciliatus               AAAAATAACG AG-ACCGTTC TCTTT---GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Acrobeles_sp_PS1156              AAAAATAACG AG-ACCGTTC TCTTT---GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Acrobeles_complexus_WCUG2        AAAAATAACG AG-ACCGTTC TCTTT---GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Cephaloboides_sp_SB227           AAATATAAAG AG-ACCAATC CTCT-----G GATTG-GTTA TT-TCAATGA GAT-GAGCTT
Cephalobus_cubaensis             AAAAATAACG AG-ACCATTC TCTCAT--GA GGCTG-GTCA TC-GGAATGG GTA-CAATTT
Cephalobus_sp._PS1143            AAAAATAACG AG-ACCGTTC TCTTAT-GGA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Cephalobus_sp._PS1196            AAAAATAACG AG-ACCGTTC TCTTAT--GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Cephalobus_oryzae_PS1165         AAAAATAACG AG-ACCGTTC TCTTAT--GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Cervidellus_alutus               AAAAATAACG AG-ACCGTTC TCTT-T--GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Pseudacrobeles_variabilis        AAAAATAACG AG-ACCGTTC TCTTCT--GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Triligulla_aluta                 AAAAATAACG AG-ACCGTTC TCTTT---GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Zeldia_punctada                  AAAAATAAC- AG-ACCGTTC TCTTCT--GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Myolaimus_sp_U81585              AAAAATAACG AG-GATGTCT TCTTT---GA GGCCA-TCTA TC-GTAATGA GTA-CAATTC
Rhabditophanes_sp._KR3021        AAAAATGACA AG-GCTACAA ATTTT---GT TTGTA-GTCA TT-GGAAATC TTC-GAGTCT
Brevibucca_sp._SB261             AAAAATAACA AG-GGCGTAC TCTTT---GA GGCCG-CCTA TT-GGAATGG GTA-CAATTT
Halicephalobus_gingivalis        TGAAATGACN AGATANGTTN TGTAT---AG AATNT-ANCA TT-GGAATGG TTT-AATTAC
Panagrobelus_stammeri            AGAAATGACA AGGCTTACTC CTTAT---GG GGTGA-GTCA TT-GGAATGG GTA-CAATTT
Plectonchus_sp._PDL0025          TGAAATGACA AGGCTTATTC CTTAT---GG AATGA-GTCA TT-GGAATGG GTC-CAATTT
Turbatrix_aceti                  TGAAATGGCA GAATCCTTTT CTTTA--TGG AACGG-ATTA TT-GCAATGA TGT-GAGTTT
Panagrellus_redivivus            AGAAGTGACA AGATCTGTCM CTTCG---GG GGCGG-GTCA TT-GGAATGG TTK-GAATTT
Panagrellus_redivivus_PS1163     AGAAGTGACA AGATCTGTCC CTTCG---GG GGCGG-GTCA TT-GGAATGG TTT-GAATTT
Panagrolaimus_subelongatus       AGAAATGACA AGATCTATTC CTTCG---GG GATGG-ATCA TT-GGAATGG TTT-GATTTT
Panagrolaimus_davidi             AGAAATGACA AGATCTATTC CTTCG---GG GATGG-ATCA TT-GGAATGG TTT-GATTTT
Panagrolaimus_cf_rigidus_AF40    AGAAATGACA AGATCTATTC CTTCG---GG GATGG-ATCA TT-GGAATGG TTT-GATTTT
Panagrolaimus sp. Sourhope ED2   AGAAATGACA AGATCTATTC CTTCG---GG GATGG-ATCA TT-GGAATGG TTT-GATTTT
Panagrolaimus sp. Sourhope ED2   AGAAATGACA AGATCTATTC CTTCG---GG GATGG-ATCA TT-GGAATGG TTT-GATTTT
Panagrolaimus sp. Sourhope ED2   AGAAATGACA AGATCTATTC CTTCG---GG GATGG-ATCA TT-GGAATGG TTT-GATTTT
Panagrolaimus sp. Sourhope ED2   AGAAATGACA AGATCTATTC CTTCG---GG GATGG-ATCA TT-GGAATGG TTT-GATTTT
Panagrolaimus sp. Sourhope ED2   AGAAATGACA AGATCTATTC CTTCG---GG GATGG-ATCA TT-GGAATGG TTT-GATTTT
Steinernema_carpocapsae          AAAAATAACA AG-ACTGGTC GCTTT---GC GAACA-GTTA TT-GGAATGG GTA-CAATTT
Strongyloides_stercoralis        AAAAATGACA ACCAAATATT ATTAT---TA ATATT-TGGA TT-GAAAATC TTC-AAGTTT
Strongyloides_ratti              AAAAATGACA ACCAAATATT ATTTT---TA GTATT-TGGA TT-GAAAATC TTC-AAGTTT
Diploscapter_sp_PS1897           AAAAATATAA AA-TCCCTCC CTCAT----G GGAGG-GATA TT-TAAATGA GTA-GAGGTT
Diploscapter_sp_PS2017           AAAAATATAA AA-TCCCTCC CTCAT----G GGAGG-GATA TT-TAAATGA GTA-GAGGTT
Heterorhabditis_bacteriophora    AAAAATAAAA AG-ACCATTC CT-AT----G GAACG-GTTA TT-TCAATGA GTA-GATCTT
Heterorhabditis_hepialus         AAAAATAAAA AG-ACCATTC CT-AT----G GAACG-GTTA TT-TCAATGA GTA-GATCTT
Heterorhabditis_zelandica        AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTA-GATCTT
Parasitorhabditis_sp_SB281       ACAACTAACG AG-ACTGCTC CCTAC---GG GAACA-GTCA TC-GAAATGG GTA-CAATTT
Rhabditoides_inermiformis        ACAACTAACG AG-ACCGTTC TCTTT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Rhabditoides_inermis_DF5001      AACAATAACG AG-ACAGCTC TCTTT---GA GGGTT-GTTA TC-GGAATGG GTT-CAATCT
Rhabditoides_regina_DF5012       ACCAATAACG AG-ACTCAGA CCTTT---GG TTTGA-GTCA TC-GGAATGG GTC-CAAAGT
Poikilolaimus_oxycerca_SB200     AACAATAACG AG-ACCGTCT TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Poikilolaimus_regenfussi_SB199   AACAATAACG AG-ACCGTCT TCTTT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Distolabrellus veechi DWF1604    ACAACTAACG AG-ACTGCGT CCTAT---GG GCGCA-GTCA TC-GAAATGG GTA-CAATTT
Distolabrellus veechi DF5024     ACAACTAACG AG-ACTGCGT CCTAT---GG GCGCA-GTCA TC-GAAATGG GTA-CAATTT
Choriorhabditis_dudichi          AAACATAAAA AG-ACCATTC CGTTC----G GAGCG-GTTT TT-TCAATGA ATA-GAGTTT
Protorhabditis_sp                AACAATATAA AA-TCCCTCC CAAAT----G GGAGG-GATA TT-TAAATGA GTA-GAGGTT
Protorhabditis_sp_DF5055         AAGAATAAAA AA-CCCTACC CTTAG----G GGTGG-GGTA TT-TGAATGA GTG-AAGTTC
Cruznema_tripartitum_DF5015      ANACATAAAA AG-ACCATTC CTAAC----G GAACG-GTTA TT-TCAATGA TAC-GAGTGT
Mesorhabditis_sp_PS1179          ACAACTAACG AG-ACTGCTC CCTAT---GG GAACA-GTCA TC-GAAATGG GTA-CAATTT
Mesorhabditis_spiculigera_SB15   ACAACTAACG AG-ACTGCTT CCTAT---GG GAGCA-GTCA TC-GAAATGG GTA-AAATTC
Mesorhabditis_anisomorpha_SB12   ACGAATAACG AG-ACTGTTC CCTCT---GG GAACA-GTCA TC-GAAATGG GTC-TAACAC
Teratorhabditis_palmarum_DF501   ACAACTAACG AG-ACTGCTC CTACG----G GAACA-GTCA TC-GAAATGG GTA-CAATTT
Teratorhabditis_synpapillata_S   ACAACTAACG AG-ACTGCTC CCTAT---GG GAACA-GTCA TC-GAAATGG GTA-CAATTT
Caenorhabditis_briggsae_PB102    AAAAATATAA AG-ACTCATC CTTTT----G GATGA-GTTA TT-TCAATGA GTT-GAATAC
Caenorhabditis_elegans_N2        AAAAATATAA AG-ACTCATC CTTTT----G GATGA-GTTA TT-TCAATGA GTT-GAATAC
Caenorhabditis_sp_CB5161         AAAAATATAA AG-ACTCATC CTTTT----G GATGA-GTTA TT-TCAATGA GTT-GAATAT
Caenorhabditis_sp_PS1010         AAAAATATAA AG-ACTCATC CTTTT----G GATGA-GTTA TT-TCAATGA GTT-GAATTT
Caenorhabditis_japonica          AAAAATATAA AG-ACTCATC CTTTT----G GATGA-GTTA TT-TCAATGA GTT-GAATAT
Caenorhabditis_sp_DF5170         AAAAATATAA AG-ACTCATC CTTCG----G GATGA-GTTA TT-TCAATGA GTT-GAATAT
Caenorhabditis_sp_SB341          AAAAATAAAA AG-ACCCCTC CCAAC----G GAGGG-GTTA TT-TCAATGA GTT-GAATAC
Caenorhabditis_plicata           AAAAATAGAA AG-AGTCATT CTTTAT---G GATGA-CTCA TT-TCAATGA GTT-GATTAT
Caenorhabditis_vulgaris          AAAAATATAA AG-ACTCATC CTTTT----G GATGA-GTTA TT-TCAATGA GTT-GAATAC
Caenorhabditis_sonorae           AAAAATAAAA AG-ACCCCTC CTTT-----G GAGGG-GTTA TT-TCAATGA GTT-GAATAC
Caenorhabditis_drosophilae       AAAAATATAA AG-ACTCATC CTTC-----G GGATGAGTTA TT-TCAATGA GTT-GAATAT
NUCLEOTIDES INCLUDED             mmmmmmmmmm mm-mmmmmmm mmmm-----m mmmmm-mmmm mm-mmmmmmm mmm-mmmmmm
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         670        680        690        700        710        720
Phasmarhabditis_hermaphrodita    GAACATAAAA AG-ACTCATC TTTCT----A GATGG-GTTA TT-TCAATGA GTT-GAACTT
Phasmarhabditis_neopapillosa     GAACATAAAA AG-ACTCATC TTTCT----A GATGG-GTTA TT-TCAATGA GTT-GAACTT
Phasmarhabditis_neopapillosa     AAAAATAAAA AG-ACCGATC CTAT-----G GATCG-GTTA TT-TCAATGA GTT-GAGCTT
Pellioditis_mediterranea_SB173   AAAAATAAAA AG-ATCAATC CTAT-----G GATTG-ATTA TT-TCAATGA GTT-GAGCTT
Pellioditis_marina               AAAAATAAAA AG-ACCGATC CTAT-----G GATCG-GTTA TT-TCAATGA GTT-GAGCTT
Prodontorhabditis_wirthi         GGAAATACAA AA-CCTTTGC CCTAT---GG GTAGA-GGTA TT-TGAATGA GAA-GATATT
Crustorhabditis_scanica          ACAACTAACG AG-ACTGCTC TCTAT---GA GAACA-GTCA TC-GAAATGG GTA-CAATTT
Dolichorhabditis_sp_CEW1         AAAAATAAAA AG-TCCAATC CTAAC----G GATCG-GATA TT-TCAATGA ATT-GAGCTT
Oscheius_sp_DF5000               AAAAATAAAA AG-ACCATTC -TAAC----G GAACG-GTTA TT-TCAATGA ATT-GAGCTT
Oscheius_sp_BW282                AAAAATAAAA AG-ACCAATC CTCAC----G GATCG-GTTA TT-TCAATGA GTT-GAGCTT
Oscheius_myriophila_EM435        AAAAATAAAA AG-ACCAATC CTCAC----G GATCG-GTTA TT-TCAATGA GTT-GAGCTT
Oscheius_insectivora             AAAAATAAAA AG-ACCAATC CTTAC----G GATCG-GTTA TT-TCAATGA GTT-CAGCTT
Oscheius_dolichuroides           AAAAATAAAA AG-ACCATTC CTAAC----G GAACG-GTTA TT-TCAATGA ATT-GAGCTT
Rhabditis_blumi_DF5010           GAAAATAAAA AG-ACCAGTC CTCT-----G GATTG-GTTA TT-TCAATGA ATT-GAGTCT
Rhabditis_sp_PS1191              GAAAATAAAA AG-ACCAATC CACT-----G GATTG-GTTA TT-TCAATGA ATT-GAGCCC
Rhabditis_sp_PS1010              AAAAATATAA AG-ACTCATC CTTTT----G GATGA-GTTA TT-TCAATGA GTT-GAATTT
Rhabditis_myriophila_EM435       AAAAATAAAA AG-ACCAATC CTCAC----G GATCG-GTTA TT-TCAATGA GTT-GAGCTT
Rhabditis_colombiana             AAAAATAAAA AG-ACCAATC CTTAC----G GATCG-GTTA TT-TCAATGA GTT-GAGCTT
Rhabditella_axei_DF5006          AAAAATAAAG AG-ACCAATC CTTT-----G GATTG-GTTA TT-TCAATGA GTT-GAGCTT
Rhabditella_sp_DF5044            AAAAATAAAG AG-ACCAATC CTTT-----G GATTG-GTTA TT-TCAATGA GTT-GAGTCT
Cuticularia_sp_PS2083            AACAATAACG AG-ACCGTCT TCTAT---GA AGCCG-GTTA TC-GGAATGG GTA-CAATTT
Necator_americanus               AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Kalicephalus_cristatus           AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Ancylostoma_caninum              AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Angiostrongylus_cantonensis      AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Angiostrongylus_costaricensis    AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Angiostrongylus_malaysiensis     AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Angiostrongylus_dujardini        AAAAATAAAA AA-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Angiostrongylus_vasorum          AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Aulurostrongylus_abstrusus       AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Didelphostrongylus_hayesi        AAAAATAAAA AA-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCTT
Crenosoma_mephitidis             AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Crenosoma_vulpis                 AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Otostrongylus_circumlitus        AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Troglostrongylus_wilsoni         AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTGA TT-TCAATGA GTT-GATCAT
Filaroides_martis                AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Oslerus_osleri                   AAAAATAAAA AG-ACCGTTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Parafilaroides_decorus           AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Metastrongylus_salmi             AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Metastrongylus_elongatus         AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Skrjabingylus_chitwoodrum        AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Parelaphostrongylus_odocoilei    AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Muelerius_capillaris             AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Protostrongylus_rufescens        AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Halocercus_invaginatus           AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Pseudalius_inflexus              AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Stenurus_minor                   AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Torynurus_convolutus             AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Syngamus_trachea                 AAAAATAAAA AG-ACCGTTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Stephanurus_dentatus             AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Nematodirus_battus               AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GAGCTT
Strongylus_equinus               AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Labiostrongylus_bipapillosus     AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Petrovinema_poculatum            AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Cylicocyclus_insignis            AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Chabartia_ovina                  AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Cyclodontostomum_purvisi         AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Zoniolaimus_mawsonae             AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Hypodontus_macropi               AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAt
Deletrocephalus_dimidiatus       AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Dictyocaulus_eckerti_P7B8        AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Dictyocaulus_capreolus_P3B2      AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCGT
Dictyocaulus_sp._P6A1            AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Dictyocaulus_filaria             AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Dictyocaulus_capreolus_P2C10     AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCGT
Dictyocaulus_viviparus           AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Haemonchus_sp._V3091             AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Haemonchus_contortus             AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Haemonchus_placei                AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Haemonchus_similis               AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Ostertagia_ostertagi             AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Ostertagia_leptospicularis       AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Nippostrongylus_brasileinsis     AAAAATAAGA AG-ACCATTC CTAT-----G GAACG-GTCA TT-CCAATGA GTT-GATCAT
Heligmosomoides_polygyrus        AAAAATAAGA AG-ACCATTC CTAT-----G GAACG-GTCA TT-CCAATGA GTT-GATCAT
Trichostrongylus_colubriformis   AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Tetrabothriostrongylus mackerr   AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Herpestrongylus_pythonis         AAAAATAAGA AG-ACCATTC CTAT-----G GAACG-GTCA TT-CCAATGA GTT-GATCAT
Nicollina_cameroni               AAAAATAAGA AG-ACCATTC CTAT-----G GAACG-GTCA TT-CCAATGA GTT-GATCAT
NUCLEOTIDES INCLUDED             mmmmmmmmmm mm-mmmmmmm mmmm-----m mmmmm-mmmm mm-mmmmmmm mmm-mmmmmm
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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         670        680        690        700        710        720
Filarimena_flagrifer             AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Amidostomum_cygni                AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Teratocephalus_lirellus          AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Brumptaemilius_justini           AAAAATAACG AG-ACCGTTC TCTWT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Anguillicola_crassus             AAAAATAACG GG-GCCGTTC TCTTT---GA GGCCG-GTTA CC-GGAATGG GTA-CAATCT
Dracunculus_medinensis           AAAAATAACG AG-ACCGTTC TCATT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Dracunculus_oesophageus          AAAAATAACG GG-ACCGTTC TCATT---GA GGCCG-GTTA TT-GGAATGG GTA-CAATTT
Dracunculus_sp._V3104            AAAAATAACG AG-ACCGTTC TCATT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Philonema_sp_A                   AAAAATAACG AG-ACCGTAC TCAAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Philometra_obturans              AAAAATAACG AG-ACCGTAC TCGAT---GA GGCCG-GTTA TC-GGAATGG GCA-CAATCT
Camallanus_oxycepahalus          AAAAATAACG AG-ACCGTTC TCTTC---GA GGCCG-GTTA TC-GGAATGA GTA-CAATTT
Acanthocheilonema_viteae         AAAAATAACG AG-ACCGTTC TCTTT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Loa_loa                          AAAAATAACG AG-ACCGTTC TCTTT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Onchocerca_cervicalis            AAAAATAACG AG-ACCGTTC TCTTT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Dirofilaria_immitis              AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Brugia_malayi                    AAAAATAACG AG-ACCGTTC TCTTT---GR GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Wuchereria_bancrofti             AAAAATAACG AG-ACCGTTC TCTTT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Litomosoides_sigmodontis         AAAAATAACG AG-ACCGTTC TCTTT---GA GGCCG-GTTA TC-GGAATGN NTA-AAATTT
Setaria_digitata                 AAAAATAACG AG-ACCGTTC TCTTT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Gnathostoma_turgidum             AAAAATAACG AA-ACCGATC TCAAT---GA GGCCG-GTTA TC-GGAATGA GTC-ACGCTT
Gnathostoma_neoprocyonis         AAAAATAACG AA-ACCGATC TCAAT---GA GGCCG-GTTA TC-GGAATGA GTC-ACGCTT
Gnathostoma_binucleatum          AAAAATAACG AA-ACCGATC TCAAT---GA GGCCG-GTTA TC-GGAATGA GTC-ACGCTT
Physaloptera_alata               AAAAATAACG AG-ACCGTTC TCTTT---GG GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Physaloptera_turgida             AAAAATAACG AG-ACCGTTC TCTTT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Ascarophis_arctica               AAAAATAACG AG-ACCGTTC TCTTC---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Spinitectus_carolini             AAAAATAACG AG-ACCGTTC TCTTC---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Thelazia_lacrymalis              AAAAATAACG AG-ACCGTTC TCTTT---GA GGCCG-GTTA TC-GGAATGG GTA-CAATTT
Aphelenchus_avenae               AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTCA TC-GGAATGG GTA-CAATCT
Aphelenchoides_fragariae         AGAAATAACA AG-TCCGTTC TCTTT---GA GGTCG-GACA TT-GGAATGG ATG-AAATCT
Bursaphelelenchus_sp             AGAAATAACG AG-ATCGTTC TCTTT---GA GGTCG-GTTA TT-GGAATGA GTA-CAATCC
Deladenus_sp                     AGAAATAACG AG-ACCGTTC TCTAC---GA GGCCG-GTCA TC-GGAATGG GTA-CAATCC
Criconema_sp                     AAAAATAACA AG-GCTGTTC TCTAC---GA GGCCA-GCCA TT-GGAATGG GTA-CAACAC
Hemicycliophora_conida           AAAAATAACA AG-GCCGTTC TCTTAT--GA GGCCG-GCCA TT-GGAATGG GTA-CAACTC
Paratylenchus_dianthus           AAAAATAACA AG-GCCGTTC TCTTT---GA GGCCG-GCCA TT-GGAATGG GTA-CAACTT
Pratylenchus_thornei             AGAAATAACG AG-GCCGTTC TCTTT---GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Tylenchulus_semipentrans         AAAAATAACG AG-ACCGTTC TCTAC---GA GGCCG-GTCA TC-GGAATGG GTA-CAACTC
Ditylenchus_angustus             AGAAATAACG AG-ACCGTTC TTTTT---AA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Subanguina_radicola              AAAAATAACG AG-ACCGTTC TCTAT---GA GGCCG-GTCA TC-GGAATGG GTA-CAATCT
Tylenchorhynchus_maximus         AGAAATATCG AG-ACCGTTC TCTTAA--GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Geocenamus_quadrifer             AGAAATAACG AG-ACCGTTC TCTAC---GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Globodera_pallida                AGAAATAACG AG-ACCGATC TCTTAT--GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Scutellonema_bradys              AGAAATAACG AG-GCCGTAC TCTTAC--GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Helicotylenhcus_dihystera        AGAAATAACA AG-ACCGTTC TCTTAC--GA GGCCG-GTTA TT-GGAATGG GTA-CAATTT
Rotylenchus_robustus             AGAAATAACG AG-ACCGTTC TCACAA--GA GGCCG-GTCA TC-GGAATGG GTA-CAATCT
Meloidogyne_arenaria             AGAAATAACG AG-ACTGTTC TCTTT---GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Meloidogyne_incognita_KT         AGAAATAACG AG-ACTGTTC TCTTT---GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Meloidogyne_javanica             AGAAATAACG AG-ATTGTTC TCTTT---GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Meloidogyne_artiellia            AGAAATAACA AG-ACCGTTC TCTTCA--GA GGCCG-GTCA TT-GGAATGG GTA-CAACTT
Meloidogyne_duytsi               AGAAATAACG AG-ATCGTTC TCTTAT--GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Meloidogyne_exigua               AGAAATAACG AG-ACCGTTC TCTTT---GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Meloidogyne_hapla                AGAAATAACG AG-GTCGTTC TCAAAT--GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Meloidogyne_ichinohei            AGAAATAACG AG-GCCGTTC TCTTCT--GA GGCCG-GTCA TC-GGAATGG GAA-AAATTT
Meloidogyne_maritima             AGAAATAACG AG-ATCGTTC TCTTAT--GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Meloidogyne_microtyla            AGAAATAACG AG-ATCGTTC TCATAT--GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Nacobbus_aberrans                AGAAATAACG AG-ACAGTTC TCTTAT--GA GGCCT-GTCA TC-GGAATGG GTA-CAATCT
Pratylenchoides_ritteri          AGAAATAACG AG-ACCGTTC TCTAC---GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Pratylenchoides_magnicauda       AGAAATAACG AG-ACCGTTC TCTAC---GA GGCCG-GTCA TC-GGAATGG GTA-CAATTT
Hirschmanniella_sp._JH_2003      AGAAATAACG AG-ACTGTTC TCTTCA--GA GGCCA-GTCA TC-GGAATGG GTA-CAATTT
Radopholus_similis               AGAAATAACG AG-GCCGTTC TCATAC--GA GGCCG-GCCA TT-GGAATGG AAG-AGGTTT
Pratylenchus_goodeyi_VF          AGAAATAACG AG-ACCGTTC TCTTCA--GA GGCCG-GTCA TC-GGAATGG GTA-CAATCC
Boleodorus_thylactus_clone2      AGAAATAACG AG-GCCGTTC TCTAT---GA GGCCG-GTCA TC-GGAATGG GTA-CAATCT
Philippine Sequence 1            AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Philippine Sequence 2            AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Philippine Sequence 3            AAAAATAGAA AG-GGTAATC CTCT-----G GATTT-CCTA TT-TCAATGA GTT-GAGCCC
Philippine Sequence 4            AGAAATGACA AG-ATCTATT CCTTCG--GG GATGG-ATCA TT-GGAATGG TTT-GATTTT
Philippine Sequence 5            AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Philippine Sequence 6            AAAAATAAAA AG-GCCAATC CTAT-----G GATCG-GTTA TT-TCAATGA GCT-GAGCTT
Philippine Sequence 7            AAAAATATAA AG-ACTCATC CTTTT----G GATGA-GTTA TT-TCAATGA GTT-GAATAC
Tahiti Sequence 1                AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTTA TT-TCAATGA GTT-GATCAT
Tahiti Sequence 2                AAAAATAAAA AG-ACCATTC CTAT-----G GARCG-GTTA TT-SCAATGA GTC-GWTCAT
Thailand Sequence 1              AAAAATAACA AG-ACCGTTC TCTT---AGA GGCCG-GTTA TT-GGAATGA GTA-CAATTT
Ogasawara Sequence 1             AGAAATGACA AGATCTATTC CTTCG---GG GATGG-ATCA TT-GGAATGG TTT-GATTTT
Ogasawara Sequence 2             GTACATAAAA AG-ACTCATC TTTC----TA GATGG-GTTA TT-TCAATGA GTT-GAACTT
Ivory Coast Sequence 1           AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Ivory Coast Sequence 2           AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Ivory Coast Sequence 3           AAAAATAAAA AG-ACCATTC CTAT-----G GAATCGGTCA TT-TCAAKGA GTT-GATCAT
Ivory Coast Sequence 4           AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Ivory Coast Sequence 5           AAAAATAACA AG-ACCGTTC TCTAT---GA GGCCG-GTTA TT-GGAATGA GTA-CAATTT
NUCLEOTIDES INCLUDED             mmmmmmmmmm mm-mmmmmmm mmmm-----m mmmmm-mmmm mm-mmmmmmm mmm-mmmmmm
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                                        670        680        690        700        710        720
Ivory Coast Sequence 6           AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Ivory Coast Sequence 7           AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Singapore Sequence 1             AAAAATAGAA AG-GGTAATC CTCT-----G GATTT-CCTA TT-TCAATGA TTT-GAGCCC
Singapore Sequence 2             AAAAATAACA AG-ACCGTTC TCTT---AGA GGCCG-GTTA TT-GGAATGA GTA-CAATAT
Singapore Sequence 3             AAAAATATAA AG-ACTCATC CTTTT----G GATGA-GTTA TT-TCAATGA GTT-GAATAC
Singapore Sequence 4             AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Nigerian Sequence 1              AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Nigerian Sequence 2              AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
Nigerian Sequence 3              AAAAATAAAA AG-ACCATTC CTAT-----G GAACG-GTCA TT-TCAATGA GTT-GATCAT
NUCLEOTIDES INCLUDED             mmmmmmmmmm mm-mmmmmmm mmmm-----m mmmmm-mmmm mm-mmmmmmm mmm-mmmmmm


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                                        730        740
Gordius_aquaticus                A-AATCCTTT AACGAGGATC TATTGGAG
Priapulus_caudatus               A-AATCCTTT AACGAGGATC TATTGGAG
Brachionus_plicatilis            A-AAACCCTT AACGAGGATC TATTGGAG
Chordodes_morgani                A-AATCCTTT AACGAGGATC TATTGGAG
Paractinolaimus_macrolaimus      A-AATCCTTT AACGAGGATC TATTGGAG
Aporcelaimellus_obtusicaudatus   A-AATCCTTT AACGAGGATC TATTGGAG
Wilsonema_schuurmansstekhoveni   A-AACCCTTT AACGAGGACC TATGAGAG
Mesodorylaimus_sp_cf_nigritul    A-AATCCTTT AACGAGGATC TATTGGAG
Mesodorylaimus_bastiani          A-AATCCTTT AACGAGGATC TATTGGAG
Mesodorylaimus_japonicus         A-AATCCTTT AACGAGGATC TATTGGAG
Pungentus_sp._PDL_2005           A-AATCCTTT AACGAGGATC TATTGGAG
Allodorylaimus_sp                A-AATCCTTT AACGAGGATC TATTGGAG
Eudorylaimus_carteri             A-AATCCTTT AACGAGGATC TATTGGAG
Microdorylaimus_sp               A-AATCCTTT AACGAGGATC TATTGGAG
Longidorus_elongatus             A-AATCCTTT AACGAGGATC TATTGGAG
Xiphinema_rivesi                 A-AATCCTTT AACGAGGATC TATTGGAG
Tylencholaimus_sp                A-AATCCTTT AACGAGGATC TATTGGAG
Anoplostoma_sp._BHMM_2005        A-AATCCTTT AACGAGGATC TATTGGAG
Adoncholaimus_fuscus             A-AATCCTTT ATCGAGGATC TATTGGAG
Enoplus_meridionalis             A-AATCCTTT AACGAGGATC TATTGGAG
Enoplus_brevis_U88336            A-AATCCTTT AACGAGGATC TATTGGAG
Enoplus_communis                 A-AATCCTTT AACGAGGATC TATTGGAG
Enoploides_brunettii             A-AATCCTTT AACGAGGATC TATTGGAG
Syringolaimus_striatocaudatus    A-AATCCTTT AACGAGGATC CATTGGAG
Ironus_dentifurcatus             A-AATCCTTT AATGAGGATC TATTGGAG
Calyptronema_maxweberi           A-AATCTTTT ATCGAGGATC TATTGGAG
Viscosia_sp._BHMM_2005           A-AATCATTT ATCGAGGATC TATTGGAG
Viscosia_viscosa                 A-AATCATTT ATCGAGGATC TATTGGAG
Pontonema_vulgare                A-AATCATTT ATCGAGGATC TATTGGAG
Oncholaimus_sp._BHMM_2005        A-AATCATTT ATCGAGGATC TATTGGAG
Alaimus_sp_PDL_2005              A-AATCCTTT AACGAGGATC AATTGGAG
Prismatolaimus_intermedius       A-AATCCTTT AACGAGGAT- TATTGGAG
Tobrilus_gracilis                A-AATCCTTT AACGAGGATC TATTGGAG
Tripyla_cf_filicaudata_JH_2004   A-AATCCTTT AACGAGGAAC TATTGGAG
Bathylaimus_sp                   A-AATCCTTT AACGAGGATC TATTGGAG
Bathylaimus_assimilis            A-AATCCTTT AACGAGGATC TATTGGAG
Bathylaimus_sp._BHMM_2005        A-AATCCTTT AACGAGGATC TATTGGAG
Tripyloides_sp._BHMM_2005        A-AATCCTTT AACGAGGATC TATTGGAG
Trischistoma_monohystera         A-AATCCTTT AACGAGGATC TATTGGAG
Mermis_nigrescens                A-AATCCTTT AACGAGGATC TATTAGAG
Mylonchulus_arenicolus           A-AATCTTTT AACGAGGATC TATTAGAG
Anatonchus_tridentacus           A-AAAACTTT AACGAGGATC TATTAGAG
Mononchus_truncatus              A-AATCTTTT AACGAGGATC TATTAGAG
Prionchulus_muscorum             A-AATCTTTT AACGAGGATC TATTAGAG
Clarkus_sp                       A-AATCTTTT AACGAGGATC TATTAGAG
Trichinella_spiralis             A-CACACGCT AACGAGTAGC AATTGGAG
Trichinella_papuae               A-CACACGCT AACGAGTAGC AATTGGAG
Trichinella_britovi              A-CACACGCT AACGAGTAGC AATTGGAG
Trichinella_murrelli             A-CACACGCT AACGAGTAGC AATTGGAG
Trichinella_pseudospiralis       A-CACACGCT AACGAGTAGC AATTGGAG
Trichinella_nativa               A-CACACGCT AACGAGTAGC AATTGGAG
Trichinella_zimbabwensis         A-CACACGCT AACGAGTAGC AATTGGAG
Trichinella_nelsoni              A-CACACGCT AACGAGTAGC AATTGGAG
Trichuris_suis                   A-CACAAGCT CGGCTAAATC TATTGGAG
Trichuris_trichiura              A-CATAAGTT CGGCTAAATC TATTGGAG
Trichuris_muris                  A-CATAAGCT CGGCTAATTC TATTGGAG
Tylolaimophorus_minor            A-AATCCTTT AACGAGGATC TATTGGAG
Paratrichodorus_pachydermus      A-AATCCTTT AACGAGGATC TATTGGAG
Paratrichodorus_anemones         A-AATCCTTT AATGAGGATC TATTGGAG
Trichodorus_primitivus           A-AATCCTTT AACGAGGATC TATTGGAG
Axonolaimus_helgolandicus        A-AACCTTTT AACGAGGATC TACGAGAG
Ascolaimus_elongatus             A-AACCTTTT AACGAGGATC TACGAGAG
Odontophora_rectangula           A-AACCTTTT AACGAGGATC TACGAGAG
Cylindrolaimus_sp._202149        A-AACCCTTT AACGAGGATC TACGAGAG
NUCLEOTIDES INCLUDED             m-mmmmmmmm mmmmmmmmmm mmm.....
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                                         730        740
Tylocephalus_auriculatus         A-AACCCTTT AACGAGGACC TATGAGAG
Plectus_acuminatus_BS9           A-AACCCTTT AACGAGGACC TATGAGAG
Plectus_aquatilis                A-AACCCTTT AACGAGGACC TATGAGAG
Anaplectus_sp                    A-AACCCTTT AACGAGGACC TATGAGAG
Anisakis_sp_WKT                  A-AACCCGTT AACGAGGATC TATGAGAG
Anisakis_sp_Nadler               A-AACCCGTT AACGAGGATC TATGAGAG
Contracaecum_multipapillatum     A-AACCCGTT AACGAGGATC TATGAGAG
Pseudoterranova_decipiens        A-AACCCGTT AACGAGGATC TATGAGAG
Raphidascaris_acus               A-AACCCGTT AACGAGGATC TATGAGAG
Terranova_caballeroi             A-AACCCGTT AACGAGGATC TATGAGAG
Ascaris_suum                     A-AACCCGTT AACGAGGATC TATGAGAG
Ascaris_lumbricoides             A-AACCCGTT AACGAGGATC TATGAGAG
Baylisascaris_procyonis          A-AACCCGTT AACGAGGATC TATGAGAG
Baylisascaris_transfuga          A-AACCCGTT AACGAGGATC TATGAGAG
Parascaris_equorum               A-AACCCGTT AACGAGGAAC TATGAGAG
Porrocaecum_depressum            A-AACCCGTT AACGAGGATC TATGAGAG
Toxascaris_leonina               A-AACCCGTT AACGAGGATC TATGAGAG
Heterocheilus_tunicatus          A-AACCCGTT AACGAGGATC TATGAGAG
Goezia_pelagia                   A-AACCCGTT AACGAGGATC TATGAGAG
Hysterothylacium_fortalezae      A-AACCCGTT AACGAGGATC TATGAGAG
Hysterothylacium_pelagicum       A-AACCCGTT AACGAGGATC TATGAGAG
Hysterothylacium_reliquens       A-AACCCGTT AACGAGGATC TATGAGAG
Iheringascaris_inquies           A-AACCCGTT AACGAGGATC TATGAGAG
Toxocara_canis                   A-AACCCGTT AACGAGGATC TATGAGAG
Nemhelix_bakeri                  A-AACCCGTT AACGAGGATC TATGAGAG
Raillietnema_sp._V3060           A-AACCCGTT AACGAGGATC TATAAGAG
Cruzia_americana                 A-AACCCGTT AACGAGGATC TATGAGAG
Heterakis_sp_14690               A-AATCCGTT AACGAGGATC TATGAGAG
Heterakis_gallinarum             A-AATCCGTT AACGAGGATC TATGAGAG
Paraspidodera_sp_21303           A-AACCCGTT AACGAGGATC TATGAGAG
Chromodora_nudicapitata          A-AACCCTTT AACGAGGATC TATTGGAG
Chromadora_sp._BHMM_2005         A-AACCCTTT AACGAGGATC TATTGGAG
Atrochromadora_microlaima        A-AACCCTTT AACGAGGATC TATTGGAG
Chromadorina_germanica           A-AACCCTTT AACGAGGATC TATTGGAG
Chromadorita_tentabundum         A-AACCCTTT AACGAGGATC TATTGGAG
Dichromadora_sp._BHMM_2005       A-AACCCTTT AACGAGGATC TATTGGAG
Neochromadora_BHMM_2005          A-AACCCTTT AACGAGGATC TATTGGAG
Spilophorella_paradoxa           A-AACCCTTT AACGAGGATC TATTGGAG
Paracanthonchus_caecus           A-AACCCTTT AACGAGGATC TATTGGAG
Paracyatholaimus_intermedius     A-AACCCGTT AACGAGGATC TATTGGAG
Praeacanthonchus_punctatus       A-AACCCTTT AACGAGGATC TATTGGAG
Praeacanthonchus_sp              A-AACCCTTT AACGAGGATC TATTGGAG
Cyatholaimus_sp._BHMM_2005       A-AACCCTTT AACGAGGATC TATTGGAG
Spirinia_parasitifera            A-AACCCTTT AACGAGGATC TATTGGAG
Acanthopharynx_micans            A-AACCCTTT AACGAGGATC TATTGGAG
Xyzzors_sp                       A-AACCCTTT AACGAGGATC TATTGAAG
Metachromadora_sp                A-AACCCTTT AATGAGGATC TATTGGAG
Metachromadora_remanei           A-AACCCTTT AATGAGGATC TATTGGAG
Catanema_sp                      A-AACCCTTT AACGAGGATC TATTGGAG
Eubostrichus_dianae              A-AACCCTTT AACGAGGATC TATTGGAG
Eubostrichus_topiarus            A-AACCCTTT AACGAGGATC TATTGGAG
Eubostrichus_parasitiferus       A-AACCCTTT AACGAGGATC TATTGGAG
Laxus_oneistus                   A-AACCCTTT AACGAGGATC TATTGGAG
Laxus_cosmopolitus               A-AACCCTTT AACGAGGATC TATTGGAG
Leptonemella_sp                  A-AACCCTTT AACGAGGATC TATTGGAG
Robbea_hypermnestra              A-AACCCTTT AACGAGGATC TACTGGAG
Stilbonema_majum                 A-AACCCTTT AACGAGGATC TATTGGAG
Monoposthia_costata              A-AAAAATTT AACGATA-TC AATTGGAG
Nudora_bipapillata               A-AACCCTTT AACGAGGATC AATTGGAG
Calomicrolaimus_parahonestus     A-AACCCTTT AACGAGGATC TATTGGAG
Calomicrolaimus_sp._BHMM_2005    A-AACCCTTT AACGAGGATC TATTGGAG
Molgolaimus_demani               A-AACCCTTT AACGAGGATC TATTGGAG
Diplogaster_lethieri             A-AAGACTTT AACGAAG-TC TATGGGAG
Aduncospiculum_halicti           A-AACCCTTT AACGAGGATC TATGAGAG
Pristionchus_lheritieri          A-AAGACTTT AACGAAG-TC TATGGGAG
Pristionchus_pacificus           A-AAGACTTT AACGAAG-TC TATGGGAG
Pristionchus_pacificus           A-AAGACTTT AACGAAG-TC TATGGGAG
Sabatieria_punctata_STRAIN_343   A-AATCCTTT AACGAGGATC TAGCGGAG
Sabatieria_sp._355_BHMM_2005     A-AATCCTTT AACGAGGATC TAGCGGAG
Sabatieria_celtica               A-AATCCTTT AACGAGGATC TAGCGGAG
Sabatieria_punctata_STRAIN_200   A-AATCCTTT AACGAGGATC TAGCGGAG
Sabatieria_punctata_STRAIN_223   A-AATCCTTT AACGAGGATC TAGCGGAG
Sabatieria_sp._210_BHM_2005      A-AATCCTTT AACGAGGATC TAGCGGAG
Setosabatieria_hilarula          A-AATCCTTT AACGAGGATC TAGCGGAG
Desmolaimus_zeelandicus          A-AACGACTT ACCGAATT-C TATCAGAG
Terschellingia_longicaudata      A-AATCCTTT AACGAGGATC TAGCGGAG
Cyartonema_elegans               A-AATCCTTT AACGAGGATC TAGCGGAG
Tridentulus_sp                   A-AATCTTTT AACGAGGATC TAGTGGAG
NUCLEOTIDES INCLUDED             m-mmmmmmmm mmmmmmmmmm mmm.....
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                                         730        740
Diplolaimelloides_meyli          A-AATCTTTT AACGAGGATC TAGTGGAG
Diplolaimella_diavengatensis     A-AATCTTTT AACGAGTAAC AAGTGGAG
Geomonhystera_disjuncta          A-AAAAATTC GGCAAGGATC TAGTGGAG
Sphaerolaimus_hirsutus           A-AATGTGTT ATCGAGTAAC TAGCAGAG
Theristus_acer                   A-AACCCTTT AACGAGGACC TAGCGGAG
Daptonema_procerus               A-AATCCTTT AACGAGGACC TAGCGGAG
Daptonema_hirsutum               A-AATCCTTT AACGAGGACC TAGCGGAG
Daptonema_normandicum            A-AATCCTTT AACGAGGACC TAGCGGAG
Daptonema_oxycerca               A-AATCCTTT AACGAGGACC TAGCGGAG
Daptonema_setosum                A-AATCCTTT AACGAGGACC TAGCGGAG
Desmodora_communis               A-AACCCTTT AACGAGGATC TATTGGAG
Desmodora_ovigera                A-AACCCTTT AACGAGGATC TATTGGAG
Metadesmolaimus_sp               A-AATCCTTT AACGAGGACC TAGCGGAG
Dentostomella_sp                 A-AACCTGTT AATGAGGATC TATGAGAG
Bunonema_franzi                  A-AAACCCAT AACGAGGACC TATGAGAG
Bunonema_sp                      A-AAACCCAT AACGAGGATC TATGAGAG
Seleborca_complexa               A-AACCCTTT AACGAGTATC TATGAGAG
Acrobeloides_nanus               A-AACCCTTT AACGAGTATC TATGAGAG
Acrobeloides_bodenheimeri        A-AACCCTTT AACGAGTATC TATGAGAG
Acrobeloides_sp_PS1146           A-AACCCTTT AACGAGTATC TATGAGAG
Acrobeles_ciliatus               A-AACCCTTT AACGAGTATC TATGAGAG
Acrobeles_sp_PS1156              A-AACCCTTT AACGAGTATC TATGAGAG
Acrobeles_complexus_WCUG2        A-AACCCTTT AACGAGTATC TATGAGAG
Cephaloboides_sp_SB227           A-AATAGCTC TTCGAGGACC CAGTGGAG
Cephalobus_cubaensis             A-AACCCTTT AACGAGTATC TATGAGAG
Cephalobus_sp._PS1143            A-AACCCTTT AACGAGTATC TATGAGAG
Cephalobus_sp._PS1196            A-AACCCTTT AACGAGTATC TATGAGAG
Cephalobus_oryzae_PS1165         A-AACCCTTT AACGAGTATC TATGAGAG
Cervidellus_alutus               A-AACCCTTT AACGAGTATC TATGAGAG
Pseudacrobeles_variabilis        A-AACCCTTT AACGAGTATC TATGAGAG
Triligulla_aluta                 A-AACCCTTT AACGAGTATC TATGAGAG
Zeldia_punctada                  A-AACCCTTT AACGAGTATC TATGAGAG
Myolaimus_sp_U81585              A-AATCCTTT AACGAGGATC TATGAGAG
Rhabditophanes_sp._KR3021        A-AATAAC-T CGTT-GG-TA AAGGAAAG
Brevibucca_sp._SB261             A-AACCCTTT AACGAGGATC TATGAGAG
Halicephalobus_gingivalis        A-AATTCATT AAAGATTATC AATGAGAG
Panagrobelus_stammeri            A-AACCCTTT AACGATTATC TATGAGAG
Plectonchus_sp._PDL0025          A-AACCCTTG AACGAACG-C AAAAAGAG
Turbatrix_aceti                  ATAAACCTTA CAAATTTG-C TATGAGAG
Panagrellus_redivivus            A-CAACCTTC CTAGATTATC TATGAGAG
Panagrellus_redivivus_PS1163     A-CAACCTTC CTAGATTATC TATGAGAG
Panagrolaimus_subelongatus       A-AAATCATT AAAGAGTATC AATGAGAG
Panagrolaimus_davidi             A-AAATCATT AAAGAGTATC AATGAGAG
Panagrolaimus_cf_rigidus_AF40    A-AAATCATT AAAGAGTATC AATGAGAG
Panagrolaimus sp. Sourhope ED2   A-AAATCATT AAAGAGTATC AATGAGAG
Panagrolaimus sp. Sourhope ED2   A-AAATCATT AAAGAGTATC AATGAGAG
Panagrolaimus sp. Sourhope ED2   A-AAATCATT AAAGAGTATC AATGAGAG
Panagrolaimus sp. Sourhope ED2   A-AAATCATT AAAGAGTATC AATGAGAG
Panagrolaimus sp. Sourhope ED2   A-AAATCATT AAAGAGTATC AATGAGAG
Steinernema_carpocapsae          A-AACTCTTT AACGAGGACC TATGAGAG
Strongyloides_stercoralis        A-AATMACCT TGTTGGTAAA GGAAAGGG
Strongyloides_ratti              A-AATAAC-T TGTTGGTAAA GGAAAGGG
Diploscapter_sp_PS1897           A-AAAAGCTC TTCGAGAAAC TAAGAGAG
Diploscapter_sp_PS2017           A-AAAAGCTC TTCGAGAAAC TAAGAGAG
Heterorhabditis_bacteriophora    A-AATCTATC TTCGAGTATC TAGTGGAG
Heterorhabditis_hepialus         A-AATCTATC TTCGAGTATC TAGTGGAG
Heterorhabditis_zelandica        A-AATCTATC TTCGAGTACC TAGTGGAG
Parasitorhabditis_sp_SB281       A-AACCCTTT AACGAGGATC TATGAGAG
Rhabditoides_inermiformis        A-AACCCTTT AACGAGGATC TATGAGAG
Rhabditoides_inermis_DF5001      A-AACCCTTT ATCGAGGATC TATGAGAG
Rhabditoides_regina_DF5012       A-AACCCGTT AACGATGATC AATGAGAG
Poikilolaimus_oxycerca_SB200     A-AACCCTTT AACGAGGATC TATGAGAG
Poikilolaimus_regenfussi_SB199   A-AACCCTTT AACGAGGATC TATGAGAG
Distolabrellus veechi DWF1604    A-AACCCTTT AACGAGGATC TATGAGAG
Distolabrellus veechi DF5024     A-AACCCTTT AACGAGGATC TATGAGAG
Choriorhabditis_dudichi          A-AAACACTT TATGAGGATC AAATGGAG
Protorhabditis_sp                A-AAAATCTC TTCGAGAAAC TAAGAGAG
Protorhabditis_sp_DF5055         A-AATAACTT CTCGAGAAAC TAAGAGAG
Cruznema_tripartitum_DF5015      A-AATATCTC GTAAAGGAAC TAGTGGAG
Mesorhabditis_sp_PS1179          A-AACCCTTT AACGAGGATC AATGAGAG
Mesorhabditis_spiculigera_SB15   A-AACCCTTT AACGAGGATC AATGAGAG
Mesorhabditis_anisomorpha_SB12   A-AACCCTTG AACGAGGATC AATGAGAG
Teratorhabditis_palmarum_DF501   A-AACCCTTT AACGAGGATC TATGAGAG
Teratorhabditis_synpapillata_S   A-AACCCTTT AACGAGGATC TATGAGAG
Caenorhabditis_briggsae_PB102    A-AATGATTC TTCGAGTATC TAGTGGAG
Caenorhabditis_elegans_N2        A-AATGATTC TTCGAGTAGC AAGGAGAG
Caenorhabditis_sp_CB5161         A-AATGATTC TTCGAGTAGC AAGGAGAG
Caenorhabditis_sp_PS1010         A-AACAATTC TTCGAGTAAC AAGGAGAG
NUCLEOTIDES INCLUDED             m-mmmmmmmm mmmmmmmmmm mmm.....
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                                 ....|....| ....|....| ....|...
                                         730        740
Caenorhabditis_japonica          A-AATTATTC TTCGAGTAGC AAGGAGAG
Caenorhabditis_sp_DF5170         A-AATCGTTC TTCAAGTAAC AAGGAGAG
Caenorhabditis_sp_SB341          A-AATGATTC TTCGAGGACC CAGGAGAG
Caenorhabditis_plicata           A-AACTAATC TTCGAGTAAC AAGGAGAG
Caenorhabditis_vulgaris          A-AATGATTC TTCGAGTAGC AAGGAGAG
Caenorhabditis_sonorae           A-AATGATTC TTCGAGGACC CAGGAGAG
Caenorhabditis_drosophilae       A-AATCGTTC TTCAAGTAAC AAGGAGAG
Phasmarhabditis_hermaphrodita    A-AATAGTTC TTCGAGGACC CAGTGGAG
Phasmarhabditis_neopapillosa     A-AATAGTTC TTCGAGGACC CAGTGGAG
Phasmarhabditis_neopapillosa     A-AATAGCTC TTCGAGGACC CAGTGGAG
Pellioditis_mediterranea_SB173   A-AATAGCTC TTCGAGGACC CAGTGGAG
Pellioditis_marina               A-AATAGCTC TTCGAGGACC CAGTGGAG
Prodontorhabditis_wirthi         A-AAAATATC TCCGAGAAAC TAAGAGAG
Crustorhabditis_scanica          A-AACCCTTT AACGAGGATC TATGAGAG
Dolichorhabditis_sp_CEW1         A-AATAGCTC TATGAGGACC TAATGGAG
Oscheius_sp_DF5000               A-AATAGCTC TATGATGATC TAGTGGAG
Oscheius_sp_BW282                A-AATAGCTC TTCGAGGATC TAGTGGAG
Oscheius_myriophila_EM435        A-AATAGCTC TTCGAGGATC TAGTGGAG
Oscheius_insectivora             A-AATAGCTG TTCGAGGACC TAGTGGAG
Oscheius_dolichuroides           A-AATAGCTC TATGATGATC TAGTGGAG
Rhabditis_blumi_DF5010           A-AACAGCTC TTTGAGTAAC AAGTGGAG
Rhabditis_sp_PS1191              A-AATAGCTC TTTGAGTAAC TAGTGGAG
Rhabditis_sp_PS1010              A-AACAATTC TTCGAGTAAC AAGGAGAG
Rhabditis_myriophila_EM435       A-AATAGCTC TTCGAGGATC TAGTGGAG
Rhabditis_colombiana             A-AATAGCTC TTCGAGGACC TAGTGGAG
Rhabditella_axei_DF5006          A-AATAGCTC TTCGAGGACC CAGTGGAG
Rhabditella_sp_DF5044            A-AATAGCTC TTCGAGGACC CAGTGGAG
Cuticularia_sp_PS2083            A-AACCCTTT AACGAGGATC TATGAGAG
Necator_americanus               A-AACCTTTT TTCGAGGATC AAGTGGAG
Kalicephalus_cristatus           A-AACTTTTT TTCGAGGATC AAGTGGAG
Ancylostoma_caninum              A-AACCTTTT TTCGAGGATC AAGTGGAG
Angiostrongylus_cantonensis      A-AACCTTTT TTCGAGTATC CAGTGGAG
Angiostrongylus_costaricensis    A-AACCTTTT TTCGAGTATC AAGTGGAG
Angiostrongylus_malaysiensis     A-AACCTTTT TTCGAGTATC AAGTGGAG
Angiostrongylus_dujardini        A-AACCTTTT TTCGAGTATC AAGTGGAG
Angiostrongylus_vasorum          A-AACCTTTT TTCGAGTACC AAGTGGAG
Aulurostrongylus_abstrusus       A-AACTTCTT TTCGAGTATC AAGTGGAG
Didelphostrongylus_hayesi        A-AACATATT TTCGAGTATC AAGTGGAG
Crenosoma_mephitidis             A-AACCTTTT TTCGAGGATC AAGTGGAG
Crenosoma_vulpis                 A-AACCTTTT TTCGAGGATC AAGTGGAG
Otostrongylus_circumlitus        A-AACCTTTT TTCGAGGATC AAGTGGAG
Troglostrongylus_wilsoni         A-AACCTTTT TTCGAGGATC AAGTGGAG
Filaroides_martis                a-AACCTTTT TTCGAGTATC AAGTGGAG
Oslerus_osleri                   A-AACATTTT TTCAAGTATC AAGTGGAG
Parafilaroides_decorus           A-AACCTTTT TTCGAGTATC AAGTGGAG
Metastrongylus_salmi             A-AACCTTTT TTCGAGTATC AAGTGGAG
Metastrongylus_elongatus         A-AACCTTTT TTCGAGTATC AAGTGGAG
Skrjabingylus_chitwoodrum        A-AACATTTT TTCGAGGATC AAGTGGAG
Parelaphostrongylus_odocoilei    A-AACCTTTT TTCGAGTATC AAGTGGAG
Muelerius_capillaris             A-AACGTTTT TTCGAGTATC AAGTGGAG
Protostrongylus_rufescens        A-AACCTTTT TTCGAGTATC AAGTGGAG
Halocercus_invaginatus           A-AACTATTT TTCGAGTATC GAGTGGAG
Pseudalius_inflexus              A-AACTTTTT TTCGAGTATC AAGTGGAG
Stenurus_minor                   A-AACCTTTT TTCGAGTATC AAGTGGAG
Torynurus_convolutus             A-AACCTTTT TTCGAGTATC AAGTGGAG
Syngamus_trachea                 A-AACCTTTT TTCGAGGATC AAGTGGAG
Stephanurus_dentatus             A-AACTTTTT TTCGAGGATC AAGTGGAG
Nematodirus_battus               A-AACCTTTT TTCGAGGATC AAGTGGAG
Strongylus_equinus               A-AACCTCTT TTCGAGGATC AAGTGGAG
Labiostrongylus_bipapillosus     A-AACCTTTT TTCGAGGATC AAGTGGAG
Petrovinema_poculatum            A-AACCTCTT TTCGAGGATC AAGTGGAG
Cylicocyclus_insignis            A-AACCTCTT TTCGAGGATC AAGTGGAG
Chabartia_ovina                  A-AACCTTTT TTCGAGGATC AAGTGGAG
Cyclodontostomum_purvisi         A-AACCTTTT TTCGAGGATC AAGTGGAG
Zoniolaimus_mawsonae             A-AACCTTTT TTCGAGGATC AAGTGGAG
Hypodontus_macropi               A-AACCTTTT TTCGAGGATC AAGTGGAG
Deletrocephalus_dimidiatus       A-AACCTTTT TTCGAGGATC AAGTGGAG
Dictyocaulus_eckerti_P7B8        A-AACGTTTT TTCGAGTATC GAGTGGAG
Dictyocaulus_capreolus_P3B2      A-AACGTTTT TTCGAGTATC GAGTGGAG
Dictyocaulus_sp._P6A1            A-AACGTTTT TTCGAGTATC GAGTGGAG
Dictyocaulus_filaria             A-AACCATTT TTCGAGTATC AAGTGGAG
Dictyocaulus_capreolus_P2C10     A-AACGTTTT TTCGAGTATC GAGTGGAG
Dictyocaulus_viviparus           A-AACGTTTT TTCGAGTATC GAGTGGAG
Haemonchus_sp._V3091             A-AACCTTTT TTCGAGGATC AAGTGGAG
Haemonchus_contortus             A-AACCTTTT TTCGAGGATC AAGTGGAG
Haemonchus_placei                A-AACCTTTT TTCGAGGATC AAGTGGAG
Haemonchus_similis               A-AACCTTTT TTCGAGGATC AAGTGGAG
Ostertagia_ostertagi             A-AACCTTTT TTCGAGGATC AAGTGGAG
NUCLEOTIDES INCLUDED             m-mmmmmmmm mmmmmmmmmm mmm.....
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                                 ....|....| ....|....| ....|...
                                        730        740
Ostertagia_leptospicularis       A-AACCTTTT TTCGAGGATC AAGTGGAG
Nippostrongylus_brasileinsis     A-AACCTTTT TTCGAGGAAC AAGTGGAG
Heligmosomoides_polygyrus        A-AACCTTTT TTCGAGGATC CAGTGGAG
Trichostrongylus_colubriformis   A-AACCTTTT TTCGAGGATC AAGTGGAG
Tetrabothriostrongylus mackerr   A-AACCTTTT TTCGAGGATC AAGTGGAG
Herpestrongylus_pythonis         A-AACCTTTT TTCGAGGATC AAGTGGAG
Nicollina_cameroni               A-AACCTTTT TTCGAGGATC AAGTGGAG
Filarimena_flagrifer             A-AACCTTTT TTCGAGGATC AAGTGGAG
Amidostomum_cygni                A-AAACTTTT TTCGAGGATC AAGTGGAG
Teratocephalus_lirellus          A-AACCCTTT AACGAGGATC TATGAGAG
Brumptaemilius_justini           A-AACCCGTT AACGAGGATC TATGAGAG
Anguillicola_crassus             A-AACCCTTT AACGAGGATC TATGAGAG
Dracunculus_medinensis           A-AACCTGTT AACGAGGACC TATGAGAG
Dracunculus_oesophageus          A-AACCTGTT AACGAGGATC TATGAGAG
Dracunculus_sp._V3104            A-AACCTGTT AACGAGGATC TATGAGAG
Philonema_sp_A                   A-AACCCGTT AACGAGGATC TATGAGAG
Philometra_obturans              A-AACCCGTT AACGAGGATC AATGAGAG
Camallanus_oxycepahalus          A-AAGCCGTT AACAAGGATC TATGAGAG
Acanthocheilonema_viteae         A-AACCTGTT AACGAGGATC TATGAGAG
Loa_loa                          A-AACCCGTT AACGAGGATC TATGAGAG
Onchocerca_cervicalis            A-AACCCGTT AACGAGGATC TATGAGAG
Dirofilaria_immitis              A-AACCTGTT AACGAGGATC TATGAGAG
Brugia_malayi                    A-AACCTGTT AACGAGGATC TATGAGAG
Wuchereria_bancrofti             A-AACCCGTT AACGAGGATC TATGAGAG
Litomosoides_sigmodontis         A-AACCTGTT AACGAGGATC TATGAGAG
Setaria_digitata                 A-AACCCGTT AACGAGGATC TATGAGAG
Gnathostoma_turgidum             A-AACCCTCT AACGAGGATC TATGAGAG
Gnathostoma_neoprocyonis         A-AACCCTCT AACGAGGATC TATGAGAG
Gnathostoma_binucleatum          A-AACCCTCT AACGAGGATC TATGAGAG
Physaloptera_alata               A-AACCCGTT AACGAGGATC TATGAGAG
Physaloptera_turgida             A-AACCCGTT AACGAGGATC TATGAGAG
Ascarophis_arctica               A-AACCCGTT AACGAGGATC TATGAGAG
Spinitectus_carolini             A-AACCCGTT AACGAGGATC TATGAGAG
Thelazia_lacrymalis              A-AACCTGTT AACGAGGATC TATGAGAG
Aphelenchus_avenae               A-AACCCTTT AACGAGTATC TATGAGAG
Aphelenchoides_fragariae         A-AACAATTT CATGAGTACC TACGAGAG
Bursaphelelenchus_sp             A-GACATTTT AACGAGTATC TACGAGAG
Deladenus_sp                     A-AACCCTTT AACGAGTATC TATGAGAG
Criconema_sp                     A-AACCCTTT AACGAGTATC AATGAGAG
Hemicycliophora_conida           A-AACCCTTT AACGAGTATC AATGAGAG
Paratylenchus_dianthus           A-AACCCTTT AACGAGTATC AATGAGAG
Pratylenchus_thornei             A-AACCCTTT AACGAGTATC TATGAGAG
Tylenchulus_semipentrans         A-AACCCTTT AACGAGTATC AATGAGAG
Ditylenchus_angustus             A-AACCCTTT GACGAGTATC TATGAGAG
Subanguina_radicola              A-AACCCTTT AACGAGTATC TATGAGAG
Tylenchorhynchus_maximus         A-AACCCTTT AACGAGTATC TATGAGAG
Geocenamus_quadrifer             A-AACCCTTT AACGAGTATC TATGAGAG
Globodera_pallida                A-AACCCTTT AACGAGTATC TATGAGAG
Scutellonema_bradys              A-AACCCTTT AACGAGTATC TATGAGAG
Helicotylenhcus_dihystera        A-AACCCTTT AACGAGTATC TATGAGAG
Rotylenchus_robustus             A-AACCCTTT AACGAGTATC TATGAGAG
Meloidogyne_arenaria             A-AACCCTTT AACGAGTATC AAGCAGAG
Meloidogyne_incognita_KT         A-AACCCTTT AACGAGTATC AAGCAGAG
Meloidogyne_javanica             A-AACCCTTT AACGAGTATC AAGCAGAG
Meloidogyne_artiellia            A-AACCCTTT AACGAGTATC TACGAGAG
Meloidogyne_duytsi               A-AACCCTTT AACGAGTATC AAGCAGAG
Meloidogyne_exigua               A-AACCCTTT AACGAGTATC AAGGAGAG
Meloidogyne_hapla                A-AACCCTTT AACGAGTATC AAGCAGAG
Meloidogyne_ichinohei            A-AATCCTTT ATCGAGTATC TACGAGAG
Meloidogyne_maritima             A-AACCCTTT AACGAGTATC AAGCAGAG
Meloidogyne_microtyla            A-AACCCTTT AACGAGTATC AAGCAGAG
Nacobbus_aberrans                A-AACCCTTT AACGAGTATC TATGAGAG
Pratylenchoides_ritteri          A-AACCCTTT AACGAGTATC TATGAGAG
Pratylenchoides_magnicauda       A-AACCCTTT AACGAGTATC TATGAGAG
Hirschmanniella_sp._JH_2003      A-AACCCTTT AACGAGTATC TATGAGAG
Radopholus_similis               A-AAACCCCC ATTGAGTATC TACGAGAG
Pratylenchus_goodeyi_VF          A-AACCCTTT AACGAGTATC TATGAGAG
Boleodorus_thylactus_clone2      A-AACCCTTT AACGAGTATC TATGAGAG
Philippine Sequence 1            A-AACCTTTT TTCGAGTATC CAGTGGAG
Philippine Sequence 2            A-AACCTTTT TTCGAGTATC CAGTGGAG
Philippine Sequence 3            A-AATAGCTC TTGGATGACC CAG.....
Philippine Sequence 4            A-AAACCATT AAAGAGTATC AATGAGAG
Philippine Sequence 5            A-AACCTTTT TTCGAGGATC AAG.....
Philippine Sequence 6            A-AATAGCTC TACGAGGACC CAGTGGAG
Philippine Sequence 7            A-AATGATTC TTCGAGTAGC AAG.....
Tahiti Sequence 1                A-AACCTTTT TTCGAGTATC CAGTGGAG
Tahiti Sequence 2                A-AATCTTTT CTTGAGTATC CAG.....
Thailand Sequence 1              A-AATCCGTT AACGAGGATC TATGAGAG
NUCLEOTIDES INCLUDED             m-mmmmmmmm mmmmmmmmmm mmm.....
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                                 ....|....| ....|....| ....|...
                                         730        740
Ogasawara Sequence 1             A-AAACCATT AAAGAGTATC AATGAGAG
Ogasawara Sequence 2             A-AATAGTTC TTCGAGGACC CAGTGAGG
Ivory Coast Sequence 1           A-AACCTTTT TTCGAGTATC AAGTGGAG
Ivory Coast Sequence 2           A-AACCTTTT TTCGAGTATC AAGTGGAG
Ivory Coast Sequence 3           A-AACCTTTT TTCGAGTATC GAATGGAG
Ivory Coast Sequence 4           A-AACCTTTT TTCGAGTATC AAGTGGAG
Ivory Coast Sequence 5           A-AATCCGTT AACGAGGATC TATGAGAG
Ivory Coast Sequence 6           A-AACCTTTT TTCGAGTATC AAGTGGAG
Ivory Coast Sequence 7           A-AACCTTTT TTCGAGTATC AAGTGGAG
Singapore Sequence 1             A-AATAGCTC TTGAT-GACC CAGTGGAG
Singapore Sequence 2             A-AATCCGTT AACGAGGATC ........
Singapore Sequence 3             A-AATGATTC TTCGAGTAGC AAGGAGAG
Singapore Sequence 4             A-AACCTTTT TTCGAGTATC AAGTGGAG
Nigerian Sequence 1              A-AACCTTTT TTCGAGTATC AAGTGGAG
Nigerian Sequence 2              A-AACCTTTT TTCGAGGATC AAGTGGAG
Nigerian Sequence 3              A-AACCTTTT TTCGAGTATC AAGTGGAG
NUCLEOTIDES INCLUDED             m-mmmmmmmm mmmmmmmmmm mmm.....
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Appendix 6.3: Log likelihood scores of the different models used for comparison for the **(A)** the Nematoda and **(B)** the Rhabditida within Nematoda using the SSU rRNA gene to determine the phylogenetic positions of the nematode sequences from a trial population of *Achatina fulica* and *Laevicaulis alte* in the Philippines. A total of 376 unambiguously aligned nucleotide sites of the 5’ end of the SSU rRNA gene were used. Log Likelihood Ratio Tests for both the Nematoda and the Rhabditida revealed GTR+Γ as the optimal model. Note that the K2P and F81 models are non-nested and therefore cannot be compared using LRT.

(A) Nematoda (B) Rhabditida

Model	Log-Likelihood Score	Model	Log-Likelihood Score
JC	21909.35435	JC	14354.91018
JC+Γ	19844.13051	JC+Γ	13100.12574
F81	21.855.63587	F81	14325.96300
F81+Γ	19747.80473	F81+Γ	13031.31768
K2P	21623.78574	K2P	14234.74221
K2P+Γ	19518.62434	K2P+Γ	12957.97008
HKY85	21549.39123	HKY	14192.26735
HKY85+Γ	19361.80971	HKY+Γ	12844.49245
TN93	21435.08416	TrN93	14129.30390
TN93+Γ	19353.15979	TN93+Γ	12846.67437
GTR	21370.61122	GTR	13930.31599
GTR+Γ	**19339.54695**	**GTR+Γ**	**12725.79552**

Appendix 6.4: Alignment of the full-length SSU rRNA gene for the Metastrongylina and and two Trichostrongylina outgroups. Positions included for the phylogeny analyses were marked by “`m`” within “`NUCEOTIDES INCLUDED`”

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                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         10         20         30         40         50         60
Angiostrongylus cantonensis      ---------- ---------- ---------- ---------- -ATTAAGCCA TGCATGAGGA
Angiostrongylus costaricensis    ---------- ---------- ---------- ---------- ---------- ------AGGA
Angiostrongylus malaysiensis     ---------- ---------- ---------- ---------- ---------- ------AGGA
Angiostrongylus dujardini        ---------- ---------- ---------- ---------- ---------- ------AGGA
Angiostrongylus vasorum          ---------- ---------- ---------- ---------- ---------- ------AGGA
Aelurostrongylus abstrusus       ---------- ---------- CGATATATGT TCAGTTAAAA GGTTAAGCCA TGCACGAGGA
Didelphostrongylus hayesi        ---------- ---------- --TATATGCT CAGTTAAAAG ATT-AAGCCA TGCATGTGGA
Crenosoma mephitiditis           ---------- ---------- --TATATGCT CAGTTAAAAG ATTGAAGCCA TGCATGTGGA
Otostrongylus circumlitus        ---------- ---------- ---------- ---------- GATTAAGCCA TGCATGTCGA
Troglostrongylus wilsoni         ---------- ---------- ---------- ---------- GATTAAGCCA TGCATGTTGA
Filaroides martis                ---------- ---------- ---------- ---------- GATTAAGCCA TGCATGTCGA
Oslerus osleri                   ---------- ---------- ---------- ---------- GATTAAGCCA TGCATGTCGA
Parafilaroides decorus           ---------- ---------- ---------- ---------- -ATTAAGCCA TGCATGTCGA
Metastrongylus salmi             ---------- ---------- ---------- ---------- --TTAAGCCA TGCATGTCGA
Skrjabingylus chitwoodorum       ---------- ---------- --TATATGCT CAGTTAAAAG ATTAAGCCAT GCAATGTGGA
Parelaphostrongylus odocoilei    ---------- ---------- ---------- ---------- -ATTAAGCCA TGCATGTGGA
Muellerius capillaris            ---------- ---------- ---------- ---------- ---------- ----TGTGGA
Halocercus invaginatus           ---------- ---------- ---------- ---------- ---------- ----TGTCGA
Pseudalius inflexus              ---------- ---------- ---------- ---------- --------CA TGCATGTCGA
Stenurus minor                   ---------- ---------- ---------- ---------- -ATTAAGCCA TGCATGTCGA
Torynurus convolutus             ---------- ---------- ---------- ---------- -ATTAAGCCA TGCATGTCGA
Nematodirus battus               TACCTGATTG ATTCTGTCAG CGCTATATGC TCAGTTTAAA GATTAAGCCA TGCATGTCGA
Nippostrongylus brasiliensis     ---------- ---------- ---------- ---------- ---------- ----AGTCGA
NUCELOTIDES INCLUDED             ---------- ---------- ---------- ---------- ---------- ------mmmm


                                 ....|....| ....|....| ....|....| ....|....| ....|....| ....|....|
                                         70         80         90        100        110        120
Angiostrongylus cantonensis      GTTCAGCTTT -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTGATT TATTCGGAAA
Angiostrongylus costaricensis    GTTCAGCTTC -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTGATT TATTCGGAAA
Angiostrongylus malaysiensis     GTTCAGCTTC -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTGATT TATTCGGAAA
Angiostrongylus dujardini        GTTCAGCTTC -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Angiostrongylus vasorum          GTTCAGCTTC -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Aelurostrongylus abstrusus       GTTCAACTTC -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Didelphostrongylus hayesi        GTTCAGCTTT AAAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTATTT TAATCGGTAA
Crenosoma mephitiditis           GTTCAGCTTC -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Otostrongylus circumlitus        GTTCAGCTTC -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Troglostrongylus wilsoni         GTTCAGCTTC -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Filaroides martis                GTTCAGCTTC -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Oslerus osleri                   GTTCAACTTC -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Parafilaroides decorus           GTTCAGCTTC -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Metastrongylus salmi             GTTCAACTTC -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Skrjabingylus chitwoodorum       GTTCAGCTTC -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATATCATT TATTCGGAAA
Parelaphostrongylus odocoilei    GTTCAACTTC AAAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Muellerius capillaris            GTTCAATTTC TATGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Halocercus invaginatus           GTTCAGCTTT GAAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Pseudalius inflexus              GTTCAACTTC -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Stenurus minor                   GTTCAGCTTC -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Torynurus convolutus             GTTCAGCTTC -AAGTGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Nematodirus battus               GTTCATCTTT -GAGAGAAAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAA
Nippostrongylus brasiliensis     GTTCATGTA- -TAGAG-AAC TGCGAACGGC TCATTAGAGC AGATGTCATT TATTCGGAAC
NUCELOTIDES INCLUDED             mmmmmmmm-- -mmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                        130        140        150        160        170        180
Angiostrongylus cantonensis     ATCC-TATTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCGTATAAA CCCTGACTTT
Angiostrongylus costaricensis   ATCC-TATTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCGTATAAA CCCTGACTTT
Angiostrongylus malaysiensis    ATCC-TATTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCGTATAAA CCCTGACTTT
Angiostrongylus dujardini       ATCC-TATTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCGGTTAAG CCCTAACTTT
Angiostrongylus vasorum         ATCT-TATTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCGATTAAA CCCTGACTTT
Aelurostrongylus abstrusus      GTTC-ACCTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCAGTAGGA CCCTGACTTT
Didelphostrongylus hayesi       TTTG-AATTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCAGATAAA CTCTGACTTT
Crenosoma mephitiditis          ATCC-ATTTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCGATTAAA CCCTGACTTT
Otostrongylus circumlitus       ATCC-ATTTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCGATTAAA CCCTGACTTT
Troglostrongylus wilsoni        ATCC-AATTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCGATTAAA CCCTGACTTT
Filaroides martis               ATCC-AATTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCGATTAAA CCCTGACTTT
Oslerus osleri                  GACG-AATTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCGATAAAA CCCTGACTTT
Parafilaroides decorus          ATCC-AATTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCTATTAAA CCCTGACTTT
Metastrongylus salmi            ATCC-AATTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCGATTAAA CCCTGACTTT
Skrjabingylus chitwoodorum      TTCC-AATTG GATAACTGCG GTAATTCTGG AGCTAATACA TGTGATTAAA CCCTGACTTT
Parelaphostrongylus odocoilei   ATCCTTAATG GATAACTGCG GTAATTCTGG AGCTAATACA TATGCATAAA CCCTGACTCT
Muellerius capillaris           ATGA-CAATG GATAACTGCG GTAATTCTGG AGCTAATACA TGCAATAAAA TCCTGACTTT
Halocercus invaginatus          ATCC-AATTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCTATTAGA CCCTGACTTT
Pseudalius inflexus             ATCTCAATTG GATAACTGCG GTAATTCTGG AGCTAATACA TTCTATTAAA CCCTGACTTT
Stenurus minor                  ATCC-AATTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCTATTAAA CCCTGACTTT
Torynurus convolutus            ATCC-AATTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCTATTAAA CCCTGACTTT
Nematodirus battus              ATCCTTTTTG GATAACTGCG GCAATTCTGG AGCTAATACA TGCGTTTAGG CCCTGACTTT
Nippostrongylus brasiliensis    GTCC-TATTG GATAACTGCG GTAATTCTGG AGCTAATACA TGCAATAAAA CCCTGACTTT
NUCELOTIDES INCLUDED            mmmm-mmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                        190        200        210        220        230        240
Angiostrongylus cantonensis     -CGAAAGGGT GCAATTATTA GAGCAAATCA ATCATTTTCG GATGTAGTTT GCTGACTCTG
Angiostrongylus costaricensis   -CGAAAGGGT GCAATTATTA GAGCAAATCA ATCATTTTCG GATGCAGTTT GCTGACTCTG
Angiostrongylus malaysiensis    -CGAAAGGGT GCAATTATTA GAGCAAATCA ATCATTTTCG GATGCAGTTT GCTGACTCTG
Angiostrongylus dujardini       -CGAAAGGGT GCAATTATTA GAGCAAATCA ATCATTTTCG GATGTAGTTT GCTGACTCTG
Angiostrongylus vasorum         -CGAAAGGGT GCAATTATTA GAGCAAATCA ATCATTTTCG GATGTAGTTT GCTGACTCTG
Aelurostrongylus abstrusus      -CGGAAGGGT GCAATTATTA GAGCAAATCA ATCATTTTCG GATGTAGTTT GCTGACTCTG
Didelphostrongylus hayesi       -TGAAAGGGT GCAATTATTA GAGCAAATCA ATCATCTTCG GATGTAGTTT GCTGACTCTG
Crenosoma mephitiditis          -TGAAAGGGT GCAATTATTA GAGCAAATCA ATCATTTTCG GATGTAGTTT GCTGACTCTG
Otostrongylus circumlitus       -TGAAAGGGT GCAATTATTA GAGCAAATCA ATCATTTTCG GATGTAGTTT GCTGACTCTG
Troglostrongylus wilsoni        -TGAAAGGGT GCAATTATTA GAGCAAATCA ATCATTTTCG GATGTAGTTT GCTGACTCTG
Filaroides martis               -CGAAAGGGT GCAATTATTA GAGCAAATCA ATCATTTTCG GATGTAGTTT GCTGACTCTG
Oslerus osleri                  -TGAAAGGGT GCAATTATTA GAGCAAATCA ATCATCTACG GATGTAGTTT GCTGACTCTG
Parafilaroides decorus          -TGAAAGGGT GCAATTATTA GAGCAAATCA ATCATTTTCG GATGTAGTTT GCTGACTCTG
Metastrongylus salmi            -TGAAAGGGT GCAATTATTA GAGCAAATCA ATCATTTACG GATGTAGTTT GCTGACTCTG
Skrjabingylus chitwoodorum      -TGAAAGGGT GCAATTATTA GAGCAAATCA GTCATTTTCG GATGTAGTTT GCTGACTCTG
Parelaphostrongylus odocoilei   GTGAAAGGGT GCAATTATTA GAGCAAATCA ATCATTTTCG GATGTAGTTT GCTGACTCTG
Muellerius capillaris           -TGAAAGGAT GCAATTATTA GAGCAAATCA ATCATCTTCG GATGTAGTTT GCTGACTCTG
Halocercus invaginatus          -TGAAAGGGT GCAATTATTA GAGCAAATCA ATCATTTTCG GATGTAGTTT GCTGACTCTG
Pseudalius inflexus             -TGAAAGGGT GCAATTATTA GAGCAAATCA ATCATTTTCG GATGTAGTTT GCTGACTCTG
Stenurus minor                  -TGAAAGGGT GCAATTATTA GAGCAAATCA ATCATTTTCG GATGTAGTTT GCTGACTCTG
Torynurus convolutus            -TGAAAGGGT GCAATTATTA GAGCAAATCA ATCATTTTCG GATGTAGTTT GCTGACTCTG
Nematodirus battus              -TGAAAGGGT GCAATTATTA GAGCAAATCA ATCTCCTTCG GGTGCTGTTT GCTGACTCTG
Nippostrongylus brasiliensis    -TGGAAGGGT GCAATTATTA GTGCAAACCA ATCATCTTCG GATGTTGTTT GCTGACTCTG
NUCELOTIDES INCLUDED            -mmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                        250        260        270        280        290        300
Angiostrongylus cantonensis     AATAACGCAG CATATCGGCG GCTTGTTCGC CGATAATCCG AAAAAGTGTC TGCCCTATCA
Angiostrongylus costaricensis   AATAACGCAG CATATCGGCG GCTTGTTCGC TGATAATCCG AAAAAGTGTC TGCCCTATCA
Angiostrongylus malaysiensis    AATAACGCAG CATATCGGCG GCTTGTTCGC TGATAATCCG AAAAAGTGTC TGCCCTATCA
Angiostrongylus dujardini       AATAACGCAG CATATCGGCG GCTTGTTCGC CGATAATCCG AAAAAGTGTC TGCCCTATCA
Angiostrongylus vasorum         AATAACGCAG CATATCGGCG GCTTGTTCGC CGATAATCCG AAAAAGTGTC TGCCCTATCA
Aelurostrongylus abstrusus      AATAACGCAG CATATCGGCG GCTTGATCGC CGATATTCCG AAAAAGTGTC TGCCCTATCA
Didelphostrongylus hayesi       AATAACGCAG CATATCGGCG GCTTGTTCGC CGATAATCCG AAAAAGTGTC TGCCCTATCA
Crenosoma mephitiditis          AATAACGCAG CATATCGGCG GCTTGTTCGC CGATAATCCG AAAAAGTGTC TGCCCTATCA
Otostrongylus circumlitus       AATAACGCAG CATATCGGCG GCTTGTTCGC CGATAATCCG AAAAAGTGTC TGCCCTATCA
Troglostrongylus wilsoni        AATAACGCAG CATATCGGCG GCTTGTTCGC CGATATTCCG AAAAAGTGTC TGCCCTATCA
Filaroides martis               AATAACGCAG CATATCGGCG GCTTGTTCGC CGATATTCCG AAAAAGTGTC TGCCCTATCA
Oslerus osleri                  AATAACGCAG CATATCGGCG GCTTGTTCGC CGATATTCCG AAAAAGTGTC TGCCCTATCA
Parafilaroides decorus          AATAACGCAG CATATCGACG GCTTGTTCGT CGATATTCCG AAAAAGTGTC TGCCCTATCA
Metastrongylus salmi            AATAACGCAG CATATCGGCG GCTTGTTCGC CGATAATCCG AAAAAGTGTC TGCCCTATCA
Skrjabingylus chitwoodorum      AATAACGCAG CATATCGGCG GCTTGATCGC CGATATTCCG AAAAAGTGTC TGCCCTATCA
Parelaphostrongylus odocoilei   AATAACGCAG CATATCGGCG GCTTGTTCGC CGATATTCCG AAAAAGTGTC TGCCCTATCA
Muellerius capillaris           AATAACGCAG CATATCGGCG GCTTGTTCGC CGATATTCCG AAAAAGTGTC TGCCCTATCA
Halocercus invaginatus          AATAACGCAG CATATCGGCG GCTTGTTCGC CGATATTCCG AGAAAGTGTC TGCCCTATCA
Pseudalius inflexus             AATAACGCAG CATATCGGCG GCTTGTTCGC CGATATTCCG AAAAAGTGTC TGCCCTATCA
Stenurus minor                  AATAACGCAG CATATCGGCG GCTTGTTCGC CGATATTCCG AAAAAGTGTC TGCCCTATCA
Torynurus convolutus            AATAACGCAG CATATCGGCG GCTTGTTCGC CGATATTCCG AAAAAGTGTC TGCCCTATCA
Nematodirus battus              AATAATGCAG CATATCGGCG GCTTGACCGC TGATAATCCG AAAAAGTGTC TGCCCTATCA
Nippostrongylus brasiliensis    AATAACGCAG CATATCGGCG GCTTGTCCGC TGATATTCCG AAAAAGTGTC TGCCCTATCA
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                        310        320        330        340        350        360
Angiostrongylus cantonensis     ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Angiostrongylus costaricensis   ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Angiostrongylus malaysiensis    ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Angiostrongylus dujardini       ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Angiostrongylus vasorum         ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Aelurostrongylus abstrusus      ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Didelphostrongylus hayesi       ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Crenosoma mephitiditis          ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Otostrongylus circumlitus       ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Troglostrongylus wilsoni        ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Filaroides martis               ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Oslerus osleri                  ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Parafilaroides decorus          ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Metastrongylus salmi            ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Skrjabingylus chitwoodorum      ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Parelaphostrongylus odocoilei   ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Muellerius capillaris           ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Halocercus invaginatus          ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Pseudalius inflexus             ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Stenurus minor                  ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Torynurus convolutus            ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Nematodirus battus              ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
Nippostrongylus brasiliensis    ACCTGATGGT AGTCTATTAG TCTACCATGG TTATTACGGG TAACGGAGAA TAAGGGTTCG
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                        370        380        390        400        410        420
Angiostrongylus cantonensis     ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Angiostrongylus costaricensis   ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Angiostrongylus malaysiensis    ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Angiostrongylus dujardini       ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Angiostrongylus vasorum         ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Aelurostrongylus abstrusus      ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Didelphostrongylus hayesi       ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Crenosoma mephitiditis          ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Otostrongylus circumlitus       ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Troglostrongylus wilsoni        ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Filaroides martis               ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Oslerus osleri                  ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Parafilaroides decorus          ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Metastrongylus salmi            ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Skrjabingylus chitwoodorum      ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Parelaphostrongylus odocoilei   ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Muellerius capillaris           ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Halocercus invaginatus          ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Pseudalius inflexus             ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Stenurus minor                  ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Torynurus convolutus            ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Nematodirus battus              ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
Nippostrongylus brasiliensis    ACTCCGGAGA GGGAGCCTTA GAAACGGCTA CCACATCCAA GGAAGGCAGC AGGCGCGAAA
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                        430        440        450        460        470        480
Angiostrongylus cantonensis     CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Angiostrongylus costaricensis   CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Angiostrongylus malaysiensis    CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Angiostrongylus dujardini       CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAAACCAT TCCTATGGAA
Angiostrongylus vasorum         CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Aelurostrongylus abstrusus      CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Didelphostrongylus hayesi       CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAAACCAT TCCTATGGAA
Crenosoma mephitiditis          CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Otostrongylus circumlitus       CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Troglostrongylus wilsoni        CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Filaroides martis               CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Oslerus osleri                  CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCGT TCCTATGGAA
Parafilaroides decorus          CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Metastrongylus salmi            CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Skrjabingylus chitwoodorum      CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Parelaphostrongylus odocoilei   CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Muellerius capillaris           CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Halocercus invaginatus          CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Pseudalius inflexus             CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Stenurus minor                  CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Torynurus convolutus            CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Nematodirus battus              CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AAAAGACCAT TCCTATGGAA
Nippostrongylus brasiliensis    CTTATCCAAT CTTGAATAGA TGAGATAGTG ACTAAAAATA AGAAGACCAT TCCTATGGAA
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                        490        500        510        520        530        540
Angiostrongylus cantonensis     CGGTTATTTC AATGAGTTGA TCATAAACCT TTTTTCGAGT ATCCAGTGGA GGGCAAGTCT
Angiostrongylus costaricensis   CGGTTATTTC AATGAGTTGA TCATAAACCT TTTTTCGAGT ATCAAGTGGA GGGCAAGTCT
Angiostrongylus malaysiensis    CGGTTATTTC AATGAGTTGA TCATAAACCT TTTTTCGAGT ATCAAGTGGA GGGCAAGTCT
Angiostrongylus dujardini       CGGTTATTTC AATGAGTTGA TCATAAACCT TTTTTCGAGT ATCAAGTGGA GGGCAAGTCT
Angiostrongylus vasorum         CGGTTATTTC AATGAGTTGA TCATAAACCT TTTTTCGAGT ACCAAGTGGA GGGCAAGTCT
Aelurostrongylus abstrusus      CGGTCATTTC AATGAGTTGA TCATAAACTT CTTTTCGAGT ATCAAGTGGA GGGCAAGTCT
Didelphostrongylus hayesi       CGGTTATTTC AATGAGTTGA TCTTAAACAT ATTTTCGAGT ATCAAGTGGA GGGCAAGTCT
Crenosoma mephitiditis          CGGTCATTTC AATGAGTTGA TCATAAACCT TTTTTCGAGG ATCAAGTGGA GGGCAAGTCT
Otostrongylus circumlitus       CGGTTATTTC AATGAGTTGA TCATAAACCT TTTTTCGAGG ATCAAGTGGA GGGCAAGTCT
Troglostrongylus wilsoni        CGGTGATTTC AATGAGTTGA TCATAAACCT TTTTTCGAGG ATCAAGTGGA GGGCAAGTCT
Filaroides martis               CGGTTATTTC AATGAGTTGA TCATAAACCT TTTTTCGAGT ATCAAGTGGA GGGCAAGTCT
Oslerus osleri                  CGGTCATTTC AATGAGTTGA TCATAAACAT TTTTTCAAGT ATCAAGTGGA GGGCAAGTCT
Parafilaroides decorus          CGGTTATTTC AATGAGTTGA TCATAAACCT TTTTTCGAGT ATCAAGTGGA GGGCAAGTCT
Metastrongylus salmi            CGGTCATTTC AATGAGTTGA TCATAAACCT TTTTTCGAGT ATCAAGTGGA GGGCAAGTCT
Skrjabingylus chitwoodorum      CGGTCATTTC AATGAGTTGA TCATAAACAT TTTTTCGAGG ATCAAGTGGA GGGCAAGTCT
Parelaphostrongylus odocoilei   CGGTCATTTC AATGAGTTGA TCATAAACCT TTTTTCGAGT ATCAAGTGGA GGGCAAGTCT
Muellerius capillaris           CGGTCATTTC AATGAGTTGA TCATAAACGT TTTTTCGAGT ATCAAGTGGA GGGCAAGTCT
Halocercus invaginatus          CGGTTATTTC AATGAGTTGA TCATAAACTA TTTTTCGAGT ATCGAGTGGA GGGCAAGTCT
Pseudalius inflexus             CGGTTATTTC AATGAGTTGA TCATAAACTT TTTTTCGAGT ATCAAGTGGA GGGCAAGTCT
Stenurus minor                  CGGTTATTTC AATGAGTTGA TCATAAACCT TTTTTCGAGT ATCAAGTGGA GGGCAAGTCT
Torynurus convolutus            CGGTTATTTC AATGAGTTGA TCATAAACCT TTTTTCGAGT ATCAAGTGGA GGGCAAGTCT
Nematodirus battus              CGGTCATTTC AATGAGTTGA GCTTAAACCT TTTTTCGAGG ATCAAGTGGA GGGCAAGTCT
Nippostrongylus brasiliensis    CGGTCATTCC AATGAGTTGA TCATAAACCT TTTTTCGAGG AACAAGTGGA GGGCAAGTCT
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                        550        560        570        580        590        600
Angiostrongylus cantonensis     GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Angiostrongylus costaricensis   GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Angiostrongylus malaysiensis    GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Angiostrongylus dujardini       GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Angiostrongylus vasorum         GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Aelurostrongylus abstrusus      GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Didelphostrongylus hayesi       GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ACCGTCATTG CTGCGGTTAA
Crenosoma mephitiditis          GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Otostrongylus circumlitus       GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Troglostrongylus wilsoni        GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Filaroides martis               GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Oslerus osleri                  GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Parafilaroides decorus          GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Metastrongylus salmi            GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Skrjabingylus chitwoodorum      GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Parelaphostrongylus odocoilei   GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Muellerius capillaris           GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Halocercus invaginatus          GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Pseudalius inflexus             GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Stenurus minor                  GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Torynurus convolutus            GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Nematodirus battus              GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
Nippostrongylus brasiliensis    GGTGCCAGCA GCCGCGGTAA TTCCAGCTCC ACTAGTGTAA ATCGTCATTG CTGCGGTTAA
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                        610        620        630        640        650        660
Angiostrongylus cantonensis     AAAGCTCGTA GTTGGATCTG AGTTGCATGC AATGATTCGC CTTTGGCGTT AATCATTGTT
Angiostrongylus costaricensis   AAAGCTCGTA GTTGGATCTG AGTTACATGC AATGATTCGC CTTTGGCGTT AATCATTGTT
Angiostrongylus malaysiensis    AAAGCTCGTA GTTGGATCTG AGTTGCATGC AATGATTCGC CTTTGGCGTT AATCATTGTT
Angiostrongylus dujardini       AAAGCTCGTA GTTGGATCTG AGTTGCATGC AATGGTTCGC CTTTGGCGTT AATCATTGTT
Angiostrongylus vasorum         AAAGCTCGTA GTTGGATCTG AGTTGCATGC AATGATTCGC CTTTGGCGTT AATCATTGTT
Aelurostrongylus abstrusus      AAAGCTCGTA GTTGGATCTG AGTTGCATGC AGTGGTTCGC CTTTGGCGTT AATCACTGTT
Didelphostrongylus hayesi       AAAGCTCGTA GTTGGATCTG AGTCATATGC AATGATTCGC TATTAGCGTT AATTATTGTT
Crenosoma mephitiditis          AAAGCTCGTA GTTGGATCTG AGTCGCATGC AGTAGTTCGC CTTTGGCGTT AATTACTGTT
Otostrongylus circumlitus       AAAGCTCGTA GTTGGATCTG AGTCGCATGC AATGGTTCGC CTTTGGCGTT AATCATTGTT
Troglostrongylus wilsoni        AAAGCTCGTA GTTGGATCTG AGTCACATGC AGTGATTCGC CTTTGGCGTT AATCATTGTT
Filaroides martis               AAAGCTCGTA GTTGGATCTG AGTCGCATGC AGTGGTTCGC CTTTGGCGTT AATCATTGTT
Oslerus osleri                  AAAGCTCGTA GTTGGATCTG AGTCGCATGC AGTGGTTCGC CCTTGGCGTT AATCACTGTT
Parafilaroides decorus          AAAGCTCGTA GTTGGATCTG AGTCACATGC AATGATTCGC CTTTGGCGTT AATCATTGTT
Metastrongylus salmi            AAAGCTCGTA GTTGGATCTG AGTCGCATGC AGTGATTCGC CTTTGGCGTT AATCACTGTT
Skrjabingylus chitwoodorum      AAAGCTCGTA GTTGGATCTG AGTCACATGC AATGATTCGC CTTTGGCGTT AATTATTGTT
Parelaphostrongylus odocoilei   AAAGCTCGTA GTTGGATCTG AGTCGCATGC AATGATTCGC CTTTGGCGTT AATCATTGTT
Muellerius capillaris           AAAGCTCGTA GTTGGATCTG AGTCGCATGC AATGATTCGC CTTTGGCGTT AATTATTGTT
Halocercus invaginatus          AAAGCTCGTA GTTGGATCTG AGTCACATGC AATTGGTTGC CTTTGGCGTT AATCATTGTT
Pseudalius inflexus             AAAGCTCGTA GTTGGATCTG AGTCACATGC AATAATTCAC CTTTGGTGTT AATTATTGTT
Stenurus minor                  AAAGCTCGTA GTTGGATCTG AGTCACACGC AATGATTCGC CTTTGGCGTT AATCATTGTT
Torynurus convolutus            AAAGCTCGTA GTTGGATCTG AGTCACACGC AATGATTCGC CTTTGGCGTT AATCATTGTT
Nematodirus battus              AAAGCTCGTA GTTGGATCTG AGTCACATGC AGTGGTTCGC CTTTGGCGTT AATCGCTGTT
Nippostrongylus brasiliensis    AAAGCTCGTA GTTGGATCTG AGTTACATGC AG-TGGTTAC CTTTGGTGTT AATCGCTGTT
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                       670        680        690        700        710        720
Angiostrongylus cantonensis     GTGACTATTT ----GCTGGT TTTCTATTGA AATTTCGATT TCTTTAGTGG CTAGCGAGTT
Angiostrongylus costaricensis   GTGACTATTT ----GCTGGT TTTCTATTGA AATCTCGATT TCTTTAGTGG CTAGCGAGTT
Angiostrongylus malaysiensis    GTGACTATTT ----GCTGGT TTTCTATTGA AATTTCGATT TCTCTAGTGA CTGGCGAGTT
Angiostrongylus dujardini       GTGACTATTT ----GCTGGT TTTCTATTGA AATCTCGATT TCTTTAGTGG CTAGCGAGTT
Angiostrongylus vasorum         GTGACTATTT ----GCTGGT TTTCTATTGA AATTTCGATT TCTTTAGTGG CTAGCGAGTT
Aelurostrongylus abstrusus      GCGACTATTT ----GCTGGT TTTCTGCAGA GATTTCGATT TCTGTAGTGG CTAGCGAGTT
Didelphostrongylus hayesi       GTGACTAGCA --TTGCTGGT TTTCTATTGA GATTTCGATT TCATTAGTGA CTAGCGAGTT
Crenosoma mephitiditis          GTGACTATTT ----GCTGGT TTTCTATTGA AATTTCGATT TCTTTAGTGG CTAGCGAGTT
Otostrongylus circumlitus       GTGACTATTT ----GCTGGT TTTCTATTGA AATTTCGATT TCTTTAGTGG CTAGCGAGTT
Troglostrongylus wilsoni        GTGACTATTT ----GCTGGT TTTCTATTGA AATTTCGGTT TCTTTAGTGG CTAGCGAGTT
Filaroides martis               GTGACTATTT ----GCTGGT TTTCTATTGA AATCTCGATT TCTTTAGTGG CTAGCGAGTT
Oslerus osleri                  GTGACTATTT ----GCTGGT TTTCTATTGA AATTTCGGTT TCTTTAGTGA CTAGCGAGTT
Parafilaroides decorus          GTGACTATTT ----GCTGGT TTTCTATTGA GATTTCGATC TCTTTAGTGG CTAGCGAGTT
Metastrongylus salmi            GTGACTATTT ----GCTGGT TTTCTATTGA AATTTCGGTT TCTTTAGTGG CTAGCGAGTT
Skrjabingylus chitwoodorum      GTGACTATTT ----GCTGGT TTTCTATTGA GATTTCGATT TCAATAGTGG CTAGCGAGTT
Parelaphostrongylus odocoilei   GTGACTATTT ----GCTGGT TTTCTATTGA AATTTCGATT TCTATAGTGG CTAGCGAGTT
Muellerius capillaris           GTGACTATTT ----GCTGGT TTTCTATAGT AATTTCGATT TCTATAGTGG CTAGCGAGTT
Halocercus invaginatus          GTGACTATCT RT--GCTGGT TTTCTATTGA GATTTCGATT TCAATAGTGG CTAGCGAGTT
Pseudalius inflexus             GTGACTATTT ----GCTGGT TTTCTATTGA AATTTCGATT TCTATAGTGG CTAGCGAGTT
Stenurus minor                  GTGACTATTT ----GCTGGT TTTCTATTGA AATTTCGATT TCTTTAGTGG CTAGCGAGTT
Torynurus convolutus            GTGACTATTT ----GCTGGT TTTCTATTGA AATTTCGATT TCTTTAGTGG CTAGCGAGTT
Nematodirus battus              GTGACTATTT ----GCTGGT TTTCTATTGA GGTTTCGATC TCTTTAGTGG CTAGCGAGTT
Nippostrongylus brasiliensis    GTGACTATTT ----GCTGGT TTTCTATTAA AGCTTCGGCT TTTTTAGTGG CTAGCGAGTT
NUCELOTIDES INCLUDED            mmmmmmmmmm ----mmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                       730        740        750        760        770        780
Angiostrongylus cantonensis     TACTTTGAAT AAATTAAAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Angiostrongylus costaricensis   TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Angiostrongylus malaysiensis    TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Angiostrongylus dujardini       TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGA TCGATCATGG
Angiostrongylus vasorum         TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Aelurostrongylus abstrusus      TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGA TCGATCATGG
Didelphostrongylus hayesi       TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Crenosoma mephitiditis          TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Otostrongylus circumlitus       TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Troglostrongylus wilsoni        TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Filaroides martis               TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Oslerus osleri                  TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Parafilaroides decorus          TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Metastrongylus salmi            TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Skrjabingylus chitwoodorum      TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Parelaphostrongylus odocoilei   TACTTTGAAT AAATTAAAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Muellerius capillaris           TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTTA-CA GCTTGAATGT GTGATCATGG
Halocercus invaginatus          TACTTTGAAT AAATTAGAGT GCTCAAAACA AGCGTTACGT GCTTGAATGT GTGATCATGG
Pseudalius inflexus             TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Stenurus minor                  TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Torynurus convolutus            TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Nematodirus battus              TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
Nippostrongylus brasiliensis    TACTTTGAAT AAATTAGAGT GCTCAGAACA AGCGTT---T GCTTGAATGG TCGATCATGG
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmm---m mmmmmmmmmm mmmmmmmmmm

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                                       790        800        810        820        830        840
Angiostrongylus cantonensis     AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAGTA ATGATTAAGA
Angiostrongylus costaricensis   AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACGGAAGTA ATGATTAAGA
Angiostrongylus malaysiensis    AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAGTA ATGATTAAGA
Angiostrongylus dujardini       AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAGTA ATGATTAAGA
Angiostrongylus vasorum         AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAGTA ATGATTAAGA
Aelurostrongylus abstrusus      AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
Didelphostrongylus hayesi       AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGATTAAGA
Crenosoma mephitiditis          AATAATAGAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
Otostrongylus circumlitus       AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
Troglostrongylus wilsoni        AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
Filaroides martis               AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
Oslerus osleri                  AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
Parafilaroides decorus          AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
Metastrongylus salmi            AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
Skrjabingylus chitwoodorum      AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
Parelaphostrongylus odocoilei   AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
Muellerius capillaris           AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
Halocercus invaginatus          AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
Pseudalius inflexus             AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
Stenurus minor                  AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
Torynurus convolutus            AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
Nematodirus battus              AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
Nippostrongylus brasiliensis    AATAATAAAA GAGGACTTCG GTTCTATTTA TTGGTTCAGG AACTGAAATA ATGGTTAAGA
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                        850        860        870        880        890        900
Angiostrongylus cantonensis     GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Angiostrongylus costaricensis   GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Angiostrongylus malaysiensis    GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Angiostrongylus dujardini       GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Angiostrongylus vasorum         GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Aelurostrongylus abstrusus      GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Didelphostrongylus hayesi       GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Crenosoma mephitiditis          GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Otostrongylus circumlitus       GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Troglostrongylus wilsoni        GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Filaroides martis               GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Oslerus osleri                  GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Parafilaroides decorus          GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Metastrongylus salmi            GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Skrjabingylus chitwoodorum      GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Parelaphostrongylus odocoilei   GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Muellerius capillaris           GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Halocercus invaginatus          GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Pseudalius inflexus             GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Stenurus minor                  GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Torynurus convolutus            GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Nematodirus battus              GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
Nippostrongylus brasiliensis    GGGACAATTC GGGGGCATTC GTATCCCTGC GCGAGAGGTG AAATTCGTGG ACCGCAGGGG
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                        910        920        930        940        950        960
Angiostrongylus cantonensis     GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Angiostrongylus costaricensis   GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Angiostrongylus malaysiensis    GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Angiostrongylus dujardini       GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Angiostrongylus vasorum         GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Aelurostrongylus abstrusus      GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Didelphostrongylus hayesi       GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Crenosoma mephitiditis          GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Otostrongylus circumlitus       GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Troglostrongylus wilsoni        GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Filaroides martis               GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Oslerus osleri                  GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Parafilaroides decorus          GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Metastrongylus salmi            GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Skrjabingylus chitwoodorum      GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Parelaphostrongylus odocoilei   GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Muellerius capillaris           GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Halocercus invaginatus          GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Pseudalius inflexus             GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Stenurus minor                  GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Torynurus convolutus            GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Nematodirus battus              GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
Nippostrongylus brasiliensis    GACGCCCTAA AGCGAAAGCA TTTGCCAAGA ATGTCTTCAT TAATCAAGAA CGAAAGTCAG
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                        970        980        990       1000       1010       1020
Angiostrongylus cantonensis     AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Angiostrongylus costaricensis   AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Angiostrongylus malaysiensis    AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Angiostrongylus dujardini       AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Angiostrongylus vasorum         AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Aelurostrongylus abstrusus      AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Didelphostrongylus hayesi       AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Crenosoma mephitiditis          AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Otostrongylus circumlitus       AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Troglostrongylus wilsoni        AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Filaroides martis               AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Oslerus osleri                  AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Parafilaroides decorus          AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Metastrongylus salmi            AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Skrjabingylus chitwoodorum      AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Parelaphostrongylus odocoilei   AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Muellerius capillaris           AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Halocercus invaginatus          AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Pseudalius inflexus             AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Stenurus minor                  AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Torynurus convolutus            AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Nematodirus battus              AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
Nippostrongylus brasiliensis    AGGTTCGAAG GCGATTAGAT ACCGCCCTAG TTCTGACCGT AAACTATGCC ATCTAGCGAT
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                        1030       1040       1050       1060       1070       1080
Angiostrongylus cantonensis     CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Angiostrongylus costaricensis   CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Angiostrongylus malaysiensis    CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Angiostrongylus dujardini       CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Angiostrongylus vasorum         CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Aelurostrongylus abstrusus      CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Didelphostrongylus hayesi       CCGATGGGGT ATTATTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Crenosoma mephitiditis          CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Otostrongylus circumlitus       CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Troglostrongylus wilsoni        CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Filaroides martis               CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Oslerus osleri                  CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Parafilaroides decorus          CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Metastrongylus salmi            CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Skrjabingylus chitwoodorum      CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Parelaphostrongylus odocoilei   CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Muellerius capillaris           CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Halocercus invaginatus          CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Pseudalius inflexus             CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Stenurus minor                  CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Torynurus convolutus            CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Nematodirus battus              CCGATGGGGT ATATTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
Nippostrongylus brasiliensis    CCGATGGGGT ATTGTTGCCT TGTCGAGGAG CTTCCCGGAA ACGAAAGTCT TTCGGTTCCT
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                        1090       1100       1110       1120       1130       1140
Angiostrongylus cantonensis     GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Angiostrongylus costaricensis   GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Angiostrongylus malaysiensis    GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Angiostrongylus dujardini       GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Angiostrongylus vasorum         GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Aelurostrongylus abstrusus      GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Didelphostrongylus hayesi       GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Crenosoma mephitiditis          GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Otostrongylus circumlitus       GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Troglostrongylus wilsoni        GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAg
Filaroides martis               GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Oslerus osleri                  GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Parafilaroides decorus          GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Metastrongylus salmi            GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Skrjabingylus chitwoodorum      GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Parelaphostrongylus odocoilei   GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Muellerius capillaris           GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Halocercus invaginatus          GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Pseudalius inflexus             GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Stenurus minor                  GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Torynurus convolutus            GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Nematodirus battus              GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
Nippostrongylus brasiliensis    GGGGTAGTAT GGTTGCAAAG CTGAAACTTA AAGAAATTGA CGGAATGGCA CCACCAGGAG
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                        1150       1160       1170       1180       1190       1200
Angiostrongylus cantonensis     TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Angiostrongylus costaricensis   TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Angiostrongylus malaysiensis    TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Angiostrongylus dujardini       TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Angiostrongylus vasorum         TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Aelurostrongylus abstrusus      TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Didelphostrongylus hayesi       TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Crenosoma mephitiditis          TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Otostrongylus circumlitus       TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Troglostrongylus wilsoni        TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Filaroides martis               TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Oslerus osleri                  TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Parafilaroides decorus          TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Metastrongylus salmi            TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTGA
Skrjabingylus chitwoodorum      TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Parelaphostrongylus odocoilei   TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Muellerius capillaris           TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Halocercus invaginatus          TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Pseudalius inflexus             TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Stenurus minor                  TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Torynurus convolutus            TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Nematodirus battus              TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
Nippostrongylus brasiliensis    TGGAGCCTGC GGCTTAATTT GACTCAACAC GGGAAAACTC ACCCGGCCCG GACACCGTAA
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                        1210       1220       1230       1240       1250       1260
Angiostrongylus cantonensis     GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Angiostrongylus costaricensis   GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Angiostrongylus malaysiensis    GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Angiostrongylus dujardini       GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Angiostrongylus vasorum         GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Aelurostrongylus abstrusus      GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Didelphostrongylus hayesi       GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Crenosoma mephitiditis          GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Otostrongylus circumlitus       GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Troglostrongylus wilsoni        GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Filaroides martis               GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Oslerus osleri                  GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Parafilaroides decorus          GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Metastrongylus salmi            GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Skrjabingylus chitwoodorum      GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Parelaphostrongylus odocoilei   GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Muellerius capillaris           GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Halocercus invaginatus          GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Pseudalius inflexus             GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Stenurus minor                  GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Torynurus convolutus            GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Nematodirus battus              G-ATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
Nippostrongylus brasiliensis    GGATTGACAG ATTGAAAGCT CTTTCTCGAT TTGGTGGTTG GTGGTGCATG GCCGTTCTTA
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                        1270       1280       1290       1300       1310       1320
Angiostrongylus cantonensis     GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Angiostrongylus costaricensis   GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Angiostrongylus malaysiensis    GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Angiostrongylus dujardini       GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Angiostrongylus vasorum         GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Aelurostrongylus abstrusus      GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Didelphostrongylus hayesi       GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Crenosoma mephitiditis          GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Otostrongylus circumlitus       GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Troglostrongylus wilsoni        GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Filaroides martis               GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Oslerus osleri                  GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Parafilaroides decorus          GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Metastrongylus salmi            GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Skrjabingylus chitwoodorum      GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Parelaphostrongylus odocoilei   GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Muellerius capillaris           GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Halocercus invaginatus          GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Pseudalius inflexus             GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Stenurus minor                  GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Torynurus convolutus            GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Nematodirus battus              GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
Nippostrongylus brasiliensis    GTTGGTGGAG CGATTTGTCT GGTTTATTCC GATAACGAGC GAGACTCTAG CCTGCTAAAT
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                        1330       1340       1350       1360       1370       1380
Angiostrongylus cantonensis     AGTGACTAGA TTATTGA--- -GTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Angiostrongylus costaricensis   AGTGACTAGA TTACTGT--- -GTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Angiostrongylus malaysiensis    AGTGACTAGA TTATTGA--- -GTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Angiostrongylus dujardini       AGTGACTAGA TTACTGT--- -GTCTAGTCC ACTTCTTAGA GGGATAAGCG GTCCTTAAGC
Angiostrongylus vasorum         AGTGACTAGA TTATTGT--- -GTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGCTTA-GC
Aelurostrongylus abstrusus      AGTGACTGGA TTTTCAC--- -GTCTAGTTC ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Didelphostrongylus hayesi       AGTGACTAGA TTTTTAT--- -GTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Crenosoma mephitiditis          AGTGACTGGA TTTTTAT--- -GTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Otostrongylus circumlitus       AGTGACAAGA TTTTTAT--- -GTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Troglostrongylus wilsoni        AGTGACTAGA TTTTTAT--- -GTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Filaroides martis               AGTGACTAGA TTTTTGT--- -GTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Oslerus osleri                  AGTGACTAGA TTTTTAC--- -GTCTAGTTT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Parafilaroides decorus          AGTGACTAGA TTTTTAT--- -GTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Metastrongylus salmi            AGTGACTAGA TTTTTAC--- -GTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Skrjabingylus chitwoodorum      AGTGACTAGA TTATTAT--- -GTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Parelaphostrongylus odocoilei   AGTGACTAGA TACGTAT--- -GTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Muellerius capillaris           AGTGACTAGA TTCTTAT--- -GTCTAGTCA ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Halocercus invaginatus          AGTGACTAGA TTCTTTTGTG TGTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Pseudalius inflexus             AGTGACTAGA TTTTTGT--- -GTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Stenurus minor                  AGTGACTAGA TTTTTGT--- -GTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Torynurus convolutus            AGTGACTAGA TTTTTGT--- -GTCTAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Nematodirus battus              AGTGCCTGGA TTTTTAC--- -GTCCAGTCT ACTTCTTAGA GGGATAAGCG GTGTTTA-GC
Nippostrongylus brasiliensis    AGTGGCTGAA TTTTCAT--- -GTTCAGTCT ACTTCTTAGA GGGATAAGCG GTGACTA-GC
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmm--- -mmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmm-mm
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                                        1390       1400       1410       1420       1430       1440
Angiostrongylus cantonensis     CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Angiostrongylus costaricensis   CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Angiostrongylus malaysiensis    CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Angiostrongylus dujardini       CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Angiostrongylus vasorum         CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Aelurostrongylus abstrusus      CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTTCGGGG CTGCACGCGC
Didelphostrongylus hayesi       CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTTCGGGG CTGCACGCGC
Crenosoma mephitiditis          CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Otostrongylus circumlitus       CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Troglostrongylus wilsoni        CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Filaroides martis               CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Oslerus osleri                  CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Parafilaroides decorus          CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Metastrongylus salmi            CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Skrjabingylus chitwoodorum      CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Parelaphostrongylus odocoilei   CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTTCGGGG CTGCACGCGC
Muellerius capillaris           CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Halocercus invaginatus          CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Pseudalius inflexus             CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTTCGGGG CTGCACGCGC
Stenurus minor                  CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Torynurus convolutus            CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTTCGGGG CTGCACGCGC
Nematodirus battus              CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
Nippostrongylus brasiliensis    CGCACGAGAT TGAGCGATAA CAGGTCTGTG ATGCCCTTAG ATGTCCGGGG CTGCACGCGC
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                        1450       1460       1470       1480       1490       1500
Angiostrongylus cantonensis     GCTACAATGG AAGAATCAGC TGGCCTATCC ATTGCCGAAA GGTATTGGTA AACCGTTGAA
Angiostrongylus costaricensis   GCTACAATGG AAGAATCAAC TGGCCTATCC ATTGCCGAAA GGTATTGGTA AACCGTTGAA
Angiostrongylus malaysiensis    GCTACAATGG AAGAATCAGC TGGCCTATCC ATTGCCGAAA GGTATTGGTA AACCGTTGAA
Angiostrongylus dujardini       GCTACAATGG AAGAATCAGC TGGCCTATCC ATTGCCGAAA GGTATTGGTA AACCGTTGAA
Angiostrongylus vasorum         GCTACAATGG AAGAATCAGC TGGCCTATCC ATTGCCGAAA GGTATTGGTA AACCGTTGAA
Aelurostrongylus abstrusus      GCTACAATGG AAGAATCAGC TGGCCTACCC ATTGCCGAAA GGTATTGGTA AACCGTTGAA
Didelphostrongylus hayesi       GCTACAATGG AAGAATCAAC TGGCCTATCC ATTACCGAAA GGTATTGGTA AACCGTTGAA
Crenosoma mephitiditis          GCTACAATGG AAGAATCAGC TGGCCTATCC ATTGCCGAAA GGTATTGGTA AACCGTTGAA
Otostrongylus circumlitus       GCTACAATGG AAGAATCAGT TGGCCTATCC ATTGCCGAAA GGTATTGGTA AACCGTTGAA
Troglostrongylus wilsoni        GCTACAATGG AAGAATCAGC TGGCCTATCC ATTGCCGAAA GGTATTGGTA AACCGTTGAA
Filaroides martis               GCTACAATGG AAGAATCAGC TGGCCTATCC ATTGCCGAAA GGTATTGGTA AACCGTTGAA
Oslerus osleri                  GCTACAATGG AAGAATCAGC TGGCCTATCC ATTACCGAAA GGTATTGGTA AACCGTTGAA
Parafilaroides decorus          GCTACAATGG AAGAATCAGC TGGCCTATCC ATTGCCGAAA GGTATTGGTA AACCGTTGAA
Metastrongylus salmi            GCTACAATGG AAGAATCAGC TGGCCTATCC ATTACCGAAA GGTATTGGTA AACCGTTGAA
Skrjabingylus chitwoodorum      GCTACAATGG AAGAATCAGC TGGCCTATCC ATTGCCGTAA GGTATTGGTA AACCGTTGAA
Parelaphostrongylus odocoilei   GCTACAATGG AAGAATCAGC TGGCCTATCC ATTACCGAAA GGTATTGGTA AACCGTTGAA
Muellerius capillaris           GCTACAATGG AAGAATCAGC TGGCTTATCC ATTGCCGAAA GGTATTGGTA AACCGTTGAA
Halocercus invaginatus          GCTACAATGG AAGACGCAGC TGGCTTATCC ATTGCCGAAA GGTATTGGTA AACCGTTGAA
Pseudalius inflexus             GCTACAATGG AAGAATCAGC TGGCTTATCC ATTGCCGTAA GGTATTGGTA AACCGTTGAA
Stenurus minor                  GCTACAATGG AAGATGCAGC TGGCCTATCC ATTGCCGAAA GGTATTGGTA AACCGTTGAA
Torynurus convolutus            GCTACAATGG AAGATGCAGC TGGCCTATCC ATTGCCGAAA GGTATTGGTA AACCGTTGAA
Nematodirus battus              GCTACAATGG AAGAATCAGC TGGCCTATCC ATTACCGAAA GGTATTGGTA AACCGTTGAA
Nippostrongylus brasiliensis    GCTACAATGG AAGAATCAGC TGGCCTATCC ATTGCCGAAA GGCATTGGTA AACCGTTGAA
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                        1510       1520       1530       1540       1550       1560
Angiostrongylus cantonensis     ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Angiostrongylus costaricensis   ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Angiostrongylus malaysiensis    ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Angiostrongylus dujardini       ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Angiostrongylus vasorum         ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Aelurostrongylus abstrusus      ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Didelphostrongylus hayesi       ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Crenosoma mephitiditis          ACTCTTCCGT GACCGGGATA GGGAATTGTA ACTATTTCCC TTGAACGAGG AATTCCTAGT
Otostrongylus circumlitus       ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Troglostrongylus wilsoni        ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Filaroides martis               ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Oslerus osleri                  ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Parafilaroides decorus          ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Metastrongylus salmi            ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Skrjabingylus chitwoodorum      ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Parelaphostrongylus odocoilei   ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Muellerius capillaris           ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Halocercus invaginatus          ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Pseudalius inflexus             ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Stenurus minor                  ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Torynurus convolutus            ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Nematodirus battus              ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
Nippostrongylus brasiliensis    ACTCTTCCGT GACCGGGATA GGGAATTGTA ATTATTTCCC TTGAACGAGG AATTCCTAGT
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm
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                                        1570       1580       1590       1600       1610       1620
Angiostrongylus cantonensis     AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Angiostrongylus costaricensis   AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Angiostrongylus malaysiensis    AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Angiostrongylus dujardini       AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Angiostrongylus vasorum         AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Aelurostrongylus abstrusus      AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Didelphostrongylus hayesi       AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Crenosoma mephitiditis          AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Otostrongylus circumlitus       AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Troglostrongylus wilsoni        AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Filaroides martis               AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Oslerus osleri                  AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Parafilaroides decorus          AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Metastrongylus salmi            AAGTGTGAGT CATCAGCTCA CGTTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Skrjabingylus chitwoodorum      AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Parelaphostrongylus odocoilei   AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Muellerius capillaris           AAGTGTGAGT CATTAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Halocercus invaginatus          AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Pseudalius inflexus             AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Stenurus minor                  AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Torynurus convolutus            AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Nematodirus battus              AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
Nippostrongylus brasiliensis    AAGTGTGAGT CATCAGCTCA CGCTGATTAC GTCCCTGCCA TTTGTACACA CCGCCCGTCG
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                        1630       1640       1650       1660       1670       1680
Angiostrongylus cantonensis     CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC TGTATTGAGG CCTTCGGGTC
Angiostrongylus costaricensis   CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC TGTATTGAGG CCTTCGGGTC
Angiostrongylus malaysiensis    CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC TGTATTGAGG CCTTCGGGTC
Angiostrongylus dujardini       CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC TGTATTGAGG CCTTCGGGTC
Angiostrongylus vasorum         CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC TGTATTGAGG CCTTCAGGTC
Aelurostrongylus abstrusus      CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC TGTATTGAGG CCTTCGGGTC
Didelphostrongylus hayesi       CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC TATATTGAGG CCTTCGGGTC
Crenosoma mephitiditis          CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTGC TGTATTGAGG CCTTCGGGTC
Otostrongylus circumlitus       CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTGC TGTATTGAGG CCTTCGGGTC
Troglostrongylus wilsoni        CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTGC TGTATTGAGG CCTTCGGGTC
Filaroides martis               CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC TGTATTGAGG CCTTCGGGTC
Oslerus osleri                  CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC TGTATTGAGG CCTGCGGGTC
Parafilaroides decorus          CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC CGTATTGAGG CCTTCGGGTC
Metastrongylus salmi            CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC TGTATTGAGG CCTCCGGGTC
Skrjabingylus chitwoodorum      CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTGC TGTATTGAGG CTTTTGGGTC
Parelaphostrongylus odocoilei   CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC TGTATTGAGG CCTTCGGGTC
Muellerius capillaris           CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC TGTATTGAGG CCTTCGGGTC
Halocercus invaginatus          CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC TGTATTGAGG CCTTCGGGTC
Pseudalius inflexus             CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC TGTATTGAGG CCTTCGGGTC
Stenurus minor                  CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC TGTATTGAGG CCTTCGGGTC
Torynurus convolutus            CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTAC TGTATTGAGG CCTTCGGGTC
Nematodirus battus              CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTGC TGTATCGAGG CTTTCGGGTC
Nippostrongylus brasiliensis    CTGTCCGGGA CTGAGCTGTC TCGAGAGGAC TGCGGACTGC TGTATCGAGG CTTTCGGGTC
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm mmmmmmmmmm

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                                        1690       1700       1710       1720       1730       1740
Angiostrongylus cantonensis     GCGATATGGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-AACA
Angiostrongylus costaricensis   GCGATATAGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-AACA
Angiostrongylus malaysiensis    GCAATATGGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-AACA
Angiostrongylus dujardini       GCGATATAGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-AACA
Angiostrongylus vasorum         GCGATATGGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA G.........
Aelurostrongylus abstrusus      GCGATATGGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-AACA
Didelphostrongylus hayesi       GTGATATGGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-AACA
Crenosoma mephitiditis          GCGGTATGGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-AACA
Otostrongylus circumlitus       GTGGTATAGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-AACA
Troglostrongylus wilsoni        GCGGTATAGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-AACA
Filaroides martis               GCGGTATGGC GGGAAAACAG TTCAATCGCA ATGGCT-GAA CCGGG-AAAA GTCGT-AACA
Oslerus osleri                  GTGATATGGT GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-AACA
Parafilaroides decorus          GCGGTATGGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCG......
Metastrongylus salmi            GCGGTATGGT GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-AACA
Skrjabingylus chitwoodorum      GCGATATAGT GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-AACA
Parelaphostrongylus odocoilei   GCGATATGGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-A...
Muellerius capillaris           GCGATATGGC GGGAAA-CAG TT........ .......... .......... ..........
Halocercus invaginatus          GCGATATGGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA G.........
Pseudalius inflexus             GTGATATGGC GGAAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-AACA
Stenurus minor                  GCGATATGGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-AACA
Torynurus convolutus            GCGATATGGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-AACA
Nematodirus battus              GCGGTATGGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA GTCGT-AACA
Nippostrongylus brasiliensis    GCGGTATGGC GGGAAA-CAG TTCAATCGCA ATGGCTTGAA CCGGGTAAAA -TCGT-AACA
NUCELOTIDES INCLUDED            mmmmmmmmmm mmmmmm-mmm mm........ .......... .......... ..........
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                                ....|....| ....|....| ....|....| ....|
                                        1750       1760       1770
Angiostrongylus cantonensis     AGGTATCTG. .......... .......... .....
Angiostrongylus costaricensis   AGGTATCTG. .......... .......... .....
Angiostrongylus malaysiensis    AGGTATCTG. .......... .......... .....
Angiostrongylus dujardini       AGGTATCTG. .......... .......... .....
Angiostrongylus vasorum         .......... .......... .......... .....
Aelurostrongylus ABSTRUSUS      AGGTATCTGT AGGTGAACCT GCAGATGGAT CATCG
Didelphostrongylus hayesi       AGGTATCT.. .......... .......... .....
Crenosoma mephitiditis          AGGTATCT.. .......... .......... .....
Otostrongylus circumlitus       AGGTATCTGT AGGTGAACCT GG........ .....
Troglostrongylus wilsoni        AGG....... .......... .......... .....
Filaroides martis               AG........ .......... .......... .....
Oslerus osleri                  AGGTATCTGT AGGT...... .......... .....
Parafilaroides decorus          .......... .......... .......... .....
Metastrongylus salmi            AGGTAT.... .......... .......... .....
Skrjabingylus chitwoodorum      AGGTATCTGT AGG....... .......... .....
Parelaphostrongylus odocoilei   .......... .......... .......... .....
Muellerius capillaris           .......... .......... .......... .....
Halocercus invaginatus          .......... .......... .......... .....
Pseudalius inflexus             AG........ .......... .......... .....
Stenurus minor                  AGGTAT.... .......... .......... .....
Torynurus convolutus            AGG....... .......... .......... .....
Nematodirus battus              AGGTATCTGT AGGTGAACCT GCAGATGGAT CATCG
Nippostrongylus brasiliensis    AGGTATCTGT AGGTGAACTG .......... .....
NUCELOTIDES INCLUDED            .......... .......... .......... .....
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Appendix 6.5: Log likelihood scores of the different models used for comparison for the Sub-order Metastrongylina using 1628 unambiguously aligned nucleotide sites from the near full-length SSU rRNA gene. Log Likelihood Ratio Tests revealed GTR+Γ as the optimal model. Note that the K2P and F81 models are non-nested and therefore cannot be compared using LRT.

Model	**Log-Likelihood Score**
JC	4572.59040
JC+Γ	4273.02522
F81	4555.55232
F81+Γ	4256.28503
K2P	4495.17230
K2P+Γ	4193.80011
HKY	4477.60518
HKY+Γ	4172.09473
TN93	4475.64206
TN93+Γ	4172.09461
GTR	4455.11204
GTR+Γ	**4149.04297**

Appendix 7.1: Log likelihood scores of the different models used for comparison for the **(A)** the Nematoda and **(B)** the Rhabditida within Nematoda using SSU rRNA gene to determine the phylogenetic positions of the nematode type sequences from global populations of *Achatina fulica*, African populations of *Achatina* sp. and Philippine populations of *Laevicaulis alte*. A total of 376 unambiguously aligned nucleotide sites of the 5’ end of the SSU rRNA gene were used. Log Likelihood Ratio Tests for both the Nematoda and the Rhabditida reveal GTR+Γ as the optimal model. Note that the K2P and F81 models are non-nested and therefore cannot be compared using LRT.

(A) Nematoda (B) Rhabditida

Model	**Log-Likelihood Score**	**Model**	**Log-Likelihood Score**
JC	22626.94349	JC	14988.30034
JC+Γ	20485.39787	JC+Γ	13664.52274
F81	22551.59800	F81	14962.62351
F81+Γ	20366.41757	F81+Γ	13565.99042
K2P	22346.17796	K2P	14843.88334
K2P+Γ	20156.78913	K2P+Γ	13508.78184
HKY85	22261.34758	HKY	14795.57154
HKY85+Γ	19983.22991	HKY+Γ	13374.22988
TN93	22163.39719	TN93	14760.22240
TN93+Γ	19957.42496	TN93+Γ	13388.72096
GTR	22099.17630	GTR	14645.08708
GTR+Γ	**19963.29509**	**GTR+Γ**	**13341.76120**