



**Morphological Variation of Longhorned Beetles
(Coleoptera: Cerambycidae) from Subfamily Lamiinae**

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Bachelor of Science with Honours
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Final Year Project Report



Masters

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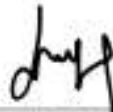
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**Morphological Variation of Longhorned Beetles
(Coleoptera: Cerambycidae) from Subfamily Lamiinae**

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A final report submitted in partial fulfillment of the requirement for the degree of
Bachelor of Science with Honours
(Animal Resource Science and Management)

Supervisor: Madam Wan Nurainie binti Wan Ismail

Faculty of Resource Science and Technology
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2022

DECLARATION

I hereby declare that this thesis is a representation of my original work. No portion of this work has been previously submitted for any other degree of qualification of Universiti Malaysia Sarawak of any institution of higher learning.



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Morphological Variation of Longhorned Beetles (Coleoptera: Cerambycidae) from Subfamily Lamiinae

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ABSTRACT

Longhorned beetle, Cerambycidae is among the most important economic wood boring insect, it interferes and brings damages to the forests including shade trees, fruit trees, nut trees, vegetable plantation, seeds, orchids, and flowers. Most of the longhorned beetles are from the subfamily Lamiinae with 20,036 species, covers 58% of the total longhorned beetles species. This study determined the species from subfamily Lamiinae in family Cerambycidae, records and elucidates the morphological variation using the voucher specimens of longhorned beetles under subfamily Lamiinae deposited in UNIMAS Insect Reference Collection (UIRC), Faculty of Resource Science and Technology (FRST) of Univerisiti Malaysia Sarawak. A total of 253 specimens of subfamily Lamiine consisting of 71 species representing 12 tribes, Ancyronotini, Apomecynini, Batocerini, Ceroplesini, Dorcaschematini, Homonoeini, Lamiini, Mesosini, Morimopsini, Pteropliini, Saperdini and Xylorhizini from were examined and recorded. The most abundant species recorded was *Epepeotes luscus* with 26 individuals (10.28% of total) and the most diverse genus was *Glenea* with 13 species recorded. The species were categorised into 13 clades based on their similarity on four external morphology characteristic.

Key words: Cerambycidae, subfamily Lamiine, morphological variation

ABSTRAK

*Kumbang tanduk panjang, Cerambycidae adalah antara serangga penggerudian kayu ekonomi yang paling penting, ia mengganggu dan membawa kerosakan kepada hutan termasuk pokok teduhan, pokok buah-buahan, pokok kacang, ladang sayur-sayuran, biji benih, orkid, dan bunga. Kebanyakan kumbang tanduk panjang adalah daripada subfamili Lamiinae dengan 20,036 spesies, meliputi 58% daripada jumlah spesies kumbang tanduk panjang. Kajian ini menentukan spesies daripada subfamili Lamiinae dalam famili Cerambycidae, merekod dan menjelaskan variasi morfologi menggunakan spesimen baucar kumbang tanduk panjang di bawah subfamili Lamiinae yang disimpan dalam Koleksi Rujukan Serangga (UIRC), Fakulti Sains dan Teknologi Sumber (FRST) Univerisiti Malaysia Sarawak. Sebanyak 253 spesimen subfamili Lamiine yang terdiri daripada 71 spesies mewakili 12 puak, Ancyronotini, Apomecynini, Batocerini, Ceroplesini, Dorcaschematini, Homonoeini, Lamiini, Mesosini, Morimopsini, Pteropliini, Saperdini dan Xylorhizini daripada telah direkodkan. Spesies yang paling banyak direkodkan ialah *Epepeotes luscus* dengan 26 individu (10.28% daripada jumlah keseluruhan) dan genus yang paling pelbagai ialah *Glenea* dengan 13 spesies direkodkan. Spesies ini dikategorikan kepada 13 klad berdasarkan persamaannya pada empat ciri morfologi luaran.*

Kata kunci: Cerambycidae, subfamili Lamiine, variasi morfologi

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LIST OF ABBREVIATIONS

| | |
|--------|--|
| UIRC | Insect Reference Collection |
| FRST | Faculty of Resource Science and Technology |
| UNIMAS | Universiti Malaysia Sarawak |
| % | Percent |
| mm | Milimetre |

1.0 INTRODUCTION

The name of Coleoptera was created by Aristotle to signify the hardened and shield-like forewings of beetles, coleo means shield; ptera means wing (McHugh & Liebherr, 2009). The forewings are called elytra. The order Coleoptera is the largest order among the other orders in the animal kingdom that comprises about 40% of all the insects and almost 30% of all the animal species. Most of the beetles served as the major pests in agriculture and product storage (Meyer, 2020).

Cerambycidae is a family under Order Coleoptera, popularly known as longicorns, longhorned beetles, longhorned borers, or round-headed borers, are one of the most diverse and economically important families under Coleoptera (Fahri & Noerdjito, 2016). Cerambycids are distributed widely everywhere in the world (Fahri & Noerdjito, 2016). There are a total of 34,490 described species Cerambycidae in the world (Rossa & Goczal, 2021), longhorned beetles acknowledged around the world and are found everywhere except Antarctica (Linsley, 1959).

These beetles play an important role in the earth ecosystem, for example, as bioindicators, saproxylic, pollinators, and as food source for other organisms (Fahri & Noerdjito, 2016). Mostly all the larvae of the cerambycidae feed on dead plants and hold a major role in decomposing dead plants but, there are also around 200 cerambycid species in the world that bring economic impact on the field of agriculture, forestry, and horticulture, which resulting in losing production due to the damages caused by the cerambycid pest, environmental disasters, and some management costs. They may also cause damages in the host plants whether through direct feeding and transmission of plant diseases (Monné *et al.*, 2017).

As stated by Heffern (2005), it is challenging in identifying many longhorn beetles species, especially subfamily Lamiinae to separate the similar genera and species by using the available literature references. Photographs and digital images of these beetles specimens can be an easy way for specialists in order to identify the species. There is a lack of published research on morphological variation among the longhorned beetles in Malaysia. Longhorned beetles have different sizes, shapes, and colours, and they also commonly mimicking unappealing beetles from other families such as stinging ants or wasps which makes this family rather difficult to identify (Slipinski & Escalona, 2013). As the longhorned beetles are greatly diverse from both taxonomy and ecology, and are closely associated with their host plants, they may assist in providing key data and evolutionary “guidelines” associated with their host plants for the studies of ecology and zoogeography (Maymoona, 2011). In the previous study of Razak (2015) and Ismail (2013), they studied on the diversity of beetles, coleoptera whereas in Lim (2017) and Woon (2006), they studied about the systematics and distribution of subfamily Lamiinae in family Cerambycidae.

2.0 LITERATURE REVIEW

2.1 Family Cerambycidae

The family Cerambycidae comprises eight subfamilies: Cerambycinae, Dorcasominae, Lamiinae, Lepturinae, Necydalinae, Parandrinae, Prioninae, and Spondylidinae (Monné *et al.*, 2017). Most of the longhorned beetles are from the family Lamiinae with 20,036 species, covers 58% of all the longhorned beetle species and Cerambycinae with 11,172 species, covers 33% of the Cerambycidae species which added up covers 90.5% of the longhorn beetles (Rossa & Goczal, 2021). There are a total of 4,959 genera in the Cerambycidae (Rossa & Goczal, 2021).

All the subfamilies have both diurnal and nocturnal species during their adult stage. The adult beetles from subfamilies Lamiinae, Paradrinae, Prioninae, Spondylidinae, and Aseminae are mostly nocturnal whereas the adult beetles from subfamilies Cerambycinae, Lepturinae, and Necydalinae are mostly diurnal. Almost all of the nocturnal species are attracted to the light (Wang, 2008).

2.2 Longhorned Beetle General Morphology

Longhorned beetles had the characteristic feature of having extremely long antennae which are as long or longer than their bodies, approximately 1.5 to 2 times their body length (Meng *et al.*, 2015). The body length of the adult beetle ranges from less than 0.2 cm in *Cyrtinus pygmaeus* (Burange *et al.*, 2020) to greater than 17.0 cm in *Titanus giganteus* [L.] (Walker, 2001). The general external morphology of the longhorn beetles is diagnosed as the antennae of these beetles are usually generally filiform, elongate, and 11-segmented, that rarely serrate and below 12-segmented, usually inserted on pronounced tubercles and eyes are usually emarginate; the prothorax of these beetles has no pleural sutures; tibia with two distinct tibial spurs; the tarsi are usually pseudotetramerous with fourth tarsomere usually minute and concealed by third tarsomere; the elytra are generally covering abdomen; they have hind wings with a spur on radio-medial cross vein; the abdomen of the beetles has five visible sternites and fifth sternite entire (Monné *et al.*, 2017).

2.3 Subfamily Lamiinae

The subfamily Lamiinae are commonly called as flat-faced longhorns, the general features of this subfamily are pointed terminal segment of the maxillary palps, elongated face that is rather vertical, parallel-sided and rather cylindrical. They have slightly narrow pronotum than the elytra base (Ponpinji *et al.*, 2011). According to a study by Rossa & Goczal (2021) regarding the global distribution, the top five of the richest genera from Cerambycidae came from the Lamiine subfamily: *Pterolophia* Breuning, 1961, *Glenea* Jordan, 1894, *Sybra* Hayashi, 1956, *Dorcadion* Ganglb., 1884, and *Exocentrus* Dejean, 1835. As mention by Souza *et al.* (2020), Lamiinae is the most diverse subfamily in Cerambycidae, with around 20,000 described species divided into 80 tribes.

2.4 Cerambycid as Forests Pests

Longhorned beetles gained attention in the recent years due to their pest potential (Kariyanna *et al.*, 2017). Almost all longhorned beetles are phytophagous and consume primarily on woody plants but also some species do consume on herbaceous plants. The cerambycids grow in almost all parts of woody plants, mainly in roots, trunks, and branches, but sometimes in leaves, cones, pods, and seeds. The larvae of cerambycid grow almost in all the major tissues of woody plants, such as the outer bark, inner bark, cambium, sapwood, heartwood, and also the pith (Haack, 2017). Cerambycids infest a wide variety of tree host that can be in the condition from healthy to stressed tree (Haack & Slansky, 1987). Longhorned beetles happen to be serious pest of timber, pulpwood trees, landscape trees, fruit trees, and ornamental plants for the reason that they have wood-boring habits (Rogers, 2016). The adult beetles girdle twigs or branches of the plants for their feeding.

Some adult cerambycid species pick healthy trees for oviposition, while others pick unhealthy trees, such as fire-damaged, drought-stressed, windthrown, and severely defoliated trees. Eventually, the larval feeding and their development can cause death to both classes of trees (Allison *et al.*, 2004).

The genus of longhorn beetles such as *Monochamus* are recorded to transmit the pinewood nematode, *Bursaphelenchus xylophilus*, the pine wilt disease is recorded occurred in East Asia, Europe, and North America (Robertson *et al.*, 2011). In recent past, the Asian longhorned beetles, *Anoplophora glabripennis*, are of the quarantine concern in the USA and they were recorded across New York and Chicago, for the first time in the year 1996 as they caused serious damage to the hardwood trees and was recorded introduced from China by shipment material (Lingafelter & Hoebeke, 2002). Many of the longhorned beetle species are becoming

serious pests in the field of agriculture, plantations, and forest are due to intensive farming, extreme deforestation associated with global warming (Kariyanna *et al.*, 2017).

2.5 Previous Studies on Cerambycidae in Borneo

In a study by Muslim *et al.* (2010), a total of 11 species and two unidentified species from the Cerambycidae were collected at the Ginseng Camp, Maliau Basin by using white screen light trap. Samplings were done from 27 February 2005 to 1 March 2005, started at 6.30 p.m. until 10.30 p.m. The species collected were *Rhaphipodus hopei* from subfamily Prioninae, *Cyriopalus wallacei*, *Dialeges pauperoides*, *Euryphagus lundi*, *Hoplocerambyx spinicornis*, *Trirachys orientalis*, *Xoanodera striata*, *Zegriades magister*, *Aeolesthes* sp. and *Diorthus* sp. from subfamily Cerambycinae, *Batocera parryi*, *B. rubus*, and *Palimna annulata*, from subfamily Lamiinae.

From the survey conducted by Chung *et al.* (2010) which was also at the Ginseng Camp, white screen light-trapping was also used and survey were carried out between 7 p.m. to 9 p.m. from 6 to 12 March 2010. A total of eight species of Cerambycidae were collected, *Zegriades magister*, *Aeolesthes aurifaber*, *Aeolesthes* sp. and *Trachylophus* sp. from subfamily Cerambycinae, *Macrotoma* sp. from subfamily Prioninae, and *Batocera rubus*, *B. parryi*, and *Peribasis princeps* from subfamily Lamiinae.

In the article by Vives (2016), a total of 11 new species representing two subfamilies of Cerambycidae, namely Lepturinae (one species) and Cerambycinae (10 species) were described, illustrated, and recorded. The specimens of the longhorned beetles are from Borneo, mostly from Sabah and a small quantity are from Sarawak and West Kalimantan.

Based on the study by Sennang (2006) on a review of the genus *Pterolophia* (Cerambycidae: Lamiinae) in Sarawak, a total of 244 specimens were examined by using a Jena Carl Zeiss stereomicroscope (0.8 X – 4.0 X) illuminated by a 6 V halogen lamp with light blue filter that were deposited in the Sarawak Museum, Sarawak Forestry Corporation, and UNIMAS Insect

Reference Collection. The morphological characteristics such as the colours, and elytra's pattern, pronotum's pattern, colours of the antennae and legs for each specimen were examined, described and recorded. The total length and width of the body of the specimens were also taken by using calliper. The study revealed that there were lacking of described and documented longhorn beetles from South East Asia as in this study there are 19 species of beetles from genus *Pterolophia* that has not identified.

From the study carried out by Raine *et al.* (2018), the morphometric data of over 1,700 individuals of 12 species of dung beetles were collected and compared among the individuals that were collected from primary forest, logged forest, and oil palm plantation in Sabah, Malaysia during February and March 2011. Six morphological traits, the relative body size, abdomen size, wing aspect ratio, wing loading, eye size, and hind leg size of each beetle were calculated using morphometric software Leica Application Suite (version 3.0) from the measurement of 13 linear dimensions and one area such as eye length, body length, wing width, wing length and other morphometric measurement. From the study, there were intraspecific differences in the morphological traits across the three different land use types, it showed that the measurement of the leg and eyes of dung beetles can be used in the prediction of their behavioural traits.

Based on a study by Lim (2017), a total of 622 specimens consisting of 39 species under 23 genera from the tribe Lamiini in subfamily Lamiinae were recorded from UIRC and Research Development and Innovation Division (RDID) of Sarawak Forest Department. The most abundant species recorded in the study were *Epepeotes luscus* and *Acalolepta rusticatrix*. Systematic account and distribution maps of the tribe Lamiini in Sarawak were also interpreted in this study.

3.0 MATERIALS AND METHODS

3.1 Data Collection

Voucher specimens of longhorned beetle of the subfamily Lamiinae from UNIMAS Insect Reference Collection, Faculty of Resource Science and Technology (UIRC) were used in this study. The species' locality, collection date, and collector's name were recorded. The body length, antenna length, elytra length and width, pronotum length and width, head length and width of the specimens were measured using Mitutoyo digital calliper. The measured data were compared between tribe. The anterior elytral humeral, pronotum, and apex were also observed using Nikon C-Leds stereo microscope and photos were captured and shown in **Appendix 4**. The photograph of each species were also taken by putting the specimens on a polystyrene with white paper background under LED light by using phone camera (**Appendix 2**). The data matrix for the character was analysed by using PAST4 to form a neighbour joining clustering.

3.2 Species Identification

The unidentified longhorn beetles were identified by referring to the book, A Guide to Beetles of Borneo by Arthur Y. C. Chung, C. L. Chan, and Steven Bosuang and online resource from Old World Cerambycidae Catalog website (<http://bezbycids.com>), by Larry G. Bezark and referring to the specimens in the UNIMAS Insect Reference Collection, Faculty of Resource Science and Technology (UIRC). The identified specimens were label with a second label which contained their identification information and name of the person that identified the specimen and the year of identification made.

4.0 RESULTS

4.1 Species of Longhorn Beetles

A total of 253 specimens from 40 genera and 71 species representing 13 tribes of the subfamily Lamiinae were examined in this study (Table 1). These specimens were collected since 1967 till 2022 from different location in Sabah and Sarawak. The tribe Lamiini with 27 species represented the most diverse tribe recorded in this study. Saperdini was found to be the second most diverse tribe with 15 species, followed by Mesosini and Batocerini with eight and five species recorded, respectively. The tribes Gnomini and Dorcaschematini are represented by four species and three species, respectively, followed by tribes Ancyronotini, Apomecynini, and Xylorhizini with two species recorded each. The least diverse tribe with only one species recorded were tribes Ceroplesini, Homonoecini, Morimopsini and Pteropliini.

In terms of number of individuals, the tribe Lamiini was found to be the most abundant tribe with 104 individuals (41.12% of total) (Figure 1). The second most abundant tribe was Batocerini with 42 individuals (16.61% of total), followed by Ancyronotini with 24 individuals (9.49% of total). The tribes Dorcaschematini, Mesosini, and Saperdini are represented by 21 individuals (8.31% of total) each, followed by tribe Xylorhizini is represented by seven individuals (2.77% of total). The tribe Gnomini is represented by five individuals (1.98% of total), followed by Apomecynini, Ceroplesini and Homonoecini with two individuals (0.79% of total) each. Only a single specimen of the tribes Morimopsini and Pteropliini were recorded in the collections examined. Heffern (2005) stated that there are 22 tribes of longhorned beetles under subfamily Lamiinae from Borneo. The specimens in UIRC consist of 59.09% of the tribe recorded, 13 tribes in Heffern (2005) as shown in Table 2.

The most diverse genus was *Glenea* with 13 species whereas for the least diverse genera, there were 29 genera with only one species recorded; *Palimna*, *Apomecyna*, *Niphoropica*, *Apriona*, *Moechotypa*, *Imantocera*, *Homonoea*, *Amechana*, *Celosterna*, *Euthyastus*, *Hotarionomus*, *Mimohammus*, *Myagrus*, *Nephelotus*, *Omocyrius*, *Paradesisa*, *Parepicedia*, *Rhodopina*, *Sarothrocera*, *Thestus*, *Triammatus*, *Trachystola*, *Coptops*, *Dolichostyrax*, *Daxata*, *Oberea*, *Scytasis*, *Thylactus* and *Xylorhiza*.

The most abundant species recorded was *Epepeotes luscus* with 26 individuals (10.28% of total), followed by *Batocera rubus* and *Palimna annulata* with 24 individuals each (9.49% of total). the least abundant species recorded with only a single species were *Apomecyna tigrine tigrine*, *Niphoropica albipennis*, *Batocera breuningi*, *Olenecamptus sarawakensis*, *Gnoma gilmouri*, *G. luzonica*, *Imantocera plumosa*, *Amechana nobilis*, *Anhammus dalenii borneensis*, *A. aurivillii*, *Celosterna pollinosa*, *Cereopsius arbiter*, *Mimohammus flavescens*, *Myagrus vinosus*, *Nephelotus conspersus*, *Omocyrius jansonii*, *Paradesisa borneensis*, *Peribasis larvata*, *Sarothrocera lowii*, *Thestus armatus*, *Triammatus saundersi*, *Agelasta nigrolineata*, *Choeromorpha pigra*, *C. polynesa*, *C. vivesi*, *Dolichostyrax aurivillius*, *Daxata ustulata*, *Glenea argyrostetha*, *G. baia*, *G. bellona albomaculata*, *G. camelina*, *G. collaris*, *G. dimidiata*, *G. fatalis*, *G. rufa*, *G. laudata*, *G. regina*, *Oberea curialis*, *Scytasis nitida* were recorded in the collections examined.

Table 1. Species list of the subfamily Lamiinae deposited in UIRC.

| Species | No. of Individuals | Relative Abundance (%) | Locality |
|----------------------------------|--------------------|------------------------|----------------|
| Tribe Ancylonotini | | | |
| <i>Palimna annulata</i> | 24 | 9.49 | Sabah, Sarawak |
| Tribe Apomecynini | | | |
| <i>Apomecyna tigrine tigrina</i> | 1 | 0.395 | Sabah |
| <i>Niphoropica albipennis</i> | 1 | 0.395 | Sarawak |
| Tribe Batocerini | | | |
| <i>Apriona flavescens</i> | 7 | 2.77 | Sabah, Sarawak |

| | | | |
|------------------------------------|----|-------|----------------|
| <i>Batocera breuningi</i> | 1 | 0.395 | Sarawak |
| <i>Batocera rubus</i> | 24 | 9.49 | Sabah, Sarawak |
| <i>Batocera thomsonii</i> | 4 | 1.58 | Sarawak |
| <i>Batocera victoriana</i> | 6 | 2.37 | Sarawak |
| Tribe Ceroplesini | | | |
| <i>Moechotypa thoracica</i> | 2 | 0.79 | Sarawak |
| Tribe Dorcaschematini | | | |
| <i>Olenecamptus affinis</i> | 13 | 5.14 | Sarawak |
| <i>Olenecamptus bilobus</i> | 7 | 2.77 | Sabah, Sarawak |
| <i>Olenecamptus sarawakensis</i> | 1 | 0.395 | Sarawak |
| Tribe Gnomini | | | |
| <i>Gnoma gilmouri</i> | 1 | 0.395 | Sarawak |
| <i>Gnoma longicollis</i> | 2 | 0.79 | Sabah, Sarawak |
| <i>Gnoma luzonica</i> | 1 | 0.395 | Sarawak |
| <i>Imantocera plumosa</i> | 1 | 0.395 | Sarawak |
| Tribe Homonoeini | | | |
| <i>Homonoea praecisa</i> | 2 | 0.79 | Sarawak |
| Tribe Lamiini | | | |
| <i>Acalolepta borneesis</i> | 11 | 4.35 | Sarawak |
| <i>Acalolepta opposita</i> | 3 | 1.19 | Sarawak |
| <i>Acalolepta rusticatrix</i> | 12 | 4.74 | Sarawak |
| <i>Amechana nobilis</i> | 1 | 0.395 | Sarawak |
| <i>Anhammus dalenii borneensis</i> | 1 | 0.395 | Sarawak |
| <i>Anhammus aurivillii</i> | 1 | 0.395 | Sarawak |
| <i>Celosterna pollinosa</i> | 1 | 0.395 | Sarawak |
| <i>Cereopsius arbiter</i> | 1 | 0.395 | Sarawak |
| <i>Cereopsius dictator</i> | 3 | 1.19 | Sarawak |
| <i>Cereopsius helena</i> | 2 | 0.79 | Sarawak |
| <i>Epepeotes lateralis</i> | 3 | 1.19 | Sabah, Sarawak |
| <i>Epepeotes luscus</i> | 26 | 10.28 | Sarawak |
| <i>Euthyastus binotatus</i> | 3 | 1.19 | Sarawak |
| <i>Hotarionomus blattoides</i> | 3 | 1.19 | Sabah, Sarawak |
| <i>Mimohammus flavescens</i> | 1 | 0.395 | Sarawak |
| <i>Myagrus vinosus</i> | 1 | 0.395 | Sarawak |
| <i>Nephelotus conspersus</i> | 1 | 0.395 | Sarawak |
| <i>Omocyrius jansoni</i> | 1 | 0.395 | Sabah |
| <i>Paradesisa borneensis</i> | 1 | 0.395 | Sarawak |
| <i>Parepicedia fimbriata</i> | 2 | 0.79 | Sabah, Sarawak |
| <i>Peribasis albisparsa</i> | 14 | 5.53 | Sarawak |
| <i>Peribasis larvata</i> | 1 | 0.395 | Sabah |
| <i>Rhodopina seriata</i> | 2 | 0.79 | Sarawak |
| <i>Sarothrocera lowii</i> | 1 | 0.395 | Sarawak |
| <i>Thestus armatus</i> | 1 | 0.395 | Sabah |
| <i>Triammatus saundersi</i> | 1 | 0.395 | Sarawak |
| <i>Trachystola granulata</i> | 6 | 2.37 | Sarawak |
| Tribe Mesosini | | | |
| <i>Agelasta lecideosa</i> | 2 | 0.79 | Sarawak |
| <i>Agelasta nigrolineata</i> | 1 | 0.395 | Sarawak |
| <i>Choeromorpha amica</i> | 2 | 0.79 | Sarawak |
| <i>Choeromorpha muscaria</i> | 3 | 1.19 | Sarawak |
| <i>Choeromorpha pigra</i> | 1 | 0.395 | Sarawak |
| <i>Choeromorpha polynesa</i> | 1 | 0.395 | Sarawak |
| <i>Choeromorpha vivesi</i> | 1 | 0.395 | Sarawak |
| <i>Coptops undulatus</i> | 10 | 3.95 | Sabah, Sarawak |