# BIOMETRIC ANALYSIS OF TWO SPECIES OF *Amphidromus* TREE SNAIL WITH COIL DIMORPHISM

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THIS THESIS IS SUBMITTED AS A PARTIAL REQUIREMENT TO OBTAIN BACHELOR OF SCIENCE (Hons.) DEGREE



CONSERVATION BIOLOGY PROGRAM
SCHOOL OF SCIENCE AND TECHNOLOGY
UNIVERSITI MALAYSIA SABAH

2006

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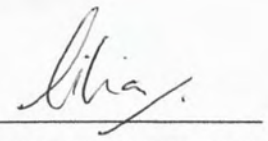

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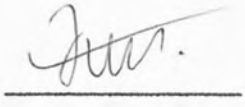

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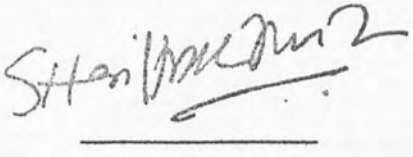

# ACKNOWLEDGEMENT

I would like to take this opportunity to appreciate those who help me to complete this final year research project. Firstly, both of my parents and family, their mentally and financially support really help me a lot upon the completion of this project.

Next, to my respected project supervisor, Prof Dr. Menno Schilthuizen, with his help and guidance in many aspects of this project, I finally completed this project without much problem.

I would like to thank Prof Madya Dr.Abdul Hamid Ahmad for his concern and his helpful explanation in doing better thesis. Then, im also greatful to examiners for their hard work.

Finally but not least, I would like to thank to Cynthia, Kenny Sim, Wong Siew Ching, Dina, and all my friends for your help from the start to the end of this project.

# BIOMETRIC ANALYSIS OF TWO SPECIES OF *AMPHIDROMUS* TREE SNAIL WITH COIL DOMORPHISM

## ABSTRACT

Biometric analysis may reveal the variation and differences between the *Amphidromus martensi* and *Amphidromus inversus* for their dextral and sinistral shell. This study has produced a set of morphometric with eleven different variables that have been measured based on certain landmarks on the snail's shell. Multivariate analysis was used and the data showed that the data shows that five characters including shell height, shell width, aperture width inside part, aperture width outside outside part, and the height of penultimate whorl, are the main characters that contribute to the differentiation between the dextral and sinistral *Amphidromus martensi* shell. For *Amphidromus inversus*, there are also five characters components which are, the shell height of penultimate whole, aperture width outside part, aperture height, and height of penultimate first whorl, are the main characters that contribute to the differentiation between the dextral and sinistral Amphidromus inversus. This shows partial overlap between sinistral and dextral shell in both *Amphidromus martensi* and *Amphidromus inversus.*

# ANALISIS BIOMETRI KE ATAS DUA SPESIES SIPUT *AMPHIDROMUS* YANG MEMPUNYAI SIFAT DWI-LILITAN

## ABSTRAK

Analisis biometri dapat mendedahkan kepelbagaian dan menunjukkan perbezaan antara dua spesies (*Amphidromus martensi* dan *Amphidromus inversus*) yang mempunyai sifat cengkerang tang berlilitan kiri dan kanan antara spesies. Kajian ini telah menghasilkan satu set data morfometrik yang terdiri daripada sebelas pemboleh ubah karakter yang diperlukan untuk mengukur cengkerang pada siput. Analisis 'multivariate' dijalankan dan data menunjukan keputusan yang jelas bahawa terdapatnya lima karakter termasuklah, ketinggian cengkerang, kelebaran cengkerang, kelebaran apetur dalaman, kelebaran apetur luaran, dan ketinggian pada lingkaran kedua akhir pada cengkerang merupakan karakter yang utama bagi memberi sumbangan dalam membezakan *Amphidromus martensi* daripada bersifat lilitan kiri dan kanan dalam spesiesnya. Bagi *Amphidromus inversus* pula, terdapat lima karakter, iaitu ketinggian cengkerang, ketinggian lingkaran kedua akhir, kelebaran apetur luaran, ketinggian apetur dan ketinggian lingkaran pada cengkerang terakhir merupakan karakter utama untuk membezakan *Amphidromus inversus* daripada bersifat lilitan kiri dan lilitan kanan. Ini telah menunjukkan hanya sedikit perbezaan antara cengkerang yang bersifat lilitan kiri dan kanan antara kedua-dua spesies *Amphidromus martensi* dan *Amphidromus inversus.*

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# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

Mollusks is a phylum of soft-bodied invertebrate animals. There are over 50,000 different species of mollusks living today. Some major classes of mollusks include the bivalves, cephalopods such as octopuses and squids, aplacophorans (worm-like mollusks), chitons, monoplacophorans, scaphopods (tusk shells), and gastropods which are snails and slugs. Other gastropods, which lack a conspicuous shell, are commonly called slugs, and are scattered throughout groups that primarily include snails

Snails are gastropods, a soft-bodied type of mollusk that is basically a head with a flattened foot. The soft body is protected by a hard shell, which the snail retreats into when alarmed. These invertebrates (animals with no backbone) are found worldwide in the marine, fresh water, and terrestrial environment. While most people are familiar with only terrestrial snails, the majority of snails is not terrestrial. The name Gastropod means stomach-foot. This makes sense as the whole group gets about by gliding on a muscular structure on the bottom of the abdomen, called the foot. The action that produces motion is a well-coordinated, wavelike

contraction of muscles on the bottom of the foot that propels the gastropod smoothly forward over just about any surface.

Snails move by crawling, swimming, or floating with currents. Land snails crawl on the ground, creeping along on their large, flat foot; a special gland in the foot secretes mucus (a slimy fluid) that helps the snail move. The common garden snail is one of the slowest moving animals; it can travel about 0.05 km per h.

## 1.2 STUDY BACKGROUND

The BORNEENSIS collection at the Institute for Tropical Biology and Conservation (UMS) contains specimens of Amphidromus inversus from Pulau Kapas in Terengganu West Malaysia and Amphidromus martensi from Guamantong forest, Sabah. With low dispersal like in snails and the effects of endemism, each population, also populations assigned to the same species, has a characteristic shell shape that is slightly or strongly different from that of other population. Biometric analysis may reveal the variation and differences between the Amphidromus martensi and Amphidromus inversus for their dextral and sinistral shell.

## 1.3 RATIONALE OF STUDY

The rational of this study is to carry out a biometric analysis of two species Amphidromus tree snail with coil dimorphism (*Amphidromus inversus* and *Amphidromus martensi*). All the specimens were obtained from the BORNEENSIS dry collection at the Institute for Tropical Biology and Conservation in UMS.

## 1.4 Objective

I) To find out if there is a shape difference between individuals that are coiled clockwise and individuals that are coiled anti-clockwise for the species *Amphidromus inversus* and *Amphidromus martensi*.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Land Snails

Land snails live on land, they occupy almost every habitat along the sea, in the deserts and on the mountain peaks. Meanwhile, land snails are the terrestrial representative of the great molluscan class of Gastropoda. Land snails are separated into two large groups which are those breathing with gills (Prosobranchia) and those breathing with lungs (Pulmonata). The gilled snails have a single pair of tentacles with the eyes located at the base, and an operculum for sealing the generally rounded aperture, and the sexes are usually in separate animals. They are mainly tropical animals with a few genera in semi-tropical areas. The snails with lungs have two sets of tentacles with the eyes at the tip of the upper pair, lack an operculum, and are hermaphroditic.

The great majority of land snails are pulmonates. Solem (1984) and Schilthuizen (2004) mentioned that land snails were diverse in cool, humid region in the Northern and Southern temperature zones. Including Borneo, which as a rich fauna of land snails comparising some 500 different species (Vermeulen, 1996). Vermeulen and Whitten

(1999) reported that 50 land snail species are endemic to one large karst outcrop in the state of Sarawak. There were some work in the last few years has proved in the humid Tropics are in fact the richest regions where land snails are concerned (Schilthuizen, 2003).

Molluscs besides with its slow movement, the varied and aesthetically pleasing series of snail shells can give the information the similarities and differences among the species of snails. The shells are easy to collect and preserve, so that material sufficiently copious for studies of this kind can usually be obtained without difficultly (Nonaka, 2002).

## 2.2 Body plan

Shell, in all their different shapes, sizes, colors, binding patterns have always fascinated people, more scientific study of mollusks, including the anatomy of their soft parts, is known as the sciences of malacology. The shell, through homogeneous in appearance, has three different layers. The most external one, the periostracum, is a very thin protein film that usually is brownish or translucent. The middle and innermost layers are called ostracum and hipostracum. The shell can be coiled several to many times, and it may be coiled to the right (known as dextral) or to the left (sinistral). Each coil is called a whorl, and the suture divides each whorl from the neighboring ones. They can be rounded, angular, shouldered, or flattened. The aperture often has a thickened rim called the peristome (Vermeulen, 1996).

When the peristome is folded away from shell, it is called a lip. On the underside of the shell, the last whorl encircles an opening in the centre, which is called the umbilicus. The subclasses of land snails are different in body plan. Pulmonata have a real lung, have no operculum, and have eyes on stalks (Schilthuizen, 2003). Then, Prosobranchia have gills, and operculum functioning as the door to its shell and eyes at the basis of their tentacles. Then, operculum is a kind of trapdoor that protects the animals from predators or from reverse condition. The form and the shape of the mouth or aperture of shell are important characteristics that can used to separate the different species of snail.

## 2.3 *Amphidromus inversus* and *Amphidromus martensi*

*Amphidromus* can be found in forest throughout Southeast Asia. Of the two species that are the target of this study, *Amphidromus martensi* occurs in Borneo, whereas *Amphidromus inversus* is widely distributed in Sundaland. *Amphidromus martensi* lives in the forest canopy. It has a beautiful yellow and purple color pattern on the shell.

In *Amphidromus martensi*, all populations show morph frequencies that are close to 50%-50%. Research has been done for understanding what maintains the coil polymorphism, by mapping spatial distributions of coiling morphs and by observing copulations in *Amphidromus martensi* and *Amphidromus inversus*.

## 2.4 Coil Dimorphism

Snail shells can be left-handed or right-handed, sometimes within one species. The vast majority of snail species are almost exclusively dextral, Schilthuizen (2004) mentioned that, tree snail of subgenus *Amphidromus s. str* are usually because of the chiral dimorphism that exists in many species, with clockwise (dextrally) and counter-clockwise (sinistrally) coiled individuals co-occuring in the same population. In some species, including *Amphidromus martensi* and *Amphidromus inversus*, appears to be a stable balance between the total of dextral and sinistral shells. Some species of snails not only appears to mate randomly between different chiral types, but also have a stable, within-population chiral dimorphism, which suggest the involvement of a balancing factors (Davison, 2002).

Left-right coiled shell is intriguing individuals of opposite chirality are either unable to mate or can only mate with difficulty, so could be reproductively isolated from each other (Davison, 2002). *Amphidromus*, not only appear to mate randomly between different chiral types, but also have a stable, within-population chiral dimorphism, which suggests the involvement of a balancing factors (Schilthuizen, 2003).

## 2.5 Asymmetry

Left-right asymmetry is an integral part of the establishment of a body plan that may ultimately be traced back to a much deeper molecular asymmetry. Snails are the tools of studying left and right asymmetry because of the chirality. The chirality of a snail determined at a early cleavage. Therefore, several of snail species have morphological variation (Hosoiri, 2003). Some recent work have carried out on the issues of why snails are almost invariant in charity. Species that are particular chirally dimorphic, even most population are fixed for particular type with exceptation of *Amphidromus*.

Most animals exhibit a distinct left- right asymmetry of some internal organs, while appearing bilaterally symmetric on the outside (Mercola, 2003 and Wood, 1998). For example, vertebrates shows asymmetries in the position and morphology of the heart, liver, and gut, structures such as gonad and intestine are asymmetric.

Shell morphology in land snails have been of interest since the observation by researcher that the members widely sepatate and the taxonomically distinct land snail fauna tend to be high-or low spired (Gittenberger, 1993). Some research have been carried out, reported that reciprocal mating between dimorphic low- spriled snail is not usually possible, this is because of the genitalia of sinistrl individual cannot engage whit whose are dextral snail. But, the high-spired dimorphic snail species are able to mate (Lipton, 1979 and Asami, 1998).

Snails are mostly dextral. Dextral and sinistral shell asymmetries have evolved roughly equally frequently in fossil cephalopods and in living and fossil bivalves (Askell et al, 1957) then the snail with sinistral shells were not only more common among early monoplacophorans and graspoda (Morris, 1990), but among living taxa they have also evolve repeatedly from dextral ancestors (Vermeij, 1975).

## 2.6 Snail Handedness

Left-right asymmetry can be traced back as far as the first division in the spiral cleavage pattern of snail embryos (Conklin et al, 1902). In this case, this spiral cleavage is characterised by the oblique angle of the early cleavage planes and the alternation of direction of successive divisions

Based on Crampton (1894), he was among the first to describe how cleavages in sinistral *Physa* and dextral *Lymnaea* were mirror-image pattern of one another. Crampton attributed the reversed orientation of division to a reversal of spindle inclination and cleavage plane. In Freeman (1982), it also research about the observation of dextral and sinistral embryos accur within a single species of *Lymanaea*.

Then, Meshcheryakov & Beloussov (1975) attributed the reversal of cleavage pattern between sinistral and dextral species to a reversal from clockwise to anti-clockwise of the spiral rotation of the daughter micromeres during cytokinesis. These rotations were independent of the orientation of the spindle. According to both models, the reversal of handedness is caused by a reversal of cellular machinery. The discrepancies between these two views have yet to be resolved.

## 2.7 Biometric analysis on land snails

The process of biometric is concerned with methods for the description and sinistral analysis of shape variation within and among samples of organisms and of the alaysis of the shape change as a result of growth, experimental treatment or evolution. Just like morphometric analysis, to acess the biometric analysis, methods are needed to compare the shapes of some organisms or some particular structure.

By using the biometric analysis, this application enables tostudy of shape differences among samples of organisms adjusted to comman size (Rohlf and Marcus, 1993). Some measurements are needed such as the height and width of specimens. The result will get in numerically and graphically in term of linear combination of the maesured variables. Snails have sttracted attention for their low mobality which makes them good candidates for testing adaptation to natural conditions.

Examples of the techniques used are principal component analysis, discriminant functions and generalised distances (Smith and Patton, 1988).

# CHAPTER 3

# METHODOLOGY

## 3.1 Location of Samples

Dry sample of the species *Amphidromus inversus* and *Amphidromus martensi* were obtained from the Borneensis collectionof the Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah (IBTP). The sample *Amphidromus inversus* derived from Pulau Kapas in Terengganu, West-Malaysia, whereas the sample for *Amphidromus martensi* was from Gomantong Forest Reserve, Sabah.

## 3.2 Sampling

Before snail measuring, samples were still in good condition, unbroken were chosen. There are fifty-four individuals of *Amphidromus inversus* with twenty right-handed (dextral) and thirty-four right-handed (sinistral) were chosen. Seventy-three individual or *Amphidromus martensi* with forty-four right-handed (dextral) and twenty-nine left-handed (sinistral) were chosen. The shells were first cleaned to make sure all measurements can be taken properly.

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