



Faculty of Resource Science and Technology

**Systematics and Phylogeny of Family Reduviidae Latreille, 1807 (Insecta:
Hemiptera: Heteroptera) in Sarawak**

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Systematics and Phylogeny of Family Reduviidae Latreille, 1807 (Insecta:
Hemiptera: Heteroptera) in Sarawak

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DECLARATION

I hereby declare that, except as acknowledged in the text, the work presented in the thesis is entirely my own. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

(Siti Hanisah Binti Zahuri)

Date:

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ABSTRACT

The family Reduviidae Latreille, 1807 (Insecta: Hemiptera: Heteroptera) is composed approximately 25 subfamilies, 913 genera and with almost 7,000 species worldwide, their diversity was mostly found in the tropics. However, it is yet the most poorly studied species of Reduviidae. In Sarawak, there is no effort done on the systematics and phylogeny study on heteropterans although there were some revisions of genus and species that have been documented. The findings of this study will be useful as the fundamental to ecological and pest management of heteropterans and significantly contribute to the worldwide studies of Reduviidae. This study constructs a phylogenetic tree of described species of Reduviidae in Sarawak based on the morphological structures with reference to voucher specimens from UNIMAS Insect Reference Collection (UIRC), Forest Research Centre (FRC), Semongok Agriculture Research Centre (ARC), and Sarawak Biodiversity Centre (SBC), as well as new field collections. A phylogenetic analysis using maximum parsimony criteria which included 101 ingroup and 3 outgroup (Pentatomorpha) of taxa based on 61 morphological structures was run using Tree Analysis using New Technology (TNT) software is constructed. The monophyly of Reduviidae is well supported with Pentatomorpha as their outgroup. The results also present the monophyly of Tribelocephalinae, Salyavatinae, and Ectrichodiinae in a clade that also include Physoderinae, Saicinae and Reduviinae (*Acanthaspis quadriannulata*). The monophyly of Harpactorinae with basal position of Harpactorini in a clade is presented. In addition, a systematic account based on 23 genera and 52 species of subfamily Harpactorinae is presented. A key to the genera Harpactorinae is provided based on the comparative morphological structures with addition geological distribution map of each Harpactorinae

species in Sarawak.

Keywords: Systematics, morphological structures, Reduviidae, Harpactorinae, Sarawak

Sistematik dan Filogeni Famili Reduviidae Latreille, 1807 (Insecta: Hemiptera: Heteroptera) di Sarawak
ABSTRAK

*Famili Reduviidae Latreille, 1807 (Insecta: Hemiptera: Heteroptera) terdiri daripada 25 subfamili, 913 genus dan dengan mempunyai hampir 7,000 spesies di seluruh dunia, kepelbagaian mereka kebanyakannya dijumpai di kawasan tropika. Namun begitu spesies Reduviidae yang paling kurang dikaji. Di Sarawak, tiada usaha terhadap kajian sistematik dan filogenesis pada heteropteran, walaubagaimanapun terdapat beberapa semakan genus dan spesies yang telah didokumenkan. Hasil kajian ini akan berguna sebagai kajian asas mengenai pengurusan ekologi dan perosak heteropteran, dan menyumbang kepada kajian Reduviidae dengan lebih meluas. Kajian ini membina pokok filogenetik terhadap spesies Reduviidae yang telah diperihalkan berdasarkan struktur morfologi dengan merujuk kepada spesimen baucer dari Koleksi Rujukan Serangga UNIMAS (UIRC), Pusat Penyelidikan Pertanian Semongok (ARC), Jabatan Hutan Sarawak (SFD), dan Pusat Kepelbagaian Biologi Sarawak (SBC), serta spesimen daripada koleksi lapangan. Satu analisis filogenetik menggunakan kriteria maksimum parsimoni yang mengandungi 101 ingroup dan 3 outgroup (Pentatomorpha) taxa berdasarkan 61 struktur morfologi telah dijalankan melalui perisian Tree Analysis using New Technology (TNT). Monofili Reduviidae telah disokong baik dengan Pentatomorpha sebagai outgroup mereka. Hasil kajian juga membentangkan monofili Tribelocephalinae, Salyavatinae, dan Ectrichodiinae di dalam satu klad yang sama dengan Physoderinae, Saicinae dan Reduviinae (*Acanthaspis quadriannulata*). Monofili Harpactorinae dengan Harpactorini berada di kedudukan basal di dalam satu klad dibentangkan. Tambahan pula, sistematik akaun berdasarkan 23 genus dan 52 spesies dari subfamili Harpactorinae dibentangkan. Kunci*

kepada genus Harpactorinae disediakan berdasarkan perbandingan struktur morfologi dengan tambahan peta taburan geologi untuk setiap spesies di Sarawak.

Kata kunci: *Sistematik, struktur morfologi, Reduviidae, Harpactorinae, Sarawak*

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LIST OF ABBREVIATIONS

ARC	Agriculture Research Centre
ENSP	Ectrichodiinae species
FRC	Forest Research Centre
HNSP	Harpactorinae species
LED	Light-emitting diode
QGIS	Quantum Geographic Information System
SBC	Sarawak Biodiversity Centre
SEM	Scanning Electron Microscope
SLSP	Salyavatinae species
STSP	Stenopodainae species
TNT	Tree Analysis using New Technology
UIRC	UNIMAS Insect Reference Collections

CHAPTER 1

GENERAL INTRODUCTION

1.1 Introduction

Reduviidae, or commonly known as the assassin bugs, is a family of terrestrial predators within suborder Heteroptera (Insecta: Hemiptera) with almost to 7,000 species worldwide. Reduviidae is well known as the second largest, after Miridae, and one of the most diverse families of true bugs with their diversity was mostly found in the tropics (Patterson, 2007; Swanson, 2011; Weirauch, 2008).

The members of assassin bugs are predaceous on other insects and zoophagous although some of the species are found feeding on the blood of mammals and birds (Biswas & Mitra, 2011; Froeschner, 1985; Grimaldi & Engel, 2005; Patterson, 2007; Triplehorn & Johnson, 2005). Some members of Reduviidae are valuable as a control agent for specified pests or also known as a biological control agent due to their habit on preying other insects.

Wygodzinsky and Usinger (1960) has described Reduviidae according to the following characters: 1) body elongate-oval or slender; 2) legs variously incrassate and sometimes spines; 3) rostrum three-segmented, stout and curved, the tip reaching prosternal stridulatory sulcus; 4) antennae four-segmented except in the Ectrichodiinae, where eight segments are visible; 5) head divided behind eyes by transverse sulcus; 6) abdominal spiracles 2 to 7 ventral; 7) hemelytra without cuneus; 8) adults with metathoracic scent gland openings concealed in acetabula of hind coxae; and 9) eggs with distinct cap or lid.

Systematics is the study of organismal diversity and understanding biological phenomena in an evolutionary context, whether based on molecular data or morphology, which it

depends on the study (Gullan & Cranston, 2010; Hwang, 2012; Simola, 2005). Based on three different studies, Reduviidae has shown to be a monophyletic group (e.g. based on morphological characters performed by Weirauch (2008), based on molecular data (Hwang and Weirauch, 2012), and a combination of both morphological characters and molecular data by Schuh et al. (2009). However, there are significant difficulties in establishing generic limits of genera in the family Reduviidae as it is the second largest family of the suborder Heteroptera, and some information and description of genera are inadequately defined.

In this study, a total of 101 species, 50 genera and 12 subfamilies of Reduviidae from four institutions: 1) UNIMAS Insect Reference Collection (UIRC); 2) Forest Research Centre (FRC); 3) Semongok Agriculture Research Centre (ARC); 4) Sarawak Biodiversity Centre (SBC), and four new field collections: 1) PPB Oil Palm Plantations, Miri; 2) Borneo Highland, Padawan; 3) Santubong National Park, Kuching; and 4) Sri Aman were examined and documented. However, there are 44 species that could not be identified due to lack of literature on the identification of true bugs from this region. A total of 101 species of Reduviidae were used in the phylogenetic study using Tree Analysis using New Technology (TNT) based on 61 morphological characters, which include colouration, structures, and vestiture.

On the other hand, the systematics revision of Reduviidae mainly focused on the subfamily Harpactorinae, the largest subfamily within Reduviidae, and the most collected specimens from the institutions and field collection with a total of 23 genera and 52 species, including 22 undescribed species. A key to the genera of Harpactorinae is provided based on the comparative morphological structures; with additional geological distribution map

constructed using QGIS of each Harpactorinae species in Sarawak.

The third chapter of this project focuses on the phylogenetic relationships of family Reduviidae from Sarawak. Specific objective is to study the relationship among the subfamilies of reduviids from Sarawak using morphological data. The fourth chapter discusses on the systematic revision of the subfamily Harpactorinae in Sarawak.

1.2 Problem Statement

The true bugs (Heteroptera) are known to be abundant and well distributed throughout the world. The heteropteran normally act as biological control agent, predatory of insect pest and also as bio-indicator to the environmental pollution. Although several studies had been conducted on this group, the systematic of the true bugs in Malaysia are inadequately defined and the knowledge on the morphology of this local species is limited. Until now, there is no study that has been done on the systematics and phylogeny of heteropterans in Sarawak. The majority of published studies on the systematics and phylogeny of the true bugs focus on the Palaearctic, Afrotropical, Nearctic and Australian regions. This study will cover important information such as external morphology features, as well as species redescription of the family Reduviidae. This information will provide a baseline data for future reference, management and conservation of the insect fauna in this country. In addition, these findings will be useful as the fundamentals to the ecological and pest management studies of heteropteran in the future and will make a significant contribution to worldwide studies of Reduviidae.

1.3 Objectives

The objectives of this study are:-

- I. To study the phylogenetic relationship among the subfamilies of Reduviidae from Sarawak using morphological data.
- II. To review the taxonomic status of the subfamily Harpactorinae as well as documenting their distributions in Sarawak.

CHAPTER 2

LITERATURE REVIEW

2.1 Family Reduviidae

Hemiptera is composed approximately 145 families with almost 115,000 described species distributed worldwide and is the most diverse of the non-endopterygote orders (Gullan & Cranston, 2010; Sharkey, 2007), yet many species still await discovery and description. Hemiptera comprises five suborders that can be recognized: i) Heteroptera (known as true bugs with almost 40,000 described species); ii) Coleorrhyncha (known as moss bugs); iii) Cicadomorpha (with about 30,000 described species); iv) Fulgromorpha (with almost 12,000 described species); and v) Sternorrhyncha (with more than 16,000 species) (Gullan & Cranston, 2010). The Cimicomorpha is the infraorder of Heteroptera, comprising of 16 families, which consists two of the largest families of Heteroptera, the Miridae and Reduviidae.

Reduviidae, or commonly known as the assassin bugs, is a family of terrestrial predators within suborder Heteroptera (Insecta: Hemiptera) with almost 7,000 species worldwide. Reduviidae is well known as the second largest, after Miridae, and one of the most diverse families of true bugs with their diversity and mostly found in the tropics (Patterson, 2007; Swanson, 2011; Weirauch, 2008). In Maldonado's study (as cited in Ambrose, 2006), Reduviidae has 913 genera with 6,250 species and subspecies. The number of the approximate genera of Reduviidae was not mentioned by the recent authors; however they only stated the number of species and the numbers increases concomitantly with the year of the paper published. Patterson (2007) stated that Reduviidae is composed of 6,000 species, while Weirauch (2008) stated more than 6,600 species and Hwang (2012) stated

~6,800 species. In addition, Weirauch et al. (2014) stated Reduviidae has roughly 7,000 described species.

The subfamilies of the Reduviidae have been recognised and described to have between 21 to 27 subfamilies by different authors. According to Henry (2009), he stated that in 1985 until 1989, Putshkov and Putshkov recognized 21 subfamilies, however the recognition of Reduviidae subfamilies were still debated and continued to increase to 25 subfamilies in 1990 by Maldonado; 26 and 27 subfamilies in 1995 by different authors, formerly by Cassis and Gross and latter by Schuh and Slater, and in 1996 the subfamilies decreased to only 23 subfamilies by Putshkov and Putshkov. In recent studies, Weirauch (2008) recognised and gave strong support for 21 subfamilies using cladistic analysis, and Weirauch et al. (2014) stated 25 subfamilies based on the identification key, namely: Bactrodinae; Centrocnemidinae; Cetherinae; Chryxinae; Ectrichodiinae; Elasmodeminae; Emesinae; Hammacerinae; Harpactorinae; Holoptilinae; Manangocorinae; Peiratinae; Phimophorinae; Phymatinae; Physoderinae; Pseudocetherinae; Reduviinae; Saicinae; Salyavatinae; Sphaeridopinae; Stenopodainae; Triatominae; Tribelocephalinae; Vesciinae; and Visayanocorinae.

Wygodzinsky and Usinger (1960) has described Reduviidae according to these following characters: 1) body elongate-oval or slender; 2) legs variously incrassate and sometimes spines; 3) rostrum three-segmented, stout and curved, the tip reaching prosternal stridulatory sulcus; 4) antennae four-segmented except in the Ectrichodiinae, where eight segments are visible; 5) head divided behind eyes by transverse sulcus; 6) abdominal spiracles 2 to 7 ventral; 7) hemelytra without cuneus; 8) adults with metathoracic scent gland openings concealed in acetabula of hind coxae; 9) Eggs with distinct cap or lid.

The members of the Reduviidae are significantly varied with each other in terms of diets, habits, and importance. Most of the members of assassin bugs are predaceous on other insects and zoophagous, feed on the body fluid of other insects (e.g., Emesinae, Harpactorinae), but few of them feed on the blood of mammals (e.g., Reduviinae) and birds although their appetite are not adapted completely to these blood-diet (Biswas & Mitra, 2011; Frank & Slosser, 1996; Froeschner, 1985; Grimaldi & Engel, 2005; Carcavallo et al., 2000; Patterson, 2007; Triplehorn & Johnson, 2005). Several members of Reduviidae are diurnal while others are nocturnal, several are secretive preying while others, openly preying (Froeshner, 1985), and in some special cases, a few of the members seek food from trapped insects on spider webs and they even adapted to living on the webs (Schuh & Slater, 1995). The Reduviidae is also known as a large cosmopolitan group of predatory insects as they prey on more numbers and a wider range of prey due to their large body size compared to other predaceous land bugs, with the greatest diversity mostly found in the tropics (Ambrose, 2006; Swanson, 2011). Reduviidae can be found in a large range of habitats as they adapted nearly in all ecosystems, both terrestrial and aquatic, but most of the species are found in the tropics (Carcavallo et al., 2000; Swanson, 2011). Since their habits are insectivorous, preying on many species of insects, many species of the members of Reduviidae are valuable as a control agent for specified pests (Froeschner, 1985; Swanson, 2011), thus act as a biological control in crops.

2.2 Reduviidae in Sarawak, Malaysia

Sarawak is one of two states in Malaysia located on the island of Borneo with its landmass covering 12.4 million hectares, with more than 80% of the areas classified as Permanent Forest Estate, Totally Protected Areas, and Stateland Forest (Forest Department Sarawak,

2016). There were five types of natural forest in Sarawak, in which three of the forests predominate the said areas; hill mixed dipterocarp forest, peat swamp forest, and mangrove forest, while kerangas and montane forest are the minority forest that covered the said areas in Sarawak (Forest Department Sarawak, 2016). Until now, there is no effort on the systematics and phylogeny study of heteropterans either in Sarawak or Malaysia. However, there were studies regarding revisions of genus and species that have been documented (e.g., Miller, 1955). The finding of systematics and phylogeny of Reduviidae studies will be useful as the fundamentals to the ecological and pest management studies of heteropteran in the future and will make a significant contribution to worldwide studies of Reduviidae, besides to improve our knowledge on the systematics of Reduviidae.

Based on literature records, 11 out from 25 subfamilies of Reduviidae are found in Malaysia, which are: Centrocnemidinae, Ectrichodiinae, Emesinae, Harpactorinae, Holoptilinae, Peiratinae, Physoderinae, Reduviinae, Salvatinae, Stenopodainae, and Triatominae, as shown in Table 2.1 (Ambrose, 2006; Hwang, 2012; Jurberg & Galvao, 2006; Kovac & Yang, 1995; Pape, 2013; Patterson, 2007; Redei, 2008; Redei et al., 2012; Truong et al., 2010). The subfamilies are mostly found and collected in Peninsular Malaysia, such as Selangor and Pahang, a few in Sarawak, and most of the subfamilies' specific whereabouts at the time of recording remain unknown although they were recorded as "Malaysia".

Table 2.1: List of subfamilies of Reduviidae recorded in Malaysia.

Subfamily	Genus	Species	Locality	Author(s)
Centrocnemidinae	<i>Centrocnemis</i>	-	Malaysia	Truong et al. (2010)
Ectrichodiinae	<i>Ectrychotes</i>	-	Johor and Selangor	Hwang (2012)
	<i>Ectrychotes</i>	<i>E. atripennis</i>	Malacca	Ambrose (2006)
	<i>Villius</i>	<i>V. limbifer</i>	Malaysia	Ambrose (2006)
Emesinae	<i>Emesopsis</i>	<i>E. gaius</i>	Selangor	Kovac & Yang (1995)
		<i>E. obsoletus</i>	Selangor	Kovac & Yang (1995)
		<i>E. plagiatus</i>	Selangor	Kovac & Yang (1995)
		<i>E. streiti</i>	Selangor	Kovac & Yang (1995)
	<i>Ploiaria</i>	<i>P. vandoesburgi</i>	Pahang	Redei (2008)
	<i>Bagauda</i>	<i>B. cavernicola</i>	Malaysia	Pape (2013)
	<i>Gardena</i>	<i>G. kivuensis</i>	Malaysia	Ambrose (2006)
Harpactorinae	<i>Euagoras</i>	-	Selangor	Hwang (2012)
	<i>Velinus</i>	-	Pahang	Hwang (2012)
	<i>Vesbius</i>	<i>V. purpureus</i>	Pahang	Hwang (2012)
	<i>Endochus</i>	<i>E. inornatus</i>	Malaysia	Ambrose (2006)
		<i>E. umbrinus</i>	Malaysia	Ambrose (2006)
		<i>E. conspersus</i>	Malaysia	Ambrose (2006)
	<i>Epidaus</i>	<i>E. famulus</i>	Malaysia	Ambrose (2006)
	<i>Euagoras</i>	<i>E. plagiatus</i>	Malaysia	Ambrose (2006)
		<i>I. heros heros</i>	Malacca	Ambrose (2006)
		<i>I. reticulatus</i>	Malacca	Ambrose (2006)
		<i>reticulatus</i>		
	<i>Macracanthopsis</i>	<i>M. nodipes</i>	Malaysia	Ambrose (2006)
	<i>Panthous</i>	<i>P. icarus</i>	Malacca	Ambrose (2006)
	<i>Sycanus</i>	<i>S. collaris</i>	Malacca, Sarawak	Ambrose (2006)
		<i>S. croceovittatus</i>	Malaysia	Ambrose (2006)
		<i>S. vividus</i>	Malaysia	Ambrose (2006)
	<i>Vesbius</i>	<i>V. purpureus</i>	Malaysia	Ambrose (2006)
		<i>V. sanguinosus</i>	Malaysia	Ambrose (2006)

Table 2.1 continued.

Subfamily	Genus	Species	Locality	Author(s)
Holoptilinae	<i>Locoptiris</i>	<i>L. pendleburyi</i>	Described from Kuala Lumpur, identified from Borneo	Redei & Tsai (2011)
Peiratinae	<i>Ectomocoris</i>	<i>E. atrox</i>	Malaysia	Ambrose (2006)
		<i>E. elegans</i>	Malaysia	Ambrose (2006)
	<i>Lestomerus</i>	<i>L. affinis</i>	Malaysia	Ambrose (2006)
Physoderinae	<i>Breviphysoderes</i>	<i>B. fulvopicta</i>	Sarawak	Hwang (2012)
		<i>B. hobbyi</i>	Sarawak	Hwang (2012)
		<i>B. planicollis</i>	Sarawak	Hwang (2012)
		<i>B. shelfordi</i>	Sarawak	Hwang (2012)
		<i>B. tenebrosa</i>	Sarawak	Hwang (2012)
		<i>B. vestita</i>	Peninsular Malaysia	Hwang (2012)
	<i>Tapeinus</i>	-	Pahang	Hwang (2012)
Reduviinae	<i>Acanthaspis</i>	<i>A. fulvipes</i>	Malacca	Ambrose (2006)
	<i>Velitra</i>	<i>V. rubropicta</i>	Malacca	Ambrose (2006)
	<i>Syberena</i>	<i>S. izzardii</i>	Selangor	Patterson (2007)
Salyavatinae	<i>Valentia</i>	<i>V. apetala</i>	Malaysia	Ambrose (2006)
	<i>Sastrapada</i>	-	Selangor, Pahang border, Malaysia	Hwang (2012)
Stenopodainae	<i>Canthesancus</i>	<i>C. gulo</i>	Malacca	Ambrose (2006)
	<i>Oncocephalus</i>	<i>O. annulipes</i>	Malaysia	Ambrose (2006)
	<i>Phygolampis</i>	<i>P. foeda</i>	Sarawak	Ambrose (2006)
	<i>Staccia</i>	<i>S. diluta</i>	Malaysia	Ambrose (2006)
	<i>Triatoma</i>	<i>T. cavernicola</i>	Northern Malaysia	Patterson (2007)
Triatominae		<i>T. migrans</i>	Malaysia	Patterson (2007)
		<i>T. cavernicola</i>	Malaysia	Jurberg & Galvao (2006)
		<i>T. migrans</i>	Malaysia	Jurberg & Galvao (2006)
		<i>T. rubrofasciata</i>	Malaysia	Jurberg & Galvao (2006)

2.3 Phylogenetic Study of Reduviidae

Systematics is the study of organismal diversity and understanding biological phenomena in an evolutionary context, whether based on molecular data or morphology, (Gullan & Cranston, 2010; Hwang, 2012; Simola, 2005). Taxonomy and phylogenetic are parts of the systematic, in which the former is the practice of discovering, classifying, describing, and testing the concepts of new and known species in a system that reflects evolution, while the latter is to reconstruct the evolutionary relationships of all organisms (Hwang, 2012). Systematics mostly uses recognisable discontinuities in the distribution of features (character states), in which the data sources can be used from behaviour, ecology, distribution, and morphology and the differences in external features, often united with internal genital features, were used for discriminating the insect species (Gullan & Cranston, 2010). However, there were significant difficulties in establishing generic limits of genera in the family Reduviidae as Reduviidae is the second largest family of the Heteroptera and some information and description of genera are inadequately defined.

On the other hand, according to Coscaron et al. (1994), the most significant problems of biological systematics are two or more classifications of the same group of taxa based on different sets of characters are not always synchronised. There are various analysis used to study systematics, such as phylogenetic analysis, which shows the evolutionary relationships of all organisms, resulting in phylogenetic trees (Hwang, 2012); cladistic analysis, which shows a group of organisms that share derived characters, resulting in statements of relationship without indicating ancestors by cladogram (Lipscomb, 1998); and phenetic analysis, which organisms are classified based on overall similarity, resulting in phenograms. The results produced from the analysis varied based on the study conducted, whether to study the relationships such as historically and characteristics or

distribution among species collected.

The phylogenetic analysis based on external and internal characters, including head, body colour, thorax, abdomen, and male and female genitalia, which the characters are presented in a data matrix are mostly focused on species and genus level (e.g., Coscaron & Melo, 2003; Coscaron & Morrone, 1997; Coscaron et al., 1994) rather than subfamily and family level. The results of the phylogenetic analysis are used for various purposes, including studying the biogeography of a genus, studying the effects of different data sets on the classification of a genus, and documenting the external and internal characters of a species.

The phylogenetic study on Reduviidae were recently studied where the results had shown that Reduviidae is a monophyletic group of Hemiptera based on two different studies that had been conducted; morphological characters and molecular data. The studies were based on morphological characters which had been performed by Weirauch (2008) using 162 morphological characters based on cladistic analysis and molecular data based on five molecular markers by Hwang and Weirauch (2012).

2.4 Comparative Morphology of Reduviidae

The comparative morphology study of Heteroptera is initially been studied on external characters, including colouration before internal structures were introduced and used for species identification and species description. This study is useful to describe species especially new species that has been discovered, and with the help of from new technology, more advanced studies have been documented at a molecular level, molecular systematics, to study the relationship and evolution between species, genus, subfamily, and

family of Heteroptera.

In Reduviidae, the comparative morphology study is studied at species level based on observations of external characters, including head, antennae, labium, pronotum, scutellum, hemelytra, legs and abdomen, and internal structures such as pygophore, parameres, phallosome, aedeagus, genital chamber, and posterior wall has been studied and documented to identify the species, describe the species, and establish generic limit (e.g., Coscaron & Melo, 2003; Coscaron & Morrone, 1997; Coscaron et al., 1994; Doesburg & Forero, 2012; Forero, 2006; Forero et al., 2010; Gil-Santana & Galvao, 2013; Ishikawa & Okajima, 2006; Ishikawa, 2008; Ishikawa et al., 2006; Ishikawa et al., 2008; Forero & Weirauch, 2012). The genitalic morphology study in Reduviidae is used for species identification and delimitation, and is useful for cladistic analysis at the family level (Forero & Weirauch, 2012).

According to Forero and Weirauch (2012) study, Sing-Pruthi did the first study on male genitalia in 1925, before Scudder introduced a study on female genitalia in 1957. During that era, comparative study on female genitalic structures was less focused in the studies compared to the male genitalic structure as one of the female's organs, bursa copulativa, is overlooked as informative. This made the female genitalic structure being neglected as a source of taxonomic characters although other organs (e.g., gonocoxae and gonapophyses) were documented. After 23 years, Szerlip recognised one of the female's organs, sclerites, as a taxonomic character in his revisions study of *Apiomerus* in 1980.

In a recent study, Forero and Weirauch (2012) discussed the genitalic morphology of both male and female of 12 *Apiomerini* species, which the genitalic structures were well-illustrated. The comparative study on genitalia accepted and included female genitalic

structure as well as male genitalic structure in most studies as informative characters to identify the species of Reduviidae. Although the females' genitalic characters are common in the studies, however, the specimens of females are harder to find compared to male specimens. Thus, the information on female genitalic characters is only included in the studies when the specimens are found.

On the other hand, an illustrated identification key to the subfamilies and tribes of Reduviidae has been studied by Weirauch et al. (2014). In this study, the key provided along with images for each external morphological structure followed by taxon treatments that provided a discussion of diagnostic characters that are present in each subfamily or tribe. In addition to that, also provided in the study were some remarks on taxonomy, distribution, and comments on taxa occurring in Canada, as well as discussions on a few notes from natural history of each subfamily and tribe of Reduviidae including a short up to date bibliography.

CHAPTER 3

PHYLOGENETIC RELATIONSHIPS OF FAMILY REDUVIIDAE LATREILLE, 1807 (INSECTA: HEMIPTERA: HETEROPTERA) IN SARAWAK

3.1 Introduction

Reduviidae Latreille, 1807 is well known as the second largest and one of the most diverse families of true bugs and is composed of approximately 25 subfamilies with almost to 7,000 species worldwide (Patterson, 2007; Swanson, 2011; Weirauch, 2008; Weirauch et al., 2014). The recognition of subfamilies in Reduviidae are in debated for 25 years and throughout the years, 21 to 27 subfamilies have been described by different authors. The first recognition of the subfamilies started in 1989 with 21 subfamilies until the recent study by Weirauch et al. (2014) stated 25 subfamilies based on the identification key, although Weirauch (2008) recognised and gave strong support for 21 subfamilies using cladistic analysis.

Based on literature records, 11 subfamilies of Reduviidae are found in Malaysia. However, the records of these subfamilies did not specify distribution data on the places they were found as records mostly stated “Malaysia”, although some authors did specify several states such as Selangor, Pahang, Sarawak, and mostly stated as “Malaysia”. There were studies that have been documented in Malaysia regarding the revision of genus and species, yet there is still no effort on the systematics and phylogeny of Reduviidae. The findings of this study will be useful as the fundamental to the ecological and pest management studies of true bugs in future, as well as to improve knowledge on the systematics of Reduviidae.

Sarawak is one of two states in Malaysia located on the island of Borneo with five types of natural forest in Sarawak, which three of the forests predominate many areas; hill mixed dipterocarp forest, peat swamp forest, and mangrove forest, while kerangas and montane forest are the minority forest that covered several areas in Sarawak (Forest Department Sarawak, 2016). Four institutions including new field collections, yielded 101 species comprising 12 subfamilies of Reduviidae that were collected in Sarawak; Centrocnemidinae, Ectrichodiinae, Harpactorinae, Holoptilinae, Peiratinae, Physoderinae, Reduviinae, Saicinae, Salyavatinae, Stenopodainae, Triatominae, and Tribelocephalinae have biogeographic distribution which was collected at all five types of forest as stated above, and most of the species are distributed at Southwest Sarawak.

Reduviidae species has specialisation techniques on preying other arthropods and insects, which allow them inhabit and survive in the tropics. Each subfamily of Reduviidae species possess different characters which make them specialised in hunting different preys. Some of the subfamilies of Reduviidae feed on blood (e.g., Reduviinae and Triatominae), prey on small insects and spiders (e.g., Emesinae), prey on termites (e.g., Salyavatinae), specialised in millipede-hunting (e.g., Ectrichodiinae), and hunting by using sticky substances (e.g., Harpactorinae), as well as causing Chagas disease (e.g., Triatominae) (Biswas & Mitra, 2011; Forthman & Weirauch, 2012; Froeschner, 1985; Grimaldi & Engel, 2005; Patterson, 2007; Triplehorn & Johnson, 2005; Weirauch et al., 2014; Wygodzinsky & Usinger, 1960; Yildirim et al., 2010; Zhang & Weirauch, 2013).

Reduviidae has unique characters that differentiate them from other families of heteropterans as described by Wygodzinsky and Usinger (1960): 1) body elongate-oval or slender; 2) legs either incrassate or spines; 3) rostrum three-segmented, stout and curved, the apex reached prosternal stridulatory sulcus; 4) antennae four-segmented, but eight

segments are presence in Ectrichodiinae; 5) head divided behind eyes by transverse sulcus; 6) abdominal spiracles 2 to 7 ventral; 7) hemelytra without cuneus; 8) adults with metathoracic scent gland openings concealed in acetabula of hind coxae; and 9) Eggs with distinct cap or lid.

In the collections, due to their biogeographic distribution, the members of assassin bugs consist of small (7.61 mm-*Physoderes curculionis* (Physoderinae) to large (31.49 mm-*Eulyes* sp. 1 (e.g. Harpactorinae)) in size); cryptic in coloration (brown and black; e.g. Centrocnemidinae, Stenopodainae) to bright body colours (e.g. Harpactorinae, Reduviinae); unique morphological structures (e.g. labium with four segments visible (e.g. Centrocnemidinae), forefemur with teeth (e.g. Stenopodainae), foretarsus claw with basal tooth (e.g. Harpactorinae); and long setae on antennae and legs (e.g. Holoptilinae). On the other hand, some species are collected and are present in certain institutions, such as Tribelocephalinae which has two genera with four species present, while Holoptilinae, Physoderinae, Saicinae, and Triatominae has one species present each.

Until now, there is no study that has been done on the systematics and phylogeny of heteropterans in Sarawak, although, there are few studies regarding revisions of genus and species that have been documented in Malaysia (e.g. Miller, 1955). The majority of published studies on the systematics and phylogeny of the true bugs focus on the Palaearctic, Afrotropical, Nearctic and Australian regions. Hence, the aim of this study is to conduct the first phylogenetic analysis for the family Reduviidae from Sarawak. Specific objective is to study the relationship among the subfamilies of reduviids from Sarawak using morphological character's data. Modern phylogenetic analysis of subfamily relationships of Reduviidae are firstly performed by Weirauch (2008) (Zhang, 2012) based on morphological characters, followed by Hwang (2012) based on molecular data. The

present phylogenetic analysis is constructed to improve our knowledge and understanding on the phylogenetic relationships within the subfamily of the Reduviidae through the use of morphological characters.

3.2 Materials and Methods

3.2.1 Materials

This study was based on an examination of voucher specimens from four institutions, as well as new field collections. Collecting data such as collecting date, locality, coordinate, sex, and collector's name were recorded. The voucher specimens available for this study were deposited from the following institutions: 1) UNIMAS Insect Reference Collection (UIRC); 2) Forest Research Centre (FRC); 3) Semongok Agriculture Research Centre (ARC); and 4) Sarawak Biodiversity Centre (SBC). On the other hand, field collections were conducted at four sampling sites, namely: 1) PPB Oil Palm Plantations, Miri, Sarawak for 10 days, from 4th to 14th February 2015; 2) Borneo Highland, Padawan, Sarawak for seven days, from 20th to 27th August 2015; 3) Santubong National Park, Kuching, Sarawak for seven days, from 6th to 13th November 2015; and 4) Sri Aman, Sarawak for four days, from 18th to 22nd December 2015.

There were three methods used during the collection of Reduviidae species, which were aerial net, modified Pennsylvanian light trap, and white screen. The aerial net method was the most effective method for the specimens' collection as most of the species were diurnal and few species were found nocturnal, such as *Oncocephalus* species from Stenapodainae and *Tribelocephala* species from Tribelocephalinae (Table 3.1).

Table 3.1: List of Reduviidae species in Sarawak.

No.	Subfamily	Species
1	Centrocnemidinae Miller, 1956	<i>Neocentrocnemis</i> sp. 1
2		<i>Neocentrocnemis</i> sp. 2
3		<i>Neocentrocnemis</i> sp. 3
4	Ectrichodiinae Amyot and Serville, 1843	<i>Ectrychotes colouratus</i> (Mayr, 1865)
5		<i>Neoscadra</i> sp.
6		<i>Santos lugubris</i> (Poey, 1860)
7		<i>Santos</i> sp. 1
8		<i>Santos</i> sp. 2
9		<i>Scadra aliena</i> (Walker, 1873)
10		<i>S. costalis</i> (Lethierry, 1888)
11		<i>Schottus luteicollis</i> (Walker, 1873)
12		Ectrichodiinae sp.
13	Harpactorinae Amyot and Serville, 1843	<i>Agriolestes festivus</i> (Miller, 1941)
14		<i>Agyrius podagricus</i> (Stål, 1863)
15		<i>Astinus m-album</i> (Amyot & Serville, 1843)
16		<i>A. nebulo</i> (Miller, 1941)
17		<i>A. pustulatus</i> (Stål, 1863)
18		<i>Astinus</i> sp. 1
19		<i>Astinus</i> sp. 2
20		<i>Biasticus moultoni</i> (Bergroth, 1913)
21		<i>Biasticus</i> sp. 1
22		<i>Campsolomus</i> sp.
23		<i>Colpochilocoris horrendus</i> (Walker, 1873)
24		<i>Coranus fuscipennis</i> (Reuter, 1881)
25		<i>Cosmolestes picticeps</i> (Stål, 1859)
26		<i>Epidaus conspersus</i> (Stål, 1863)
27		<i>E. latispinus</i> (Stål, 1863)
28		<i>E. validispinus</i> (Stål, 1863)
29		<i>Epidaus</i> sp. 1
30		<i>Epidaus</i> sp. 2
31		<i>Epidaus</i> sp. 3
32		<i>Euagoras sordidatus</i> (Stål, 1866)
33		<i>Eulyes amoena</i> (Guérin-Méneville, 1838)
34		<i>Eulyes</i> sp. 1
35		<i>Hagia punctoria</i> (Stål, 1863)
36	Harpactorinae Amyot and Serville, 1843	<i>Isyndus heros</i> (Fabricius, 1803)
37		<i>I. heros heros</i> (Fabricius, 1969)
38		<i>Panthous daedalus</i> (Stål, 1863)
39		<i>P. ectinoderoides</i> (Bergroth, 1913)

Table 3.1 continued.

No.	Subfamily	Species
40		<i>Panthous</i> sp. 1
41		<i>Panthous</i> sp. 2
42		<i>Panthous</i> sp. 3
43		<i>Poeciloclopius patagiatus</i> (Stål, 1863)
44		<i>Polididus armatissimus</i> (Stål, 1859)
45		<i>Rhynocoris marginellus</i> (Fabricius, 1803)
46		<i>Scipinia rapax</i> (Miller, 1941)
47		<i>Sphedanolestes fallax</i> (Miller, 1941)
48		<i>Sycanus dilutus</i> (Miller, 1941)
49		<i>S. macracanthus</i> (Stål, 1866)
50		<i>S. maculatus</i> (Miller, 1941)
51		<i>S. tuberculatus</i> (Reuter, 1881)
52		<i>Sycanus</i> sp. 1
53		<i>Sycanus</i> sp. 2
54		<i>Sycanus</i> sp. 3
55		<i>Sycanus</i> sp. 4
56		<i>Velinus nigrigena</i> (Amyot & Serville, 1843)
57		<i>Vesbius purpureus</i> (Thunberg, 1783)
58		<i>Yolinus fuliginosus</i> (Stål, 1867)
59		Harpactorinae sp. 1
60		Harpactorinae sp. 2
61		Harpactorinae sp. 3
62		Harpactorinae sp. 4
63		Harpactorinae sp. 5
64		Harpactorinae sp. 6
65	Holoptilinae Amyot & Serville, 1843	<i>Holoptilus leprosus</i> (Miller, 1940)
66	Peiratinae Amyot and Serville, 1843	<i>Ectomocoris atrox</i> (Stål, 1855)
67		<i>E. elegans</i> (Fabricius, 1803)
68		<i>Sirthena flavipes</i> (Stål, 1855)
69	Physoderinae Miller, 1954	<i>Physoderes curculionis</i> (China, 1935)
70	Reduviinae Latreille, 1807	<i>Acanthaspis quadriannulata</i> (Stål, 1870)
71		<i>Sminthocoris singularis</i> (Distant, 1902)
72		<i>Tiarodes</i> sp.
73		<i>Velitra rubropicta</i> (Amyot & Serville, 1843)
74	Saicinae Stål, 1859	<i>Polytoxus vagans</i> (Miller, 1940)
75	Salyavatinae Amyot & Seville, 1843	<i>Lisarda inornata</i> (Walker, 1873)
76		<i>L. umbrosa</i> (Miller, 1940)
77		<i>Salyavata</i> sp.
78		<i>Syberna munita</i> (Walker, 1873)
79		<i>Valentia apetala</i> (Vuillefroy, 1864)
80		Salyavatinae sp. 1

Table 3.1 continued.

No.	Subfamily	Species
81		Salyavatinae sp. 2
82	Stenopodainae Amyot and Serville, 1843	<i>Aulacogenia sarawakensis</i> (Miller, 1940)
83		<i>Aulocogenia</i> sp.
84		<i>Canthesancus gulo</i> (Stahl, 1863)
85		<i>Oncocephalus annulipes</i> (Stål, 1855)
86		<i>O. cingalensis</i> (Walker, 1873)
87		<i>O. lineosus</i> (Distant, 1904)
88		<i>O. sarawakensis</i> (Miller, 1940)
89		<i>Oncocephalus</i> sp. 1
90		<i>Oncocephalus</i> sp. 2
91		<i>Pygolampis</i> sp.
92		<i>Sastrapada</i> sp.
93		<i>Staccia diluta</i> (Stål, 1859)
94		<i>Thodelmus matangensis</i> (Miller, 1940)
95		Stenopodainae sp. 1
96		Stenopodainae sp. 2
97	Triatominae Jeannel, 1919	<i>Triatoma migrans</i> (Breddin, 1903)
98	Tribelocephalinae Stål, 1866	<i>Opistoplatys perakensis</i> (Miller, 1940)
99		<i>Opistoplatys</i> sp.
100		<i>Tribelocephala</i> sp. 1
101		<i>Tribelocephala</i> sp. 2
TOTAL	12	101

3.2.2 Methods

3.2.2.1 Examination of Morphological Structures

A study of Reduviidae morphological characters followed the comparative methods outlined by Schuh and Brower (2009). Species were differentiated on the basis of character discontinuities of external characters which include colouration, structures and vestitures, as well as measurement data. Specimens were examined using Nikon C-Leds stereo microscope. Some characters were taken using Scanning Electron Microscope (SEM) to show the differences between the obvious characters. The chosen characters were coated in gold coat using JFC-1600 Auto Fine Coater machine to give a conductive layer to the

samples before the samples were placed inside JEOL JSM-6390LA scanning electron microscope.

3.2.2.2 Habitus Photograph

Habitus photographs were taken for each species based on Kerr et al. (2008) light-emitting diode (LED) dome lighting system method with modification. Polystyrene covered with white paper was positioned in the middle of a spherical LED light. A specimen was mounted in the middle of the polystyrene before covering the LED light with a hemispherical box. The light would spread inside the box and cast shadow below the specimen. At the top of the box, a circular hole was cut out. The camera lens was positioned through the hole on the top of the box. A photograph was taken for each species through the hemispherical box. In this study, the camera used to take a habitus photograph of each specimen was an Olympus Stylus TG-4 Tough with microscope function. The captured images then were transferred to Adobe Photoshop CS6 for further corrections on the background colour of the images (Appendix 4 – Appendix 14).

3.2.2.3 Measurement of External Characters

The measurements of the external characters for each species of Reduviidae were taken using a digital micrometre, in millimetres, based on 15 characters according to Hwang (2012) with modification. These include the body length, antennae, labium, scutellum, pronotum, thorax, abdomen and legs. The external characters measured were: body total length and width, head length and width, distance between eyes, labium total length, labium 2nd segment, labium 3rd segment, labium 4th segment, antennae scape length, antennae segment I and II length, pronotum total length, anterior pronotal lobe length and

width, posterior pronotal lobe length and width, scutellum length and width, thorax length, abdomen length, hemelytra, length of forefemur, foretibia, foretarsus, midfemur, midtibia, midtarsus, hindfemur, hindtibia, and hindtarsus, width of forefemur, midfemur and hindfemur. The labium segment started with the 2nd segment as only subfamily Centrocnemidinae has labium 1st segment (Appendix 2 and Appendix 3).

3.2.2.4 Phylogenetic Methods

A study on phylogenetic analysis among the subfamilies of Reduviidae (Insecta: Hemiptera: Heteroptera) in Sarawak was conducted using TNT version 1.1 by Goloboff et al. (2008). TNT is a phylogeny program for phylogenetic analysis under parsimony that allows fast searches of large data sets with discrete or continuous characters, extensive tree handling and a variety of methods for diagnosing trees (Goloboff et al., 2008). A total of 12 subfamilies of Reduviidae from Sarawak were included in the analysis.

Outgroup comparison method was used to root the trees and determine character polarity (Faris, 1982; Nixon & Carpenter, 1993). Three species from the family Pentatomidae were used as outgroups: *Dalpada oculata*, *D. trimaculata* and *Rhynchocoris serratus*. These outgroups were selected based on close relationships between them. In the previous studies on the analysis of the higher taxa, Pentatomorpha has been grouping with Cimicomorpha (Grazia et al., 2008; Wheeler et al., 1993; Weirauch & Schuh, 2011).

A morphological matrix with a total of 61 characters was compiled. These include morphological characters of the head, thorax, abdomen and colouration. These morphological characters are coded from examination of specimens. The data was also obtained from literature where specimens were not available. Most of the characters used in this study have been previously used in cladistic analysis performed by Weirauch (2008)

and some are referred to illustration identification key constructed by Weirauch et al. (2014). A complete list of character and character states used in the phylogenetic analysis are presented in Table 3.2 and the data matrix in Appendix 1.

Table 3.2: List of characters and character states used in the phylogenetic analysis.

No.	Characters and character states
Body	
1.	<i>Body shape</i> : (0) elongate-oval; (1) elongate; (2) oval.
2.	<i>Body dorsal - colouration</i> : (0) variable; (1) plain brown with black.
Head	
3.	<i>Length of anteocular region</i> : (0) long; (1) short.
4.	<i>Length of postocular region</i> : (0) long; (1) short.
5.	<i>Length of anteocular region almost twice than postocular region</i> : (0) absent; (1) present.
6.	<i>Length of head</i> : (0) almost twice as long as high; (1) about as long as high.
7.	<i>Apex of clypeus with process</i> : (0) absent; (1) present.
8.	<i>Anteriad process length on clypeus</i> : (0) absent; (1) short; (2) long.
9.	<i>Frontal process with spine</i> : (0) absent; (1) present.
10.	<i>Shape of maxillary plate</i> : (0) without anteriad lobe; (1) with anteriad lobe.
11.	<i>Size of mandibular plate</i> : (0) small; (1) large.
12.	<i>Dorsal margin of eye</i> : (0) rounded or straight; (1) notched.
13.	<i>Posterior margin of eye</i> : (0) globose; (1) flat.
14.	<i>Ocelli</i> : (0) present; (1) absent.
15.	<i>Distance between ocelli</i> : (0) close; (1) distance; (2) absent.
16.	<i>Structure of labrum</i> : (0) subdivided by transverse membrane; (1) sclerotized.
17.	<i>Labium</i> : (0) 3 segments visible; (1) 4 segments visible.
18.	<i>Length of labium 2nd segment</i> : (0) short; (1) long.
19.	<i>Labium 2nd segment</i> : (0) stout; (1) slender; (2) extremely slender.
20.	<i>Apex of labial 4th segment</i> : (0) reaching collar; (1) reaching 1 st coxae; (2) reaching 2 nd coxae or abdomen.
21.	<i>Antennifer large</i> : (0) absent; (1) present.
22.	<i>Length of scapus</i> : (0) short or very short; (1) very long.
23.	<i>Short stout scapus</i> : (0) absent; (1) present.
24.	<i>Scapus</i> : (0) shorter than pedicel; (1) almost the same length as pedicel.
25.	<i>Shape of setae</i> : (0) Simple; (1) tomentose; (2) spatulate.
26.	<i>Length of setae on antennae</i> : (0) short; (1) long and distance; (2) long and close.
Pronotum and Scutellum	
27.	<i>Transverse sulcus on pronotum</i> : (0) at the middle or in front of pronotum; (1) behind the middle of pronotum.

Table 3.2 continued.

No.	Characters and character states
28.	<i>Transverse sulcus on pronotum foveolate</i> : (0) absent; (1) present.
29.	<i>Pronotum enlarged</i> : (0) absent; (1) present.
30.	<i>Anterior angle of pronotum</i> : (0) smooth or pointed; (1) spines or thorn-like; (2) small distinct tubercles scattered; (3) 2 medium tubercles.
31.	<i>Anterior disc of pronotum</i> : (0) absent; (1) thorn-like; (2) spines; (3) 2 medium tubercles.
32.	<i>Posterior humeral angle of pronotum</i> : (0) rounded or widely rounded with apex blunt or sharp; (1) spines; (2) thorn-like; (3) strong triangular spines.
33.	<i>Posterior disc of pronotum</i> : (0) smooth; (1) thorn-like; (2) spines; (3) distinct tubercles or craters.
34.	<i>Posterior lobe of scutellum</i> : (0) absent; (1) spines; (2) flat-plate.
35.	<i>Scutellum with posteriorly projecting prongs</i> : (0) present; (1) absent.
36.	<i>Apex of scutellum with long spine</i> : (0) absent; (1) present.
Hemelytra	
37.	<i>Corium with spots</i> : (0) absent; (1) white spots; (2) yellow spots.
38.	<i>Posterior margin of corium</i> : (0) yellow; (1) orange; (2) red; (3) absent.
39.	<i>Quadrangle cell on forewings</i> : (0) present; (1) absent.
40.	<i>Pentagonal or hexagonal cell on forewings</i> : (0) present; (1) absent.
41.	<i>Shape cell formed by cubital and postcubital veins in the membrane of forewings</i> : (0) rounded; (1) rectangular, apex blunt; (2) triangular, apex pointed.
Connexivum	
42.	<i>Width of connexivum</i> : (0) hemelytra covered the connexivum; (1) small width between connexivum and hemelytra; (2) connexivum width as same as hemelytra; (3) enlarged.
43.	<i>Connexivum</i> : (0) absent; (1) spines; (2) teeth-like.
44.	<i>Margin connexivum</i> : (0) absent; (1) small, close wave-like; (2) large wave-like; (3) lobed.
Leg	
45.	<i>Shape of forecoxae</i> : (0) rounded or tubular; (1) elongated.
46.	<i>Legs nodules</i> : (0) absent; (1) indistinct; (2) distinct.
47.	<i>Vertical forefemur with one or two medium spine(s)</i> : (0) absent; (1) present.
48.	<i>Length of setae on forefemur</i> : (0) short; (1) one-third long of tarsus; (2) as same as tarsus.
49.	<i>Vertical forefemur with teeth</i> : (0) absent; (1) present.
50.	<i>Forefemur colours</i> : (0) uni-colour; (1) bi-colours; (2) tri-colours.
51.	<i>Foretibiae incrassate</i> : (0) absent; (1) basal; (2) apex.
52.	<i>Ventral spine on apex of foretibiae</i> : (0) absent; (1) present.
53.	<i>Apex of foretibiae</i> : (0) straight; (1) slightly curved.
54.	<i>Apex of foretibiae with fossula spongiosa</i> : (0) absent; (1) present.
55.	<i>Length of setae on foretibiae</i> : (0) short; (1) long and distance; (2) long and close.
56.	<i>Midfemur incrassate</i> : (0) absent; (1) present.

Table 3.2 continued.

No.	Characters and character states
57.	<i>Vertical midfemur with one or two spine(s)</i> : (0) absent; (1) present.
58.	<i>Vertical hindfemur with one or two spine(s)</i> : (0) absent; (1) present.
59.	<i>Hindtibiae</i> : (0) straight; (1) slightly curved.
60.	<i>Density of setae on hindtibiae</i> : (0) sparsely; (1) dense.
61.	<i>Basal tooth on foretarsus claw</i> : (0) absent; (1) present.

The data was analysed using Traditional Search according to Weirauch (2008) parameters with some modification. The following parameters were used in the analysis: hold 10 000 trees in memory; 100 random-addition replicates of tree-bisection-reconnection (TBR) branch swapping; and hold 10 starting trees in memory. Implied weighting default function was set to $K = 3$ (Concavity may range between $K = 1$ and $K = 6$ (Weirauch, 2008)). This analysis resulted in 40 most parsimonious trees of 247 steps (consistency (CI) and retention (RI) indices): CI = 79, RI = 91. The strict consensus of these trees had 260 steps. Branch support was calculated using bootstrap values that run 1000 random addition replicates. The bootstrap supports followed Hwang and Weirauch (2012) as follows: >90% (strongly supported); 90-70% (well supported); and <70% (weakly supported). In Figure 3.1, only >50% bootstrap values were showed.

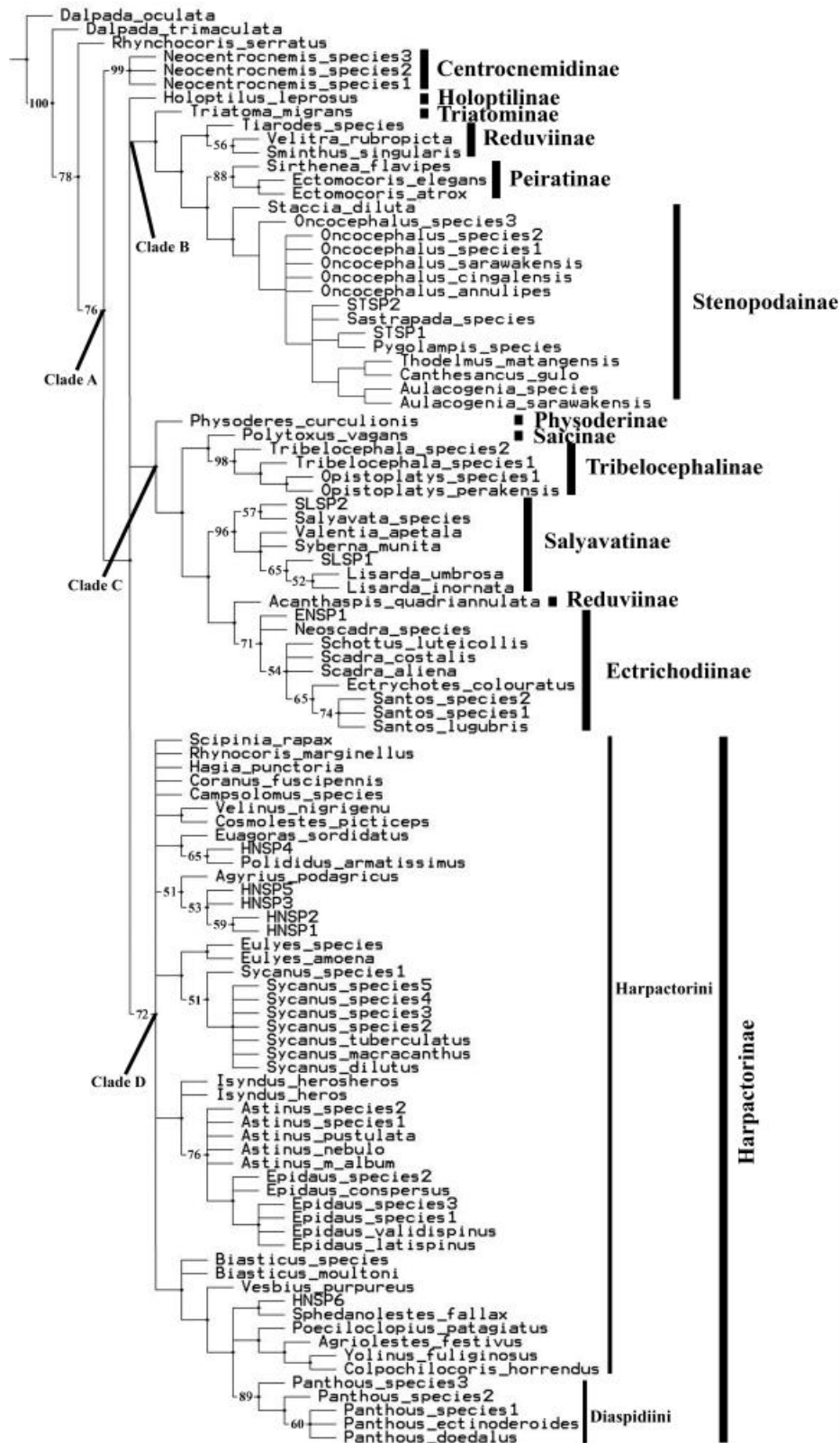


Figure 3.1: Strict consensus of 40 most parsimonious trees of 101 species of Reduviidae and outgroup representatives based on 61 morphological structures using TNT (length = 260; consistency index = 79; retention index = 91). Number on the branches is bootstrap values and only >50% were showed.

3.3 Results and Discussion

3.3.1 Character Homology and Terminology

In the analysis, four colour characters were used based on body, corium, posterior margin of corium, and forefemur. There were five vestiture characters used on body, antennae, femora, and tibiae. The other 52 characters were based on head, labium, antennae, pronotum, scutellum, connexivum, and legs. A total of 61 morphological characters were used in the phylogenetic analysis:

1. **Body shape:** (0) elongate-oval; (1) elongate; (2) oval. Most Reduviidae have elongate-oval body shape, the size of lower body enlarged from middle body size (Figure 3.1A). Peiratinae, Saicinae, some Stenopodainae, and some Harpactorinae (Figure 3.1C) have body elongate, the size of lower body as same as middle body size, while outgroup and Holoptilinae have oval body shape (Figure 3.1B).

2. **Body dorsal colouration:** (0) variable; (1) plain brown with black. Centrocnemidinae, Holopilineae, Stenopodainae and Tribelocephalinae have plain brown with black body colours (Figure 3.1B, C), while most Reduviidae and outgroup have variable body colours (Figure 3.1A). The body of Stenopodainae is often brown or pale (Weirauch et al., 2014) with black colouration. However, Centrocnemidinae and Holoptilinae that included in this analysis have plain brown with some small black spots or marking. Weirauch et al. (2014) stated that members of Holoptilinae are often brown. Three of the species from Tribelocephalinae have plain brown body colour and only *Tribelocephala* sp. 2 has black body colour.

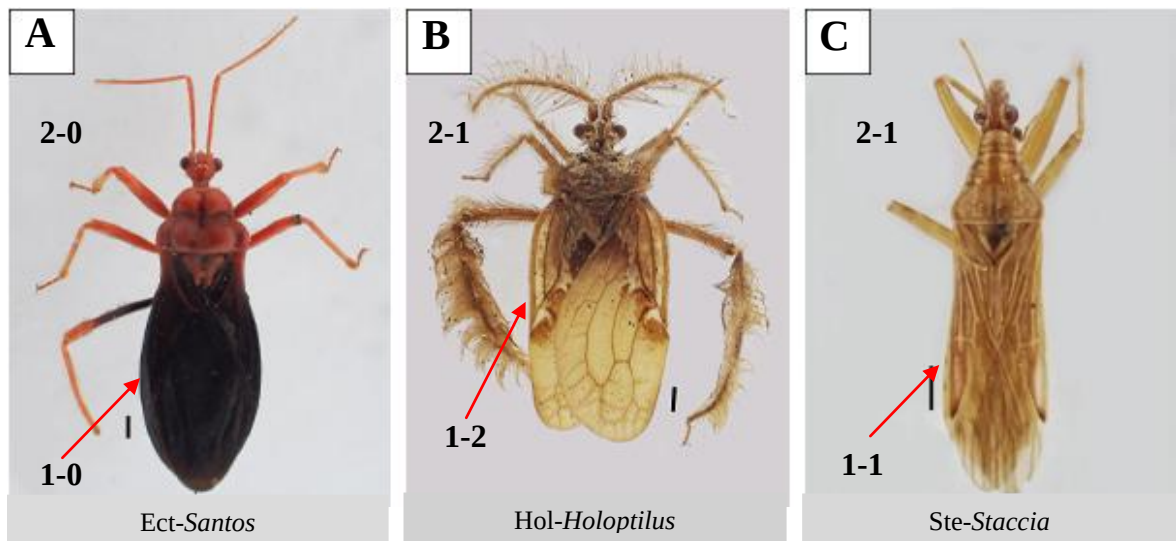


Figure 3.2: Body shape and colour in some Reduviidae. **A.** *Santos* sp. 1; **B.** *Holoptilus leprosus*; and **C.** *Staccia diluta*. Scale = 1 mm.

3. **Length of anteocular region:** (0) long; (1) short. Some Reduviidae have a short anteocular region (Figure 3.2A, B), while most other Reduviidae and outgroup have a long anteocular region (Figure 3.2C). Ectrichiinae and Salyavatinae appear as synapomorphic, but with independent origins in *Vesbius purpureus* from Harpactorinae and *Velitra rubropicta* from Reduviinae. In Weirauch (2008), Salyavatinae appears as synapomorphic with independent origins in *Ectinoderus nitidus* from Ectrichiinae that is included in the analysis.

4. **Length of postocular region:** (0) long; (1) short. Most Reduviidae have a long postocular region (Figure 3.2A). In Triatominae, some Stenopodainae, some Reduviinae, Peiratinae, Ectrichiinae except *Neoscadra* sp. and Ectrichiinae sp., and outgroup have a short length of the postocular region (Figure 3.2B, C).

5. **Length of anteocular region almost twice than postocular region:** (0) absent; (1) present. Most Reduviidae and outgroup have the length of anteocular region almost as same as or three times longer than postocular region. In Peiratinae and Stenopodainae, the

length is almost twice longer than postocular region, which this character is appeared to be synapomorphic and support the sister-group of Peiratinae and Stenopodainae.

6. **Length of head:** (0) almost twice as long as high; (1) about as long as high. Most Reduviidae and *Rhynchocoris serratus* from Pentatomidae has length of head almost twice as long as high (Figure 3.2A, B). The length of head about as long as high (Figure 3.2 C) is appeared to be synapomorphic in Salyavatinae, while present in two species from outgroup and Ectrichodiinae. Salyavatinae is characterised by the presence of short head (Weirauch et al., 2014). In Ectrichodiinae, *Neoscadra* sp. and Ectrichodiinae sp. has length of head almost twice as long as high due to long postocular region.

7. **Apex of clypeus with process:** (0) absent; (1) present. This character is only present in Tribelocephalinae considered in the analysis (Figure 3.2E). Some Tribelocephalinae has apex of clypeus extended into an anteriad process and as a synapomorphy to this subfamily (Weirauch, 2008) (Figure 3.2I). Most Reduviidae and outgroup has apex of clypeus with rounded or blunt shape.

8. **Anteriad process length on clypeus:** (0) absent; (1) short; (2) long. The Tribelocephalinae with anteriad process on clypeus has different length to differentiate between the genus *Opisthoplatys* and *Tribelocephala*. *Tribelocephala* has its length of anteriad process longer (Figure 3.2E) compared to *Opisthoplatys* which has shorter length (Figure 3.2F).

9. **Frontal process with spine:** (0) absent; (1) present. The spine at the apex of head is absent in most Reduviidae and outgroup. According to Weirauch (2008), most members of Salyavatinae possess spine-like frontal process (Figure 3.2G), while (Weirauch et al.,

2014) stated that only the largest genus have a frontal process. In this analysis, all species of Salyavatinae has spine-like structure on the apex of the head, which is treated as synapomorphy.

10. **Shape of maxillary plate:** (0) without anteriad lobe; (1) with anteriad lobe. Centrocnemidinae is the only subfamily that has extended maxillary plate shaping like lobe (Figure 3.2H). Weirauch (2008) used enlarged anteriad-directed maxillary plates as independent origins in Hammacerinae and Centrocnemidinae as maxillary plates, mandibular plates, and antennifer were often not identified specifically by earlier authors. In this analysis, shape of maxillary plate is separated from antennifer.

11. **Size of mandibular plate:** (0) small; (1) large. The large mandibular plate is present in Reduviinae with independent origins in *Acanthaspis quadriannulata*, Triatominae, and Stenopodainae (Figure 3.2I). Most Reduviinae and outgroup have small mandibular plate.

12. **Dorsal margin of eye:** (0) rounded or straight; (1) notched. Centrocnemidinae and Holoptilinae are the only subfamilies that have notched dorsal margin of eye (Figure 3.2J), while most Reduviidae and outgroup have this character to be either rounded or straight (Figure 3.2G). This character supports the monophyly of Phymatine Complex as only Centrocnemidinae, Holoptilinae, and Phymatinae have notched eyes (Weirauch, 2008).

13. **Posterior margin of eye:** (0) globose; (1) flat. Most Reduviidae and outgroup have globose eyes. Tribelocephalinae has flat eyes (Figure 3.2E, F), which is treated as synapomorphy. Weirauch (2008) used three characters of posterior margin of eyes, flat (a character that supports Tribelocephalinae), pedunculate (character support the monophyly of Cetherinae), and globose (most Reduviidae possess this character). This analysis is

absent in Cetherinae and only two characters, globose and flat, were included in the analysis.

14. **Ocelli:** (0) present; (1) absent. The absence of ocelli (Figure 3.2F) is appeared to be synapomorphic in Saicinae and Tribelocephalinae. The ocelli are present in most Reduviidae, but Saicinae and Tribelocephalinae, including Emesinae and Vesciinae which are not included in this analysis, are either usually or always absent (Davis, 1969). These two subfamilies have been diagnosed by the absence of ocelli on the forehead (Weirauch et al., 2014), while other subfamily and outgroup are present of this character. Instead of using the presence/absence of ocelli which indicate the presence/absence of neuronal structures associated with the ocellar lens, Weirauch (2008) used the value of presence/absence of ocellar lens in adult.

15. **Distance between ocelli:** (0) close; (1) distance; (2) absent. The species with the ocelli have either close of distance between the ocelli. Some species have close range between the ocelli (Figure 3.2J) and some have distance between the ocelli (Figure 3.2K).

16. **Structure of labrum:** (0) subdivided by transverse membrane; (1) sclerotized. Most Reduviidae and outgroup have labrum sclerotized, which the labrum is not subdivided by transverse sulcus. This character is only present in Ectrichodiinae and Triatominae and treated as synapomorphy. Weirauch (2008) used this character in her analysis and stated that only these subfamilies have labrum subdivided by transverse sulcus (Figure 3.2C).

17. **Labium:** (0) 3 segments visible; (1) 4 segments visible. All Reduviidae species has four segments of labium but the first segment is only visible in Centrocnemidinae (Figure 3.2H) (Li et al., 2009; Panizzi & Grazia, 2015; Redei & Tsai, 2011; Weirauch, 2008; Weirauch et al., 2014), while reduced in other subfamilies as Reduviidae is the only group

in Heteroptera that its first segment is completely lost (Schuh et al., 2009). This character has been used in Schuh et al. (2009) and Weirauch et al. (2014), and appeared to be synapomorphic in Centrocnemidiinae.

18. Length of labium 2nd segment: (0) short; (1) long. The length of labium 2nd segment in Reduviidae is either shorter or longer than 3rd segment. Most species of Reduviidae show variation within subfamilies. Davis (1969) stated that the long labium in Harpactorinae is either present in 1st or 2nd segment (he did not include the reduced segment), while Triatominae, Peiratinae, and Vesciinae have 1st segment longer than 2nd segment. In the current analysis, Triatominae, Saicinae, Physoderinae, Peiratinae, Holoptilinae, and outgroup have labium 2nd segment shorter than 3rd segment (Figure 3.2B), while Centrocnemidinae has labium 2nd segment longer than 3rd segment (Figure 3.2A). On the other hand, Harpactorinae has variation in its labium length (2nd segment may be longer than 3rd segment or vice versa).

19. Labium 2nd segment: (0) stout; (1) slender; (2) extremely slender. Most Reduviidae and outgroup show variation on the width of the 2nd labium segment. Some of the species have slender 2nd labium segment, and a few of the species have either stout or extremely slender labium. Davis (1969) stated that the structures of the labium: long and thick, long and slender, or short and thick, are related to their habits in preying, feeding, and stridulation.

20. Apex of labial 4th segment: (0) reaching collar; (1) reaching 1st coxae; (2) reaching 2nd coxae or abdomen. In outgroup, the apex of labium in *Dalpada oculata* and *D. trimaculata* reached 2nd coxae, while *Rhynchocoris serratus* reached abdomen. Centrocnemidinae, Saicinae, Triatominae, and Tribelocephalinae has apex of labium reached 1st coxae (Figure

3.2L). In Harpactorinae, *Vesbius purpureus* is the only species that has apex of labium reaching the collar (Figure 3.2M), while in Salyavatinae, *Syberna munita* is the only species that has apex of labium reaching the collar. In Stenopodainae, most species have apex of labium reaching the collar except *Thodelmus matangensis* that reached 1st coxae and *Staccia diluta* reached 2nd segment (Figure 3.2N).

21. **Antennifer large:** (0) absent; (1) present. The antennifer large is present and appeared to be synapomorphic in Physoderinae, Salyavatinae, and Triatominae (Figure 3.2O). In Triatominae, the large antennifer is referred as antenniferous tubercles, which is an important character to differentiate between species by its length (Da Rosa et al., 1999; De Oliveira et al., 2015). Most Reduviidae and outgroups have small antennifer (Figure 3.2I).

22. **Length of scapus:** (0) short or very short; (1) very long. The long length of scapus present in Centrocnemidinae, Ectrichodiinae missing in *Scadra aliena*, Holoptilinae, Peiratinae, and Stenopodainae (except *Thodelmus matangensis*) (Figure 3.2O). On the other hand, Harpactorinae, Physoderinae, and Triatominae (except *Opistoplatys perakensis* and *Opistoplatys* sp. 1) have short length of scapus (Figure 3.2F, K). On the other hand, character scapus missing in Saicinae.

23. **Short stout scapus:** (0) absent; (1) present. Most Reduviidae and outgroup either have slender scapus or long stout scapus. In Centrocnemidinae, Holoptilinae, Physoderinae, and some Reduviinae, the scapus is short and stout (Figure 3.2P).

24. **Scapus:** (0) shorter than pedicel; (1) almost the same length as pedicel. Most Reduviidae and outgroup has scapus shorter than pedicel (Figure 3.2K). In Ectrichodiinae, Physoderinae, *Acanthaspis quadriannulata* from Reduviinae, Salyavatinae, some

Stenopodainae, and Tribelocephalinae, the length of scapus is almost the same as pedicel (Figure 3.2F, O).

25. **Shape of setae:** (0) simple; (1) tomentose; (2) spatulate. Most Reduviidae and outgroup have simple setae, while Tribelocephalinae has tomentose, and Physoderinae has spatulate setae. The body of Tribelocephalinae is covered with dense woolly setae and Physoderinae with spatulate seta. These are diagnostic characters for both subfamilies (Ishikawa, Cai, & Tomokuni, 2015; Weirauch et al., 2014). This character is appeared to be synapomorphic in Physoderinae and Tribelocephalinae.

26. **Length of setae on antennae:** (0) short; (1) long and distance; (2) long and close. Most species of Reduviidae and outgroup have short setae on the antennae. Some species in Ectrichodiinae and Tribelocephalinae have long length and distance of setae (Figure 3.2E), while Holoptilinae has very long and close setae on the antennae (Figure 3.2P). The antennae and legs of Holoptilinae that are densely covered have long setae which usually give them a peculiar appearance (Redei & Tsai, 2011). This character is treated as synapomorphy in Holoptilinae.

27. **Transverse sulcus on pronotum:** (0) at the middle or in front of pronotum; (1) behind the middle of pronotum. The transverse sulcus in most Reduviidae and outgroup situated either at the middle or in front of the pronotum (Figure 3.3H). Peiratinae and some Stenopodainae included in this analysis have transverse sulcus situated behind the middle of pronotum (Figure 3.3G). According to Weirauch et al. (2014), only Peiratinae is characterised by this character, but most not all species of Stenopodainae are present of this character and a few of the species have transverse sulcus located in the middle or in front of the pronotum.

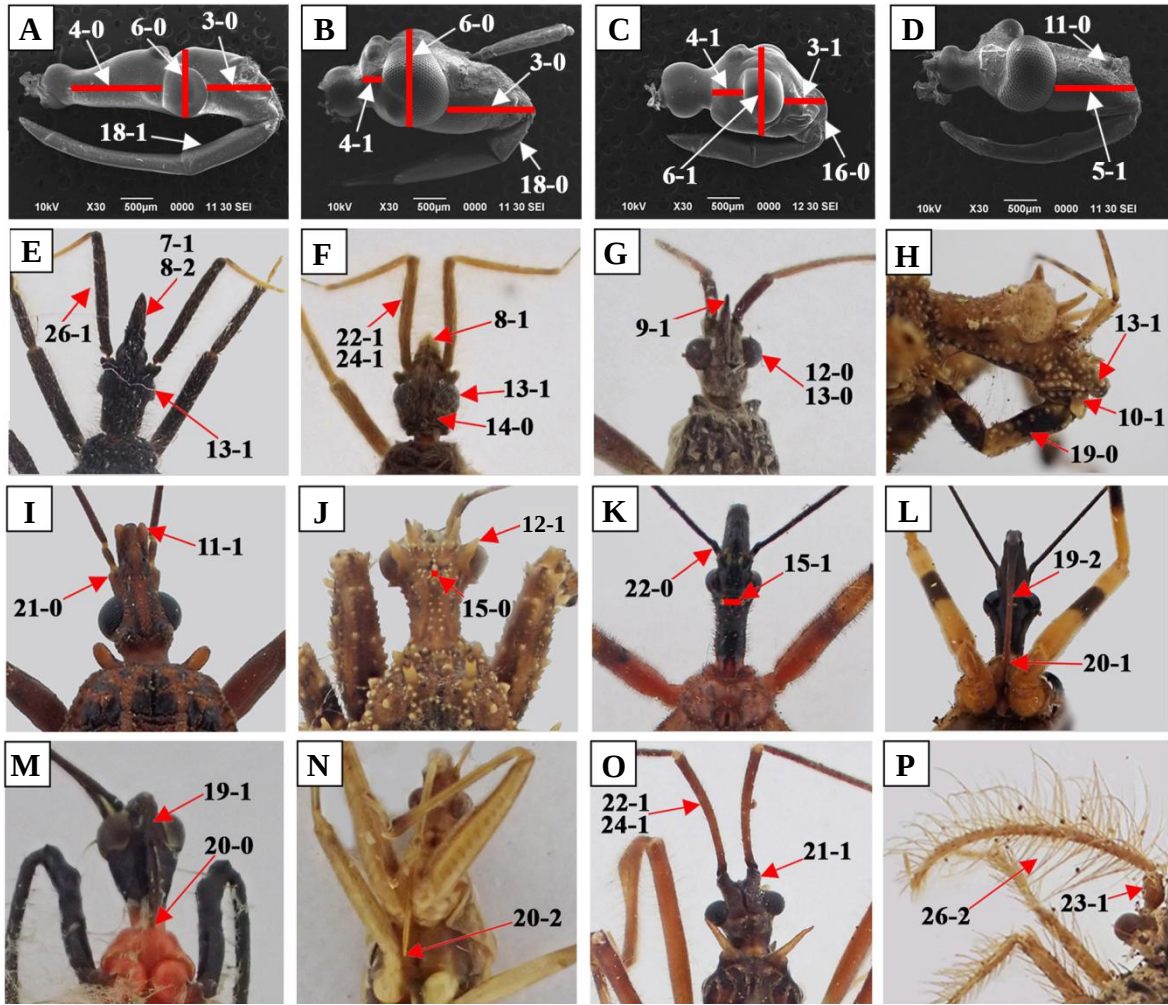


Figure 3.3: Head structures in some Reduviidae. **A.** *Velinus nigrigenu*; **B.** *Ectomocoris atrox*; **C.** *Ectrychotes colouratus*; **D.** *Oncocephalus annulipes*; **E.** *Tribelocephala* sp. 2; **F.** *Opisthoplatys* sp.; **G.** *Salyavatinae* sp. 1; **H.** & **J.** *Neocentrocnemis* sp. 1; **I.** *Triatoma migrans*; **K.** *Agriolestes festivus*; **L.** *Eulyes* sp. 1; **M.** *Vesbius purpureus*; **N.** *Staccia diluta*; **O.** *Syberna munita*; and **P.** *Holoptilus leprosus*. Pictures A, B, C, and D are taken by SEM.

28. **Transverse sulcus on pronotum foveolate:** (0) absent; (1) present. Most Reduviidae and outgroup have transverse sulcus with a line. The transverse sulcus on pronotum in Ectrichodiinae has small pits patterning in continued line, which is also present on the middle and lateral side of the Ectrichodiinae pronotum (Figure 3.3B). This character has been used to differentiate the species within Ectrichodiinae (Miller, 1955) and synapomorphic to this subfamily.

29. **Pronotum enlarged:** (0) absent; (1) present. Pronotum enlarged and covering the scutellum is characterised in genus *Panthous* from Harpactorinae (Figure 3.3D). Most Reduviidae and outgroup has pronotum not enlarged, scutellum is exposed, while tribe Diaspidiini has been diagnosed by the pronotum completely covering the scutellum (Weirauch et al., 2014). The enlarged pronotum is appeared to be synapomorphic to this tribe.

30. **Anterior angle of pronotum:** (0) smooth or pointed; (1) spines or thorn-like; (2) small distinct tubercles scattered; (3) 2 medium tubercles. Reduviidae has a variable shape of the anterior angle of pronotum, most of them have smooth or pointed (Figure 3.3H) as same as outgroup, some have spines or thorn-like projected outward (Figure 3.3J), and few have tubercles. Although Centrocnemidinae and Physoderinae were characterised by having a tuberculate body (Li et al., 2009; Redei and Tsai 2011; Weirauch et al., 2014), however, small distinct tubercles only can be seen in Centrocnemidiinae. In Triatominae, 2 medium tubercles projected outward from the anterior angle of pronotum (Figure 3.3K).

31. **Anterior disc of pronotum:** (0) absent; (1) thorn-like; (2) spines; (3) 2 medium tubercles. Most Reduviidae and outgroup have smooth anterior disc of pronotum. In Centrocnemidiinae, 2 medium tubercles project upward from anterior disc of pronotum, close to transverse sulcus (Figure 3.3A). Harpactorinae has variable shape of anterior disc of pronotum, most have smooth anterior disc, some have thorn-like (Figure 3.3L), and few have spines projected upward on the disc.

32. **Posterior humeral angle of pronotum:** (0) rounded or widely rounded with apex blunt or sharp; (1) spines; (2) thorn-like; (3) strong triangular spines. The shape of posterior humeral angle of pronotum in Reduviidae and outgroup are variable, most have posterior

humeral angle of pronotum rounded or widely rounded with apex either blunt or sharp (Figure 3.3D), some have spines (Figure 3.3I, J) and thorn-like (Figure 3.3F, L) shape, while strong triangular spines are only present in Centrocnemidinae and *Rhynchocoris serratus* from outgroup (Figure 3.3A).

33. Posterior disc of pronotum: (0) smooth; (1) thorn-like; (2) spines; (3) distinct tubercles or craters. Most Reduviidae have smooth posterior disc of pronotum (Figure 3.3K), some have thorn-like (Figure 3.3L), and few have spines. Distinct tubercles (Figure 3.3A) or craters are present in Centrocnemidinae and outgroup, where Centrocnemidinae has body tuberculate while outgroup has a body covered with craters.

34. Posterior lobe of scutellum: (0) absent; (1) spines; (2) flat-plate. The posterior lobe of scutellum in *Salyavata* sp. and Salyavatinae sp. 2 from Salyavatinae has long spines projected upward (Figure 3.3J), while Physoderinae has small flat-plate at both sides of scutellum (Figure 3.3C).

35. Scutellum with posteriorly projecting prongs: (0) present; (1) absent. Ectrichodiinae is diagnosed by the presence of posteriorly projecting prongs on scutellum (Figure 3.3B) or also known as bifurcated scutellum (Weirauch et al., 2014), while most Reduviidae and outgroup has scutellum with pointed apex. In Weirauch (2008), all Reduviidae species including outgroup that has been included in the analysis has a median, posterior process of scutellum, while Ectrichodiinae has the apex of scutellum notched and this character is treated as synapomorphy in Ectrichodiinae. In the current analysis, the presence of posterior projecting prong has been treated as synapomorphic in Ectrichodiinae.

36. **Apex of scutellum with long spine:** (0) absent; (1) present. The apex of scutellum with a long spine is present in genus *Sycanus* from Harpactorinae and appeared to be synapomorphic in Saicinae (Figure 3.3E, I), while most Reduviidae and outgroup are absent of this character.

37. **Corium with spots:** (0) absent; (1) white spots; (2) yellow spots. White spots on corium of forewings are used to differentiate genera in Harpactorinae. The white spots are present in genus *Astinus* except for *Astinus* sp. 1, *Epidaus*, and *Panthous* (Figure 3.4A), while yellow spots are present in some Salyavatinae, some Harpactorinae and *Tiarodes* sp. from Reduviinae (Figure 3.4C). In Harpactorinae, yellow spots on corium of forewings are present in *Agriolestes* and *Astinus* sp. 1, while in Salyavatinae this character is present in *Lisarda umbrosa* and *Valentia apetala*. Most Reduviidae and outgroup are absent of this character.

38. **Posterior margin of corium:** (0) yellow; (1) orange; (2) red; (3) absent. The colours on the posterior margin of corium are used to differentiate species within *Sycanus* from Harpactorinae, which is also present in *Cosmolestes picticeps*. Most Reduviidae and outgroup do not have colours on the posterior margin of corium.

39. **Quadrate cell on forewings:** (0) present; (1) absent. Cubitus in most Reduviidae and outgroup did not form any cell shape on corium except Harpactorinae and Stenopodainae (Figure 3.4A). The crossvein between Cubitus (Cu) vein and Postcubitus (Pcu) vein at first were called pentagonal, however, for convenience, the cell was changed to a quadrate cell (Davis, 1969). The quadrate cell on the membrane has been used in Davis (1969) and Weirauch (2008) in their analysis and stated that only Harpactorinae is present of this character. This character has been used to diagnosed Harpactorinae (Forero, 2011; Weirauch et al., 2014), and this character appeared to be synapomorphic in this analysis.

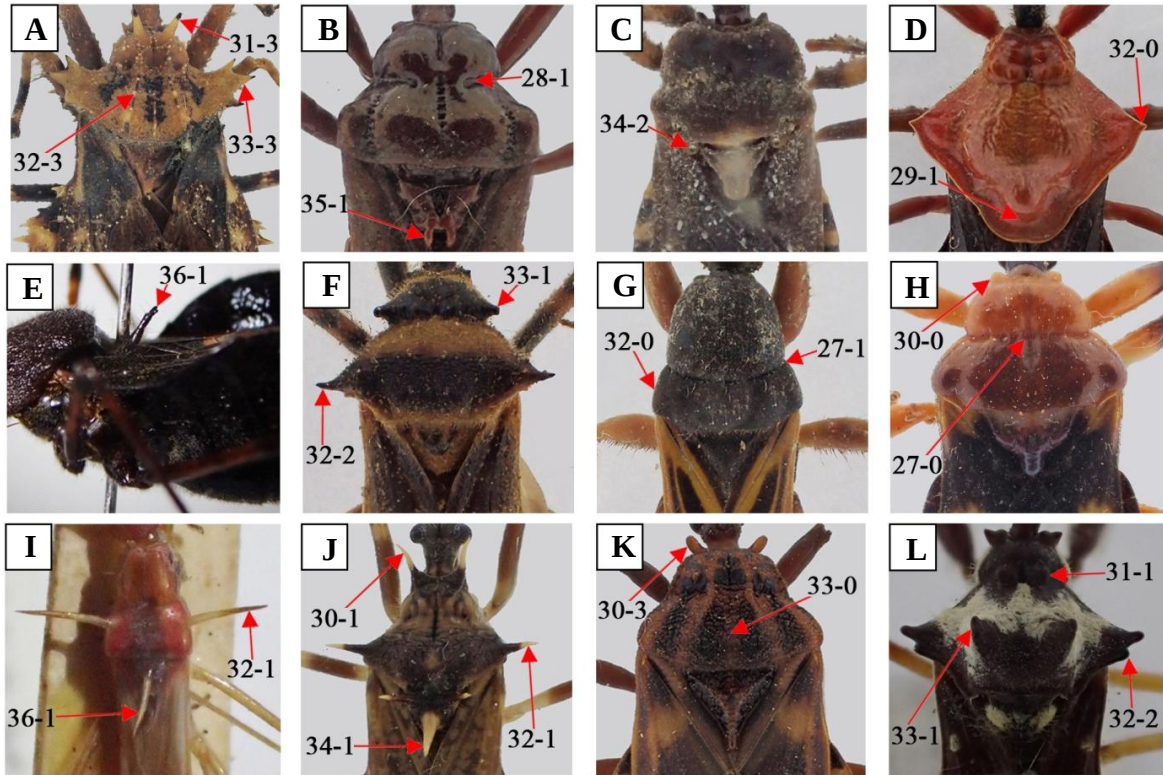


Figure 3.4: Pronotum and scutellum structures in some Reduviidae. **A.** *Neocentrocnemis* sp. 2; **B.** *Neoscadra* sp.; **C.** *Physoderes curculionis*; **D.** *Panthous daedalus*; **E.** *Sycanus macracanthus*; **F.** *Isyndus heros*; **G.** *Ectomocoris elegans*; **H.** *Tiarodes* sp.; **I.** *Polytoxus vagans*; **J.** SLSP2; **K.** *Triatoma migrans*; and **L.** *Astinus pustulatus*.

40. **Pentagonal or hexagonal cell on forewings:** (0) present; (1) absent. Stenopodainae is diagnosed by the presence of pentagonal or hexagonal cell formed by cubitus on the forewing (Figure 3.4B) (Weirauch and Munro, 2009; Weirauch et al., 2014). In the present analysis, all taxa in Stenopodainae are present of this character and appeared to be synapomorphic.

41. **Shape cell formed by cubital and postcubital veins in the membrane of forewings:** (0) rounded; (1) rectangular, apex blunt; (2) triangular, apex pointed. The shape cell formed by cubital and postcubital veins in the membrane of forewings has a rounded apex in most Reduviidae and outgroup that has been included in this analysis (Figure 3.4A). Holoptilinae and Physoderinae have rectangular with a blunt apex of shape cell (Figure

3.4D), while Peiratinae and Saicinae have triangular with the apex pointed shape cell (Figure 3.4E).

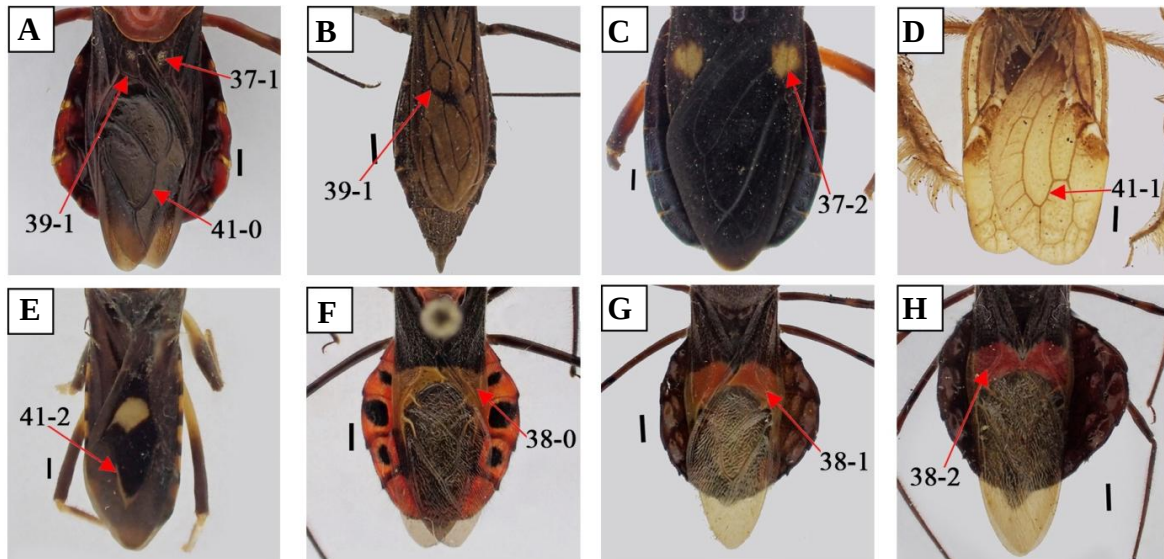


Figure 3.5: Hemelytra structures in some Reduviidae. **A.** *Panthous* sp. 2; **B.** *Stenopodainae* sp. 2; **C.** *Tiarodes* sp.; **D.** *Holoptilus leprosus*; **E.** *Ectomocoris atrox*; **F.** *Sycaenus maculatus*; **G.** *Sycaenus* sp. 3; and **H.** *Sycaenus tuberculatus*. Scale=1mm.

42. **Connexivum:** (0) hemelytra covered the connexivum; (1) small width between connexivum and hemelytra; (2) connexivum width as same as hemelytra; (3) enlarged. Reduviidae and outgroup show variation in connexivum; most of the species have small width connexivum (Figure 3.5B); some of the species has enlarged connexivum (Figure 3.5A); while few either have connexivum width as same as hemelytra (Figure 3.5D). The outgroup and ectrichodiinae have hemelytra covered the connexivum (from dorsal observation) (Figure 3.5C).

43. **Connexivum with spines or teeth-like:** (0) absent; (1) spines; (2) teeth-like. The connexivum with spines or are teeth-like are present in Centrocnemidinae, Harpactorinae, Salyvatinae, and outgroup. The connexivum with teeth-like shapes facing downward on the margin of connexivum is present in genus *Sycaenus* in Harpactorinae, genus *Lisarda* and Salyavatinae sp. 2 in Salyavatinae, and genus *Dalpada* in outgroup (Figure 3.5F),

while spines connexivum is present in Centrocnemidinae, some Salyavatinae, and *Rhynchocoris serratus* in outgroup (Figure 3.5E).

44. **Margin connexivum:** (0) absent; (1) small, close wave-like; (2) large wave-like; (3) lobed. The small and close wave-like (Figure 3.5C), and large wave-like (Figure 3.5A) on margin connexivum is present in Harpactorinae, where former is present in *Panthous*, Harpactorinae sp. 1, Harpactorinae sp. 2 in Harpactorinae, while latter is present in *Agriolestes*, *Colpochilocoris*, *Cosmolestes*, *Velinus*, and *Yolinus* in Harpactorinae. In some Stenopodainae, the margin of connexivum forms lobed (Figure 3.5F), which only present in *Canthesancus gulo* and Stenopodainae sp. 1.

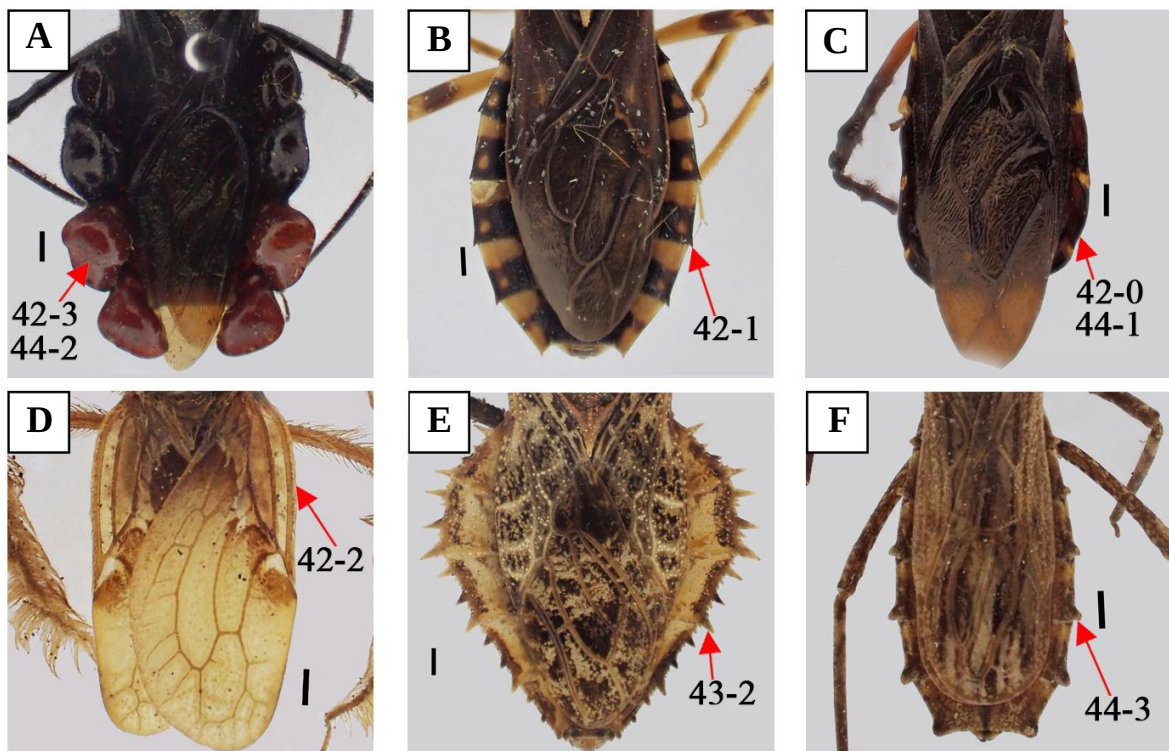


Figure 3.6: Connexivum and abdomen structures in some Reduviidae. **A.** *Yolinus fuliginosus*; **B.** *Lisarda umbrosa*; **C.** *Panthous ectinoderoides*; **D.** *Holoptilus leprosus*; **E.** *Neocentrocnemis* sp. 2; and **F.** *Aulacogenia* sp.. Scale=1mm.

45. **Shape of forecoxae:** (0) rounded or tubular; (1) elongated. Most Reduviidae and outgroup have procoxae either rounded or tubular, while Peiratinae and Saicinae have

elongated forecoxae (Figure 3.6A). Peiratinae is characterised by the presence of elongated forecoxae with a distinctly flattened anterior surface, while Saicinae is diagnosed by the presence of three times as long as wide procoxae (Weirauch et al., 2014). In this analysis, the elongated forecoxae appeared to be synapomorphic in Peiratinae and Saicinae.

46. **Legs nodules:** (0) absent; (1) indistinct; (2) distinct. Harpactorinae is the only subfamily that has nodules legs, while most Reduviidae and outgroup are absent of this characters. In *Panthous*, the femur and tibiae of the species are covered with distinct nodules (Figure 3.6B), while most Harpactorinae have indistinct nodules which are only present at the apex of the femur (Figure 3.6C). This character is appeared to be synapomorphic in genus *Panthous*, which separate tribe Diaspidini from Harpactorini.

47. **Vertical forefemur with one or two medium spine(s):** (0) absent; (1) present. Most Reduviidae and outgroup are absent of this character. The spine(s) on the vertical forefemur is present in Salyavatinae (Figure 3.6E), however, the spine only appears in *Lisarda* and Salyavatinae sp. 1.

48. **Length of setae on forefemur:** (0) short; (1) one-third long of tarsus; (2) as same as tarsus. Most species of Reduviidae and outgroup have short setae on the forefemur (Figure 3.6A). Some species in Ectrichodiinae, Harpactorinae, Reduviinae, Saicinae, and Tribelocephalinae have a setae length of one-third long of tarsus (Figure 3.6B), while Holoptilinae has very long setae which as same as length of tarsus on the forefemur (Figure 3.6F).

49. **Vertical forefemur with teeth:** (0) absent; (1) present. The presence of teeth on vertical forerefemur is also stated as spines or spinose by some authors. The forefemur aligned

vertically with teeth is present in Physoderinae and Stenopodainae (Figure 3.6D). Miller (1954) has diagnosed *Physoderes* by the presence of spines on the femora. On the other hand, Diez and Coscaron (2014) used this character to diagnose *Oncocephalus* as distinctly spinose, but the spines are also present in other genera in Stenopodainae.

50. **Forefemur colours:** (0) uni-colour; (1) bi-colours; (2) tri-colours. Most Reduviidae and outgroup have single colours on forefemur, but in some species of Reduviidae have two colours (Figure 3.6D), and few of them have three colours on foretibiae (Figure 3.6B).

51. **Foretibiae incrassate:** (0) absent; (1) basal; (2) apex. The incrassated foretibiae are present in *Syberna munita* from Salyavatinae and *Dalpada oculata* from outgroup. *S. munita* has foretibiae incrassate at the basal of the foretibiae (Figure 3.6G), while *D. oculata* has foretibiae incrassate at the apex of the foretibiae. This character is present in few species of Salyavatinae, and only several genera in African and Oriental have variously inflated foretibiae (Weirauch, 2014).

52. **Ventral spine on apex of foretibiae:** (0) absent; (1) present. The ventral spine on the apex of foretibiae is present in *Agyrius podagricus* and four undescribed species in Harpactorinae (Figure 3.6I), which these five species shared the same shape of foretibiae, foretibiae slightly curved downward.

53. **Apex of foretibiae:** (0) straight; (1) slightly curved. Most Reduviidae and outgroup have straight hindtibiae, while the curved downward foretibiae are only present in five species in Harpactorinae (Figure 3.6I).

54. **Apex of foretibiae with fossula spongiosa:** (0) absent; (1) present. In Weirauch (2008), she treated the presence of fossula spongiosa as plesiomorphic features, characters that are

acquired from ancestors, which the outgroups and Reduviidae that possess it are treated as homologous, while the absence of this character is represented as independent loss. In the current analysis, the presence of fossula spongiosa appeared in Ectrichodiinae, Peiratinae, Reduviinae, and Salyavatinae (Figure 3.6H). Weirauch et al. stated that the mentioned subfamilies have been diagnosed by the presence of fossula spongiosa, including Saicinae. However, in the current analysis, the presence/absence of fossula spongiosa in Saicinae is hard to be determined due to the conditioned of the sample (old and fragile).

55. **Length of setae on foretibiae:** (0) short; (1) long and distance; (2) long and close. Most species of Reduviidae and outgroup have short setae on the foretibiae (Figure 3.6D). Some species in Ectrichodiinae, Harpactorinae, Reduviinae, Salyavatinae, and Tribelocephalinae have long and distance length of setae (Figure 3.6B), while Holoptilinae has very long and close setae on the foretibiae (Figure 3.6F).

56. **Midfemur incrassate:** (0) absent; (1) present. Most Reduviidae and outgroup either have midfemur width as same as forefemur and hindfemur or as large as forefemur. In Ectrichodiinae, Peiratinae except for *Sirthena*, Physoderinae, and Reduviinae have midfemur incrassate as same as forefemur (Figure 3.6J).

57. **Vertical midfemur with one or two spine(s):** (0) absent; (1) present. Most Reduviidae and outgroup are absent of this character. The spine(s) on the vertical midfemur is present in Salyavatinae, however, the spine only appeared in genera *Lisarda*, *Syberna*, *Valentia*, and Salyavatinae sp. 1 (Figure 3.6E).

58. **Vertical hindfemur with one or two spine(s):** (0) absent; (1) present. Most hindfemur on Reduviidae and outgroup are spineless. In Salyavatinae, the species included in the

analysis has spine(s) on the vertical hindfemur (Figure 3.6E). Salyavatinae was not diagnosed by the presence of this character which suggests that not all species of Salyavatinae has spine of the hindfemur.

59. ***Hindtibiae***: (0) straight; (1) slightly curved. The slightly curved hindtibiae is only present in Harpactorinae sp. 6 from Harpactorinae (Figure 3.6L). Harpactorinae sp. 6 is an undescribed species in which this character can be used to differentiate it from other species.

60. ***Density of setae on hindtibiae***: (0) sparsely; (1) dense. Most species of Reduviidae and outgroup have either dense or sparse setae on the antennae. Some species in Ectrichodiinae, Harpactorinae, Holoptilinae, Peiratinae, and Tribelocephalinae have dense setae on hindtibiae (Figure 3.6L) while most Reduviidae have sparse setae on the hindtibiae (Figure 3.6C).

61. ***Basal tooth on foretarsus claw***: (0) absent; (1) present. Most Reduviidae and outgroup are absent of basal tooth on foretarsus claw. Harpactorinae and Stenopodainae are the only subfamilies that have basal tooth on foretarsus claw (Figure 3.6K) (Weirauch et al., 2014), however, in this analysis, the species in Stenopodainae are absent of this character.

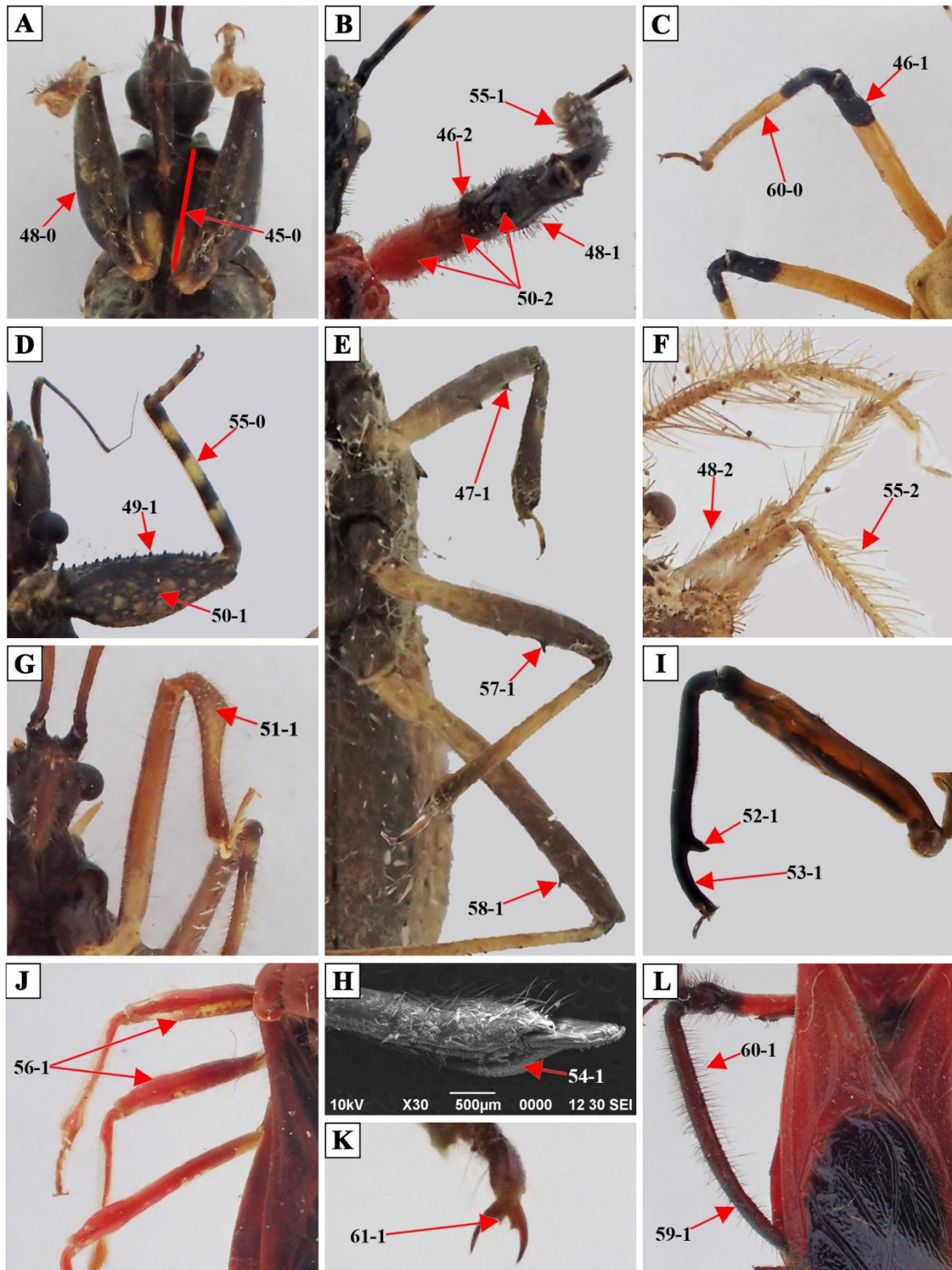


Figure 3.7: Leg structures in some Reduviidae. **A.** & **H.** *Pei-Ectomocoris atrox*; **B.** *Har-Panthous* sp. 1; **C.** *Har-Velinus nigrigenu*; **D.** *Ste-Oncocephalus* sp. 2; **E.** *Sal-SLSP1*; **F.** *Hol-Holoptilus leprosus*; **G.** *Sal-Syberna munita*; **I.** *Har-Harpactorinae* sp. 2; **J.** *Ect-Santos lugubris*; **K.** *Har-Agriolestes festus*; and **L.** *Har-Harpactorinae* sp. 6. Scale=1mm.

3.3.2 Phylogenetic Inference

3.3.2.1 Clade A: Monophyly of Reduviidae

The monophyly of Reduviidae is well supported (76% bootstrap values) in the current analysis. The characters that support the monophyly of Clade A are elongate-oval body shape (#1); the long length of postocular region (#4); and the apex of labium only reached until 1st coxae (#20), which these characters are present in most taxa. Some characters which present in Reduviidae such as the apex of labium reached 2nd coxae, oval body shape, and long anteocular region are also present in Pentatomidae, but due to the differences between absence and presence characters included in the analysis, Pentatomidae is excluded from Reduviidae.

Weirauch (2008) stated that the apex of labium structure has been used as a diagnostic character in Reduviidae. This character is also present in both Phymatinae and Elasmodeiminae, and the presence of this character does not prevent them to be excluded from the Reduviidae. In the present analysis, Reduviidae are supported as monophyletic group of Hemiptera although the characters that used to support the monophyletic group of Reduviidae are not stated as diagnostic characters. Apart from morphological characters performed by Weirauch (2008), the monophyly of Reduviidae has been proven based on 2 studies that have been conducted; molecular data (Hwang & Weirauch, 2012; Weirauch & Munro, 2009) and combination of both morphological characters and molecular data (Schuh et al., 2009).

3.3.2.2 Paraphyly of Phymatine Complex

The origins of all subfamily level clades within the Phymatine Complex, including; Hammacerinae, Phymatinae, Centrocnemidinae, and Holoptilinae, are constantly recovered as the sister-group to the Higher Reduviidae (Hwang & Weirauch, 2012). Hammacerinae is the oldest subfamily in Phymatine Complex while Holoptilinae and Centrocnemidinae are the youngest, which makes Phymatine Complex rather older than all subfamily level clades in the Higher Reduviidae except Peiratinae (Hwang & Weirauch, 2012). In Higher Reduviidae, Peiratinae (97Ma) is older than Holoptilinae and Centrocnemidinae (90 Ma), while Triatominae is the youngest (32Ma) (Hwang & Weirauch, 2012).

In the present analysis, two subfamilies within Phymatine Complex which are Centrocnemidinae and Holoptilinae are found in Sarawak. The Phymatine Complex shows to be paraphyletic group and not monophyletic group as presented by recent studies, although it branches off early from the phylogenetic tree. The monophyly of Phymatine Complex is well supported in the analysis (Weirauch, 2008) which includes Centrocnemidinae, Elasmoideminae, Holoptilinae, and Phymatinae with exception to Hammacerinae. The Hammacerinae is positioned as the sister-group to all remaining Reduviidae while Centrocnemidinae is sister-group to all the remaining taxa in Reduviidae. Schuh et al. (2009) stated Phymatinae as sister-group to all remaining Reduviidae based on molecular data and morphological character as Hammacerinae was not studied. Hammacerinae was rejected as sister-group to all remaining Reduviidae based on mitochondrial and nuclear ribosomal genes (Weirauch and Munro, 2009), but based on 162 morphological character (Weirauch, 2008) and molecular data (Hwang and Weirauch, 2012), Hammacerinae is well supported as sister-group to all remaining Reduviidae. However, in Usinger's study (as cited in Weirauch, 2008), Phymatine Complex is treated

as branching off early from the Reduviidae evolution, while study by Clayton rejects the monophyly of Phymatine Complex, by presenting Centrocnemidinae group with Cetherinae and Salyavatinae.

The paraphyly of Phymatine Complex showed that the Centrocnemidinae is well supported as sister-group to all remaining taxa in Reduviidae, while Holoptilinae branches off early from the Higher Reduviidae. The characters that supported the monophyly of Centrocnemidinae are maxillary plate with anteriad lobe (#10), the present of small distinct tubercles (#30) and two medium tubercles (#31) on the anterior angle of pronotum, which are only present in Centrocnemidinae; dorsal margin of eye notched (#12), which also present in Holoptilinae; and four characters which also present in other subfamilies, elongate-oval body shape (#1), distance between ocelli (#15), connexivum extremely enlarged (#42), and midfemur incrassate (#56).

3.3.2.3 Polyphyly of Reduviinae

The Reduviinae shows to be polyphyletic group and separated into two clades, which are Clade B and Clade C. In Clade B, part of Reduviinae are grouping with Peiratinae + Stenopodainae, while in Clade C, *Acanthaspis quadriannulata* is grouping with Salyavatinae and Ectrichodiinae. The polyphyly of Reduviinae has been studied in cladistic analysis based on 162 morphological characters (Weirauch, 2008) and in two molecular phylogeny studies based on 5 markers (Hwang & Weirauch, 2012) and mitochondrial and nuclear ribosomal genes (Weirauch & Munro, 2009). The monophyly of Reduviinae are rejected in these studies and proven to be polyphyletic group as according to Weirauch et al. (2014), Reduviinae are usually recognized by the absence of specific morphological characters that are characteristic for other subfamilies.

3.3.2.4 Clade B: Triatominae, part of Reduviinae, monophyly of Peiratinae and Stenopodainae

Clade B which consists of Triatominae, part of Reduviinae, Peiratinae, and Stenopodainae is weakly supported (12% bootstrap values) by two synapomorphies: characters short length of the postocular region (#4) and large mandibular plate (#11). Weirauch (2008) has weakly supported Clade G which consists of same subfamilies with the present analysis with additional subfamily Psedocetherinae by one synapomorphy, cave organ.

The polyphyly of Triatominae has been proposed (Schofield, 1988; Schofield and Dujardin, 1999) and studied based on Random amplification of polymorphic DNA (RAPD) (Garcia et al., 1998), and mitochondrial DNA sequences (Garcia and Powell, 1998), which were then controverted by Hypša et al. (2002) based on 16S and 12S rDNAs, and Weirauch (2008) based on 162 morphological characters. The monophyly of Triatominae is well supported in cladistic analysis performed by Weirauch (2008) using four species from two tribes, Rhodniini and Triatomini, while Hypša et al. (2002) studied 57 species from three tribes, Rhodniini, Linshcosteini, and Triatomini based on molecular data. The monophyly of Triatominae is not determined in the current analysis as only one species is used, and separated with other taxa by having slightly or greatly distance between ocelli (#15).

A group consists of part of Reduviinae, Peiratinae, and Stenopodainae is weakly supported by 12% of bootstrap values. The sister-group of Peiratinae and Stenopodainae is weakly supported (8% bootstrap values) by characters length of the anteocular region almost twice than the postocular region (#5) and transverse sulcus of pronotum located behind the middle of pronotum (#27), which are present in all Peiratinae and some Stenopodainae. In

addition, the monophyly of Peiratinae and Stenopodainae is supported by bootstrap values, which latter are supported by 30%, while former with 88% bootstrap values.

3.3.2.5 Clade C: Physoderinae, Saicinae, Reduviinae (*Acanthaspis quadriannulata*), and the monophyly of Tribelocephalinae, Salyavatinae, and Ectrichodiinae

This clade is weakly supported (11% bootstrap values) in the analysis by one synapomorphy: length of scapus is almost as same as pedicel (#24), which this character is also present within Clade B (Triatominae and some Stenopodainae). Physoderinae is separated from other taxa by having very short scapus (#22), while others have very long scapus; and bicolours forefemur (#50), although this character is also present in some species within Salyavatinae, Reduviinae, and Ectrichodiinae. Davis (1961) suggested that Physoderinae and Tribelocephalinae are closely related and have a possible relationship to Ectrichodiinae. On the other hand, the cladistic analysis performed by Weirauch (2008), and two molecular phylogeny performed by Hwang and Weirauch (2012) and Weirauch and Munro (2009) support the sister-group between Tribelocephalinae and Ectrichodiinae. However, these phylogenetic analyses showed that Physoderinae falls into different clade. In the present analysis, Physoderinae forming a clade with Ectrichodiinae and Tribelocephalinae, however, the sister-group of Tribelocephalinae and Ectrichodiinae are not supported.

In addition, a sister-group of Saicinae and Tribelocephalinae is weakly supported (38% bootstrap values) in the analysis. It is based on the absent of ocelli (#14), which both of these subfamilies have been diagnosed by the absence of this character (Weirauch, 2008; Weirauch et al., 2014); and have moderate length of setae on forefemur (#48), which is also present in other subfamilies. A group consists of Salyavatinae, *Acanthaspis*

quadriannulata, and Ectrichodiinae is supported by the short length of the anteocular region (#3); variation in labium length, 3rd segment of labium is shorter than 2nd segment or vice versa (#18), which this character also present in Harpactorinae; and the presence of fossula spongiosa (#54), which this character is also present in Peiratinae.

3.3.2.6 Clade D: Monophyly of Harpactorinae

Weirauch (2008) supported the monophyly of Harpactorinae and studied the relationship of tribes within Harpactorinae. Harpactorinae consists of seven tribes, namely: 1) Apiomerini; 2) Diaspidiini; 3) Ectinoderini; 4) Harpactorini; 5) Rhaphidosomini; 6) Tegeini; and 7) Dicrotelini, where the tribe Harpactorini is the largest tribe in Harpactorinae (Weirauch et al., 2014). Ectinoderini has been proposed as sister-group to the remaining Harpactorinae, followed by Apiomerini, while Diaspidini is strongly supported as a clade that also consists of Harpactorini and Tegeini (Weirauch, 2008).

In the present analysis, the monophyly of Harpactorinae is well supported (72% bootstrap values). Characters that support the monophyly of Clade D are the apex of labial 4th segment reached 1st coxae (#20), except apex of labium of *Vesbius purpureus* reached collar; the presence of the quadrate cell in the forewing (#39), which these characters support the monophyly of Harpactorinae in Weirauch (2008); femora nodules (#46); and the presence of basal tooth on foretarsus claw (#61). An illustrated identification key provided by Weirauch et al. (2014) showed that there were two subfamilies that have basal tooth on the foretarsus claw, Harpactorinae and Stenopodainae. However, in the current analysis, the character is only present in Harpactorinae, which the presence of basal tooth in Stenopodainae is only for certain species. There were two tribes of Harpactorinae in Sarawak and included in the analysis, Harpactorini and Diaspidini, which Harpactorini is

strongly placed at the basal clade. The monophyly of Diaspidini is well supported (89% bootstrap values) by characters pronotum enlarged and covered the scutellum (#29); margin of connexivum with small, close wave-like (#44); and femora with distinct nodules (#46), which are used to discriminate Diaspidini with Harpactorini.

3.4 Conclusion

A phylogenetic analysis based on 101 ingroup and 3 outgroup (Pentatomorpha: Pentatomidae: *Dalpada oculata* and *Dalpada trimaculata* (Halyini), and *Rhynchocoris serratus* (Rhynchocorini)) based on 61 morphological structures using Tree Analysis using New Technology (TNT) software was constructed. Based on the phylogenetic tree, the monophyly of Reduviidae is well supported by three synapomorphies: length of the postocular region, the shape of labium 2nd segment, and apex of labium only reached until 1st coxae, with Pentatomorpha as their outgroup. The results of this study support the sister-group of Centrocnemidinae to all remaining taxa in Reduviidae, the paraphyly of Phymatine Complex (Centrocnemidinae and Holoptilinae), the polyphyly of Reduviinae, and a clade that comprises Triatominae, part of Reduviinae, and the monophyly of Peiratinae and Stenopodainae. The results also present the monophyly of Tribelocephalinae, Salyavatinae, and Ectrichodiinae in a clade that also include Physoderinae, Saicinae and Reduviinae (*Acanthaspis quadriannulata*). The monophyly of Harpactorinae, which include tribes Harpactorini and Diaspidini, is presented with basal position of Harpactorini in the clade.

CHAPTER 4

SYSTEMATICS OF SUBFAMILY HARPACTORINAE AMYOT & SERVILLE, 1843 (INSECTA: HEMIPTERA: HETEROPTERA: REDUVIIDAE) IN SARAWAK

4.1 Introduction

Harpactorinae Amyot & Serville, 1843 is the largest subfamily of Reduviidae and most of their members were diurnal. Represented by approximately 320 genera with 2,800 described species, however, it is yet the most poorly studied subfamily of Reduviidae (Cai & Tomokuni, 2003; Melo & Coscaron, 2005; Weirauch et al., 2014). They are found distributed in all biogeographical regions. Members of the Harpactorinae are easily recognised by having elongated head and variable body colour, which are usually striking. According to Weirauch et al. (2014), the harpactorines are characterised by cubitus formed quadrate cell on the corium, and subapical spur on the foretibia that carries the foretibial comb, and most species also have a cylindrical region on the head and elongated antennal scape.

The subfamily Harpactorinae consist of seven tribes, namely: 1) Apiomerini; 2) Diaspidiini; 3) Ectinoderini; 4) Harpactorini; 5) Rhaphidosomini; 6) Tegeini; and 7) Dicrotelini, where the tribe Harpactorini is the largest tribe in Harpactorinae with a worldwide distribution; Apiomerini are only known to the New World; Diaspidiini and Rhaphidosomini are Afrotropical; Ectinoderini are only known to the Oriental region; while Dicrotelini and Tegeini occur in the Old World tropics (Weirauch et al., 2014).

The members of Harpactorinae are predaceous on other invertebrates. Some are zoophagous and feed on the body fluid of other invertebrates (Ambrose, 2000; Froeschner, 1985; Patterson, 2007), and in rare cases, few of them are phytophagous feeding on the

fluid of plants (Berenger & Pluot-Sigwalt, 1997). Some species are valuable as biological control agents of various insect pests (Schaefer & Panizzi, 2000) due to their polyphagous diet. The Harpactorinae species were mostly found closely associated with plants as they were using plants as preferred place for preying (Berenger & Pluot-Sigwalt, 1997), oviposition substrate (Choe & Rust, 2007), and source of exogenous resin (Forero, 2011). Although some of the species have been studied as biological control agents of crop pests (e.g. Grundy, 2007; Grundy & Maelzer, 2003), however, little studies have been conducted on the Harpactorinae of Sarawak.

Based on literature records, 16 species and 9 genera of Harpactorinae are found in Malaysia, however, the species that were found are not specified at particular distribution, although the authors recorded the locality as Selangor, Pahang, Malacca, Sarawak, and mostly recorded as “Malaysia”. The species recorded are *Euagoras famulus* (Ambrose, 2006), *E. plagiatus* (Ambrose, 2006), *Euagoras* sp. (Hwang, 2012), *Endochus inornatus* (Ambrose, 2006), *E. umbrinus* (Ambrose, 2006), *Epidaus conspersus* (Ambrose, 2006), *Isyndus heros heros* (Ambrose, 2006), *I. reticulatus reticulatus* (Ambrose, 2006), *Macracanthopsis nodipes* (Ambrose, 2006), *Panthous icarus* (Ambrose, 2006), *Sycanus collaris* (Ambrose, 2006), *S. croceovittatus* (Ambrose, 2006), *S. vividus* (Ambrose, 2006), *Velinus* sp. (Hwang, 2012), *Vesbius purpureus* (Ambrose, 2006; Hwang, 2012), and *V. sanguinosus* (Ambrose, 2006).

In Sarawak, Harpactorinae species can be found distributed at Bako National Park, Baram, Bario, Batu Kitang, Bau, Bintulu, Betong, Borneo Highland, Bukit Arip, Bukit Semalong, Dulit Range, Engkelili, Gunung Begat, Gunung Serapi, Julau, Kalimantan, Kapit, Kemena, Kenari, Kota Samarahan, Kuching, Labang Forest Reserve, Lambir, Lawas, Lidong, Limbang, Maludam, Matang, Mulu National Park, Mukah, Niah, Niah Forest Reserve,

Niah National Park, Oya Nursery Road, PPB Oil Palm Plantation, Ranchan Recreational Park, Retus, Samiling, Sampadi Forest Reserve, Samunsam Wildlife Sanctuary, Santubong National Park, Sarikei, Sematan, Semenggoh, Semonggok, Serian, Setuan, Sibu, Siburan, Similajau, Sri Aman, Sungai Sekai, Sungai Sibiyu, Sungai Simunjan Kanan, Sungai Nah, Sungei Tengah, Simunjan, Tarat Agriculture Station, Tebakang, and UNIMAS. Most of the Harpactorinae species were found distributed at Southwest Sarawak (Figure 4.1).

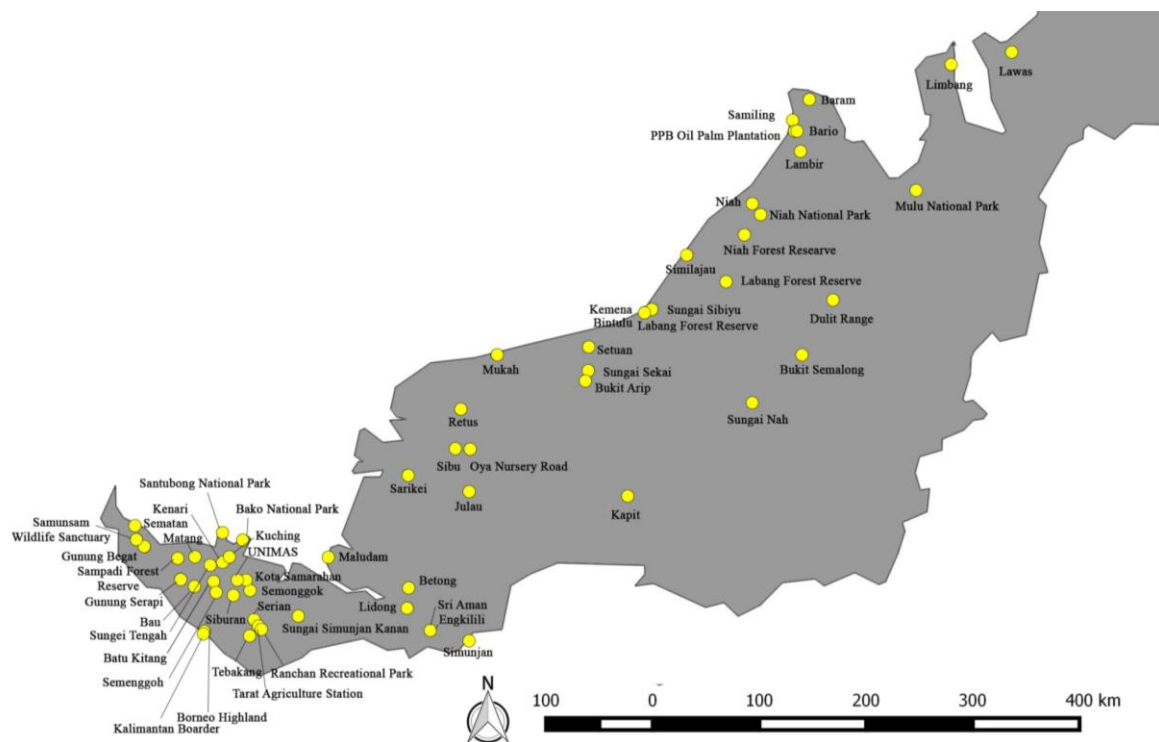


Figure 4.1: Distribution of Harpactorinae in Sarawak.

Currently, there is not much information of Harpactorinae species in Sarawak. Harpactorinae is known as the largest subfamily of Reduviidae which they are widely distributed in almost any types of vegetations and due to their habits as predators some of the species may act as a biological control agent for selected pest species. Based on the previous chapter, Harpactorinae is well supported to be monophyletic based on three synapomorphies: quadrate cell on the forewing, femora nodules, and basal tooth on

foretarsus claw. In addition, the cladistic analysis of Harpactorinae by previous studies also supported the monophyletic of Harpactorinae (e.g. Forero, Berniker, & Weirauch, 2013; Weirauch, 2008).

Thus, the objective of this study is to review the taxonomic status of the subfamily Harpactorinae as well as documenting their distributions in Sarawak. In this study, a total of 23 genera and 52 species, including 22 undescribed species were described. However, some species redescrptions are not specific for male or female as the specimens are too old and fragile to handle in the collections.

4.2 Materials and Methods

4.2.1 Specimens

This study was based on an examination of voucher specimens from four institutions, as well as new field collections. Comparative morphological characters were observed to discriminate among Harpactorinae species to find discontinuities of external characters using Nikon C-Leds stereo microscope. The voucher specimens available for this study were deposited from the following institutions: 1) UNIMAS Insect Reference Collection (UIRC); 2) Forest Research Centre (FRC); 3) Semongok Agriculture Research Centre (ARC); and 4) Sarawak Biodiversity Centre (SBC). On the other hand, field collection were conducted at four sampling sites, namely: 1) PPB Oil Palm Plantations, Miri, Sarawak for 10 days, from 4th to 14th February 2015; 2) Borneo Highland, Padawan, Sarawak for seven days, from 20th to 27th August 2015; 3) Santubong National Park, Kuching, Sarawak for seven days, from 6th to 13th November 2015; and 4) Sri Aman, Sarawak for four days, from 18th to 22nd December 2015.

4.2.2 Systematics Account

Among 12 subfamilies of Reduviidae, systematic accounts based on subfamily Harpactorinae with a total of 23 genera and 52 species were presented. In this study, the described and undescribed species were examined for diagnosis and redescription based on the samples available in the collections. A key to the genera of the subfamily Harpactorinae based on the comparative morphological characters were presented.

4.2.3 Habitus Photograph

Habitus photograph was presented for each species based on Kerr et al. (2008) light-emitting diode (LED) dome lighting system method with modification. In this study, a camera used in the habitus photograph is Olympus Stylus TG-4 Tough with microscope function. The captured images were then transferred into Adobe Photoshop CS6 for further corrections on the background colour of the images. Some image of the species may not be in clear state as the specimens were not in good condition and there is no new collection of the species.

4.2.4 Measurements

Measurements were taken for each species of Harpactorinae. The measurements of each species have been recorded using a digital micrometre, in millimetres, based on 15 characters according to Coscaron et al. (1994) with modification. The characters that were measured are total body length, antennae, labium, scutellum, pronotum, thorax, abdomen, and legs. The missing character is stated as “-” (Appendix 2 and Appendix 3).

4.2.5 Distribution Map

Geological distribution maps of the examined specimens were generated using Quantum Geographic Information System (QGIS). The GPS coordinates were estimated using Google Earth based on the record on the locality labels. Estimated GPS coordinates were denoted by parentheses (e.g. [109.8372 ° E; 1.6719 ° N], 65 m) (Figure 4.54-4.61).

4.3 Results and Discussion

A total of 724 specimens from Sarawak, comprising 23 genera and 52 species were evaluated. *Velinus nigrigenu* dominated other species with 25.83% followed by *Cosmolestes picticeps* (23.34%), *Sycanus macracanthus* (9.25%), *Euagoras sordidatus* (5.80%), *Rhynocoris marginellus* (4.83%), *Vesbius purpureus* (4.56%), *Astinus pustulatus* (3.04%), *S. dilutus* (2.62%), *Polididus armatissimus* (1.79%), *A. m-album* (1.52%), *Hagia punctoria* (1.38%), *Poeciloclopius patagiatus* (1.10%), *A. nebulo* and *Scipinia rapax* (0.97%), *Campsolomus* sp. and *Coranus fuscipennis* (0.83%), *Isyndus heros*, *Sphedanolestes fallax*, and *Harpactorinae* sp. 6 (0.69%), *Biasticus* sp. 1, *Epidaus* sp. 2, and *Harpactorinae* sp. 4 (0.55%), and *Astinus* sp. 1 and *Biasticus moultoni* (0.41%). On the other hand, *Agriolestes festivus*, *Colpochilocoris horrendus*, *E. latispinus*, *Epidaus* sp. 1, *Isyndus heros heros*, *Sycanus tuberculatus*, *Sycanus* sp. 3, *Sycanus* sp. 4, and *Yolinus fuliginosus* each represented by 0.28%, while *Agyrius podagricus*, *Astinus* sp. 2, *E. conspersus*, *E. validispinus*, *Epidaus* sp. 3, *Eulyes* sp. 1, *Panthous daedalus*, *P. ectinoderoides*, *Panthous* sp. 1, *Panthous* sp. 2, *Panthous* sp. 3, *S. maculatus*, *Sycanus* sp. 1, *Sycanus* sp. 2, *Harpactorinae* sp. 1, *Harpactorinae* sp. 2, *Harpactorinae* sp. 3, and *Harpactorinae* sp. 5 each represented by 0.14% (Table 4.1).

Table 4.1: List of species of the subfamily Harpactorinae evaluated.

Genus	Species	Number of individuals	Percentage (%)
<i>Agriolestes</i> (Stål, 1866)	<i>A. festivus</i> (Miller, 1941)	2	0.28
<i>Agyrius</i> (Stål, 1863)	<i>A. podagricus</i> (Stål, 1863)	1	0.14
<i>Astinus</i> (Stål, 1859)	<i>A. m-album</i> (Amyot & Serville, 1843)	11	1.52
	<i>A. nebulo</i> (Miller, 1941)	7	0.97
	<i>A. pustulatus</i> (Stål, 1863)	22	3.04
	<i>A. sp. 1</i>	3	0.41
	<i>A. sp. 2</i>	1	0.14
<i>Biasticus</i> (Stål, 1866)	<i>B. moultoni</i> (Bergroth, 1913)	3	0.41
	<i>B. sp. 1</i>	4	0.55
<i>Campsolomus</i> (Stål, 1870)	<i>C. sp.</i>	6	0.83
<i>Colpochilocoris</i> (Reuter, 1881)	<i>C. horrendus</i> (Walker, 1873)	2	0.28
<i>Coranus</i> (Curtis, 1833)	<i>C. fuscipennis</i> (Reuter, 1881)	6	0.83
<i>Cosmolestes</i> (Stål, 1859)	<i>C. picticeps</i> (Stål, 1859)	169	23.34
<i>Epidaus</i> (Stål, 1859)	<i>E. conspersus</i> (Stål, 1863)	1	0.14
	<i>E. latispinus</i> (Stål, 1863)	2	0.28
	<i>E. validispinus</i> (Stål, 1863)	1	0.14
	<i>E. sp. 1</i>	2	0.28
	<i>E. sp. 2</i>	4	0.55
	<i>E. sp. 3</i>	1	0.14
<i>Euagoras</i> (Burmeister, 1843)	<i>E. sordidatus</i> (Stål, 1866)	42	5.80
<i>Eulyes</i> (Amyot & Serville, 1843)	<i>E. amoena</i> (Guérin-Ménéville, 1838)	13	1.79
	<i>E. sp. 1</i>	1	0.14
<i>Hagia</i> (Stål, 1863)	<i>H. punctoria</i> (Stål, 1863)	10	1.38
<i>Isyndus</i> (Stål, 1858)	<i>I. heros</i> (Fabricius, 1803)	5	0.69
	<i>I. heros heros</i> (Fabricius, 1858)	2	0.28
<i>Panthous</i> (Stål, 1863)	<i>P. daedalus</i> (Stål, 1863)	1	0.14
	<i>P. ectinoderoides</i> (Bergroth, 1913)	1	0.14
	<i>P. sp. 1</i>	1	0.14
	<i>P. sp. 2</i>	1	0.14
	<i>P. sp. 3</i>	1	0.14
<i>Poeciloclopius</i> (Stål, 1863)	<i>P. patagiatus</i> (Stål, 1863)	8	1.10
<i>Polididus</i> (Stål, 1859)	<i>P. armatissimus</i> (Stål, 1859)	13	1.79
<i>Rhynocoris</i> (Hahn, 1834)	<i>R. marginellus</i> (Fabricius, 1803)	35	4.83
<i>Scipinia</i> (Stål, 1861)	<i>S. rapax</i> (Miller, 1941)	7	0.97
<i>Sphedanolestes</i> (Stål, 1866)	<i>S. fallax</i> (Miller, 1941)	5	0.69

Table 4.1 continued.

Genus	Species	Number of individuals	Percentage (%)
<i>Sycanus</i> (Amyot & Serville, 1843)	<i>S. dilutus</i> (Miller, 1941)	19	2.62
	<i>S. macracanthus</i> (Stål, 1866)	67	9.25
	<i>S. maculatus</i> (Miller, 1941)	1	0.14
	<i>S. tuberculatus</i> (Reuter, 1881)	2	0.28
	<i>S. sp. 1</i>	1	0.14
	<i>S. sp. 2</i>	1	0.14
	<i>S. sp. 3</i>	2	0.28
	<i>S. sp. 4</i>	2	0.28
<i>Velinus</i> (Amyot & Serville, 1843)	<i>V. nigrigenu</i> (Amyot & Serville, 1843)	187	25.83
<i>Vesbius</i> (Stål, 1865)	<i>V. purpureus</i> (Thunberg, 1783)	33	4.56
<i>Yolinus</i> (Amyot & Serville, 1843)	<i>Y. fuliginosus</i> (Stål, 1867)	2	0.28
	Harpactorinae sp. 1	1	0.14
	Harpactorinae sp. 2	1	0.14
	Harpactorinae sp. 3	1	0.14
	Harpactorinae sp. 4	4	0.55
	Harpactorinae sp. 5	1	0.14
	Harpactorinae sp. 6	5	0.69
TOTAL		724	100

The Harpactorinae prey on different types of invertebrates and due to their variety of habits and diet, they can be found distributed in all biogeographical regions. The species of this subfamily were found distributed in seven types of vegetations in Sarawak, namely: 1) Mixed dipterocarp forest; 2) Peat swamp forest; 3) Mangrove forest; 4) Fragmented forest; 5) Beach forest; 6) Oil palm plantation; and 7) Paddy field. The peat swamp forest was stated as the most recorded specimens with a total of 306 specimens, followed by mixed dipterocarp forest with 255 specimens, fragmented forest with 59 specimens, oil palm plantation with 30 specimens, mangrove forest with 9 specimens, beach forest 8 specimens, and paddy field with 2 specimens (Table 4.2).

Table 4.2: List of the subfamily Harpactorinae from different types of vegetation in Sarawak. *MDF*=Mixed dipterocarp forest; *PSF*=Peat swamp forest; *MF*=Mangrove forest; *FF*=Fragmented forest; *BF*=Beach forest; *OPP*=Oil palm plantation; *PF*=Paddy field.

Species	Types of vegetation						
	MDF	PSF	MF	FF	BF	OPP	PF
<i>Agriolestes festivus</i>	1	1	-	-	-	-	-
<i>Agryrius podagricus</i>	1	-	-	-	-	-	-
<i>Astinus m-album</i>	5	2	3	1	-	-	-
<i>Astinus nebulo</i>	-	6	-	-	-	-	-
<i>Astinus pustulatus</i>	1	20	-	1	-	-	-
<i>Astinus</i> sp. 1	-	3	-	-	-	-	-
<i>Astinus</i> sp. 2	-	1	-	-	-	-	-
<i>Biasticus moultoni</i>	1	2	-	-	-	-	-
<i>Biasticus</i> sp. 1	2	1	-	-	1	-	-
<i>Campsolomus</i> sp.	-	4	-	-	-	1	-
<i>Colpochilocoris horrendus</i>	1	1	-	-	-	-	-
<i>Coranus fuscipennis</i>	-	6	-	-	-	-	-
<i>Cosmolestes picticeps</i>	68	44	1	20	-	10	-
<i>Epidaus conspersus</i>	1	-	-	-	-	-	-
<i>Epidaus latispinus</i>	-	2	-	-	-	-	-
<i>Epidaus validispinus</i>	1	-	-	-	-	-	-
<i>Epidaus</i> sp. 1	1	-	-	-	1	-	-
<i>Epidaus</i> sp. 2	3	-	1	-	-	-	-
<i>Epidaus</i> sp. 3	-	1	-	-	-	-	-
<i>Euagoras sordidatus</i>	23	12	-	-	-	-	1
<i>Eulyes amoena</i>	3	7	-	-	-	1	-
<i>Eulyes</i> sp. 1	1	-	-	-	-	-	-
<i>Hagia punctoria</i>	3	2	-	-	5	-	-
<i>Isyndus heros</i>	-	5	-	-	-	-	-
<i>Isyndus heros heros</i>	1	1	-	-	-	-	-
<i>Panthous daedalus</i>	-	1	-	-	-	-	-
<i>Panthous ectinoderoides</i>	-	1	-	-	-	-	-
<i>Panthous</i> sp. 1	1	-	-	-	-	-	-
<i>Panthous</i> sp. 2	1	-	-	-	-	-	-
<i>Panthous</i> sp. 3	1	-	-	-	-	-	-
<i>Poeciloclopius patagiatus</i>	3	1	4	-	-	-	-
<i>Polididus armatissimus</i>	5	4	-	1	-	1	-
<i>Rhynocoris marginellus</i>	15	16	-	1	1	-	-
<i>Scipinia rapax</i>	2	3	-	-	-	-	-
<i>Sphedanolestes fallax</i>	-	5	-	-	-	-	-
<i>Sycanus dilutus</i>	4	12	-	-	-	-	-
<i>Sycanus macracanthus</i>	4	50	0	8	0	3	1
<i>Sycanus maculatus</i>	-	-	-	1	-	-	-
<i>Sycanus tuberculatus</i>	1	1	-	-	-	-	-
<i>Sycanus</i> sp. 1	-	1	-	-	-	-	-
<i>Sycanus</i> sp. 2	1	-	-	-	-	-	-
<i>Sycanus</i> sp. 3	1	1	-	-	-	-	-
<i>Sycanus</i> sp. 4	-	2	-	-	-	-	-

Table 4.2 continued.

Species	Types of vegetation						
	MDF	PSF	MF	FF	BF	OPP	PF
<i>Velinus nigrigenus</i>	78	67	-	22	-	14	-
<i>Vesbius purpureus</i>	12	18	-	-	-	-	-
<i>Yolinus fuliginosus</i>	2	-	-	-	-	-	-
Harpactorinae sp. 1	-	-	-	1	-	-	-
Harpactorinae sp. 2	-	-	-	1	-	-	-
Harpactorinae sp. 3	-	-	-	1	-	-	-
Harpactorinae sp. 4	4	-	-	-	-	-	-
Harpactorinae sp. 5	-	-	-	1	-	-	-
Harpactorinae sp. 6	1	3	2	-	-	-	-
TOTAL	255	306	9	59	8	30	2

4.3.1 Taxonomy

Harpactorinae Amyot & Serville, 1843

Diagnosis. Small to large size; variable body colour, usually striking colour; head usually elongated, postocular head region longer than anteocular head region; labium with three segments visible; third segment of labium gently curved; scape of antennae short; variable structure of humeral angle, thorn-like structure, spines, or rounded; transverse sulcus in front of pronotum; scutellum usually visible except tribe Diaspidiini, where pronotum enlarged and covered the scutellum; scutellum either smooth or with spines; cubitus formed a quadrate cell on the corium; Hemelytra without cuneus; forewings usually longer than apex of abdomen; variable structure of connexivum, smooth, wave-like structure, or semi-sphere structure; first abdominal segment narrowed and enlarged at the middle of abdominal segment; forefemur claw with basal tooth.

Key to Genera of the Subfamily Harpactorinae in Sarawak

1. Scutellum not visible; pronotum completely covering the scutellum; distinct nodules over entire legs.....*Panthous*

- Scutellum visible; pronotum not enlarged and covered the scutellum; distinct or indistinct nodules on femora.....2
2. Length of anteocular region is 1/3 shorter than postocular region of head; apex of labium reached collar.....*Vesbius*
- Length of anteocular region is 2/3 shorter than or almost as same as postocular region of head; apex of labium reached 1st coxae.....3
3. Apex of femora with distinct nodules; legs with densely long setose, hindtibiae slightly curved..... Harpactorinae sp. 6
- Apex of femora with indistinct nodules; legs with either densely/sparsely long/short setose; hindtibiae straight.....4
4. Small body size, length 9.70 mm, width 1.66 mm; distinct nodules over entire fore femora.....*Scipinia*
- Small to large body size, length 9.95 – 29.95 mm, width 2.50 – 11.71 mm; indistinct nodules on apex of femora.....5
5. Posterior pronotal lobe disc not smooth, either with thorn-like structures, or with spines.....6
- Posterior pronotal lobe disc smooth, without thorn-like structures or spines.....9
6. Posterior pronotal lobe disc with two medium thorn-like structures projected upward, corium with small to large white or yellow spots, femora width larger than mid- and hindfemur.....7
- Posterior pronotal lobe disc with spines projected upward, body covered with small and medium spines.....8
7. Humeral angle with two dull thorn-like structures*Astinus*
- Humeral angle with two sharp thorn-like structures.....*Epidaus*

8. Anterior pronotal lobe disc, transverse sulcus, and posterior humeral angle of pronotum with large spines, dorsum mostly fawn to brown.....*Polididus*
Anterior pronotal lobe disc, anterior humeral angle, posterior humeral angle, and posterior pronotal lobe disc with medium spines, dorsum mostly orange to reddish.....*Harpactorinae* sp. 4
9. One-third apex of corium usually with pale and strong yellow, orange, and red; scutellum with a single long spine vertically.....*Sycanus*
Corium usually with a single colours or basal have different colours than apex of corium, some corium with the present of spots or markings; scutellum without spine projected upward.....10
10. Foretibiae conspicuously curved, forefemur width larger than mid- and hindfemur.....11
Foretibiae straight, forefemur width either larger than or as same as mid- and hindfemur.....15
11. Apex of foretibiae without a single spine ventrally.....*Agyrius*
Apex of foretibiae with a single spine ventrally.....12
12. Apex of forefemur black; posterior pronotal lobe either with or without black markings.....13
Forefemur black; posterior pronotal lobe red with black spot at the middle and black lines at humeral angle.....*Harpactorinae* sp. 3
13. Pronotum with black markings, membrane and basal of hemelytra dark brown; two black lines at the middle of connexivum.....*Harpactorinae* sp. 2
Pronotum without black markings; membrane black.....14
14. Connexivum black alternate with yellow with basal of connexivum

- orange.....Harpactorinae sp. 1
- Connexivum light yellow with apex of connexivum black.....Harpactorinae sp. 5
15. Connexivum enlarged, connexivum side longer than humeral angle of pronotum;
small and large body size, length 11.82 – 29.95 mm , width 2.60 – 11.88 mm; legs
usually with sparse or dense, erect to semierect, short to moderate setae.....16
- Connexivum either slightly or enlarged, connexivum side shorter than humeral
angle of pronotum; small to medium body size, length mm, width mm; legs with
sparse, short to moderate erect to semierect setae.....19
16. Small body size, 11.82 mm, width 2.60 mm; legs with sparse moderate erect setae;
dorsum generally black except connexivum red.....*Poeciloclopius*
- Large body size, length 23.58 – 29.95 mm, width 8.04 – 11.88 mm; legs with
dense, erect to semierect, short to moderate length setae; dorsum colouration not as
above.....17
17. Connexivum smooth, not formed wave-like structures; semi-sphere black spots on
connexivum; dorsum usually orange or yellow with black colours.....*Eulyes*
- Connexivum formed wave-like structures; connexivum without semi-sphere black
spots; dorsum fawn, yellow, or red with black colours.....18
18. Connexivum with four large wave-like structures; dorsum usually black and dark
red; femora black.....*Yolinus*
- Connexivum with five large wave-like structures; dorsum with fawn, yellow or red
colours; femora with three different colours.....19
19. Connexivum with small yellow spots; dorsum head black; antennae first segment
black.....*Agriolestes*
- Connexivum without yellow spots; dorsum head black with collar yellow; antennae

alternate black and yellow.....	<i>Colpochilocoris</i>
20. Dorsum generally black and yellow colours; apex of femora and basal of tibiae black.....	21
Dorsum colouration not as above.....	23
21. Antennae alternate black and yellow; dorsum head black; medium body size, length 18.48 - 18.49 mm, width 3.35 - 3.63 mm.....	<i>Velinus</i>
Antennae do not alternate black and yellow; dorsum head black and yellow; small to medium body size, length 11.92 - 14.37 mm, width 2.25 – 3.10 mm.....	22
22. Dorsum head with yellow lines in front eyes and between eyes to collar; antennae yellow with basal black; membrane upper side with light yellow line at both side; scutellum spatulated.....	<i>Cosmolestes</i>
Dorsum head black with yellow colour between eyes; antennae black; membrane without light yellow line; scutellum not spatulated.....	<i>Campsolomous</i>
23. Dorsum colours alternate with black; anterior humeral angle with two thorn-like structures projected outward.....	<i>Isyndus</i>
Dorsum colours not alternate; anterior humeral angle smooth.....	24
24. Body elongate, size of lower body as same as middle body size.....	25
Body elongate oval, size of lower body enlarged than the middle body size.....	26
25. Posterior humeral angle with spine projected outward.....	<i>Euagoras</i>
Posterior humeral angle smooth, without spine projected outward.....	<i>Hagia</i>
26. Dorsum black; connexivum alternate black and orange.....	<i>Rhynocoris</i>
Dorsum with two or three colours; connexivum either with a single colour or alternate dark fawn with black.	27
27. Small body size, length 9.95 mm, width 2.90 mm; dorsum brown and black,	

connexivum alternate dark fawn and black.....	<i>Coranus</i>
Small body size, length 10.80 – 12.01 mm, width 2.34 – 2.73 mm; dorsum yellow, black, and orange; connexivum not alternate colours.....	28
28. Dorsum generally orange except head, antennae, apex of femora, tibiae, and membrane black; femora and collar yellow.....	<i>Sphedanolestes</i>
Dorsum yellow, fawn, and black colours.....	<i>Biasticus</i>

***Agriolestes festivus* (Miller, 1941)**

Figure 4.2

Agriolestes festivus Miller, 1941a: 714.

Maldonado 1990: 160.

Materials examined. Female: SARAWAK: Lundu: Gunung Begat [109.8372° E; 1.6719° N], 65 m, 5 May 1984, Lippa Apeng. SARAWAK: Sibuh [111.8308° E; 2.3000° N], 10m, 12 August 1984, Sarkawi Omar, 1♀.

Diagnosis. Large body size, total length almost 30.00 mm; enlarged fawn connexivum with semi-sphere structure and apex dark brown with medium yellow spots at between narrowed semi-sphere structures; forefemur with three colours, orange, black and fawn; and legs densely covered with moderate long setae.

Redescription. Female: COLOURATION. Head black; collar orangish; ocelli yellow; eyes black; underside head half black half orange; antennae first, second, and third segment black; labium black; anterior pronotal lobe orange; posterior pronotal lobe fawn; scutellum dark brown with two whitish spots at basal; hemelytra dark brown; corium with two medium yellowish spots; basal connexivum fawn and apex dark brown with medium yellow spots at between narrowed semi-sphere structure; abdomen basal orange with apex black; coxae orange; femur basal orange, middle black, and apex fawn; foretibiae basal

black, middle black, and apex black; midtibiae and hindtibiae black; tarsus black. VESTITURE. Densely setose. Dorsum head with dense moderate long, semierect to erect, and decumbent setae, anterior pronotal lobe with dense short, semierect, and decumbent setae; pronotum with dense moderate long, semierect, and decumbent setae, more dense laterally; and dense moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; large size, length 29.95 mm, width 11.21 mm - 12.21 mm; head elongated; posterior head region longer than anterior head region; eyes semi-globular; antennae scape short, length 0.85 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (3.36 mm) shorter than labium third segment (5.03 mm); anterior angle with two thorn-like structures erected forward; anterior pronotal lobe disc with deep line at the middle formed two nodules; anterior humeral angle rounded; posterior humeral angle widely rounded; posterior pronotal lobe disc smooth; hemelytra longer than abdomen apex; forefemur, midfemur, and hindfemur formed wave-like structure; forefemur width (1.15 mm) slightly larger than midfemur (0.95 mm) and hindfemur (0.97 mm) width; connexivum with semi-sphere structure and enlarged.

Male: Unknown.

Local distribution. Gunung Begat in Lundu and Sibuan in Sarawak.

Remarks. *Agriolestes festivus* is only known from a single male specimen recorded from Forest Research Centre. This species is characterized by large body size, enlarged connexivum with semi-sphere structures, and forefemur with three colourations.



Figure 4.2: Habitus photograph of *Agriolestes festivus*, ♀. Scale = 1 mm.

***Agyrius nr. podagricus* (Stål, 1863)**

Figure 4.3

Agyrius podagricus Stål, 1863a: 40.

Reduvius podagricus Walker, 1873a: 198.

Maldonado 1990: 161.

Materials examined. Male: SARAWAK: Niah: Niah Forest Reserve [113.6833° E; 3.6667° N], 124 m, 20 January 1985, Sarkawi Omar.

Diagnosis. Body colour red with head, apex femur, and tibiae black; apex of foretibiae gently curved downward; and width of forefemur extremely enlarged.

Redescription. Male: COLOURATION: Head black; collar orange; underside head black; eyes black; antennae first segment black, antennae second and third segment dark brown; pronotum red; scutellum dark red with apex red; hemelytra red with apex black and membrane strong fawn; clavus black continued to membrane; connexivum red; abdomen red; coxae red; femur basal red with apex black; tibiae basal black continued to brown with apex black; tarsus black. VESTITURE. Sparsely setose. Dorsum head with sparse short and decumbent setae; pronotum with sparse short and decumbent setae; and sparse short and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size,

length 14.90 mm, width 3.15 mm; head elongated; posterior head margin longer than anterior head margin; eyes semi-globular; antennae scape short, antennae first segment width slightly larger than antennae second and third segment width; labium long, length 3.85 mm, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.81 mm) longer than labium third segment (1.54 mm); anterior angle with two thorn-like erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line in the middle formed two nodules; posterior humeral angle rounded; posterior pronotal lobe disc smooth; forefemur width (1.02 mm) larger than midfemur (0.47 mm) and hindfemur (0.45 mm); foretibiae curved downward; connexivum smooth and slightly enlarged; hemelytra longer than abdomen apex.

Female: Unknown.

Local distribution. Niah Forest Reserve, Niah in Sarawak.

Remarks. *Agyrius podagricus* is only known from a single male specimen from Forest Research Centre. This species is characterized by body red in colour and forefemur is extremely enlarged.



Figure 4.3: Habitus photograph of *Agyrius* nr. *Podagricus*, ♂. Scale = 1 mm.

***Astinus* (Stål, 1859)**

Diagnosis. Medium size: body dark brown; head elongated, posteocular head region longer than anteocular head region; labium long and slender, labium second segment longer than third segment; posterior pronotal lobe with two thorn-like structures erected forward; humeral angle with two dull thorn-like structures projected outward; transverse sulcus in front of pronotum; corium with two white or yellow spots; forefemur width larger than midfemur and hindfemur.

Key to Genus *Astinus* (Stål, 1859)

1. Membrane with red line at both side.....2
 Membrane without red line at both side.....4
2. Posterior pronotal lobe with white marking.....3
 Posterior pronotal lobe with yellowish marking.....*Astinus* sp. 1
3. Connexivum enlarged.....*A. pustulatus*
 Connexivum slightly enlarged.....*A. nebulo*
4. Connexivum pointed at the middle before narrowed to the basal.....*Astinus* sp. 2
 Connexivum rounded.....*A. m-album*

***Astinus m-album* (Amyot & Serville, 1843)**

Figure 4.4

Ploeogaster M-album Amyot & Signoret, 1843a: 364.

Ploeogaster modestus Stål, 1854a: 238.

Astinus modestus Stål, 1861a: 132.

Ploeogaster m-album Walker, 1873b: 92.

Astinus m-album Stål, 1874a: 22.

Maldonado 1990: 166.

Materials examined. Male: SARAWAK: Kuching: Bako National Park [110.4667° E; 1.7167° N], 129 m, 4 May 1979, Mercer & Yeo Eng Teck. SARAWAK: Sibü [111.8308° E; 2.3000° N], 10 m, 14 April 1981, Haidir Nusi, 1♀. SARAWAK: Kuching, Bako National Park [110.4667° E; 1.7167° N], 129 m, 3 May 1979, Mercer & Yeo Eng Teck, 1♂. SARAWAK: Niah [113.7309° E; 3.8665° N], 8 m, 21 May 1980, Mercer & Suhaili, 1♂. SARAWAK: Niah, Niah National Park [113.7869° E; 3.7981° N], 331 m, 18 May 1980, Mercer & Suhaili, 1♀. SARAWAK: Kuching: Bako National Park [110.4667° E; 1.7167° N], 129 m, 16 May 1980, Yeo Eng Teck, 1♂. SARAWAK: Niah [113.7309° E; 3.8665° N], 8 m, 26 April 1981, Lippa Apeng, 1♀.

Diagnosis. Posterior humeral angle with two medium and two small dull thorn-like structures; fawn colour on the head, pronotum, scutellum, and legs; connexivum and basal hemelytra with dark brown; and connexivum enlarged and rounded.

Redescription. Male: COLOURATION. Head fawn; underside head fawn; eyes light yellow; ocelli black; antennae first and third segment fawn, antennae second segment fawn with apex black; labium second segment fawn, labium third segment fawn with apex dark fawn, labium fourth segment dark fawn; anterior pronotal lobe dark fawn to brown; posterior pronotal lobe brown to dark fawn; scutellum brown with apex dark fawn; hemelytra basal brown, corium dark brown with medium white spots at both side, and membrane light yellow; connexivum dark brown with basal and apex yellow; abdomen black with medium yellow spot at basal and small yellow spots scattered around abdomen; forecoxae fawn; midcoxae, and hindcoxae dark brown; forefemur fawn with apex dark fawn line; midfemur yellow; hindfemur yellow with fawn line at the middle; foretibiae light fawn; midtibiae and hindtibiae yellow; tarsus fawn. VESTITURE. Moderately setose. Dorsum head with sparse short and decumbent setae; pronotum with sparse short and

decumbent setae; and dense short, semierect, and decumbent setae over entire legs.

STRUCTURE. Body elongated-oval; medium size, length 16.99 mm – 19.40 mm, width 5.26 mm – 7.13 mm; head elongated; postocular head region longer than anteocular head region; eyes semi-globular; antennae scape short, antennae first segment width slightly larger than antennae second and third segment width; labium long, length 3.98 mm, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (2.21 mm) longer than labium third segment (1.25 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior pronotal lobe disc with two medium thorn-like structures projected upward; posterior humeral angle with two medium and two small thorn-like structures projected outward; hemelytra longer than abdomen apex; forefemur width (0.79 mm) larger than midfemur (0.38 mm) and hindfemur (0.38 mm) width; connexivum smooth and enlarged.

Female: Body colouration and body structures are mostly the same as in male except for the body size in the female are slightly larger than male in both length and width; medium body size, length 19.94 mm – 21.80 mm, width 7.69 mm – 8.07 mm.

Local distribution. Bako National Park in Kuching, Niah National Park in Niah, Niah, Sibuan, and Mulu National Park in Mulu, Sarawak.

Remarks. *Astinus m-album* shared the same posterior disc with *A. nebulo*, *A. pustulatus*, *Astinus* sp. 1, and *Astinus* sp. 2 by having two medium and two small dull thorn-like structures on the posterior humeral angle. On the other hand, *A. m-album* is distinguished from other *Astinus* species mentioned above by having fawn colour on the head, pronotum, scutellum, and legs, connexivum and basal hemelytra with dark brown, and connexivum enlarged and rounded.



Figure 4.4: Habitus photograph of *Astinus m-album*, ♂. Scale = 1 mm.

***Astinus nebulo* (Miller, 1941)**

Figure 4.5

Astinus nebulo Miller, 1941a: 757 (sp. n.).

Maldonado 1990: 166.

Materials examined. SARAWAK: Betong: Maludam [111.0139° E; 1.6058° N], 10 m, 20 Jun 1964, R. Hai. SARAWAK: Kuching: Batu Kitang [110.2821° E; 1.4514° N], 18 m, 18 January 1962, S. Kueh. SARAWAK: Serian: Tarat Agriculture Station [110.5348° E; 1.2060° N] 24 m, 16 April 1963. SARAWAK: Kuching: Sungei Tengah [110.2572° E; 1.5537° N] 12 m, 13 July 1965, Salim Junes.

Diagnosis. Two medium and two small dull thorn-like structures on the posterior humeral angle; brown to dark brown colours on the head, pronotum, scutellum, connexivum, and forefemur; red line at transverse sulcus of corium; and connexivum slightly enlarged.

Redescription. COLOURATION. Head brown; underside head brown; eyes black; ocelli brown; antennae first and second segment fawn with apex black; antennae third segment fawn; labium second segment brown, labium third segment brown with apex dark brown, labium fourth segment dark brown; anterior pronotal lobe dark brown; posterior pronotal lobe dark brown with white markings in front thorn-like structures; scutellum black with

white markings at both basal side; hemelytra brown, corium with medium white spots at both side and small white spots scattered, and membrane light fawn with red line at both side; connexivum dark brown with basal fawn; abdomen black with small white spots scattered; forecoxae brown; midcoxae and hindcoxae black; forefemur brown; midfemur and hindfemur fawn to dark fawn; foretibiae light brown; midtibiae and hindtibiae fawn to dark fawn; tarsus dark fawn. VESTITURE. Moderately setose. Dorsum head with sparse short and decumbent setae, scattered moderate and long setae; pronotum with short to moderate long, semierect and decumbent setae; and dense short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 18.78 mm – 20.57 mm, width 4.97 mm – 6.66 mm; head elongated; postocular head region longer than anteocular head region; eyes semi-globular; antennae scape short, length 0.32 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.98 mm) longer than labium third segment (1.39 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior pronotal lobe disc with two medium thorn-like structures projected upward; posterior humeral angle with two medium and two small thorn-like structures projected outward; hemelytra longer than abdomen apex; connexivum smooth and slightly enlarged; forefemur width (0.87 mm) larger than midfemur (0.40 mm) and hindfemur width (0.38 mm).

Local distribution. Maludam in Betong, Batu Kitang in Kuching, Tarat Agriculture Station in Serian, Sungei Tengah in Kuching, Serian, Sematan in Lundu, Sarawak.

Remarks. *Astinus nebulo* shared the same posterior disc with *A. m-album*, *A. pustulatus*, *Astinus* sp. 1, and *Astinus* sp. 2 by having two medium and two small dull thorn-like structures on the posterior humeral angle. On the other hand, *A. nebulo* is distinguished from other *Astinus* species mentioned above by brown to dark brown colours on the head, pronotum, scutellum, connexivum, and forefemur, red line at both side of hemelytra membrane, and connexivum slightly enlarged.



Figure 4.5: Habitus photograph of *Astinus nebulo*. Scale = 1 mm.

***Astinus pustulatus* (Stål, 1863)**

Figure 4.6

Astinus pustulatus Stål, 1863a: 30.

Ploeogaster pustulatus Walker, 1873b: 92.

Maldonado 1990: 166.

Materials examined. Male: SARAWAK: Sibuan: Oya: Road Nursery [111.9212° E; 2.2960° N] 12m, 21 April 1983, Hamid & Yeo Eng Teck. SARAWAK: Sibuan: Oya: Road Nursery [111.9212° E; 2.2960° N], 12 m, 16 December 1982, Ento Team, 2♂. SARAWAK: Sibuan: Oya: Road Nursery [111.9212° E; 2.2960° N], 12 m, 17 December 1982, Ento Team, 1♂. SARAWAK: Sibuan: Oya: Road Nursery [111.9212° E; 2.2960° N], 12 m, 18 December 1982, Ento Team, 1♂. SARAWAK: Sibuan: Oya: Road Nursery [111.9212° E; 2.2960° N],

12 m, 19 December 1982, Ento Team, 1♀. SARAWAK: Sibuhaya: Road Nursery [111.9212° E; 2.2960° N], 12 m, 2 October 1981, Ento Team, 1♀. SARAWAK: Miri: PPB Oil Palm Plantation: Saremas 2 [114.0060° E; 4.3320° N], 17 m, 6 February 2015, Ento team, 1♀.

Diagnosis. Two medium and two small dull thorn-like structures on the posterior humeral angle; brown to dark brown colours on the head, pronotum, scutellum, connexivum, forefemur, and foretibiae; red line at transverse sulcus of corium; white markings on pronotum; yellow colours on apex of abdomen and basal connexivum; and connexivum enlarged.

Redescription. Male: COLOURATION. Head brown; collar brown; underside head brown; eyes black; ocelli yellow; antennae first and fourth segment brown, antennae second segment brown with apex black, antennae third segment brown with basal black; labium second segment brown, labium third segment brown with black line at apex, labium fourth segment dark brown with black tip; anterior pronotal lobe dark brown with white markings on both sides of anterior humeral angle; posterior pronotal lobe dark brown with white markings at basal; scutellum dark brown with white spot on both side of basal; hemelytra basal dark brown with small white spots at both side, corium black with medium white spots at both side and small white spots scattered, membrane yellow; connexivum black with basal yellow and small, scattered white marking at the middle of both side; abdomen black with small to medium white marking scattered; coxae black; forefemur brown with black line at apex; midfemur yellow with brown line at the middle; hindfemur basal yellow to brown at apex; foretibiae brown; midtibiae and hindtibiae yellow to light brown at apex and with black line at the middle; tarsus brown with apex dark brown. VESTITURE. Moderately setose. Dorsum head with short to moderate long, semierect to

erect and decumbent setae, anterior pronotal lobe with dense short, semierect and decumbent setae; pronotum with moderate long, semierect to erect and decumbent setae, more dense laterally; and dense short, semierect to erect, and decumbent setae over entire legs. **STRUCTURE.** Body elongated-oval; medium size, length 16.69 mm – 18.76 mm, width 5.41 mm – 6.02 mm; head elongated; postocular head region longer than anteocular head region; eyes semi-globular; antennae scape short, length 0.44 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (2.02 mm) longer than labium third segment (1.30 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; transverse sulcus behind anterior pronotal lobe with two small thorn-like structures projected upward; posterior pronotal lobe disc with two medium thorn-like structures projected upward; posterior humeral angle with two medium and two small thorn-like structures projected outward; hemelytra longer than abdomen apex; connexivum smooth and enlarged; forefemur width (0.68 mm) larger than midfemur (0.39 mm) and hindfemur width (0.36 mm).

Female: Body colouration and body structures are mostly as same as in male except for the body size in the female are greatly differ than male in both length and width; medium body size, length 19.47 mm – 20.60 mm, width 5.57 mm – 6.93 mm.

Local distribution. Oya Nursery Road in Sibul, Miri PPB Oil Palm Plantation, Niah, and Semenggoh in Kuching, Sarawak.

Remarks. *Astinus pustulatus* shared the same posterior disc with *A. m-album*, *A. nebulo*, *Astinus* sp. 1, and *Astinus* sp. 2 by having two medium and two small dull thorn-like

structures on the posterior humeral angle. On the other hand, *A. pustulatus* is distinguished from other *Astinus* species mentioned above by having brown to dark brown colours on the head, pronotum, scutellum, connexivum, forefemur, and foretibiae, red line at both sides of hemelytra membrane, white markings on pronotum, and connexivum enlarged.



Figure 4.6: Habitus photograph of *Astinus pustulatus*, ♂. Scale = 1 mm.

***Astinus* sp. 1**

Figure 4.7

Materials examined. Female: SARAWAK: Sibul: Oya, Road Nursery [111.9212° E; 2.2960° N], 12 m, 10 April 1981, Lippa Apeng. SARAWAK: Balul: Sungai Nah [113.7317° E; 2.25946° N], 496 m, 18 Jun 1994, C. K. Lim, 1♀.

Diagnosis. Two medium and two small dull thorn-like structures on posterior humeral angle; brown to dark brown colours on head, pronotum, scutellum, hemelytra, forefemur, and foretibiae; connexivum black, red line at transverse sulcus of corium; corium with two fade medium yellow spots; yellow markings on pronotum; fade yellow color on basal connexivum; and connexivum enlarged.

Redescription. Female: COLOURATION. Head brown; collar black; underside head brown; eyes dark brown; antennae first segment yellow with basal dark brown; labium second segment dark brown, labium third segment brown, labium fourth segment brown

with apex dark brown; anterior pronotal lobe dark brown; posterior pronotal lobe dark brown with yellow marking at basal; scutellum dark brown; hemelytra basal dark brown, corium with medium yellow spot at both sides, membrane dark yellow with red line at both side; connexivum black with basal brown; abdomen black with small yellow spots scattered; forecoxae dark brown; midcoxae and hindcoxae black; forefemur brown; midfemur and hindfemur yellow; foretibiae brown; midtibiae and hindtibiae yellow; tarsus brown. VESTITURE. Moderately setose. Dorsum head with sparse short to moderate long, semierect to erect and decumbent setae, anterior pronotal lobe with short, semierect and decumbent setae; pronotum with moderate long, semierect to erect and decumbent setae, more dense laterally; and dense short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 19.24 mm – 19.50 mm, width 5.82 mm – 7.22 mm; head elongated; postocular head region longer than anteocular head region; eyes semi-globular; antennae scape short, length 0.46 mm; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (2.52 mm) longer than labium third segment (1.96 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior pronotal lobe disc with two medium thorn-like structures projected upward; posterior humeral angle with two medium and two small thorn-like structures projected outward; hemelytra longer than abdomen apex; forefemur width (0.84 mm) larger than midfemur (0.48 mm) and hindfemur width (0.47); connexivum smooth and enlarged.

Male: Unknown.

Local distribution. Oya Nursery Road in Sibul, and Sungai Nah in Balul, Sarawak.

Remarks. *Astinus* sp. 1 shared the same posterior disc with *A. m-album*, *A. nebulo*, *A. pustulatus*, and *A. sp. 2* by having two medium and two small dull thorn-like structures on the posterior humeral angle. On the other hand, *A. sp. 1* is distinguished from other *Astinus* species mentioned above by having brown to dark brown colours on the head, pronotum, scutellum, hemelytra, forefemur, and foretibiae, connexivum black, red line at both sides of hemelytra membrane, and yellow markings on the pronotum.



Figure 4.7: Habitus photograph of *Astinus* sp. 1, ♀. Scale = 1 mm.

***Astinus* sp. 2**
Figure 4.8

Materials examined. Female: SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 19 April 2013, Adzmier, Kamaliyah, & Shahira.

Diagnosis. Two medium and two small dull thorn-like structures on the posterior humeral angle; brown to dark brown colours on the head, scutellum, hemelytra, forefemur, and hindfemur; dark fawn with black at the middle on connexivum; black pronotum with white markings; and connexivum pointed at the middle before narrowed to the basal.

Redescription. Female: COLOURATION. Head brown; underside head fawn; eyes dark brown; ocelli brown; antennae first fawn, antennae second and third segments brown with apex dark brown, antennae fourth segment brown; labium second segment fawn, labium

third segment fawn with basal and apex brown, labium fourth segment brown; anterior pronotal lobe dark brown to black; posterior pronotal lobe black with brown line across basal, and white markings in front thorn-like structures; scutellum dark brown with white marking at both basal side; hemelytra dark brown, corium with large white spots on both side, and membrane fawn; connexivum dark fawn with black at the middle; abdomen black with small white spots scattered and at the middle of basal abdomen dark fawn; forecoxae, midcoxae, and hindcoxae dark fawn; forefemur brown with black line at apex; midfemur fawn; hindfemur fawn with black line at the middle; foretibiae light brown; midtibiae and hindtibiae fawn to dark fawn; tarsus dark fawn. VESTITURE. Moderately setose. Dorsum head with short, semierect to erect and decumbent setae, scattered moderate long, semierect setae; pronotum with moderate long, semierect and decumbent setae, more dense laterally; and dense short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 20.00 mm, width 6.82 mm; head elongated; postocular head region longer than anteocular head region; eyes semi-globular; antennae scape short, length 0.49 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (2.66 mm) longer than labium third segment (1.70 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior pronotal lobe disc with two medium thorn-like structured projected upward; posterior humeral angle with two medium and two small thorn-like structures projected outward; hemelytra longer than abdomen apex; forefemur width (0.85 mm) larger than midfemur (0.48 mm) and hindfemur width (0.41 mm); connexivum smooth, enlarged, and pointed at the middle before narrowed to the basal.

Male: Unknown.

Local distribution. Universiti Malaysia Sarawak in Kota Samarahan, and Miri PPB Oil Palm Plantation, Sarawak.

Remarks. *Astinus* sp. 2 shared the same posterior disc with *A. m-album*, *A. nebulo*, *A. pustulatus*, and *Astinus* sp. 1 by having two medium and two small dull thorn-like structures on the posterior humeral angle.



Figure 4.8: Habitus photograph of *Astinus* sp. 2, ♀. Scale = 1 mm.

***Biasticus moultoni* (Bergroth, 1913)**

Figure 4.9

Biasticus moultoni Bergroth, 1913d: 28.

Maldonado 1990: 172.

Materials examined. Female: SARAWAK: Bintulu: Labang Forest Reserve [113.5667° E; 3.3667° N], 38 m, 21 August 1985, Ento team. SARAWAK: Kuching: Kenari College [110.3349° E; 1.5742° N], 5 m, 18 August 2002, Liza, 1♀.

Diagnosis. Small body size, total length below 11.00 mm; yellow on posterior pronotal lobe disc; connexivum uni-coloured, dark orange; and femur uni-coloured, dark brown.

Redescription. Female: COLOURATION. Head black; underside head yellow; eyes dark brown; ocelli light yellow; antennae dark brown; labium second segment dark brown,

labium third segment brown with basal dark brown, labium fourth segment brown; anterior pronotal lobe disc dark brown to black; posterior pronotal lobe disc yellow; scutellum dark brown; hemelytra dark orange, clavus dark brown continue to membrane; connexivum dark orange; abdomen yellow with three medium black line across and abdomen side apex with two medium black spots; coxae dark brown; femur dark brown; tibiae dark brown; tarsus dark brown. VESTITURE. Moderately setose. Dorsum head with short to moderate long, semierect to erect and decumbent setae, anterior pronotal lobe with short, semierect and decumbent setae; pronotum with moderate long, semierect and decumbent setae, more dense laterally; and dense short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; small size, length 10.60 mm- 10.99 mm, width 2.21 mm – 2.46 mm; head elongated; posterior head region longer than anterior head region; eyes semi-globular; antennae scape short, length 0.28 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.07 mm) longer than labium third segment (0.98 mm); anterior angle rounded; anterior humeral angle rounded; anterior pronotal lobe disc smooth; posterior humeral angle widely rounded; posterior pronotal lobe disc smooth; forefemur width (0.37 mm) almost same size with midfemur (0.34 mm) and hindfemur (0.32 mm); connexivum smooth and slightly enlarged; hemelytra longer than abdomen apex.

Male: Unknown.

Local distribution. Labang Forest Reserve in Labang, and Kenari College in Kuching, Sarawak.

Remarks. *Biasticus moultoni* is similar to *Biasticus* sp. 1 and even shared the same body size by having below 11.00 mm total body length, but this species can be differentiated

from it by body colouration. *Biasticus moultoni* is distinguished from *Biasticus* sp. 1 by having yellow on posterior pronotal lobe disc, connexivum uni-coloured; dark orange, and femur uni-coloured; dark brown, whereas *Biasticus* sp. 1 having brown posterior pronotal lobe disc, yellow connexivum with brown colour at the middle, and femur light brown to dark brown.



Figure 4.9: Habitus photograph of *Biasticus moultoni*, ♀. Scale = 1 mm.

***Biasticus* sp. 1**

Figure 4.10

Materials examined. Male: SARAWAK: Bintulu: Sungai Sibiyu: Res. Station [113.0901° E; 3.1906° N], 8 m, 10 January 1985, Haidir Nusi. SARAWAK: Limbang [115.0081° E; 4.7550° N], 7 m, 15 October 1985, Lippa Akeng, 1♀. SARAWAK: Kuching: Semenggoh [110.2951° E; 1.3811° N], 47 m, 23 January 1979, A. A. Hamid, 1♀.

Diagnosis. Small body size with total length below 11.00 mm; brown posterior pronotal lobe disc; yellow connexivum with brown colour at the middle; and femur light brown to dark brown.

Redescription. Male: COLOURATION. Head dark brown; underside head fawn; eyes black; ocelli light brown; antennae first segment fawn with apex brown, antennae second

and third segment brown; labium second segment light brown with brown at both side, labium third segment light brown with brown line at the middle from basal to apex, labium fourth segment brown; anterior pronotal lobe disc black; posterior pronotal lobe disc brown with humeral angle light brown; scutellum dark brown; hemelytra dark brown with membrane light yellow; connexivum yellow with brown at the middle; abdomen yellow with large brown line at the middle; coxae dark brown; forefemur brown to dark brown; midfemur and hindfemur light brown with apex dark brown; foretibiae, midtibiae, and hindtibiae light brown with basal dark brown; tarsus light brown. VESTITURE. Moderately setose. Dorsum head with short to moderate long, semierect to erect and decumbent setae, anterior pronotal lobe with short, semierect and decumbent setae; pronotum with short, semierect and decumbent setae, more dense laterally; and sparse moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; small size, length 10.31 mm – 10.42 mm, width 3.05 mm – 3.18 mm; head elongated; posterior head region longer than anterior head region; eyes semi-globular; antennae scape short, length 0.30 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.06 mm) longer than labium third segment (0.79 mm); anterior angle with thorn-like structures; anterior humeral angle rounded; anterior pronotal lobe disc smooth; posterior humeral angle widely rounded; posterior pronotal lobe disc smooth; forefemur width (0.35 mm) almost same size with midfemur (0.31 mm) and hindfemur (0.30 mm); connexivum smooth and slightly enlarged; hemelytra longer than abdomen apex.

Female: Body colouration and body structures are mostly as same as in male except for the body size in the female are slightly differ than male in both length and width; small body size, length 10.31 mm – 10.42 mm, width 3.05 mm – 3.18 mm.

Local distribution. Semengoh in Kuching, Sungai Sibiyu in Bintulu, Santubong National Park in Kuching, and Limbang, Sarawak.

Remarks. *Biasticus* sp. 1 is similar to *Biasticus moultoni* and even shared the same body size by having below 11.00 mm total body length, but this species can be differentiated from it by body colouration. *Biasticus* sp. 1 is distinguished from *Biasticus moultoni* by having brown posterior pronotal lobe disc, yellow connexivum with brown colour at the middle, and femur light brown to dark brown, whereas *Biasticus moultoni* having yellow on posterior pronotal lobe disc, connexivum uni-coloured; dark orange, and femur uni-coloured; dark brown.



Figure 4.10: Habitus photograph of *Biasticus* sp. 1, ♀. Scale = 1 mm.

***Campsolomus* sp.**

Figure 4.11

Materials examined. Male: SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 28 February 2011, Muhammad Syafiq Bin Ahmad Zahari. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8

m, 3 February 1995, 1st Year Student, 1♂. SARAWAK: Unknown, 1♂. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 11 May 2013, Hazirah Hanun, 1♀. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 22 April 2012, Ummi Norhanifah Abdullah, 1♀.

Diagnosis. Dark yellow between eyes; black transverse sulcus on pronotum; black to dark brown on antennae; and connexivum dark yellow with small black spots.

Redescription. Male: COLOURATION. Head black, eyes black; distance between eyes dark yellow; underside head light yellow; ocelli yellow; antennae first segment fawn with basal and apex black, antennae second segment black, antennae third segment dark brown; labium second segment light yellow with apex brown and brown line at the middle from basal to apex, labium third segment dark brown, labium fourth segment black; anterior pronotal lobe dark yellow; transverse sulcus behind anterior pronotal lobe black; posterior pronotal lobe dark yellow; scutellum dark yellow with basal black; hemelytra dark yellow, clavus black continue to membrane; connexivum dark yellow with small black spots; coxae dark yellow; forefemur yellow with apex black and black line at the middle from basal to apex; midfemur and hindfemur yellow with apex black; tibiae yellow with basal black and apex dark brown; tarsus dark brown; abdomen dark yellow with abdomen side alternate black and white spot. VESTITURE. Moderately setose. Dorsum head with dense short to moderate long, semierect to erect and decumbent setae, anterior pronotal lobe with dense short, semierect and decumbent setae; pronotum with dense short to moderate long, semierect to erect, and decumbent setae, more dense laterally; and short to moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 13.73 mm – 14.62 mm, width 3.20 mm – 3.51 mm; head elongated; posteocular head region longer than anteocular head region; antennae scape

short, length 0.32 mm; antennae first segment width slightly larger than antennae second and third segment length; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.04 mm) shorter than labium third segment (1.99 mm); anterior angle with two thorn-like structure erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle widely rounded; posterior pronotal lobe disc smooth; connexivum smooth and same size with the side of abdomen; hemelytra longer than abdomen apex; forefemur width (0.56 mm) almost same size with midfemur (0.49 mm) and hindfemur width (0.42 mm).

Female: Body colouration and body structures are mostly as same as in male except for the body size in the female are slightly larger in length and slightly smaller in width than male; medium body size, length 14.12 mm – 14.61 mm, width 2.89 mm – 3.31 mm.

Local distribution. Universiti Malaysia Sarawak in Kota Samarahan and Miri PPB Oil Palm Plantation, Sarawak.

Remarks. *Campsolomus* sp. can easily be confused with *Cosmolestes picticeps* by having yellow and black body colours. However, *Campsolomus* sp. is differentiated from *Cosmolestes picticeps* by having body size almost 15.00 mm; dark yellow between eyes; black transverse sulcus on pronotum; black to dark brown on antennae; and connexivum dark yellow with small black spots, whereas *Cosmolestes picticeps* having body size almost 13.00 mm; yellow lines in front eyes and at the middle between eyes to collar; yellow, fawn and black antennae; connexivum yellow with black lines; transverse sulcus on corium light yellow; and scutellum with yellow flat-plate.



Figure 4.11: Habitus photograph of *Campsolomus* sp, ♂. Scale = 1 mm.

***Colpochilocoris horrendus* (Walker, 1873)**

Figure 4.12

Yolinus horrendus Walker, 1873b: 79.

Colpochilocoris fasciiventris Reuter, 1881a: 284.

Colpochilocoris horrendus Distant, 1903b: 212.

Maldonado 1990: 179.

Materials examined. Female: SARAWAK: Bintulu: Kemena [113.0450° E; 3.1692° N], 13m, 14 May 1981, Mercer, Lippa, & Suhaili. SARAWAK: Simunjan: Sungai Simunjan Kanan [110.8231° E; 1.2314° N], 20 m, 2 October 1980, Mercer, Lippa, & Rahman, 1♀.

Diagnosis. Large body size, total length almost 30.00 mm; enlarged connexivum with semi-sphere bowl-like structures; alternate black and yellow antennae colours; and legs densely covered with moderate long setose.

Redescription. Female: COLOURATION. Head black; collar light yellow; eyes dark yellow; ocelli light yellow; underside head light yellow; antennae alternate dark brown and yellow started with black, antennae second segment dark black, antennae third segment dark brown; labium second segment dark brown, labium third segment basal dark brown

with apex brown, labium fourth segment dark brown; anterior pronotal lobe yellow; posterior pronotal lobe fawn; scutellum dark yellow; hemelytra and membrane dark fawn; connexivum brown with medium orange spots at between narrowed semi-sphere structure; abdomen orange with large black line across at the middle; coxae orange; femur yellow with basal orange to fawn, and medium fawn line at the middle; tibiae basal yellow with apex dark brown; tarsus dark brown. VESTITURE. Densely setose. Dorsum head with dense short to moderate long, semierect to erect and decumbent setae, anterior pronotal lobe with dense short, semierect and decumbent setae; pronotum with dense moderate long, semierect and decumbent setae, more dense laterally; and dense moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; large size, length 29.26 mm – 30.26 mm, width 7.18 mm – 8.90 mm; head elongated; postocular head region longer than anteocular head region; eyes semi-globular; antennae scape short, length 0.75 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (2.46 mm) shorter than labium third segment (4.29 mm); anterior angle rounded; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle widely rounded; posterior pronotal lobe disc smooth; forefemur, midfemur, and hindfemur formed wave-like structure; connexivum with semi-sphere structure and enlarged; hemelytra longer than abdomen apex; forefemur width (0.91 mm) almost same size as midfemur (0.85 mm) and hindfemur width (0.81 mm).

Male: Unknown.

Local distribution. Kemena in Pandan, and Simunjan Kanan in Simunjan, Sarawak.

Remarks. *Colpochilocoris horrendus* is only known from two female specimens recorded from Forest Research Centre.



Figure 4.12: Habitus photograph of *Colpochilocoris horrendus*, ♀. Scale = 1 mm.

***Coranus fuscipennis* (Reuter, 1881)**

Figure 4.13

Coranus fuscipennis Reuter, 1881a: 275.

Maldonado 1990: 182.

Materials examined. SARAWAK: Kota Samarahan [110.4883° E; 1.4599° N], 6 m, 17 May 1966, G. H. L. Rothchild. SARAWAK: Serian [110.5665° E; 1.1670° N], 21 m, 11 October 1962, G. H. L. Rothchild. SARAWAK: Miri: Lambir [114.0429° E; 4.2984° N], 56 m, 3 August 1965, Unknown. SARAWAK: Kuching [110.3785° E; 1.6077° N], 9 m, 8 October 1962, G. H. L. Rothchild.

Diagnosis. Small body size, total length below 10.00 mm; and dark body colours, fawn, brown to dark brown and black.

Redescription. COLOURATION. Head black with orange line from between eyes to collar; collar with small orange line; antennae first segment brown with apex dark brown; labium second and third segment brown, labium fourth segment black; anterior pronotal lobe dark brown to black, posterior pronotal lobe brown; scutellum dark brown to black;

hemelytra dark fawn with membrane brown to dark brown; connexivum alternate dark fawn and black start with black; abdomen black; coxae dark brown; femur brown to dark brown; tibiae alternate dark fawn with basal and apex dark brown; tarsus dark fawn with apex dark brown. **STRUCTURE.** Body elongated-oval; medium size, length 9.48 mm – 10.66 mm, width 2.37 mm – 3.65 mm; head elongated; posterior head region longer than anterior head region; antennae scape short, length 0.29 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (0.92 mm) shorter than labium third segment (1.33 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep hole at the middle formed two nodules; posterior humeral angle rounded; posterior pronotal lobe disc smooth; scutellum with a small single thorn-like structure projecting upward; forefemur, midfemur, and hindfemur formed wave-like structure; hemelytra same as abdomen apex; connexivum smooth and slightly enlarged; forefemur width (0.37 mm) almost same size as midfemur (0.39 mm) and hindfemur width (0.38 mm).

Local distribution. Kota Samarahan, Kuching, Lambir in Miri, Borneo Highland in Padawan, and Serian, Sarawak.

Remarks. *Coranus fuscipennis* are only specimens known from Semonggok Agriculture Research Centre in Sarawak with unknown sexes as the specimens were collected in 1962 and were fragile to be handled.



Figure 4.13: Habitus photograph of *Coranus fuscipennis*. Scale = 1 mm.

***Cosmolestes picticeps* (Stål, 1859)**

Figure 4.14

Reduvius picticeps Stål, 1859a: 204.

Velinus picticeps Stål, 1866a: 281.

Harpactor picticeps Walker, 1873b: 112.

Cosmolestes picticeps Stål, 1874a: 32.

Maldonado 1990: 188.

Materials examined. Male: SARAWAK: Niah [113.7309° E; 3.8665° N], 8 m, 24 September 1981, Ento Team. SARAWAK: Kuching: Semengoh [110.2951° E; 1.3811° N], 47 m, 8 December 1981, A. Rahman Osman, 2♀. SARAWAK: Sibul: Oya: Road Nursery [111.9212° E; 2.2960° N], 12 m, 14 December 1982, Ento Team, 2♀. SARAWAK: Niah [113.7309° E; 3.8665° N], 8 m, 20 May 1980, Mercer & Suhaili, 1♂. SARAWAK: Sibul [111.8308° E; 2.3000° N], 10 m, 2 October 1981, Ento Team, 1♀. SARAWAK: Niah [113.7309° E; 3.8665° N], 8 m, 26 May 1981, Alex & Yeo, 2♀.

Diagnosis. Light yellow flat-plate on the apex of scutellum; light yellow line at the transverse sulcus on corium; and yellow line at the middle of the head.

Redescription. Male: COLOURATION. Head black with yellow lines in front eyes and between eyes to collar; eyes black with yellow surrounded; underside head yellow; antennae first segment basal black with alternate fawn and yellow; antennae second segment fawn with apex black, antennae third segment fawn, antennae fourth segment dark fawn; labium second segment yellow with apex black, labium third segment yellow, labium fourth segment brown; anterior pronotal lobe brown with side yellow; posterior pronotal lobe yellow; scutellum dark brown with apex yellow; hemelytra yellow with clavus dark fawn continue to membrane; membrane upper side with light yellow line at both side; connexivum light yellow with black lines; abdomen yellow with side of abdomen white and black spots; coxae yellow; femur yellow with apex black; tibiae yellow with basal black; tarsus brown. VESTITURE. Moderately setose. Anterior pronotal lobe with short, semierect setae, posterior pronotal lobe with sparse moderate long, semierect setae; pronotum with dense short, semierect to erect and decumbent setae, more dense laterally; and sparse short to moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; small size, length 11.73 mm – 12.29 mm, width 1.42 mm – 2.64 mm head elongated, postocular head region longer than anteocular head region; antennae scape short, length 0.32 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.28 mm) shorter than labium third segment (0.29 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle widely rounded; posterior pronotal lobe disc smooth; apex of scutellum with flat-plate; connexivum smooth and same size with the side of abdomen; hemelytra longer than abdomen apex; forefemur

width (0.46 mm) almost same size as midfemur (0.41 mm) and hindfemur width (0.37 mm).

Female: Body colouration and body structures are mostly the same as in male except for the body size where female slightly differ than male, small body size; length 10.75 mm – 13.11 mm, width 2.24 mm – 3.17 mm.

Local distribution. Limbang, Kuching, Sibul, Serian, Sri Aman, Mukah, Engkilili, Kota Samarahan, Bako National Park in Kuching, Bau in Lundu, Sarikei, Betong, Kapit, Tarat Agriculture Station in Serian, Miri PPB Oil Palm Plantation, Semenggoh in Kuching, Sematan, and Niah, Sarawak.

Remarks. *Cosmolestes picticeps* can easily be confused with *Campsolomus* sp. by having yellow and black body colours. However, *Cosmolestes picticeps* is differentiated from *Campsolomus* sp. by having body size almost 13.00 mm; yellow lines in front eyes and at the middle between eyes to collar; yellow, fawn and black antennae; connexivum yellow with black lines; transverse sulcus on corium with light yellow; and scutellum with yellow flat-plate, whereas *Campsolomus* sp. having body size almost 15.00 mm; dark yellow between eyes; black transverse sulcus on pronotum; black to dark brown on antennae; and connexivum dark yellow with small black spots.



Figure 4.14: Habitus photograph of *Cosmolestes picticeps*, ♂. Scale = 1 mm.

***Epidaus* (Stål, 1859)**

Diagnosis. Medium size: head elongated, postocular head region longer than anteocular head region; labium long and slender, labium second segment longer than third segment; posterior pronotal lobe with two thorn-like structures erected forward; humeral angle with two sharp thorn-like structures projected outward; transverse sulcus in front of pronotum; corium usually with two small to medium white spots; forefemur width larger than midfemur and hindfemur.

Key to Genus *Epidaus* (Stål, 1859)

1. Body colour brown to dark brown.....2
Body orange to dark fawn.....3
2. Posterior pronotal lobe with two medium yellow spots.....*E. conspersus*
Posterior pronotal lobe without yellow spots.....*Epidaus* sp. 1
3. Connexivum slightly enlarged.....*E. latispinus*
Connexivum enlarged.....4
4. Connexivum pointed downward at the middle.....*Epidaus* sp. 2
Connexivum rounded.....5
5. Connexivum uni-coloured.....*E. validispinus*
Connexivum bi-coloured.....*Epidaus* sp. 3

***Epidaus conspersus* (Stål, 1863)**

Figure 4.15

Epidaus conspersus Stål, 1863a: 26.

Euagoras conspersus Walker, 1873b: 122.

Maldonado 1990: 199.

Materials examined. Female: SARAWAK: Niah [113.7309° E; 3.8665° N], 8 m, 24 February 1979, Hamid.

Diagnosis. Two medium and two small sharp thorn-like structures on the posterior humeral angle; brown to dark brown body colour; uni-coloured connexivum; and two medium yellow spots on the pronotal disc.

Redescription. Female: COLOURATION. Head brown; collar light brown; eyes black; ocelli brown; underside head brown; antennae first, second and third segments brown; labium brown; anterior pronotal lobe dark brown; posterior pronotal lobe dark brown with two medium yellow spots at basal side; scutellum dark brown with two medium whitish spots at basal side; hemelytra brown with small to medium whitish spots scattered and membrane fawn; connexivum dark fawn; abdomen dark brown to black with small to medium white spots scattered and abdomen side dark fawn; coxae brown; forefemur brown with basal dark brown; midfemur and hindfemur brown with apex dark brown; foretibiae brown to dark brown; midtibiae and hindtibiae brown; tarsus brown. VESTITURE. Moderately setose. Dorsum head with short, semierect to erect and decumbent setae; pronotum with dense short, semierect to erect and decumbent setae, more dense laterally; and sparse short to moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 16.98 mm, width 4.58 mm; head elongated, postocular head region longer than anteocular head region; antennae scape short, length 0.66 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.96 mm) longer than labium third segment (1.73 mm); anterior angle with two thorn-like structure erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line formed two nodules;

posterior humeral angle with two medium and two small thorn-like structure projected outward; posterior pronotal lobe disc with two thorn-like structure projected upward; connexivum smooth and slightly enlarged; hemelytra same as abdomen apex; forefemur width (0.57 mm) larger than midfemur (0.33 mm) and hindfemur (0.23 mm).

Male: Unknown.

Local distribution. Niah, Sarawak.

Remarks. *Epidaus conspersus* is only known from a single female specimen. This species shared the same posterior disc with *E. latispinus*, *E. validispinus*, *Epidaus* sp. 1, *Epidaus* sp. 2, and *Epidaus* sp. 3 by having two medium and two small sharp thorn-like structures on the posterior humeral angle. On the other hand, *E. conspersus* is distinguished from other *Epidaus* species mentioned above by having brown to dark brown body colour, unicoloured connexivum, and two medium yellow spots on the pronotal disc.



Figure 4.15: Habitus photograph of *Epidaus conspersus*, ♀. Scale = 1 mm.

***Epidaus latispinus* (Stål, 1863)**

Figure 4.16

Epidaus latispinus Stål, 1863a: 25.

Euagoras latispinus Walker, 1873b: 122.

Maldonado 1990: 199.

Materials examined. Male: SARAWAK: Kuching: Semenggoh [110.2951° E; 1.3811° N], 47 m, 28 August 1982, Yeo Eng Teck. SARAWAK: Kuching: Semenggoh [110.2951° E; 1.3811° N], 47 m, 1 February 1982, Haidir Nusi, 1♂.

Diagnosis. Two medium and two small sharp thorn-like structures on posterior humeral angle; fawn to dark fawn body colour; and connexivum slightly enlarged.

Redescription. Male: COLOURATION. Head fawn; eyes black; ocelli black; underside head fawn; antennae first segment and second segment dark fawn; labium first segment fawn, labium second segment light fawn, labium third segment light fawn with apex dark fawn; anterior pronotal lobe fawn; posterior pronotal lobe dark fawn; scutellum dark brown with apex dark fawn; hemelytra and membrane fawn with two medium white spots at both sides of corium and two small white spots below medium spot at both sides, clavus dark fawn continue to membrane side; connexivum light fawn to dark brown; abdomen brown to black with whitish markings scattered; forecoxae dark fawn, midcoxae, and hindcoxae brown; femur light fawn to fawn; tibiae light fawn to fawn; tarsus fawn. VESTITURE. Moderately setose. Dorsum head with dense short, semierect to erect and decumbent setae; pronotum with dense short, semierect and decumbent setae, more dense laterally; and dense short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 18.69 mm – 19.20 mm, width 3.60 mm – 4.17 mm; head elongated, posteocular head region longer than anteocular head region; antennae scape short, length 0.46 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.61 mm) shorter than labium third segment (2.07 mm); anterior angle with two thorn-like structures erected sideward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line

formed two nodules; posterior humeral angle with two medium and two small thorn-like structures projected outward; posterior pronotal lobe disc with two thorn-like structures projected upward; connexivum smooth and slightly enlarged; hemelytra same as abdomen apex; forefemur width (0.58 mm) larger than midfemur (0.43 mm) and hindfemur (0.45 mm).

Female: Unknown.

Local distribution. Semengoh in Kuching, Sarawak.

Remarks. *Epidaus latispinus* is only known from two male specimens. This species shared the same posterior disc with *E. conspersus*, *E. validispinus*, *Epidaus* sp. 1, *Epidaus* sp. 2, and *Epidaus* sp. 3 by having two medium and two small sharp thorn-like structures on the posterior humeral angle. On the other hand, *E. latispinus* is distinguished from other *Epidaus* species mentioned above by having fawn to dark fawn body colour, and connexivum slightly enlarged.



Figure 4.16: Habitus photograph of *Epidaus latispinus*, ♂. Scale = 1 mm.

***Epidaus validispinus* (Stål, 1863)**

Figure 4.17

Epidaus validispinus Stål, 1863a: 25.

Euagoras validispinus Walker, 1873b: 122.

Maldonado 1990: 200.

Materials examined. Male: SARAWAK: Lundu: Matang: Gunung Serapi [110.0667° E; 1.4667° N], 184 m, 19 October 1979, Mercer & Yeo Eng Teck.

Diagnosis. Sharp thorn-like structures on the posterior humeral angle; orange to dark brown body colour; whitish marking on pronotum; and connexivum enlarged.

Redescription. Male: COLOURATION. Head brown; eyes black; underside head brown; ocelli brown; antennae first segment light orange with basal brown, antennae second segment light orange; labium second segment brown with light orange lines at the middle from basal to apex, labium third segment light orange, labium fourth segment basal light orange and apex brown; anterior pronotal lobe brown with anterior angle light orange; posterior pronotal lobe light orange with whitish marking, thorn-like structure dark brown; scutellum light orange; hemelytra and membrane light orange, corium with small to medium white; connexivum orange; abdomen fawn to dark fawn covered with white marking; forecoxae orange, midcoxae and hindcoxae brown; femur basal orange to light orange apex; tibiae light orange; tarsus brown. VESTITURE. Moderately setose. Dorsum head with dense short, semierect to erect and decumbent setae; pronotum with dense short, semierect to erect and decumbent setae, more dense laterally; and dense short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; large size, length 21.53 mm, width 5.50 mm; head elongated; postocular head region longer than anteocular head region; eyes semi-globular; antennae scape short, length 0.44 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.66 mm) shorter than labium third segment (1.82 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle

rounded; anterior pronotal lobe disc smooth; posterior pronotal lobe disc with two medium thorn-like structures projected upward; posterior humeral angle with two medium and two small thorn-like structures projected outward; hemelytra same as abdomen apex; forefemur width (0.58 mm) larger than midfemur (0.41 mm) and hindfemur width (0.48 mm); connexivum smooth and slightly enlarged.

Female: Unknown.

Local distribution. Gunung Serapi, Matang in Kuching Sarawak.

Remarks. *Epidaus validispinus* is only known from a single male specimen. This species shared the same posterior disc with *E. conspersus*, *E. latispinus*, *Epidaus* sp. 1, *Epidaus* sp. 2, and *Epidaus* sp. 3 by having sharp thorn-like structures on the posterior humeral angle. On the other hand, *E. validispinus* is distinguished from other *Epidaus* species mentioned above by having orange to dark brown body colour, whitish marking on pronotum, and connexivum enlarged.



Figure 4.17: Habitus photograph of *Epidaus validispinus*, ♀. Scale = 1 mm.

***Epidaus* sp. 1**

Figure 4.18

Materials examined. Female: SARAWAK: Mulu: Mulu National Park [114.7833° E; 3.9500° N], 224 m, 19 May 1986, Lippa Apeng. SARAWAK: Kuching: Santubong National Park: Permai [110.3344° E; 1.7626° N], 439 m, 8 August 2015, White screen, 1♀.

Diagnosis. Two medium and two small sharp thorn-like structures on the posterior humeral angle; brown to dark brown body colour; bi-coloured connexivum, dark brown and yellow; sharp thorn-like structure gently curved and projected outward on the posterior humeral angle; and connexivum smooth with a nodule-like structure at the middle.

Redescription. Male: COLOURATION. Head brown to dark brown; collar dark brown; eyes black with brown surrounded; ocelli black; underside head brown; antennae first segment brown with apex dark brown, antennae second and third segment brown; labium second segment brown, labium third segment brown with apex dark brown, labium fourth segment dark brown; anterior pronotal lobe brown to dark brown; posterior pronotal lobe brown to dark brown; scutellum brown to dark brown; hemelytra and membrane brown to dark brown; connexivum alternated dark brown and yellow start with dark brown; abdomen brown to dark brown; coxae dark brown; forefemur brown with apex dark brown; midfemur and hindfemur brown with apex dark brown; foretibiae brown to dark brown; midtibiae and hindtibiae brown with apex dark brown; tarsus basal brown apex brown. VESTITURE. Moderately setose. Dorsum head with dense short, semierect to erect and decumbent setae; pronotum with dense short, semierect to erect and decumbent setae, more dense laterally; and dense short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 15.73 mm, width 4.15 mm; head elongated, postocular head region longer than anteocular head region; antennae scape short, length 0.26 mm; antennae first segment width slightly larger than antennae second

and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.38 mm) longer than labium third segment (0.76 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line formed two nodules; posterior humeral angle with a single thorn-like structures projected outward; posterior pronotal lobe disc with two thorn-like structures projected upward; connexivum smooth and slightly enlarged; hemelytra same as abdomen apex; forefemur width (0.44 mm) larger than midfemur (0.25 mm) and hindfemur (0.24 mm).

Female: Body colouration and body structures are mostly the same as in male except for the body size which females greatly differ from males; medium body size, length 23.22 mm, width 7.63 mm.

Local distribution. Mulu National Park in Mulu and Santubong National Park in Kuching, Sarawak.

Remarks. *Epidaus* sp. 1 shared the same posterior disc with *E. conspersus*, *E. latispinus*, *E. validispinus*, *Epidaus* sp. 2, and *Epidaus* sp. 3 by having two medium and two small sharp thorn-like structures on the posterior humeral angle. On the other hand, *Epidaus* sp. 1 is distinguished from other *Epidaus* species mentioned above by having brown to dark brown body colour; bi-coloured connexivum, dark brown and yellow; sharp thorn-like structure gently curved and projected outward on the posterior humeral angle; and connexivum smooth with a nodule-like structure at the middle.



Figure 4.18: Habitus photograph of *Epidaus* sp. 1, ♀. Scale = 1 mm.

***Epidaus* sp. 2**

Figure 4.19

Materials examined. Male: SARAWAK: Kuching: Bako National Park [110.4667° E; 1.7167° N], 129 m, 17 August 1978, Mercer. SARAWAK: Miri: PPB Oil Palm Plantation: Saremas 2 [114.0060° E; 4.3320° N], 17 m, 10 February 2015, Ento team, 1♂. SARAWAK: Miri: PPB Oil Palm Plantation: Saremas 2 [114.0060° E; 4.3320° N], 17 m, 11 February 2015, Ento team, 1♂1♀.

Diagnosis. Two medium and two small sharp thorn-like structures on the posterior humeral angle; fawn to dark fawn body colour; two medium white spots and two medium white spots below medium spot at both side of corium; and connexivum enlarged and pointed downward at the middle before narrowed to the basal.

Redescription. Male: COLOURATION. Head strong fawn; eyes black; ocelli black; underside head strong fawn; antennae first segment strong fawn with apex brown, antennae second segment strong fawn, antennae third segment strong fawn; labium second and third segment strong fawn, labium fourth segment strong fawn with apex dark brown; anterior pronotal lobe strong fawn; posterior pronotal lobe strong fawn; scutellum brown; hemelytra and membrane fawn, clavus brown continue to side membrane, corium with two

medium white spots and two medium white spots below medium spot at both side; connexivum brown with basal fawn and two medium white lines; abdomen brown to black with white markings; coxae dark fawn; femur strong fawn; tibiae strong fawn; tarsus fawn.

VESTITURE. Moderately setose. Dorsum head with dense short, semierect to erect and decumbent setae; pronotum with dense short, semierect to erect and decumbent setae, more dense laterally; and dense short, semierect to erect, and decumbent setae over entire legs.

STRUCTURE. Body elongated-oval; medium size, length 18.93 mm – 22.40 mm, width 4.18 mm – 5.10 mm; head elongated; postocular head region longer than anteocular head region; eyes semi-globular; antennae scape short, length 0.56 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.65 mm) longer than labium third segment (1.42 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line formed two nodules; posterior pronotal lobe disc with two medium thorn-like structures projected upward; posterior humeral angle with two medium and two small thorn-like structures projected outward; hemelytra same size as abdomen apex; forefemur width (0.76 mm) larger than midfemur (0.44 mm) and hindfemur width (0.42 mm); connexivum smooth, enlarged, and pointed downward at the middle before narrowed to the basal.

Female: Body colouration and body structures are mostly the same as in male except for the body size which females greatly differ from males; medium body size, length 24.20 mm, width 7.82 mm.

Local distribution. Miri PPB Oil Palm Plantation, and Bako National Park in Bako, Sarawak.

Remarks. *Epidaus* sp. 2 shared the same posterior disc with *E. conspersus*, *E. latispinus*, *E. validispinus*, *Epidaus* sp. 1, and *Epidaus* sp. 3 by having two medium and two small sharp thorn-like structures on the posterior humeral angle. However, *Epidaus* sp. 2 is distinguished from other *Epidaus* species mentioned above by having fawn to dark fawn body colour; two medium white spots and two medium white spots below medium spot at both side of corium; and connexivum enlarged and pointed downward at the middle before narrowed to the basal.



Figure 4.19: Habitus photograph of *Epidaus* sp. 2, ♂. Scale = 1 mm.

***Epidaus* sp. 3**

Figure 4.20

Materials examined. Male: SARAWAK: Sibul: Oya: Road Nursery [111.9212° E; 2.2960° N], 12m, 31 July 1977, Yeo Eng Teck.

Diagnosis. Two medium and two small sharp thorn-like structures on the posterior humeral angle; light yellow, fawn, dark fawn, and dark red body colour; connexivum bi-coloured; dark red and light yellow; corium with fade white spots; and connexivum enlarged.

Redescription. Male: COLOURATION. Head dark fawn; eyes black; ocelli black; underside head dark fawn; antennae first segment light yellow with dark fawn line at the

middle and apex, antennae second segment basal light yellow with apex dark fawn; labium second segment light yellow, labium third segment light yellow with apex dark fawn, labium fourth segment dark fawn; anterior and posterior pronotal lobe fawn to dark fawn; scutellum dark fawn with fawn surrounded; hemelytra dark fawn with fawn at the middle; left corium with medium fade white spots; connexivum dark red with basal fawn and markings fawn between dark red; abdomen fawn with small dark brown at abdomen side; coxae light yellow; forefemur light yellow with slight dark fawn markings at the middle, midfemur and hindfemur light yellow with apex and dark fawn line at the middle; tibiae light yellow with dark fawn at the middle, basal and apex; tarsus basal dark brown with apex fawn. VESTITURE. Moderately setose. Dorsum head with short, semierect to erect and decumbent setae; pronotum with short, semierect to erect and decumbent setae, more dense laterally; and dense short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 15.73 mm, width 4.15 mm; head elongated; postocular head region longer than anteocular head region; eyes semi-globular; antennae scape short, length 0.26 mm; antennae first segment width slightly larger than antennae second segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.38 mm) longer than labium third segment (0.76 mm); anterior angle rounded; anterior humeral angle rounded; anterior pronotal lobe disc smooth; posterior pronotal lobe disc with two small thorn-like structures projected upward; posterior humeral angle with two medium and two small thorn-like structures projected outward; hemelytra slightly shorter than abdomen apex; forefemur width (0.95 mm) larger than midfemur (0.54 mm) and hindfemur width (0.46 mm); connexivum smooth and enlarged.

Female: Unknown.

Local distribution. Oya Nursery Road in Sibul, Sarawak.

Remarks. *Epidaus* sp. 3 is only known from a single male specimen. This species shared the same posterior disc with *E. conspersus*, *E. latispinus*, *E. validispinus*, *Epidaus* sp. 1, and *Epidaus* sp. 2 by having two medium and two small sharp thorn-like structures on the posterior humeral angle. On the other hand, *Epidaus* sp. 3 is distinguished from other *Epidaus* species mentioned above by having light yellow, fawn, dark fawn, and dark red body colour; connexivum bi-coloured, dark red and light yellow; corium with fade white spots; and connexivum enlarged.



Figure 4.20: Habitus photograph of *Epidaus* sp. 3, ♂. Scale = 1 mm.

***Euagoras sordidatus* (Stål, 1866)**

Figure 4.21

Euagoras sordidatus Stål, 1866b: 273.

Euagoras sordidatus Stål, 1874a: 24.

Maldonado 1990: 201.

Materials examined. Male: SARAWAK: Serian: Ranchan Recreational Park [110.5845° E; 1.1434° N], 45 m, 1 May 2013, Shikin & Amalina. SARAWAK: Kuching: Semengoh [110.2951° E; 1.3811° N], 47 m, 2 October 1981, Yeo Eng Teck & Haidir Nusi, 3♂1♀. SARAWAK: Kuching: Semengoh [110.2951° E; 1.3811° N], 47 m, 21 February 1981, Yeo

Eng Teck, 1♀. SARAWAK: Kuching: Semengoh [110.2951° E; 1.3811° N], 47 m, 1 November 1978, Hamid, 1♂. SARAWAK: Kuching: Lundu: Matang: Gunung Serapi [110.0667° E; 1.4667° N], 184 m, 18 June 1980, Mercer & Suhaili, 1♂. SARAWAK: Niah [113.7309° E; 3.8665° N], 8 m, 26 May 1981, Alex & Yeo Eng Teck, 1♂.

Diagnosis. Total body length below 14.00 mm; fawn with apex brown on the femur.

Redescription. Male. COLOURATION. Head brown; underside head brown; eyes dark brown with fawn surrounded; antennae first segment alternate dark brown and brown start with dark brown; labium second segment light brown with basal dark brown, labium third segment light fawn with apex brown, labium fourth segment brown; anterior pronotal lobe brown; posterior pronotal lobe brown; scutellum brown; hemelytra and membrane brown with hemelytra side fawn, clavus dark brown; connexivum fawn; abdomen brown with abdomen side dark brown to black; coxae brown; femur fawn with apex brown; tibiae fawn with apex brown; tarsus brown to dark brown. VESTITURE. Moderately setose. Dorsum head with dense short and decumbent setae; pronotum with dense short, semierect and decumbent setae; and sparse short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 11.98 mm – 12.97 mm, width 2.18 mm- 2.45 mm; head elongated; posterior pronotal lobe longer than anterior pronotal lobe; eyes rounded; antennae scape short, length 0.25 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and not slender; labium third segment gently curved; labium second segment (1.06 mm) shorter than labium third segment (1.64 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior humeral angle rounded; posterior humeral angle with spine projected outward; posterior pronotal lobe disc smooth; connexivum smooth and same size with the side of abdomen; hemelytra

same as abdomen apex; forefemur width (0.39 mm) almost as same as midfemur (0.32 mm) and hindfemur width (0.33 mm)

Female: Body colouration and body structures are mostly the same as in male except for the body size which female are slightly longer in length and slightly smaller in width than male; medium body size, length 12.53 mm – 12.86 mm, width 2.11 mm – 2.91 mm.

Local distribution. Ranchan Recreational Park in Serian, Semenggoh in Kuching, Gunung Serapi, Matang in Lundu, Kuching, and Niah, Sarawak.

Remarks. *Euagoras sordidatus* shared same body structure, elongated body and the presence of spine at posterior humeral angle; and body colouration, brown to dark brown with *Harpactorinae* sp. 4, however, *E. sordidatus* is distinguished from *Harpactorinae* sp. 4 by having fawn with apex brown on femur; and body size below 14.00 mm, whereas *Harpactorinae* sp. 4 have body covered by spines; femur orange; and body size below 15.00 mm.



Figure 4.21: Habitus photograph of *Euagoras sordidatus*, ♂. Scale = 1 mm.

***Eulyes amoena* (Guérin-Ménéville, 1838)**

Figure 4.22

Reduvius amoenus Guérin-Ménéville, 1838a: 56.

Arilus amoenus Herrich-Schaeffer, 1842a: 91.

Eulyes amoena Amyot & Serville, 1843a: 359.

Eulyes amoena var, *mixta* Breddiri, 1912c: 84.

Eulyes amoena vars, *nigradorsum* and *nigrigenu* Breddiri, 1912c: 84.

Maldonado 1990: 202.

Materials examined. Female: SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 9 March 1997, Justine Payoh. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 23 February 2000, Kelvin, 1♀. SARAWAK: Lundu: Matang [110.1591° E; 1.6105° N], 21 m, 4 May 2013, Fatin, Amirah, & Elly, 1♀. SARAWAK: Kuching: Semengoh [110.2951° E; 1.3811° N], 47 m, 18 December 1980, Mercer & Lipa, 1♀. SARAWAK: Niah [113.7309° E; 3.8665° N], 8 m, 25 January 1977, T. Yeo, 2♀.

Diagnosis. Large body size, total length almost 30.00 mm; extremely enlarged connexivum; light yellow, orange and black body colours; and three colours on the femur, orange, black, and light yellow.

Redescription. Male: COLOURATION. Head black; eyes black with dark yellow surrounded; underside head black; antennae first segment black; labium second segment black, labium third segment brown with basal dark brown; labium fourth segment dark brown with apex black; anterior pronotal lobe orange, posterior pronotal lobe black; scutellum black with a single white spot at apex and two white spots on both sides of basal; hemelytra orange, membrane and membrane side dark brown; connexivum orange with medium semi-sphere black; abdomen orange, abdomen side with small black spot and white spot on top of the black spot; coxae orange; femur basal orange, middle black, apex light yellow; tibiae basal light yellow, middle black, apex fawn; tarsus brown. VESTITURE. Moderately setose. Dorsum head with dense short, semierect, and

decumbent setae; pronotum with dense short, semierect and decumbent setae; and dense short, semierect to erect, and decumbent setae over entire legs. **STRUCTURE.** Body elongated-oval; large size, length 28.94 mm – 30.31 mm, width 9.65 mm – 13.63 mm; head elongated; anteocular head region longer than posteocular head region; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and extremely slender; labium third segment gently curved; labium second segment (1.60 mm) shorter than labium third segment (5.77 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle widely rounded; posterior pronotal lobe disc smooth; connexivum formed wave-shape structure and enlarged; hemelytra longer than abdomen apex; forefemur width (0.85 mm) same as midfemur (0.84 mm) and hindfemur width (0.82 mm).

Female: Body colouration and body structures are mostly the same as male except for the body size which females slightly differ from males, large body size, length 28.82 mm-31.19 mm, width 10.82 – 12.54 mm.

Local distribution. Universiti Malaysia Sarawak in Kota Samarahan, Semongkok in Kuching, Samiling in Miri, Niah, Semenggoh in Kuching, and Matang in Lundu, Sarawak.

Remarks. *Eulyes amoena* is similar to *Eulyes* sp. 1 and even shared the same connexivum structure by having extremely enlarged connexivum, but this species can be distinguished from it by body colouration. *E. amoena* having light yellow, orange and black body colours; and three colors on femur, orange, black, and light yellow, whereas *Eulyes* sp. 1 having yellow, dark fawn and black body colour; and three colors on femur, dark yellow, black, and yellow.



Figure 4.22: Habitus photograph of *Eulyes amoena*, ♂. Scale = 1 mm.

***Eulyes* sp. 1**

Figure 4.23

Materials examined. Female: SARAWAK: Miri: Bario [113.9891° E; 4.3982° N], 11 m, 24 March 1988, Kawi.

Diagnosis. Large body size; extremely enlarged connexivum; yellow, dark fawn and black body colour; and three colours on femur, dark yellow, black, and yellow.

Redescription. Female: COLOURATION. Head black; eyes black; underside head black; antennae first, second, and third segments black; labium second segment black with apex dark brown, labium third segment brown with basal dark brown, labium fourth segment black; anterior pronotal lobe dark yellow, posterior pronotal lobe black; scutellum black with a single white spot at apex and two white spots on both side of basal; hemelytra dark yellow, membrane and membrane side dark brown; connexivum yellow with medium semi-sphere black; abdomen dark brown to black, abdomen side with small black spot and white spot on top of the black spot; forecoxae, midcoxae, and hindcoxae dark yellow; femur basal dark yellow, middle black, apex yellow; tibiae basal yellow, middle black, apex fawn; tarsus brown. VESTITURE. Moderately setose. Dorsum head with dense short, semierect, and decumbent setae; pronotum with dense short, semierect and decumbent

setae; and dense short, semierect to erect, and decumbent setae over entire legs.

STRUCTURE. Body elongated-oval; large size, length 31.49 mm, width 11.16 mm; eyes semi-globular; head elongated; anteocular head region longer than posteocular head region; antennae scape short, length 0.60 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reaching forecoxae and extremely slender; labium third segment gently curved; labium second segment (1.78 mm) shorter than labium third segment (6.03 mm); anterior angle with two thorn-like structure erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle widely rounded; posterior pronotal lobe disc smooth; connexivum formed wave-like structure and enlarged; hemelytra longer than abdomen segment; forefemur width (0.88 mm) almost as same as midfemur (0.87 mm) and hindfemur width (0.86 mm).

Male: Unknown.

Local distribution. Bario in Miri, Sarawak.

Remarks. *Eulyes* sp. 1 is only known from a single female specimen. This species is similar to *E. amoena* and even shared the same connexivum structure by having extremely enlarged connexivum, but this species can be distinguished from it by body colouration. *Eulyes* sp. 1 having yellow, dark fawn and black body colour; and three colors on femur, dark yellow, black, and yellow, whereas *E. amoena* having light yellow, orange and black body colours; and three colours on femur, orange, black, and light yellow.



Figure 4.23: Habitus photograph of *Eulyes* sp. 1, ♀. Scale = 1 mm.

***Hagia punctoria* (Stål, 1863)**

Figure 4.24

Hagia punctoria Stål, 1863a: 40.

Reduvius punctorius Walker, 1873b: 198.

Maldonado 1990: 207.

Materials examined. Male: SARAWAK: Belaga: Bukit Semalong [114.0500° E; 2.9000° N], 491 m, 11 April 1985, Peter P. K. Sie. SARAWAK: Sematan [109.7758° E; 1.8075° N], 8 m, 23 January 1985, Peter & Yeo, 1♀. SARAWAK: Kuching: Semengoh [110.2951° E; 1.3811° N], 47 m, 6 October 1980, 1♀. SARAWAK: Lundu: Samunsam Wildlife Sanctuary [109.7859° E; 1.7215° N], 23 m, 15 September 1982, Ento Team, 1♂.

Diagnosis. Medium body size, total length almost 15.00 mm; red, dark red and black body colours; short anteocular head region; and slightly enlarged connexivum.

Redescription. Male: COLOURATION. Head red; collar red; ocelli yellow; eyes black; underside head red; antennae first segment dark red with basal red, antennae second segment dark red, antennae third segment dark red, antennae fourth segment dark red with second half yellow and apex black; labium second segment red, labium third segment light red at basal and apex dark red with side apex black, labium fourth segment red with apex

black; anterior pronotal lobe red, posterior pronotal lobe red with large black spot at the middle; scutellum black with line red at basal; hemelytra black and dark red with hemelytra side red; connexivum red; abdomen red with black line at abdomen side; coxae strong orange; femur dark red and black; tibiae black and dark red with light orange at apex; tarsus light orange. VESTITURE. Moderately setose. Dorsum head with dense short to moderate long, semierect to erect and decumbent setae; pronotum with dense short, semierect to erect, and decumbent setae, more dense laterally; and dense short to moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 13.13 mm- 14.67 mm, width 3.60 mm – 3.70 mm; head elongated; posterior head region longer than anterior head region; eyes semi-globular; antennae scape short, length 0.35 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.07 mm) longer than labium third segment (0.77 mm); anterior angle with two thorn-like structures erected forward; anterior pronotal lobe disc with deep line at the middle formed two nodules; anterior humeral angle rounded; posterior humeral angle rounded; posterior pronotal lobe disc smooth; hemelytra same as abdomen apex; connexivum smooth; forefemur width (0.57 mm) almost same size as midfemur (0.48 mm) and hindfemur width (0.46 mm).

Female: Body colouration and body structures are mostly the same as male, even the body size in the females do not differ from males; medium body size, length 13.54 mm – 14.27 mm, width 3.56 mm – 3.67 mm.

Local distribution. Bukit Semalong in Belaga, Semenggoh in Kuching, Samunsam Wildlife Sanctuary in Samunsam, and Sematan, Sarawak.

Remarks. *Hagia punctoria* are known specimens from Sarawak Biodiversity Centre and Forest Research Centre, Sarawak. *Hagia punctoria* is as same as *Vesbius purpureus* and Harpactorinae sp. 6 by the presence of the short anteocular head region. This species is differed from other Harpactorinae species as most of the Harpactorinae have long anteocular head region.



Figure 4.24: Habitus photograph of *Hagia punctoria*, ♀. Scale = 1 mm.

***Isyndus heros* (Fabricius, 1858)**

Figure 4.25

Zelus heros Fabricius, 1803a: 285.

Isyndus heros Stål, 1858a:445.

Isyndus ulysses Stål, 1863a: 28.

Euagoras heros Walker, 1873b: 121.

Euagoras ulysses Walker, 1873b: 121.

Euagoras ulysses Distant, 1904c: 377.

Isyndus lativentris Distant, 1919b: 211.

Isyndus heros heros Dispons, 1969c: 70.

Maldonado 1990: 221.

Materials examined. Male: SARAWAK: Lundu: Sampadi Forest Reserve [110.0500° E; 1.6000° N], 55 m, 24 July 1985, Lippa Apeng. SARAWAK: Bintulu: Labang [113.4833° E; 3.2667° N], 19 m, 2 July 1988, Rahman, 1♀.

Diagnosis. Body colours from orange to dark brown alternate with black; anterior angle with two thorn-like structures; anterior humeral angle with two thorn-like structures; posterior humeral angle with two thorn-like structures; and a bit rounded connexivum.

Redescription. Male: COLOURATION. Anteocular head region orange, posteocular head region orange with collar and transverse sulcus behind eyes black; ocelli yellow; eyes black with orange surrounded; underside head orange; antennae first and second segments dark brown, antennae third segment dark brown with basal light orange; antennae fourth segment dark brown with apex light orange; labium first segment orange, labium third segment orange with apex dark brown, labium fourth segment dark brown; anterior pronotal lobe black with orange line behind anterior angle, posterior pronotal lobe basal orange with apex black; scutellum black; hemelytra orange with basal dark brown, membrane dark brown; connexivum strong orange with medium dark brown lines; abdomen orange with small black spots at side; coxae fade orange; femur orange with two medium lines; tibiae dark brown with basal orange; tarsus dark brown. VESTITURE. Moderately setose. Dorsum head with dense short to moderate long, semierect to erect and decumbent setae, anterior pronotal lobe with short, semierect and decumbent setae; pronotum with dense short to moderate long, semierect to erect, and decumbent setae, more dense laterally; and dense short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; large size, length 19.38 mm, width 3.89 mm; head elongated; posterior head region longer than anterior head region; eyes semi-globular; antennae first segment width slightly larger than antennae second and third segment width;

labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (2.12 mm) longer than labium third segment (1.24 mm); anterior angle with two thorn-like structures erected forward; anterior pronotal lobe disc with deep hole at the middle formed two nodules; anterior humeral angle with two thorn-like structures projected outward; posterior humeral angle with two thorn-like structures projected outward; posterior pronotal lobe disc smooth; hemelytra longer than abdomen apex; connexivum with semi-sphere structure and enlarged; forefemur width (0.73 mm) almost same size as midfemur (0.62 mm) and hindfemur width (0.56 mm).

Female: Body colouration and body structures are mostly the same as male except for the body size which females greatly differ from males in both length and width; medium body size, length 27.32 mm, width 8.42 mm.

Local distribution. Sempadi Forest Reserve in Lundu and Labang Sarawak.

Remarks. *Isyndus heros* are known specimens from Forest Research Centre, Sarawak. This species is similar to *I. heros heros*, and even shared body structures except that the connexivum of *I. heros* is a bit rounded compared to *I. heros heros*, which is slightly elongated. However, this species can be distinguished by body colours. Both species have basal body colours alternate with black. *I. heros* has basal body colours from orange to dark brown, whereas *I. heros heros* has dark fawn to dark brown body colours.



Figure 4.25: Habitus photograph of *Isyndus heros*, ♀. Scale = 1 mm.

***Isyndus heros heros* (Fabricius, 1803)**

Figure 4.26

Materials examined. Female: SARAWAK: Kuching: Semengoh [110.2951° E; 1.3811° N], 47 m, 11 February 1980, Hamid. SARAWAK: Kuching: Semengoh [110.2951° E; 1.3811° N], 47 m, 12 November 1982, Arshad Ismail, 1♀. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 7 Feb 2010, 1♀.

Diagnosis. Body colours dark fawn to dark brown alternate with black; anterior angle with two thorn-like structures; anterior humeral angle with two thorn-like structures; posterior humeral angle with two thorn-like structures; and connexivum slightly elongated.

Redescription. Female: COLOURATION. Anteocular head region dark fawn, posteocular head region dark fawn with collar and transverse sulcus behind eyes black; ocelli yellow; eyes dark fawn; underside head dark fawn; labium first segment dark fawn, labium third segment darker fawn, labium fourth segment dark brown; anterior pronotal lobe black with fawn line at behind anterior angle, posterior pronotal lobe basal dark fawn with apex black; scutellum black; hemelytra dark fawn with basal dark brown, membrane dark brown; connexivum brown with medium dark brown lines; abdomen dark fawn; coxae dark fawn; femur dark fawn with two medium lines; tibiae dark fawn to black; tarsus dark brown.

VESTITURE. Moderately setose. Dorsum head with dense short, semierect to erect and decumbent setae; pronotum with dense short to moderate long, semierect to erect, and decumbent setae, more dense laterally; and dense short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; large size, length 26.64 mm – 28.91 mm, width 7.65 mm – 10.12 mm; head elongated; posterior head region longer than anterior head region; eyes semi-globular; antennae scape short, length 0.63 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (2.99 mm) longer than labium third segment (2.22 mm); anterior angle with two thorn-like structures erected forward; anterior pronotal lobe disc with deep hole at the middle formed two nodules; anterior humeral angle with two thorn-like structures projected outward; posterior humeral angle with two thorn-like structures projected outward; posterior pronotal lobe disc smooth; hemelytra longer than abdomen apex; connexivum with semi-sphere structure and enlarged; forefemur width (1.04 mm) almost same size as midfemur (0.97 mm) and hindfemur width (0.87 mm).

Male: Unknown.

Local distribution. Semenggoh in Kuching, and Universiti Malaysia Sarawak in Kota Samarahan, Sarawak.

Remarks. *Isyndus heros heros* are only known from a single female specimen. This species is similar to *I. heros*, and even shared body structures except that the connexivum of *I. heros heros* is slightly elongated compared to *I. heros* which is a bit rounded. However, this species can be distinguished by its by body colours. Both species have basal body colours alternate with black. *I. heros heros* has dark fawn to dark brown body colours, whereas *I. heros* has basal body colours from orange to dark brown.



Figure 4.26: Habitus photograph of *Isyndus heros heros*, ♀. Scale = 1 mm.

***Panthous* (Stål, 1863)**

Description. Large size: body yellow, fawn, orange, red, dark brown and black; head elongated, posteocular head region longer than anteocular head region; labium short and slender, labium second segment shorter than third segment; posterior pronotal lobe enlarged and covered scutellum; humeral posterior angle widely rounded and sharply pointed; forefemur, midfemur and hindfemur formed wave-like structures; and three coloured patterns on the femur.

Key to Genus *Panthous* (Stål, 1863)

1. Body size medium, below 20.00 mm.....*Panthous* sp. 2
 Body size large, above 20.00 mm.....2
2. Connexivum enlarged.....*P. daedalus*
 Connexivum slightly enlarged.....3
3. Corium with two white spots.....*Panthous* sp. 1
 Corium without two white spots.....*P. ectinoderoides*

***Panthous daedalus* (Stål, 1863)**

Figure 4.27

Panthous daedalus Stål, 1863a: 42.

Harpactor daedalus Walker, 1873b: 112.

Maldonado 1990: 249.

Materials examined. SARAWAK: Lundu: Sematan [109.7758° E; 1.8075° N], 8 m, 12 March 1992, D. Rahman.

Diagnosis. Enlarged pronotum until covered scutellum; fade white spots at corium; three colours patterning on the femur, red, fawn, and yellow; antennae with alternate colours; and enlarged connexivum.

Redescription. COLOURATION. Head black; eyes dark yellow; ocelli light orange; underside head black with medium yellow spot at the middle; antennae first segment alternate black, brown and yellow, antennae second segment dark brown with yellow line; labium second and third segments black with brown line at the middle and apex orange line, labium fourth segment dark brown; anterior pronotal lobe strong orange; posterior pronotal lobe orange; hemelytra dark brown, corium with two white spots; connexivum surface dark brown, edge brown with alternate yellow lines; abdomen black to brown with medium yellow and white spots at abdomen side; forecoxae and midcoxae orange, hindcoxae dark orange; femur basal red, middle fawn, apex yellow; tibiae basal yellow with apex black; tarsus dark brown. VESTITURE. Densely setose. Dorsum head with dense short to moderate long, semierect to erect and decumbent setae, anterior pronotal lobe with short, semierect and decumbent setae; pronotum with short to moderate long, semierect and decumbent setae, more dense laterally; and dense short to moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; large size, length 27.57 mm, width 10.05 mm; head elongated; posterior head region

longer than anterior head region; eyes semi-globular; antennae scape short, length 0.73 mm; antennae first segment width slightly larger than antennae second and third segment width; labium short, labium tip not reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.55 mm) shorter than labium third segment (2.42 mm); anterior angle smooth; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle widely rounded and sharply pointed; posterior pronotal lobe disc smooth; posterior pronotal lobe enlarged and covered scutellum; connexivum smooth and enlarged; forefemur, midfemur and hindfemur formed wave-like structures; hemelytra longer than abdomen apex; forefemur width (1.22 mm) larger than midfemur (0.96 mm) and hindfemur width (1.08 mm).

Local distribution. Sematan in Lundu, Sarawak.

Remarks. *Panthous daedalus* is only known from a single specimen with unknown sexes from Semonggok Agriculture Research Centre, Sarawak. This species shared the same pronotum structure with *P. ectinoderoides*, *Panthous* sp. 1, *Panthous* sp. 2, and *Panthous* sp. 3 by having posterior pronotal lobe enlarged and covered scutellum. However, *P. daedalus* is differentiated from the mentioned above species by the presence of enlarged connexivum.



Figure 4.27: Habitus photograph of *Panthous daedalus*. Scale = 1 mm.

***Panthous ectinoderoides* (Bergroth, 1913)**

Figure 4.28

Panthous ectinoderoides Bergroth, 1913d: 25.

Maldonado 1990: 249.

Materials examined. SARAWAK: Lundu: Matang [110.1591° E; 1.6105° N], 21 m, 13 August 1961, G. Teo.

Diagnosis. Enlarged pronotum until covered scutellum; a single fade white spot at corium; two colours patterning on the femur, dark orange and dark brown; antennae black with a single yellow line; and slightly enlarged connexivum.

Redescription. COLOURATION. Head black; underside head dark brown; eyes dark brown; ocelli dark brown; antennae first segment black with a single yellow line; labium second and third segment black with apex dark brown, labium third segment dark brown; anterior pronotal lobe dark orange; posterior pronotal lobe dark brown with basal dark orange; scutellum dark brown; hemelytra dark brown; connexivum alternate dark brown and yellow start with dark brown; abdomen black with small white spots at abdomen side and abdomen basal dark brown; first half of forefemur, midfemur, and hindfemur dark orange and second half dark brown; foretibiae, midtibiae, and hindtibiae dark brown; tarsus dark brown. VESTITURE. Densely setose. Dorsum head with dense short to moderate long, semierect to erect and decumbent setae, anterior pronotal lobe with short, semierect and decumbent setae; pronotum with short to moderate long, semierect and decumbent setae, more dense laterally; and dense short to moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; large size, length 26.69 mm, width 7.15 mm; head elongated; posterior head region longer than anterior head margin; eyes semi-globular; antennae scape short, length 0.53 mm; labium third segment gently curved; labium second segment (1.44 mm) shorter than labium third segment (2.55

mm); anterior angle rounded; anterior pronotal lobe disc with deep line formed two nodules; anterior humeral angle rounded; posterior humeral angle widely rounded and sharply pointed; posterior pronotal lobe disc smooth; posterior pronotal lobe enlarged and covered scutellum; connexivum smooth and slightly enlarged; forefemur, midfemur and hindfemur formed wave-like structures; hemelytra longer than abdomen apex; forefemur width (1.00 mm) larger than midfemur (0.85 mm) and hindfemur width (0.94 mm).

Local distribution. Matang in Lundu, Sarawak.

Remarks. *Panthous ectinoderoides* is only known from a single specimen with unknown sexes from Semonggok Agriculture Research Centre, Sarawak. This species shared the same pronotum structure with *P. daedalus*, *Panthous* sp. 1, *Panthous* sp. 2, and *Panthous* sp. 3 by having posterior pronotal lobe enlarged and covered scutellum. However, *P. ectinoderoides* is differentiated from the above mentioned species by having dark orange to dark brown on pronotum; and two colourations on femur, basal dark orange with apex dark brown.



Figure 4.28: Habitus photograph of *Panthous ectinoderoides*. Scale = 1 mm.

***Panthous* sp. 1**

Figure 4.29

Materials examined. Male: SARAWAK: Limbang [115.0081° E; 4.7550° N], 7 m, 16 October 1985, Mahmud & Mardek.

Diagnosis. Enlarged pronotum until covered scutellum; anterior pronotal lobe red with black spots at the middle; posterior pronotal lobe fawn; fade white spots at corium; three colours patterning on the femur, red, fawn, and black; antennae with alternate colours; and slightly enlarged connexivum.

Redescription. Male: COLOURATION. Head black; eyes light yellow; ocelli light yellow; underside head dark brown; antennae first segment alternate black and yellow start with black, antennae second segment dark brown; labium second segment dark brown, labium third and fourth segment brown; anterior pronotal lobe dark red with two black lines at the middle; posterior pronotal lobe fawn; hemelytra dark brown; clavus with two white spots; connexivum alternate dark brown and yellow start with dark brown; abdomen red with abdomen side black from middle to apex; coxae red; forefemur, midfemur, and hindfemur basal red, middle fawn, apex black; tibiae black; tarsus dark brown. VESTITURE. Densely setose. Dorsum head with dense moderate long, erect and decumbent setae, anterior pronotal lobe with dense short, semierect and decumbent setae; pronotum with dense short to moderate long, semierect to erect, and decumbent setae, more dense laterally; and dense moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 24.68 mm, width 7.04 mm; head elongated; posterior head region longer than anterior head region; eyes semi-globular; antennae scape short, length 0.65 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second

segment (2.01 mm) shorter than labium third segment (2.60 mm); anterior angle with two small thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle widely rounded and sharply pointed; posterior pronotal lobe disc smooth; posterior pronotal lobe enlarged and covered scutellum; connexivum smooth and slightly enlarged; forefemur, midfemur and hindfemur formed wave-like structures; hemelytra longer than abdomen apex; forefemur width (1.10 mm) almost same size as midfemur (0.96 mm) and hindfemur width (1.00 mm).

Female: Unknown.

Local distribution. Limbang, Sarawak.

Remarks. *Panthous* sp. 1 is only known from a single male specimen. This species shared the same pronotum structure with *P. daedalus*, *P. ectinoderoides*, *Panthous* sp. 2, and *Panthous* sp. 3 by having posterior pronotal lobe enlarged and covered scutellum. However, this species is differentiated from the above mentioned species by having fawn pronotum.



Figure 4.29: Habitus photograph of *Panthous* sp. 1, ♀. Scale = 1 mm.

***Panthous* sp. 2**

Figure 4.30

Materials examined. Male: SARAWAK: Mukah [112.0934° E; 2.8997° N], 4 m, 12 July 1981, Mercer, Yeo Eng Teck, & Lippa Apeng.

Diagnosis. Enlarged pronotum until covered scutellum; absent white spots at corium; three colours patterning on the femur, orange, fawn, and brown; antennae with alternate colours; and slightly enlarged connexivum.

Redescription. Male: COLOURATION. Head brown; collar orange; eyes light yellow; ocelli light yellow; underside head fawn; antennae first segment alternate dark brown and yellow start with dark brown, antennae second and third segments dark brown with apex yellow; antennae fourth segment brown; labium second and third segment brown; labium fourth segment dark brown; anterior pronotal lobe dark fawn; posterior pronotal lobe dark fawn; hemelytra dark orange, clavus dark brown continue to membrane; connexivum alternate dark brown and yellow start with dark brown; abdomen dark fawn with dark brown markings; coxae orange; femur basal orange, middle brown, apex fawn; tibiae dark brown with basal fawn; tarsus dark brown. VESTITURE. Densely setose. Dorsum head with dense moderate long, erect and decumbent setae, anterior pronotal lobe with dense short, semierect and decumbent setae; pronotum with dense short to moderate long, semierect to erect, and decumbent setae, more dense laterally; and dense moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 18.24 mm, width 4.96 mm; head elongated; posterior head region longer than anterior head region; eyes semi-globular; antennae scape short, length 0.58 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (0.95 mm) shorter than labium third

segment (1.26 mm); anterior angle with two small thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc smooth; posterior humeral angle widely rounded and sharply pointed; posterior pronotal lobe disc smooth; posterior pronotal lobe enlarged and covered scutellum; connexivum smooth and slightly enlarged; hemelytra longer than abdomen segment; forefemur, midfemur and hindfemur formed wave-like structures; forefemur width (1.04 mm) larger than midfemur (0.82 mm) and hindfemur width (0.82 mm).

Female: Unknown.

Local distribution. Mukah, Sarawak.

Remarks. *Panthous* sp. 2 is only known from a single male specimen. This species shared the same pronotum structure with *P. daedalus*, *P. ectinoderoides*, *Panthous* sp. 1, and *Panthous* sp. 3 by having posterior pronotal lobe enlarged and covered scutellum. However, this species is differentiated from the above mentioned species by having yellow, orange, fawn, and dark brown body colours.



Figure 4.30: Habitus photograph of *Panthous* sp. 2, ♂. Scale = 1 mm.

***Panthous* sp. 3**

Figure 4.31

Materials examined. Female: SARAWAK: Padawan: Borneo Highland: Kalimantan boarder [110.2149° E; 1.1171° N], 999 m, 23 August 2015, Shahirah Abd. Samad.

Diagnosis. Enlarged pronotum until covered scutellum; absent white spots at corium; femur with strong orange colours with black lines at the middle except for forefemur absent of black line; antennae with alternate colours; and slightly enlarged connexivum.

Redescription. Female: COLOURATION. Head black; collar black; eyes black; ocelli light yellow; underside head dark brown; antennae first segment alternate black and yellow start with black, antennae second and third segments black with apex yellow; antennae fourth segment black; labium dark brown to black; anterior and posterior pronotal lobe strong orange; hemelytra dark orange with basal membrane black; connexivum orange with black base; abdomen dark fawn, abdomen side black with medium white spots; forecoxae strong orange, midcoxae and hindcoxae dark orange; forefemur strong orange, midfemur and hindfemur strong orange with black medium line at the middle; tibiae black with basal orange; tarsus black. VESTITURE. Densely setose. Dorsum head with dense moderate long, erect and decumbent setae, anterior pronotal lobe with dense short, semierect and decumbent setae; pronotum with dense short to moderate long, semierect to erect, and decumbent setae, more dense laterally; and dense moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; large size, length 27.45 mm, width 8.71 mm; head elongated; posterior head region longer than anterior head region; eyes semi-globular; antennae scape short, length 0.63 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (2.14 mm) shorter than labium third segment (2.81 mm); anterior

angle rounded; anterior humeral angle rounded; anterior pronotal lobe disc smooth; posterior humeral angle widely rounded and sharply pointed; posterior pronotal lobe disc smooth; posterior pronotal lobe enlarged and covered scutellum; connexivum smooth and slightly enlarged; hemelytra longer than abdomen segment; forefemur, midfemur and hindfemur formed wave-like structures; ; forefemur width (0.99 mm) almost same size as midfemur (0.83 mm) and hindfemur width (0.80 mm).

Male: Unknown.

Local distribution. Kalimantan boarder at Borneo Highland in Padawan, Sarawak.

Remarks. *Panthous* sp. 3 is only known from a single female specimen. This species shared the same pronotum structure with *P. daedalus*, *P. ectinoderoides*, *Panthous* sp. 1, and *Panthous* sp. 2 by having posterior pronotal lobe enlarged and covered scutellum. However, *Panthous* sp. 3 is differentiated from the mentioned above species by having a single colouration on forefemur; strong orange, and two colourations on midfemur and hindfemur; strong orange with black medium line at the middle.



Figure 4.31: Habitus photograph of *Panthous* sp. 3, ♀. Scale = 1 mm.

***Poeciloclopius patagiatus* (Stål, 1863)**

Figure 4.32

Reduvius patagiatus Stål, 1863a: 37.

Harpactor patagiatus Walker, 1873b: 112.

Poeciloclopius patagiatus Stål, 1874a: 35.

Maldonado 1990: 260.

Materials examined. Male: SARAWAK: Kuching: Semengoh [110.2951° E; 1.3811° N], 47 m, 27 November 1980, Haidir Nusi. SARAWAK: Kuching: Bako National Park [110.4667° E; 1.7167° N], 129 m, 16 October 1980, Yeo Eng Teck. 1♀. SARAWAK: Kuching: Bako National Park [110.4667° E; 1.7167° N], 129 m, 11 October 1980, Yeo Eng Teck, 1♀. SARAWAK: Bintulu [113.0419° E; 3.1713° N], 10 m, 10 October 1978, Hamid & Yeo Eng Teck, 1♀. SARAWAK: Kuching: Bako National Park [110.4667° E; 1.7167° N], 129 m, 12 October 1980, Yeo Eng Teck, 1♂.

Diagnosis. Small body size, total length almost 15.00 mm; brown to black body colours with enlarged bright, strong red connexivum.

Redescription. Male: COLOURATION. Head brown; eyes black; underside head brown; antennae first segment light brown with basal and apex black, antennae second segment dark brown, antennae third segment light brown; labium second and third segments brown, labium fourth segment light brown; anterior pronotal lobe black; posterior pronotal lobe dark brown; scutellum dark brown; hemelytra dark brown, membrane light fawn; connexivum red; abdomen dark brown; coxae brown; forefemur, midfemur, and hindfemur brown to dark brown; tibiae brown to dark brown; tarsus brown. VESTITURE. Moderately setose. Dorsum head with dense short to moderate long, semierect to erect, and decumbent setae; pronotum with sparse moderate long, semierect to erect, and decumbent setae, more dense laterally; and dense moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval, medium size, length 11.71 mm – 11.93 mm, width 2.57 mm – 2.63 mm; head elongated; postocular head region longer than

anteocular head region; eyes semi-globular; scape short, length 0.50 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reaching forecoxae, and slender; labium third segment gently curved; labium second segment (1.00 mm) shorter than labium third segment (1.56 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle widely rounded; posterior pronotal lobe disc smooth; hemelytra longer than abdomen apex; connexivum smooth and widely enlarged; forefemur width (0.29 mm) almost same size as midfemur (0.28 mm) and hindfemur width (0.28 mm).

Female: Body colouration and body structures are mostly the same as in male except for the body size which females slightly differ in length and greatly differ in width from males; medium body size, length 13.58 mm – 14.07 mm, width 3.20 mm – 4.74 mm.

Local distribution. Bako National Park in Kuching, Semengoh in Kuching, Samunsam Wildlife Sanctuary in Lundu, and Bintulu, Sarawak.

Remarks. *Poeciloclopius patagiatus* is characterized by strong red connexivum.



Figure 4.32: Habitus photograph of *Poeciloclopius patagiatus*, ♀. Scale = 1 mm.

***Polididus armatissimus* (Stål, 1859)**

Figure 4.33

Reduvius polyacanthus Montrouzier, 1855a: 109.

Polididus armatissimus Stål, 1859d: 376.

Harpactor polyacanthus Walker, 1873b: 114.

Leptogaster polyacanthus Stål, 1874a: 44.

Zelus armatissimus Walker, 1873b: 135.

Acanthodesma perarmata Uhler, 1896a: 271.

Polididus armatissimus Schouteden, 1907a: 115.

Maldonado 1990: 260.

Materials examined. Male: SARAWAK: Julau: Ng. Ju [111.9166° E; 2.0243° N], 23 m, 12 October 1988, Ento Team. SARAWAK: Julau: Ng. Ju [111.9166° E; 2.0243° N], 23 m, 12 October 1988, Ento Team, 2♂1♀. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak: Allamanda College [110.4324° E; 1.4598° N], 8 m, 30 March 2012, Asmaa Bt. Che Mohd Rosli, 1♀.

Diagnosis. Small to medium spines covered the whole body, including head, pronotum, scutellum, abdominal side, and legs; scapus side with medium sized spines; scutellum with three spines; transverse sulcus of pronotum with six spines; and anterior angle of pronotum with medium spines.

Redescription. Male: COLOURATION. Head brown with white lines in front eyes and between eyes to collar; eyes dark brown; ocelli brown; underside head fawn; antennae first segment fawn, antennae second segment fawn with apex dark fawn, antennae third segment dark fawn, antennae fourth segment fawn with basal dark fawn; labium second segment light brown with straight dark brown in the middle; labium second segment fawn with line at the middle from basal to apex, labium third segment fawn; labium fourth

segment brown; anterior pronotal lobe dark brown with four straight white lines; posterior pronotal lobe brown; scutellum dark brown with white markings; hemelytra brown, membrane light brown; connexivum fawn; abdomen fawn with abdomen side dark brown; coxae dark fawn; femur basal fawn with apex brown; tibiae fawn with apex brown; tarsus fawn with apex brown. VESTITURE. Moderately setose. Dorsum head with short, semierect to erect, and decumbent setae; pronotum with short, semierect, and decumbent setae; and short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated; medium size, length 9.98 mm – 11.09 mm, width 2.13 mm – 2.51 mm; head elongated; postocular head region longer than anteocular head region; eyes semi-globular; two spines erected forward between eyes and antennae scape; postocular head region with small spines erected upward; antennae scape short, length 0.32 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reaching forecoxae, and slender; labium third segment gently curved; labium second segment (1.10 mm) longer than labium third segment (0.70 mm); anterior angle with two spines erected forward; anterior humeral angle with two spines erected outward; anterior pronotal lobe disc with five small spines and two large spines projected upward; posterior humeral angle with two large spines projected outward; posterior pronotal lobe disc with spines; scutellum with three spines projected upward; connexivum with spines and same size with the side of abdomen; abdomen apex with two large spines projected outward; forefemur, midfemur, and hindfemur covered with spines; foretibiae, midtibiae, and hindtibiae covered with spines; hemelytra same as abdomen apex; forefemur width (0.53 mm) almost same size as midfemur (0.40 mm) and hindfemur width (0.33 mm).

Female: Body colouration and body structures are mostly the same as in male except for the body size which females slightly differ from males in both length and width; medium body size, length 10.71 mm- 11.56 mm, width 2.72 mm – 2.83 mm.

Local distribution. Universiti Malaysia Sarawak in Kota Samarahan, Lawas in Limbang, Kota Samarahan, Kampung Surak in Kuching, Miri PPB Oil Palm Plantation, and Ng. Ju in Julau, Sarawak.

Remarks. *Polididus armatissimus* is known specimens from UNIMAS Insect Reference Collection, Forest Research Centre, and Semenggok Agriculture Centre, Sarawak. This species is characterized by small to medium spines covered the whole body.



Figure 4.33: Habitus photograph of *Polididus armatissimus*, ♂. Scale = 1 mm.

***Rhynocoris marginellus* (Fabricius, 1803)**

Figure 4.34

Reduvius marginellus Fabricius, 1803a: 271.

Reduvius vicinus Stål, 1859a: 202.

Harpactor marginellus Walker, 1873b: 112.

Reduvius (lamphrius) marginellus Stål, 1874a: 39.

Reduvius marginellus var. *vicinus* Distant, 1904c: 334.

Maldonado 1990: 284.

Materials examined. Male: SARAWAK: Miri: PPB Oil Palm Plantation: Saremas 2 [114.0060° E; 4.3320° N], 17 m, 7 February 2015, Hanisah Zahuri. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak: East Campus [110.4324° E; 1.4598° N], 8 m, 5 May 2013, Noraina Jamal Rashid, 1♀. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 5 January 2000, Frandic anak Ranyui, 1♀. SARAWAK: Baram: Teraja Camp [114.0954° E; 4.5337° N], 9 m, 26 March 1980, Mercer & Suhaili, 1♀. SARAWAK: Simunjan: Sungai Simunjan Kanan [110.8231° E; 1.2314° N], 20 m, 30 September 1980, Mercer, Lipa, & Rahman, 1♀. SARAWAK: Niah [113.7309° E; 3.8665° N], 8 m, 20 April 1977, Yeo Eng Teck, 1♀.

Diagnosis. Small body size, total length almost 17.00 mm; dark brown, grey, and black body colours; and connexivum black with orange spots.

Redescription. Male: COLOURATION. Head black; eyes black; underside head grey; ocelli brown; antennae black; labium black; anterior pronotal lobe black; posterior pronotal lobe grey to black; scutellum black; hemelytra gray to black, membrane black; connexivum black with orange spots from basal to apex; abdomen grey; coxae black; femur black; tibiae black with apex dark brown; tarsus dark brown. VESTITURE. Moderately setose. Dorsum head with short, semierect to erect and decumbent setae; pronotum with dense short to moderate long, semierect and decumbent setae, more dense laterally; and sparse short to moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; small size, length from 13.54 mm, width from 4.01 mm; head elongated, postocular head region longer than anteocular head region; antennae scape short, length 0.41 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.53 mm) longer

than labium third segment (1.46 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle widely rounded; posterior pronotal lobe disc smooth; connexivum smooth and slightly enlarged; hemelytra longer than abdomen apex; forefemur width (0.55 mm) almost same size as midfemur (0.48 mm) and hindfemur width (0.40 mm).

Female: Body colouration and body structures are mostly the same as in male except for the body size which females greatly differ from males in both length and width; medium body size, length 14.70 mm – 16.05 mm, width 3.89 mm – 4.74 mm.

Local distribution. Universiti Malaysia Sarawak in Kota Samarahan, Matang in Lundu, Serian, Kuching, Miri PPB Oil Palm Plantation, Baram, Sungai Simunjan Kanan in Simunjan, Niah, Semenggoh in Kuching, and Sri Aman, Sarawak.

Remarks: *Rhynocoris marginellus* are known specimens recorded and collected from UNIMAS Insect Reference Collection, Forest Research Centre, Semenggok Agriculture Centre, Sarawak Biodiversity Centre, Miri PPB Oil Palm Plantation, and Borneo Highland, Sarawak. This species is characterized by small body size and connexivum with orange spots.



Figure 4.34: Habitus photograph of *Rhynocoris marginellus*, ♀. Scale = 1 mm.

***Scipinia rapax* (Miller, 1941)**

Figure 4.35

Scipinia rapax Miller, 1941a: 767.

Maldonado 1990: 294.

Materials examined. Male: SARAWAK: Padawan: Borneo Highland [110.2232° E; 1.1332° N], 760 m, 23 Aug 2015, Dainty anak Sos. SARAWAK: Kota Samarahan [110.4883° E; 1.4599° N], 6 m, 2 March 1965, M. Gines.

Diagnosis. Small body size, total length below 10.00 mm; and bigger width with the wave-like structure on forefemur.

Redescription. Male: COLOURATION: Anterior head region strong fawn with black lines between eyes, posterior head region black; underside head strong fawn; eyes black; ocelli strong fawn; labium second and third segments strong fawn, labium fourth segment black; anterior pronotal lobe strong fawn to black; posterior pronotal lobe strong fawn; scutellum dark brown and middle basal with brown; hemelytra strong fawn, membrane strong fawn to black; connexivum strong fawn; abdomen strong fawn; coxae strong fawn; femur strong fawn; tibiae strong fawn; tarsus strong fawn. VESTITURE. Moderately setose. Dorsum head with dense short, semierect to erect and decumbent setae; pronotum with dense short, semierect to erect, and decumbent setae; and dense short to moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated; medium size, length 9.63 mm – 9.77 mm, width 1.54 mm - 1.77 mm; head elongated, posterior head region longer than anterior head region; head with spines projected upward; antennae scape short, length 0.35 mm; antennae first segment width slightly larger than antennae second and third segment width; labium second segment (0.78 mm) shorter than labium third segment (1.04 mm); labium third segment gently curved; anterior angle rounded; anterior humeral angle rounded; anterior pronotal lobe disc with

four small spines projecting upward; posterior humeral angle rounded; posterior pronotal lobe disc smooth; forefemur larger than midfemur and hindfemur; forefemur, midfemur, and hindfemur formed wave-like structure; connexivum smooth and same size with the side of abdomen; hemelytra same as abdomen apex; forefemur width (0.51 mm) larger than midfemur (0.23 mm) and hindfemur width (0.35 mm).

Female: Unknown.

Local distribution. Borneo Highland in Padawan, Kuching, and Kota Samarahan, Sarawak.

Remarks. *Scipinia rapax* is the only known female specimen from Borneo Highland in Padawan with unknown sexes recorded at Semonggok Agriculture Reseach Centre, Sarawak.



Figure 4.35: Habitus photograph of *Scipinia rapax*. Scale = 1 mm.

***Sphedanolestes fallax* (Miller, 1941)**

Figure 4.36

Sphedanolestes fallax Miller, 1941a: 697.

Maldonado 1990: 300.

Materials examined. Male: SARAWAK: Sibu [111.8308° E; 2.3000° N], 10 m, 9 August 1984, Sarkawi Omar. SARAWAK: Sibu [111.8308° E; 2.3000° N], 10 m, 10 August 1984,

Lippa Apeng, 1♂3♀. SARAWAK: Belaga: Dulit Range [114.2500° E; 3.2500° N], 989 m, 22 October 1983, Lippa Apeng, 1♂.

Diagnosis. Small body size, total length below 13.00 mm; two colouration on the femur, basal dark yellow to yellow with apex black; and legs densely with setose.

Redescription. Male: COLOURATION. Head black, collar yellow to orange; eyes black; underside head yellow; ocelli light yellow; antennae first segment dark brown; antennae second segment brown; labium second segment dark brown, labium third segment black; labium fourth segment brown; anterior pronotal lobe strong orange; posterior pronotal lobe strong orange; scutellum dark orange; hemelytra black with dark orange at hemelytra side, membrane dark brown; connexivum strong orange; abdomen strong orange with large black spot at the middle; coxae orange; femur basal dark yellow to yellow with apex black; foretibiae black; midtibiae and hindtibiae black with apex light orange; tarsus light orange with apex black. VESTITURE. Densely setose. Dorsum head with dense short, semierect to erect and decumbent setae; pronotum with dense short to moderate long, semierect to erect, and decumbent setae, more dense laterally; and dense moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; small size, length 11.74 mm – 12.22 mm, width 2.52 mm – 3.09 mm; head elongated; posterior head margin longer than anterior head margin; eyes semi-globular; antennae scape short, length 0.33 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.01 mm) shorter than labium third segment (1.23 mm); anterior angle rounded; anterior humeral angle rounded; anterior pronotal lobe disc with deep line in the middle formed two nodules; posterior humeral angle rounded; posterior pronotal lobe disc smooth; connexivum smooth and slightly

enlarged; hemelytra longer than abdomen apex; forefemur width (0.49 mm) almost same size as midfemur (0.47 mm) and hindfemur (0.45 mm).

Female: Body colouration and body structures are mostly the same as in male except for the body size which females are slightly smaller in length and slightly larger in width than males; medium body size, length 11.56 mm – 12.39 mm, width 3.05 mm – 3.73 mm.

Local distribution. Sibuan and Dulit Range in Belaga, Sarawak.

Remarks. *Sphedanolestes fallax* are known specimens from Forest Research Centre, Sarawak. This species is characterized by small body size, forefemur with two colourations and legs densely with setose.



Figure 4.36: Habitus photograph of *Sphedanolestes fallax*, ♀. Scale = 1 mm.

***Sycanus* (Amyot & Serville, 1843)**

Diagnosis. Small to large size: variable body colour; head usually elongated, posteocular head region longer than anteocular head region; labium extremely long and slender, labium second segment shorter than the third segment; pronotum diamond-shape; transverse sulcus in front of pronotum; scutellum with spine projected upward; corium usually with colours; connexivum usually enlarge outward; forewings longer than apex of abdomen.

Key to Genus *Sycanus* (Amyot & Serville, 1843)

1. Connexivum enlarge outward.....2
 Connexivum not enlarge outward.....*Sycanus* sp. 1
2. Connexivum orange and semi-sphere black.....*S. maculatus*
 Connexivum dark brown and black.....3
3. Corium black.....*Sycanus* sp. 4
 Corium various colours.....4
4. Corium yellow.....5
 Corium red and orange.....6
5. Corium pale yellow.....*S. dilutus*
 Corium strong yellow.....*S. macracanthus*
6. Corium strong red.....*S. tuberculatus*
 Corium strong orange.....7
7. Body size medium, below 20.00 mm.....*Sycanus* sp. 3
 Body size large, below 24.00 mm.....*Sycanus* sp. 2

Sycanus dilutus (Miller, 1941)

Figure 4.37

Sycanus dilutes Miller, 1941a: 709.

Maldonado 1990: 311.

Materials examined. Male: SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 23 January 1995, 1st Year Student. SARAWAK: Miri: Bario, 12 April 1995, S. H., F. A., Lim, W. M., 1♀. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 11 March 1997, Norliza. 1♀. SARAWAK: Balingian: Setuan [112.6833° E; 2.9500° N], 18 m, 6 May 1981, Mercer,

Lippa, & Rahman, 1♀. SARAWAK: Mukah: Sungai Sekai [112.1667° E; 2.8000° N], 9 m, 14 July 1981, Mercer, Yeo, & Lippa, 1♂. SARAWAK: Sibuan: Retus [111.8630° E; 2.5509° N], 11 m, 27 Jun 1979, Ento team, 1♀. SARAWAK: Sri Aman [111.4621° E; 1.2370° N], 12 m, 16 July 1980, Mercer & Suhaili, 1♂. SARAWAK: Niah [113.7309° E; 3.8665° N], 8 m, 23 April 1977, Yeo Eng Teck, 1♂. SARAWAK: Simunjan [111.9153° E; 1.0730° N], 34 m, 30 September 1980, Mercer, Lippa, & Rahman, 1♂.

Diagnosis. Large body size, total length below 25.00 mm; abdomen and connexivum slightly elongated; and pale yellow on corium.

Redescription. Male. COLOURATION. Head black; eyes yellow pale; underside head black; ocelli light yellow; antennae first segment alternate brown and black start with black; labium dark brown; anterior pronotal lobe black; posterior pronotal lobe dark brown; scutellum black; hemelytra black, corium yellow pale, membrane light brown; connexivum black; abdomen black; coxae black; femur brown to black; tibiae brown to black; tarsus light brown with apex black. VESTITURE. Moderately setose. Dorsum head with dense short, semierect to erect and decumbent setae; pronotum with dense short, semierect to erect, and decumbent setae, more dense laterally; and dense short to moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; large size, length 20.13 mm – 21.80 mm, width 6.44 mm – 7.67 mm; head elongated, posteocular head region longer than anteocular head region; antennae scape short, length 0.46 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and extremely slender; labium third segment gently curved; labium second segment (2.68 mm) shorter than labium third segment (4.53 mm); anterior angle with two thorn-like structures erected frontward; anterior humeral angle rounded; anterior pronotal lobe disc smooth; posterior

humeral angle rounded; posterior pronotal lobe disc smooth; scutellum with a single long spine projected upward; connexivum formed wave-like structure and extremely enlarged; hemelytra longer than abdomen apex; forefemur width (0.56 mm) almost same size as midfemur (0.52 mm) and hindfemur width (0.50 mm).

Female. Body colouration and body structures are mostly the same as in male except for the body size where females differ from males in both length and width; medium body size, length 23.42 mm – 24.92 mm, width 7.09 mm – 8.05 mm.

Local distribution. Simunjan, Setuan in Balingian, Sungai Sekai in Mukah, Retus in Sibuan, Sri Aman, Bario in Miri, Universiti Malaysia Sarawak in Kota Samarahan, and Niah, Sarawak.

Remarks. *Sycanus dilutus* closely shared same body structures and body colours with *S. macracanthus*, and even shared same body structures with *S. maculatus*, *S. tuberculatus*, *Sycanus* sp. 1, *Sycanus* sp. 2, *Sycanus* sp. 3, and *Sycanus* sp. 4. This species is distinguished from the above mentioned species by having large body size, total length below 25.00mm; abdomen and connexivum slightly elongated; and pale yellow on corium.



Figure 4.37: Habitus photograph of *Sycanus dilutus*, ♂. Scale = 1 mm.

***Sycanus macracanthus* (Stål, 1866)**

Figure 4.38

Sycanus macracanthus Stål, 1866b: 276.

Maldonado 1990: 313.

Materials examined. Male: SARAWAK: Miri: PPB Oil Palm Plantation: Saremas 2 [114.0060° E; 4.3320° N], 17 m, 7 February 2015, Hanisah Zahuri. SARAWAK: Miri: PPB Oil Palm Plantation: Saremas 2 [114.0060° E; 4.3320° N], 17 m, 7 February 2015, Hanisah Zahuri, 3♀. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 9 April 2013, Siti Hajar Ariffin, 1♀. SARAWAK: Kota Samarahan [110.4883° E; 1.4599° N], 6 m, 23 November 2003, Lizawati, R., 1♂. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 26 April 2013, Hazirah Hanun, 1♀. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 10 April 2013, Huang Jia Huei, 1♂. SARAWAK: Kota Samarahan [110.4883° E; 1.4599° N], 6 m, 21 April 2013, Aidil Zahidin, 1♂. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 17 March 2014, M. Syafiq Nordin, 1♀.

Diagnosis. Medium body size, total length below 20.00 mm; abdomen and connexivum bit rounded; and strong yellow on corium.

Redescription. Male: COLOURATION. Head black; eyes black with yellow pale surrounded; underside head black; ocelli brown; antennae first segment light brown with apex and basal black; antennae second segment pale yellow with apex black; labium second segment brown, labium third segment light brown, labium third segment dark brown; anterior pronotal lobe black with anterior angle light brown; posterior pronotal lobe dark brown; scutellum black; hemelytra black, corium strong yellow, membrane light brown; connexivum black; abdomen black; coxae black; femur black; tibiae brown to

black; tarsus black with apex brown. VESTITURE. Moderately setose. Dorsum head with short to moderate long, semierect to erect and decumbent setae; pronotum with dense short to moderate long, semierect to erect, and decumbent setae, more dense laterally; and sparse short to moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 19.41 mm – 19.67 mm, width 7.04 mm – 7.45 mm; head elongated, posteocular head region longer than anteocular head region; antennae scape short, 0.46 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium second segment (2.65 mm) shorter than labium third segment (4.11 mm); anterior angle rounded; anterior humeral angle rounded; anterior pronotal lobe disc smooth; posterior humeral angle rounded; posterior pronotal lobe disc smooth; scutellum with a single long spine projected upward; connexivum formed wave-like structure and extremely enlarged; hemelytra longer than abdomen apex; forefemur width (0.49 mm) almost same size as midfemur (0.46 mm) and hindfemur width (0.47 mm).

Female: Body colouration and body structures are mostly the same as in male except for the body size where females differ from males in both length and width; medium body size, length 19.33 mm – 19.90 mm, width 6.73 mm – 8.04 mm.

Local distribution. Bau in Lundu, Maludam in Betong, Semonggok in Kuching, Miri PPB Oil Palm Plantation, Sibul, Simunjan, Gunung Serapi in Matang, Kuching, and Universiti Malaysia Sarawak in Kota Samarahan, Sarawak.

Remarks. *Sycanus macracanthus* closely shared same body structures and body colours with *S. dilutus*, and even shared same body structures with *S. maculatus*, *S. tuberculatus*, *Sycanus* sp. 1, *Sycanus* sp. 2, *Sycanus* sp. 3, and *Sycanus* sp. 4. This species is

distinguished from the above mentioned species by having medium body size, total length below 20.00mm; abdomen and connexivum bit rounded; and strong yellow on corium.



Figure 4.38: Habitus photograph of *Sycanus macracanthus*, ♂. Scale = 1 mm.

***Sycanus maculatus* (Miller, 1941)**

Figure 4.39

Sycanus maculatus Miller, 1941a: 707.

Maldonado 1990: 313.

Materials examined. Male: SARAWAK: Miri: PPB Oil Palm Plantation: Saremas 2 [114.0060° E; 4.3320° N], 17 m, 7 February 2015, Hanisah Zahuri.

Diagnosis. Body colours, strong orange to black; corium with strong yellow as same as *S. macracanthus*; anterior angle orange; connexivum with strong orange and black spots; orange pronotum; and enlarged connexivum.

Redescription. Male: COLOURATION. Head black; eyes yellow with black spots; ocelli light yellow; underside head black; antennae first segment alternate orange and black start with orange; antennae second segment dark orange; labium second segment dark brown to brown at apex; labium third segment dark orange; labium fourth segment dark orange with tip brown; anterior pronotal lobe black with anterior angle light orange; posterior pronotal lobe light orange to strong orange with large black spot at disc and two medium black

spots at humeral angle; scutellum strong orange; hemelytra black, corium strong yellow, membrane brown; connexivum strong orange with small to medium black spots; abdomen black with light orange across from basal to apex; coxae orange; femur black; tibiae dark brown; tarsus black. VESTITURE. Moderately setose. Dorsum head with sparse short, semierect to erect, and decumbent setae; pronotum with dense short to moderate long, semierect to erect, and decumbent setae, more dense laterally; and sparse short to moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 16.68 mm, width 5.48 mm; eyes semi-globular; head elongated; postocular head region longer than anteocular head region; antennae scape short, length 0.38 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and extremely slender; labium third segment gently curved; labium second segment (2.16 mm) shorter than labium third segment (3.22 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle widely rounded; posterior pronotal lobe disc smooth; scutellum with a single long spine projected upward; connexivum formed wave-like structure and extremely enlarged; hemelytra longer than abdomen apex; forefemur width (0.31 mm) almost same size as midfemur (0.40 mm) and hindfemur width (0.30 mm).

Female: Unknown.

Local distribution. Miri PPB Oil Palm Plantation, Sarawak.

Remarks. *Sycanus maculatus* is the only known male specimen. This species is similar to *S. dilutus*, *S. macracanthus*, *S. tuberculatus*, *Sycanus* sp. 1, *Sycanus* sp. 2, *Sycanus* sp. 3, and *Sycanus* sp. 4 in terms of body structures. This species is distinguished from the above

mentioned species by having body colours, strong orange to black; corium with strong yellow as same as *S. macracanthus*; anterior angle orange; connexivum with strong orange and black spots; orange pronotum; and enlarged connexivum.



Figure 4.39: Habitus photograph of *Sycanus maculatus*, ♂. Scale = 1 mm.

***Sycanus tuberculatus* (Reuter, 1881)**

Figure 4.40

Sycanus tuberculatus Reuter, 1881a: 286.

Maldonado 1990: 313.

Materials examined. Female: SARAWAK: Padawan: Borneo Highland: Kalimantan boarder [110.2149° E; 1.1171° N], 999 m, 21 August 2015, Hanisah Zahuri. SARAWAK: Lundu: Matang: Gunung Serapi [110.0667° E; 1.4667° N], 184 m, 7 November 1979, Mercer & Suhaili, 1♀.

Diagnosis. Brown to light brown connexivum; abdomen and connexivum a bit rounded; and strong red on corium.

Redescription. Female: COLOURATION. Head dark brown; eyes black; underside head dark brown; ocelli black; labium second segment brown; labium third segment light brown; labium fourth segment light brown to dark brown; anterior pronotal lobe black; posterior pronotal lobe dark brown; scutellum dark brown to black; hemelytra dark brown,

corium strong red, membrane light brown; connexivum brown to light brown; abdomen dark brown; coxae dark brown; femur alternate brown with black start with brown; tibiae brown with black line after basal and apex black; tarsus light brown with apex brown. VESTITURE. Moderately setose. Dorsum head with short, semierect to erect and decumbent setae; pronotum with dense short, semierect to erect, and decumbent setae, more dense laterally; and sparse moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 19.66 mm – 19.94 mm, width 7.64 mm – 7.88 mm; head elongated, postocular head region longer than anteocular head region; antennae scape short, length 0.52 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and extremely slender; labium third segment gently curved; labium second segment (2.29 mm) shorter than labium third segment (3.90 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc smooth; posterior humeral angle rounded; posterior pronotal lobe disc smooth; scutellum with a single long spine projected upward; connexivum formed wave-like structure and extremely enlarged; hemelytra longer than abdomen apex; forefemur width (0.39 mm) almost same size as midfemur (0.37 mm) and hindfemur width (0.39 mm).

Male: Unknown.

Local distribution. Gunung Serapi, Matang in Kuching and Borneo Highland in Padawan, Sarawak.

Remarks. *Sycanus tuberculatus* is the only known female specimen. This species is similar with *S. maculatus*, *S. dilutus*, *S. macracanthus*, *Sycanus* sp. 1, *Sycanus* sp. 2, *Sycanus* sp. 3, and *Sycanus* sp. 4 in terms of body structures. This species is distinguished

from the above mentioned species by having brown to light brown connexivum; and strong red on corium.



Figure 4.40: Habitus photograph of *Sycanus tuberculatus*, ♀. Scale = 1 mm.

***Sycanus* sp. 1**

Figure 4.41

Materials examined. Female: SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 31 January 2011, Farhana R.

Diagnosis. Body colours, brown to dark brown; absent colours on corium; connexivum edge with wave-like structures; and slightly enlarged connexivum.

Redescription. Female: COLOURATION. Head brown; eyes black; underside head brown; ocelli light yellow; labium second segment brown with basal dark brown, labium third and fourth segments brown; anterior pronotal lobe black; posterior pronotal lobe dark brown; scutellum dark brown; hemelytra strong fawn, corium brown, membrane light brown with strong fawn at both side; connexivum dark brown; abdomen dark brown with fawn markings; coxae dark brown to brown; femur brown with black line at the middle and apex black; tibiae alternate brown with black started with black. VESTITURE. Moderately setose. Dorsum head with dense short, semierect to erect, and decumbent setae; pronotum with dense short to moderate long, semierect to erect, and decumbent setae, more dense

laterally; and short to moderate long, semierect to erect, and decumbent setae over entire legs. **STRUCTURE.** Body elongated-oval; medium size, length 18.77 mm, width 5.00 mm; head elongated, postocular head region longer than anteocular head region; antennae scape short, length 0.33 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and extremely slender; labium third segment gently curved; labium second segment (2.47 mm) shorter than labium third segment (3.61 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc smooth; posterior humeral angle rounded; posterior pronotal lobe disc smooth; scutellum with a single long spine projected upward; connexivum formed wave-like structure and extremely enlarged; hemelytra longer than abdomen apex; forefemur width (0.30 mm) almost same size as midfemur (0.47 mm) and hindfemur width (0.44).

Male: Unknown.

Local distribution. Universiti Malaysia Sarawak in Kota Samarahan, Sarawak.

Remarks. *Sycanus* sp. 1 is the only known female specimen. This species is similar to *S. dilutus*, *S. macracanthus*, *S. maculatus*, *S. tuberculatus*, *Sycanus* sp. 2, *Sycanus* sp. 3, and *Sycanus* sp. 4 in terms of almost body structures. This species is distinguished from the above mentioned species by having body colours, brown to dark brown; absent colours on corium; connexivum edge with wave-like structures; and slightly enlarged connexivum.



Figure 4.41: Habitus photograph of *Sycanus* sp. 1, ♀. Scale = 1 mm.

***Sycanus* sp. 2**

Figure 4.42

Materials examined. Male: SARAWAK: Serian: Tebakang [110.5119° E; 1.1045° N], 19 m, 24 June 1983, Lipa Apeng.

Diagnosis. Large body size, total length below 24.00 mm; brown to black connexivum; and strong orange on corium.

Redescription. Male: COLOURATION. Head black; eyes black; underside head black; ocelli yellow; labium second segment black; labium third segment brown; labium fourth segment black; anterior pronotal lobe black; posterior pronotal lobe black; scutellum black; hemelytra black, corium strong orange, membrane brown; connexivum brown to black; abdomen dark brown to black; coxae black; femur brown to black; tibiae brown to black; tarsus brown. VESTITURE. Moderately setose. Dorsum head with short, semierect, and decumbent setae; pronotum with dense short, semierect and decumbent setae, more dense laterally; and dense short to moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; large size, length 23.17 mm, width 9.44 mm; eyes semi-globular; head elongated, posteocular head region longer than anteocular head region; antennae scape short, length 0.67 mm; antennae first segment width slightly

larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and extremely slender; labium third segment gently curved; labium second segment (2.81 mm) shorter than labium third segment (4.91 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle widely rounded; posterior pronotal lobe disc smooth; scutellum with a single long spine projected upward; connexivum formed wave-like structure and extremely enlarged; hemelytra longer than abdomen apex; forefemur width (0.53 mm) almost same size as midfemur (0.50 mm) and hindfemur width (0.47 mm).

Female: Unknown.

Local distribution. Tebakang in Serian, Sarawak.

Remarks. *Sycanus* sp. 2 is the only known male specimen. This species is similar to *S. dilutus*, *S. macracanthus*, *S. maculatus*, *S. tuberculatus*, *Sycanus* sp. 1, *Sycanus* sp. 3, and *Sycanus* sp. 4 in terms of body structures. This species is almost similar to *Sycanus* sp. 3 but it is distinguished from the above mentioned species, including *Sycanus* sp. 3 is by having brown to black connexivum and strong orange on corium as same as *Sycanus* sp. 3; and large body size, total length below 24.00 mm compared to *Sycanus* sp. 3 with medium body size, total length below 20.00 mm.



Figure 4.42: Habitus photograph of *Sycanus* sp. 2, ♂. Scale = 1 mm.

***Sycanus* sp. 3**

Figure 4.43

Materials examined. Female: SARAWAK: Lundu: Matang [110.1591° E; 1.6105° N], 21 m, 19 September 1981, Mercer, Lipa, & Suhaili. SARAWAK: Sibü [111.8308° E; 2.3000° N], 10 m, 28 June 1979, Ento Team, 1♀.

Diagnosis. Medium body size, total length below 20.00 mm; brown to black connexivum; and strong orange on corium.

Redescription. Female: COLOURATION. Head brown; eyes black; underside head brown; ocelli brown; antennae first segment fawn with black line at the middle and apex black; antennae second segment fawn with apex black; antennae third segment fawn to brown; labium second segment brown; labium third segment fawn with basal and apex brown; labium fourth segment brown; anterior pronotal lobe black; posterior pronotal lobe dark brown; scutellum dark brown to black; hemelytra dark brown, corium strong orange, membrane light brown; connexivum brown to black; abdomen dark brown; coxae dark brown; femur brown with black line at the middle and apex black; tibiae brown to black; tarsus brown with apex black. VESTITURE. Moderately setose. Dorsum head with sparse short, semierect to erect and decumbent setae; pronotum with dense short to moderate

long, semierect to erect, and decumbent setae, more dense laterally; and sparse moderate long, semierect to erect, and decumbent setae over entire legs. **STRUCTURE.** Body elongated-oval; medium size, length 18.81 mm, width 7.30 mm; eyes semi-globular; head elongated, posteocular head region longer than anteocular head region; antennae scape short, length 0.50 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and extremely slender; labium third segment gently curved; labium second segment shorter (2.22 mm) than labium third segment (3.50 mm); anterior angle with two thorn-like structure erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle widely rounded; posterior pronotal lobe disc smooth; scutellum with a single long spine projected upward; connexivum formed wave-like structure and extremely enlarged; hemelytra longer than abdomen apex; forefemur width (0.34 mm) almost same size as midfemur (0.38 mm) and hindfemur width (0.39 mm).

Male: Unknown.

Local distribution. Matang in Lundu and Sibul, Sarawak.

Remarks. *Sycanus* sp. 3 is the only known female specimens. This species is similar to *S. dilutus*, *S. macracanthus*, *S. maculatus*, *S. tuberculatus*, *Sycanus* sp. 1, *Sycanus* sp. 2, and *Sycanus* sp. 4 in terms of body structures. This species is almost similar to *Sycanus* sp. 3 but it is distinguished from the above mentioned species, including *Sycanus* sp. 2 by having brown to black connexivum and strong orange on corium as same as *Sycanus* sp. 2; and medium body size, total length below 20.00 mm compared to *Sycanus* sp. 2 with large body size, total length below 24.00 mm.



Figure 4.43: Habitus photograph of *Sycanus* sp. 3, ♀. Scale = 1 mm.

***Sycanus* sp. 4**

Figure 4.44

Materials examined. Male: SARAWAK: Niah [113.7309° E; 3.8665° N], 8 m, 26 May 1981, Alex & Yeo.

Diagnosis. Dark brown to black connexivum; and black corium.

Redescription. Male: COLOURATION. Head black; eyes dark brown; underside head black; ocelli dark brown; antennae brown with black line at the middle and apex black; antennae second segment black; antennae third segment basal brown with apex black; antennae fourth segment brown with black line at basal; labium second segment black; labium third segment brown with basal black; labium fourth segment brown; anterior pronotal lobe black; posterior pronotal lobe black; scutellum black; hemelytra black with membrane dark brown; connexivum dark brown to black; abdomen dark brown to black; coxae black; femur black; tibiae dark brown; tarsus brown. VESTITURE. Moderately setose. Dorsum head with dense short, semierect to erect, and decumbent setae; pronotum with dense short to moderate long, semierect to erect, and decumbent setae, more dense laterally; and dense short to moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; large size, length 22.90 mm, width 9.34

mm; head elongated, posteocular head region longer than anteocular head region; antennae scape short, length 0.55 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and extremely slender; labium third segment gently curved; labium second segment (2.79 mm) shorter than labium third segment (4.81 mm); anterior angle with two thorn-like structure erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle widely rounded; posterior pronotal lobe disc smooth; scutellum with long ramified spine projected upward; connexivum formed wave-like structure and extremely enlarged; hemelytra longer than abdomen apex; forefemur width (0.54 mm) almost same size as midfemur (0.48 mm) and hindfemur width (0.52 mm).

Female: Unknown.

Local distribution. Niah, Sarawak.

Remarks. *Sycanus* sp. 4 is the only known female specimen. This species is similar to *S. dilutus*, *S. macracanthus*, *S. maculatus*, *S. tuberculatus*, *Sycanus* sp. 1, *Sycanus* sp. 2, and *Sycanus* sp. 3 in terms of body structures. This species is distinguished from the above mentioned species by having dark brown to black connexivum and black corium without any colours.



Figure 4.44: Habitus photograph of *Sycanus* sp. 4, ♂. Scale = 1 mm.

***Velinus nigrigenu* (Amyot & Serville, 1843)**

Figure 4.45

Evagoras nigrigenu Amyot & Serville, 1843a: 369.

Reduvius nigrigenu Stål, 1859a: 204.

Velinus satellitus Stål, 1866b: 281.

Velinus nigrigenu Stål, 1874a: 30.

Maldonado 1990: 320.

Materials examined. Male: SARAWAK: Miri: PPB Oil Palm Plantation: Saremas 2 [114.0060° E; 4.3320° N], 17 m, 4 February 2015, Hanisah Zahuri. SARAWAK: Miri: PPB Oil Palm Plantation: Saremas 2 [114.0060° E; 4.3320° N], 17 m, 6 February 2015, Hanisah Zahuri, 1♀. SARAWAK: Miri: PPB Oil Palm Plantation: Saremas 2 [114.0060° E; 4.3320° N], 17 m, 29 August 2015, Anis Raffi, 2♂. SARAWAK: Miri: PPB Oil Palm Plantation: Saremas 2 [114.0060° E; 4.3320° N], 17 m, 27 August 2015, Anis Raffi, 2♂. SARAWAK: Miri: PPB Oil Palm Plantation: Saremas 2 [114.0060° E; 4.3320° N], 17 m, 27 August 2015, Anis Raffi, 1♀. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 10 February 2007, Madinah, Nur Aida, & Rohayu, 1♂. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8

m, 30 March 2012, Ungku Mahfuzah, 1♂. SARAWAK: Serian: Ranchan Recreational Park [110.5845° E; 1.1434° N], 45 m, 1 May 2013, Siti Hajar Ariffin, 1♂.

Diagnosis. Medium body size, total length almost 19.00 mm; black head; alternate yellow and black on antennae; connexivum yellow alternate with black; and four semi-sphere connexivum structure.

Redescription. Male: COLOURATION: Head black; collar yellow; underside light yellow; eyes black; ocelli black with surrounded light yellow; antennae first segment alternate black and light yellow started with black and apex light yellow; antennae second and third segments black; antennae fourth segment brown; labium second segment black with apex dark yellow, labium second segment yellow with basal black, labium fourth segment dark yellow and black; pronotum yellow; scutellum black with surrounded yellow; hemelytra yellow, membrane black; connexivum yellow with black spots; abdomen yellow; coxae yellow; femur yellow with apex black; tibiae yellow with basal black; tarsus yellow. VESTITURE. Moderately setose. Dorsum head with short, semierect, and decumbent setae, scattered moderate long and semierect setae; pronotum with dense short, erect, and decumbent setae, more dense laterally; and sparse short to moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated; medium size, length 17.78 mm – 19.21 mm, width 3.35 mm – 4.20 mm; eyes semi-globular; head elongated; posterior head margin longer than anterior head margin; antennae scape short, length 0.40 mm; antennae first segment width slightly larger than antennae second, third and fourth segments width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.52 mm) shorter than labium third segment (2.39 mm); anterior angle with two thorn-like structures projected outward; anterior humeral angle rounded; posterior humeral angle

widely rounded; posterior pronotal lobe disc smooth; connexivum formed semi-sphere structures and slightly enlarged; hemelytra longer than abdomen apex; forefemur width (0.51 mm) almost same size as midfemur (0.43 mm) and hindfemur width (0.46 mm).

Female: Body colouration and body structures are mostly as same the male except for the body size which females slightly differ from males in both length and width; medium body size, length 18.08 mm – 18.90 mm, width 3.00 mm – 3.70 mm.

Local distribution. Universiti Malaysia Sarawak in Kota Samarahan, Kuching, Mukah, Tarat Agriculture Centre in Serian, Bukit Arip in Sibuan, Siburan in Kuching, Bintulu, Miri PPB Oil Palm Plantation, Sibuan, Baram, Niah, Semenggoh in Kuching, Sematan, Sri Aman, and Ranchan Recreational Park in Serian, Sarawak.

Remarks. *Velinus nigrigenu* is widely distributed throughout Sarawak. This species easily confused with *Cosmolestes picticeps* by having almost same colouration. *Velinus nigrigenu* is characterized by having medium body size with total length almost 19.00 mm while *Cosmolestes picticeps* has body size 13.00 mm.



Figure 4.45: Habitus photograph of *Velinus nigrigenu*, ♂. Scale = 1 mm.

***Vesbius purpureus* (Thunberg, 1783)**

Figure 4.46

Cimex purpureus Thunberg, 1783a: 57.

Reduvius purpureus Thunberg, 1822a: 4.

Harpactor milthinus Herrich-Schaeffer, 1848a: 82.

Vesbius purpureus Stål, 1866b: 281.

Euagoroida cocciren Matsumura, 1913b: 175.

Maldonado 1990: 321.

Materials examined. Male: SARAWAK: Kuching: Semonggok [110.3372° E; 1.3965° N], 23 m, 20 July 2002, Dorina. SARAWAK: Kota Samarahan [110.4883° E; 1.4599° N], 6 m, 24 January 2004, Phyllis Lahang, 1♂. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 15 February 2008, Nursyereen, 1♀. SARAWAK: Kota Samarahan: Universiti Malaysia Sarawak [110.4324° E; 1.4598° N], 8 m, 2 April 2008, Qatrunnada Zamzam, 1♀. SARAWAK: Kota Samarahan [110.4883° E; 1.4599° N], 6 m, 23 January 2004, Phyllis Lahang, 1♂.

Diagnosis. Red body except for head, antennae, membrane of forewings and legs; and short anteocular head region.

Redescription. Male: COLOURATION: Head black; collar orange; underside head black; eyes dark brown with yellow surrounded; ocelli black; antennae first segment dark brown with basal black; labium second and third segments dark brown, labium fourth segment brown; anterior pronotal lobe disc red; posterior pronotal lobe disc red; scutellum red; hemelytra red, membrane light brown; connexivum red; abdomen red; coxae red; femur black; tibiae black; tarsus black. VESTITURE. Moderately setose. Dorsum head with short, semierect, and decumbent setae; pronotum with short, semierect, and decumbent setae; and sparse moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; small size, length 7.55 mm – 8.28 mm, width 1.93 mm – 2.01 mm; eyes semi-globular; head elongated; posterior head margin longer than

anterior head margin; anterior head margin extremely short; antennae scape short, length 0.24 mm; antennae first segment width slightly larger than antennae second and third segment width; labium short, labium tip not reached forecoxae, and stout; labium third segment gently curved; labium second segment (0.58 mm) shorter than labium third segment (0.96 mm); anterior angle rounded; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle rounded; posterior pronotal lobe disc smooth; forefemur, midfemur, and hindfemur formed wave-like structure; connexivum smooth and slightly enlarged; hemelytra longer than abdomen apex; forefemur width (0.31 mm) almost same size as midfemur (0.31 mm) and hindfemur width (0.31 mm).

Female: Body colouration and body structures are mostly as same the male except for the body size in which females are smaller than males in both length and width; medium body size, length 7.41 mm – 7.97 mm, width 1.82 mm – 1.94 mm.

Local distribution. Semongok in Kuching, Universiti Malaysia Sarawak in Kota Samarahan, Lidong in Sri Aman, Similajau in Bintulu, and Kota Samarahan, Sarawak.

Remarks. *Vesbius purpureus* is same as *Hagia punctoria* and Harpactorinae sp. 6 by the presence of the short anteocular head region. This species is differed from other Harpactorinae species as most of the Harpactorinae have long anteocular head region.



Figure 4.46: Habitus photograph of *Vesbius purpureus*, ♂. Scale = 1 mm.

***Yolinus fuliginosus* (Stål, 1867)**

Figure 4.47

Yolinus fuliginosus Stål, 1866b, p. 280.

Yolinus fuliginosus var. Reuter, 1881a: 285.

Maldonado 1990: 324.

Materials examined. Female: SARAWAK: Limbang [115.0081° E; 4.7550° N], 7 m, 20 October 1985, Lippa Apeng. SARAWAK: Limbang [115.0081° E; 4.7550° N], 7 m, 20 October 1985, Mahmud Osman, 1♀.

Diagnosis. Black body colours except for basal connexivum; four semi-sphere connexivum structures; and connexivum first basal dark brown with apex dark red.

Redescription. Female: COLOURATION. Head black; underside head black; eyes black; ocelli light yellow; antennae first segment alternate black and yellow start with black; labium second segment black, labium third and fourth segments dark brown; anterior pronotal lobe black; posterior pronotal lobe black; scutellum black; hemelytra dark brown, membrane brown; connexivum first basal dark brown with apex dark red; abdomen red with basal black; coxae black; femur black; tibiae black; tarsus black. VESTITURE. Densely setose. Dorsum head with dense short, semierect to erect, and decumbent setae,

anterior pronotal lobe with sparse short, semierect, and decumbent setae; pronotum with dense short, semierect to erect, and decumbent setae, more dense laterally; and dense moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; large size, length 23.02 mm – 24.12 mm, width 8.74 mm – 10.37 mm; eyes semi-globular; head elongated; posterior head region longer than anterior head region; antennae scape short, length 0.60 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (2.85 mm) shorter than labium third segment (3.96 mm); anterior angle rounded; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle widely rounded; posterior pronotal lobe disc smooth; connexivum with four semi-sphere structure and extremely enlarged; forefemur, midfemur, and hindfemur formed wave-like structure; hemelytra longer than abdomen apex; forefemur width (0.69 mm) almost same size as midfemur (0.65 mm) and hindfemur width (0.64 mm).

Male: Unknown.

Local distribution. Limbang, Sarawak.

Remarks. *Yolinus fuliginosus* is the only known female specimens. This species is characterized by having semi-sphere connexivum structures with two colourations.



Figure 4.47: Habitus photograph of *Yolinus fuliginosus*, ♀. Scale = 1 mm.

Harpactorinae sp. 1

Figure 4.48

Materials examined. Female: SARAWAK: Miri: PPB Oil Palm Plantation: Saremas 2 [114.0060° E; 4.3320° N], 17 m, 6 February 2015, Hanisah Zahuri.

Diagnosis. Body total length above 20.00 mm; curved foretibiae structures; a single spine ventrally on foretibiae; yellow, orange, dark fawn and black body colour; forefemur bicoloured, yellow with apex black; and posterior pronotal lobe uni-coloured, dark fawn.

Redescription. Female: COLOURATION. Head black, collar dark fawn; eyes black; underside head dark fawn; ocelli black; antennae first segment black with two yellow lines; antennae second, third, and fourth segments dark brown; labium second and third segments dark fawn with apex black, labium fourth segment black; anterior pronotal lobe brown; posterior pronotal lobe dark fawn; scutellum dark fawn; hemelytra orange, corium black, membrane dark brown; connexivum black alternate with yellow and basal orange; abdomen orange and black; forecoxae dark brown, midcoxae and hindcoxae orange; forefemur orange with apex black, midfemur light yellow with black line in the middle and apex black, hindfemur light yellow with apex black; tibiae black; tarsus black. VESTITURE. Moderately setose. Dorsum head with short, semierect to erect, and

decumbent setae; pronotum with dense short, semierect to erect, and decumbent setae, more dense laterally; and dense short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 20.89 mm, width 13.89 mm; eyes semi-globular; head elongated, posteocular head region longer than anteocular head region; antennae scape short, 0.55 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (2.85 mm) longer than labium third segment (1.56 mm); anterior angle rounded; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle of pronotum pointed outward; posterior pronotal lobe disc smooth; connexivum formed wave-like structure and enlarged; hemelytra longer than abdomen apex; foretibiae curved downward; underside foretibiae with a single spine projected backward; forefemur width (1.29 mm) larger than midfemur (0.42 mm) and hindfemur (0.43 mm).

Male: Unknown.

Local distribution. Miri PPB Oil Palm Plantation, Sarawak.

Remarks. Harpactorinae sp. 1 is the only single male specimen known. This species is almost similar to HNSP2 and shared the same foretibiae structures with Harpactorinae sp. 2, Harpactorinae sp. 3, and Harpactorinae sp. 5 by having curved foretibiae structures; and a single spine ventrally on foretibiae, but it can be distinguished from the above mentioned species based on body colours. Harpactorinae sp. 1 has yellow, orange, dark fawn and black body colour as same as Harpactorinae sp. 2 except for hemelytra orange; forefemur bicoloured, yellow with apex black; body total length above 20.00 mm; and posterior pronotal lobe uni-coloured, dark fawn.



Figure 4.48: Habitus photograph of Harpactorinae sp. 1, ♂. Scale = 1 mm.

Harpactorinae sp. 2

Figure 4.49

Materials examined. Female: SARAWAK: Miri: PPB Oil Palm Plantation: Saremas 2 [114.0060° E; 4.3320° N], 17 m, 7 February 2015, Hanisah Zahuri.

Diagnosis. Body total length above 20.00 mm; yellow, orange, dark fawn, and black body colour; hemelytra orange with black markings; forefemur bi-coloured, dark fawn with apex black; and posterior pronotal lobe bi-coloured, orange with black markings at the middle.

Redescription. Female: COLOURATION. Head black, collar dark orange; eyes black; ocelli light orange; underside head light orange; antennae first segment black with light orange lines; antennae second segment black; antennae third and fourth segment dark brown; labium second segment light orange, labium third segment light orange with apex black; labium fourth segment black; anterior pronotal lobe dark fawn; posterior pronotal lobe orange with large black spots at the middle; scutellum yellowish brown, apex black; hemelytra orange with dark brown at basal, membrane dark brown; connexivum yellow with two black lines at the middle; abdomen orange with apex and side abdomen black; coxae orange; forefemur orange and black with apex black, midfemur yellow with black line at the middle and apex black, hindfemur yellow with apex black; tibiae black; tarsus

black. VESTITURE. Moderately setose. Dorsum head with short, semierect to erect, and decumbent setae; pronotum with dense short, semierect to erect, and decumbent setae, more dense laterally; and dense short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; large size, length 20.37 mm, width 13.45 mm; eyes semi-globular; head elongated, posteocular head region longer than anteocular head region; antennae scape short, length 0.48 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (2.56 mm) longer than labium third segment (1.72 mm); anterior angle rounded; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle pointed downward; posterior pronotal lobe disc smooth; connexivum smooth and slightly enlarged; hemelytra longer than abdomen apex; foretibiae curved downward; underside foretibiae with a single spine projected backward; forefemur width (0.95 mm) larger than midfemur (0.41 mm) and hindfemur (0.38 mm).

Male: Unknown.

Local distribution. Miri PPB Oil Palm Plantation, Sarawak.

Remarks. Harpactorinae sp. 2 is the only single female specimen known. This species is almost similar to Harpactorinae sp. 1 and shared the same foretibiae structures with Harpactorinae sp. 1, Harpactorinae sp. 3, and Harpactorinae sp. 5 by having curved foretibiae structures; and a single spine ventrally on foretibiae, but it can be distinguished from the above mentioned species based on body colours. Harpactorinae sp. 2 has yellow, orange, dark fawn, and black body colour as same as Harpactorinae sp. 2 except for hemelytra orange with black markings; forefemur bi-coloured, dark fawn with apex black;

body total length above 20.00 mm; and posterior pronotal lobe bi-coloured, orange with black markings at the middle.



Figure 4.49: Habitus photograph of Harpactorinae sp. 2, ♀. Scale = 1 mm.

Harpactorinae sp. 3

Figure 4.50

Materials examined. Male: SARAWAK: Miri: PPB Oil Palm Plantation: Saremas 2 [114.0060° E; 4.3320° N], 17 m, 10 February 2015, Ento Team.

Diagnosis. Yellow, dark yellow, red, and black body colour; forefemur black; body total length above 20.00 mm; and posterior pronotal lobe bi-coloured, red with black markings at the middle.

Redescription. Female: COLOURATION. Head black, collar yellow; eyes yellow; underside head yellow; ocelli yellow; antennae first segment black with orange lines; antennae second and third segments black; labium second segment black, labium third segment black with apex dark yellow; labium fourth segment dark yellow to black; anterior pronotal lobe dark yellow; posterior pronotal lobe red with black spot at the middle and black lines at humeral angle; scutellum yellow; hemelytra red, clavus black continue to membrane, membrane brown; connexivum yellow with around side red; abdomen dark fawn; coxae dark yellow; forefemur black, midfemur and hindfemur black with yellow

line; foretibiae black; midtibiae and hindtibiae black with yellow lines; tarsus black. VESTITURE. Moderately setose. Dorsum head with short, semierect to erect, and decumbent setae; pronotum with dense short, semierect to erect, and decumbent setae, more dense laterally; and dense short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 19.12 mm, width 5.12 mm; head elongated; posterior head margin longer than anterior head margin; eyes semi-globular; antennae scape short, length 0.66 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (2.29 mm) longer than labium third segment (1.13 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle pointed outward; posterior pronotal lobe disc smooth; forefemur width larger than midfemur and hindfemur; foretibiae curved downward; underside foretibiae with a single spine projected backward; connexivum smooth and enlarged upward; hemelytra longer than abdomen apex; forefemur width (1.06 mm) larger than midfemur (0.36 mm) and hindfemur width (0.37 mm).

Male: Unknown.

Local distribution. Miri PPB Oil Palm Plantation, Sarawak.

Remarks. Harpactorinae sp. 3 is the only single male specimen known. This species shared same foretibiae structures with Harpactorinae sp. 1, Harpactorinae sp. 2, and Harpactorinae sp. 5 by having curved foretibiae structures; and a single spine ventrally on foretibiae, but it can be distinguished from the above mentioned species based on body colours. Harpactorinae sp. 3 has yellow, dark yellow, red, and black body colour;

forefemur black; body total length above 20.00 mm; and posterior pronotal lobe bi-coloured, red with black markings at the middle.



Figure 4.50: Habitus photograph of Harpactorinae sp. 3, ♀. Scale = 1 mm.

Harpactorinae sp. 4

Figure 4.51

Materials examined. Male: SARAWAK: Padawan: Borneo Highland [110.2232° E; 1.1332° N], 760 m, 22 August 2015, Hanisah Zahuri. SARAWAK: Padawan: Borneo Highland [110.2232° E; 1.1332° N], 760 m, 26 August 2015, Cyntia, Qamareena, Dainty, & Hanisah Zahuri, 1♂2♀.

Diagnosis. Total body length below 15.00 mm; body covered with spines; and femur orange.

Redescription. Male: COLOURATION. Head dark orange; eyes black; underside head orange; ocelli orange; antennae first segment orange with apex black; antennae second segment orange with basal and apex black; labium second segment dark orange with black line from basal to apex; labium third segment light orange with black line from basal to apex; labium fourth segment black; pronotum dark orange with spines orange; scutellum black to dark orange; corium dark orange; clavus black continue to membrane; connexivum reddish; abdomen black with dark orange in the middle from basal to apex;

coxae dark orange; femur orange; tibiae light orange; tarsus light orange with apex black. VESTITURE. Moderately setose. Dorsum head with short, semierect to erect and decumbent setae; pronotum with short, semierect to erect, and decumbent setae; and short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 15.16 mm – 15.22 mm, width 3.15 mm – 3.34 mm; head elongated; postocular head region longer than anteocular head region; eyes semi-globular; two spines erected forward between eyes and antennae scape; postocular head region with small spines erected upward; antennae scape short, length 0.33 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (1.57 mm) shorter than labium third segment (2.05 mm); anterior angle with two spines erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with two small spines projected upward; pronotum transverse sulcus with two large spines projected upward; anterior humeral angle with two spines erected outward; posterior humeral angle with two large spines projected outward; posterior pronotal lobe disc with two spines projected upward; connexivum smooth; forefemur, midfemur, and hindfemur covered with spines; forefemur width (0.47 mm) almost same size as midfemur (0.33 mm) and hindfemur width (0.37 mm).

Female: Body colouration and body structures are mostly as same as in male except for the body size which females slightly differ from males in both length and width; medium body size, length 15.56 mm – 15.76 mm, width 3.62 – 3.63 mm.

Local distribution. Borneo Highland in Padawan, Sarawak.

Remarks. Harpactorinae sp. 4 is the only specimens collected from Borneo Highland in Padawan, Sarawak and were absent from other research centre collections. This species

shared same body structure, elongated body and the presence of a spine at the posterior humeral angle; and body colouration, brown to dark brown with *Euagoras sordidatus*, however, Harpactorinae sp. 4 is distinguished from *E. sordidatus* by having body covered with spines; femur orange; and total body length below 15.00 mm.



Figure 4.51: Habitus photograph of Harpactorinae sp. 4, ♂. Scale = 1 mm.

Harpactorinae sp. 5

Figure 4.52

Materials examined. Male: SARAWAK: Miri: PPB Oil Palm Plantation: Saremas 2 [114.0060° E; 4.3320° N], 17 m, 10 February 2015, Ento Team.

Diagnosis. Yellow, dark yellow, dark fawn, and black body colour; forefemur bi-coloured, dark fawn and black; body total length below 20.00 mm; and posterior pronotal lobe dark fawn.

Redescription. Male: COLOURATION. Head black, collar light yellow; eyes light yellow; underside head light yellow; ocelli light yellow; antennae first, second, and third segments black; labium second segment yellow, labium third segment yellow with black line at the middle; labium fourth segment dark yellow with apex black; anterior pronotal lobe dark fawn; posterior pronotal lobe dark fawn; scutellum dark fawn; hemelytra yellow, membrane and membrane side brown; connexivum light yellow with apex black; abdomen

light yellow; coxae yellow; forefemur dark fawn with apex black; midfemur and hindfemur light yellow with apex black; foretibiae and midtibiae black with light yellow line at the middle, hindtibiae black; tarsus black. VESTITURE. Moderately setose. Dorsum head with short, semierect to erect, and decumbent setae; pronotum with dense short, semierect to erect, and decumbent setae, more dense laterally; and dense short, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 16.18 mm, width 3.20 mm; head elongated; posterior head margin longer than anterior head margin; eyes semi-globular; antennae scape short, length 0.27 mm; antennae first segment width slightly larger than antennae second and third segment width; labium long, labium tip reached forecoxae, and slender; labium third segment gently curved; labium second segment (2.06 mm) longer than labium third segment (1.16 mm); anterior angle with two thorn-like structures erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle pointed outward; posterior pronotal lobe disc smooth; forefemur width larger than midfemur and hindfemur; foretibiae curved downward; underside foretibiae with a single spine projected backward; connexivum smooth and slightly enlarged; hemelytra longer than abdomen apex; forefemur width (0.80 mm) larger than midfemur (0.37 mm) and hindfemur width (0.35 mm).

Female: Unknown.

Local distribution. Miri PPB Oil Palm Plantation, Sarawak.

Remarks. Harpactorinae sp. 5 is the only single male specimen known. This species shared the same foretibiae structures with Harpactorinae sp. 1, Harpactorinae sp. 2, and Harpactorinae sp. 3 by having curved foretibiae structures; and a single spine ventrally on foretibiae, but it can be distinguished from the above mentioned species based on body

colours and body size. Harpactorinae sp. 5 has yellow, dark yellow, dark fawn, and black body colour; forefemur bi-coloured, dark fawn and black; body total length below 20.00 mm; and posterior pronotal lobe dark fawn.



Figure 4.52: Habitus photograph of Harpactorinae sp. 5, ♂. Scale = 1 mm.

Harpactorinae sp. 6

Figure 4.53

Materials examined. Male: SARAWAK: Limbang [115.0081° E; 4.7550° N], 7 m, 16 October 1985, Manis Lintang. SARAWAK: Limbang [115.0081° E; 4.7550° N], 7 m, 17 October 1985, Manis Lintang, 1♂. SARAWAK: Niah [113.7309° E; 3.8665° N], 8 m, 17 January 1985, Manis Lintang, 1♀. SARAWAK: Bintulu: Labang Forest Reserve [113.5667° E; 3.3667° N], 38 m, 12 January 1985, Lippa Akeng, 1♀.

Diagnosis. Medium body size, total length almost 16.00 mm; red body colours except for head, forewings membrane, the apex of the femur, and tibiae; legs covered with densely setose; and basal of hindfemur slightly curved.

Redescription. Male: COLOURATION. Head black, collar red; eyes black with dark yellow surrounded; underside head black; ocelli light yellow; antennae first and second segments dark brown; labium second segment dark brown, labium third segment black with dark brown line at the middle from basal to apex; labium fourth segment dark brown;

anterior pronotal lobe red; posterior pronotal lobe red; scutellum dark red; hemelytra red to dark red with membrane light brown; connexivum dark red; abdomen red with basal left side and apex black; coxae red; femur red with apex black; tibiae black; tarsus dark brown. VESTITURE. Densely setose. Dorsum head with scattered moderate long, semierect to erect and decumbent setae; pronotum with dense short to moderate long, semierect to erect, and decumbent setae, more dense laterally; and dense moderate long, semierect to erect, and decumbent setae over entire legs. STRUCTURE. Body elongated-oval; medium size, length 13.49 mm – 13.54 mm, width 2.70 mm – 3.60 mm; head elongated; posterior head margin longer than anterior head margin; eyes semi-globular; antennae scape short, length 0.43 mm; antennae first segment width slightly larger than antennae second and third segment width; labium short, labium tip not reached forecoxae, and stout; labium third segment gently curved; labium second segment (0.82 mm) longer than labium third segment (0.76 mm); anterior angle with two thorn-like structure erected forward; anterior humeral angle rounded; anterior pronotal lobe disc with deep line at the middle formed two nodules; posterior humeral angle widely rounded; posterior pronotal lobe disc smooth; connexivum smooth and slightly enlarged; hemelytra longer than abdomen apex; forefemur width (0.60 mm) almost same as midfemur (0.57 mm) and hindfemur (0.54 mm).

Female: Body colouration and body structures are mostly as same as in male except for the body size which females are smaller in length and larger in width than males; medium body size, length 15.06 mm – 15.22 mm, width 5.06 mm – 5.12 mm.

Local distribution. Niah, Bintulu, and Limbang in Sarawak.

Remarks. Harpactorinae sp. 6 is the only specimens recorded from UNIMAS Insect Reference Collection at Universiti Malaysia Sarawak, and Forest Research Centre,

Sarawak. This species is same as *Vesbius purpureus* and *Hagia punctoria* by the present of the short anteocular head region. This species is differed other Harpactorinae species as most of the Harpactorinae have long anteocular head region.



Figure 4.53: Habitus photograph of Harpactorinae sp. 6, ♀. Scale = 1 mm.

4.4 Conclusion

A total of 23 genera and 52 species from subfamily Harpactorinae were examined from four institutions and four sampling sites in Sarawak. A systematic account of each described and undescribed species were constructed based on the comparative morphological structures. A key to the genera of the subfamily Harpactorinae was presented. A geographical distribution map using Quantum Geographic Information System (QGIS) were constructed for each species.

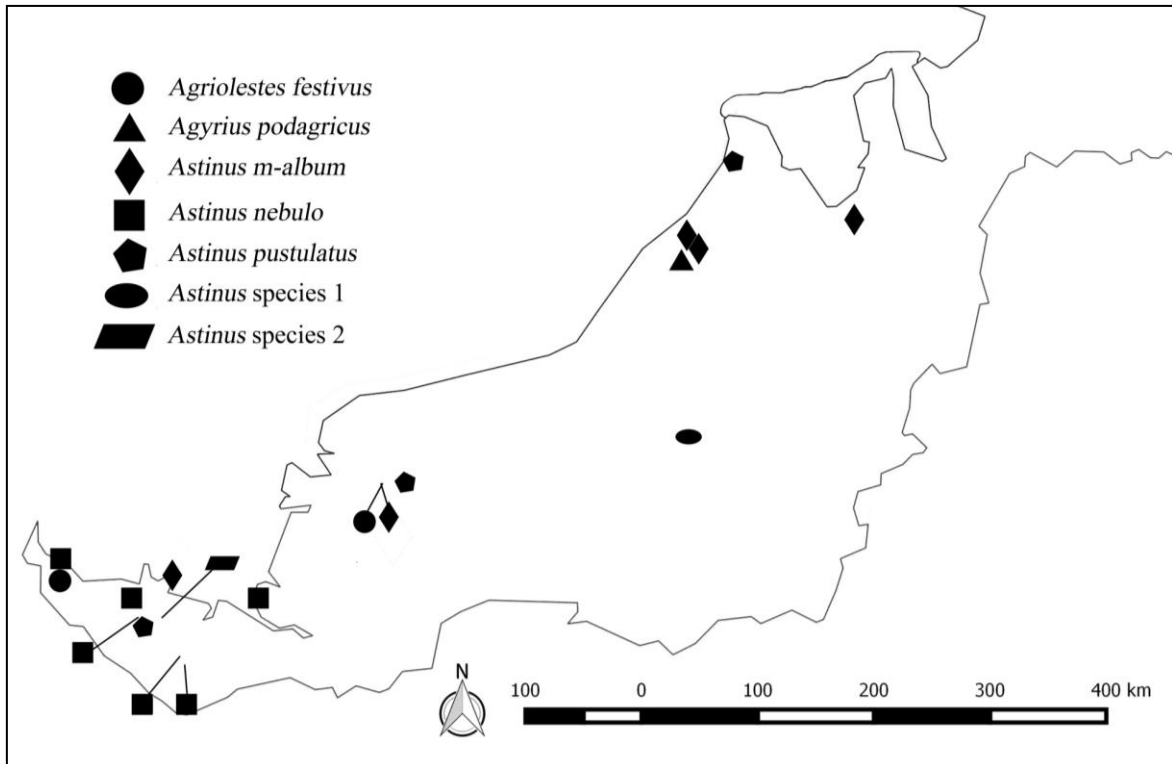


Figure 4.54: Geological distribution map of *A. festivus*, *A. podagricus*, *A. m-album*, *A. nebulo*, *A. pustulatus*, *Astinus* sp. 1, and *Astinus* sp. 2 in Sarawak.

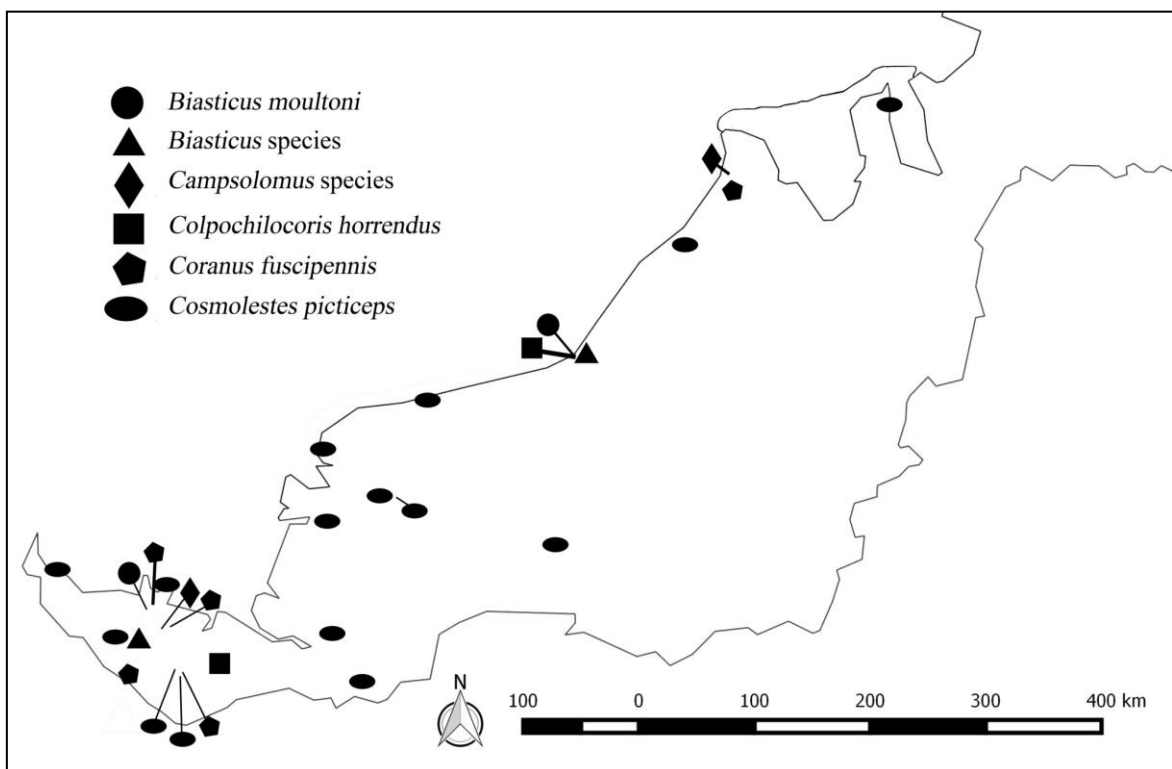


Figure 4.55: Geological distribution map of *B. moultoni*, *Biasticus* sp. 1, *Campsolomus* sp., *C. horrendus*, *C. fuscipennis*, *C. picticeps* in Sarawak.

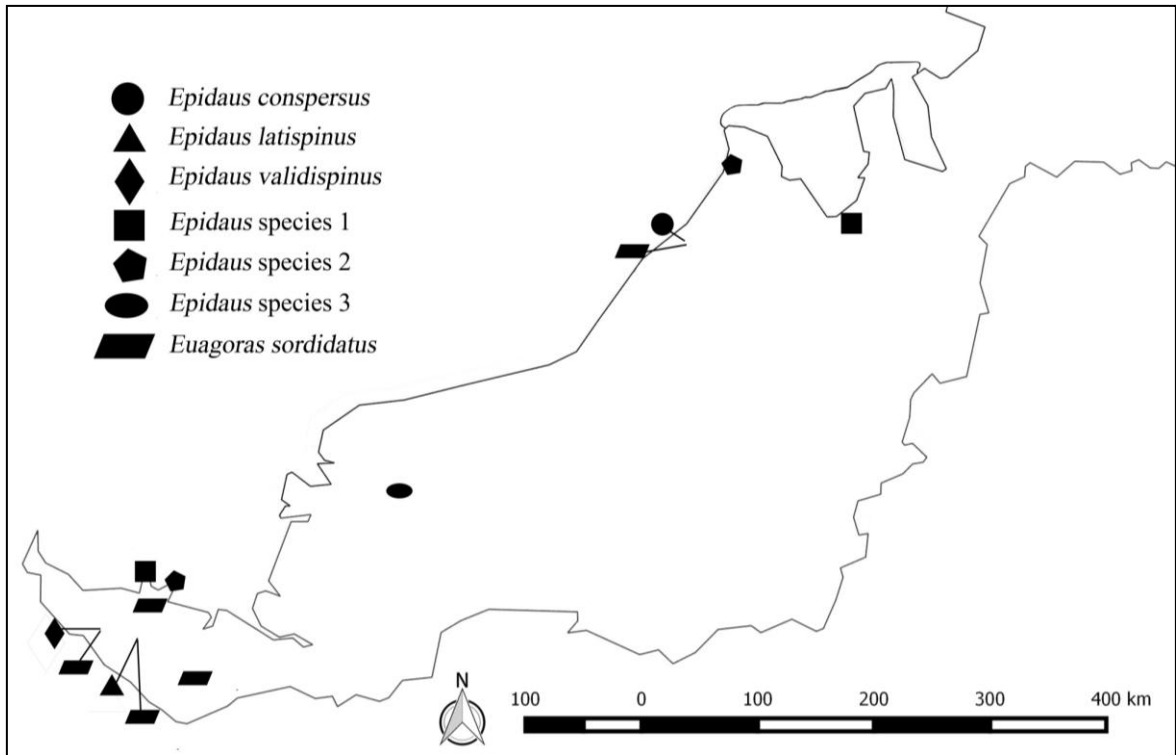


Figure 4.56: Geological distribution map of *E. conspersus*, *E. latispinus*, *E. validispinus*, *Epidaus* sp. 1, *Epidaus* sp. 2, *Epidaus* sp. 3, and *E. sordidatus* in Sarawak.

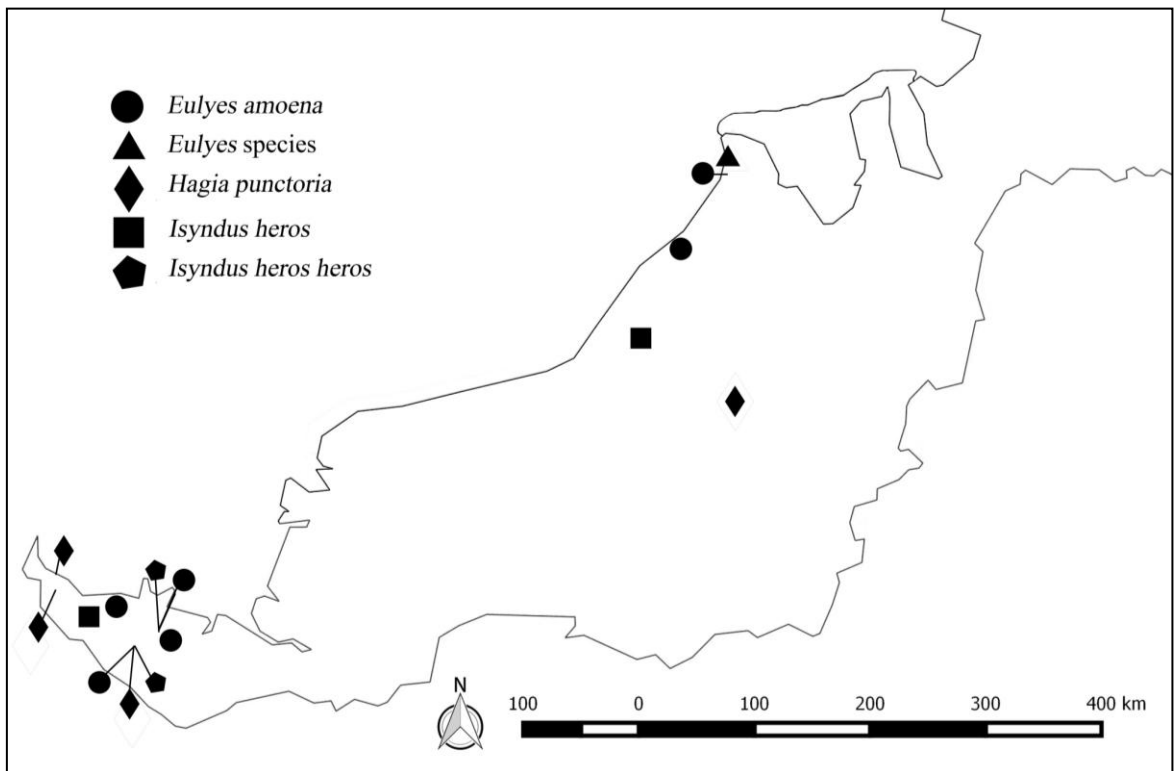


Figure 4.57: Geological distribution map of *E. amoena*, *Eulyes* sp. 1, *H. punctoria*, *I. heros*, and *I. heros heros* in Sarawak.

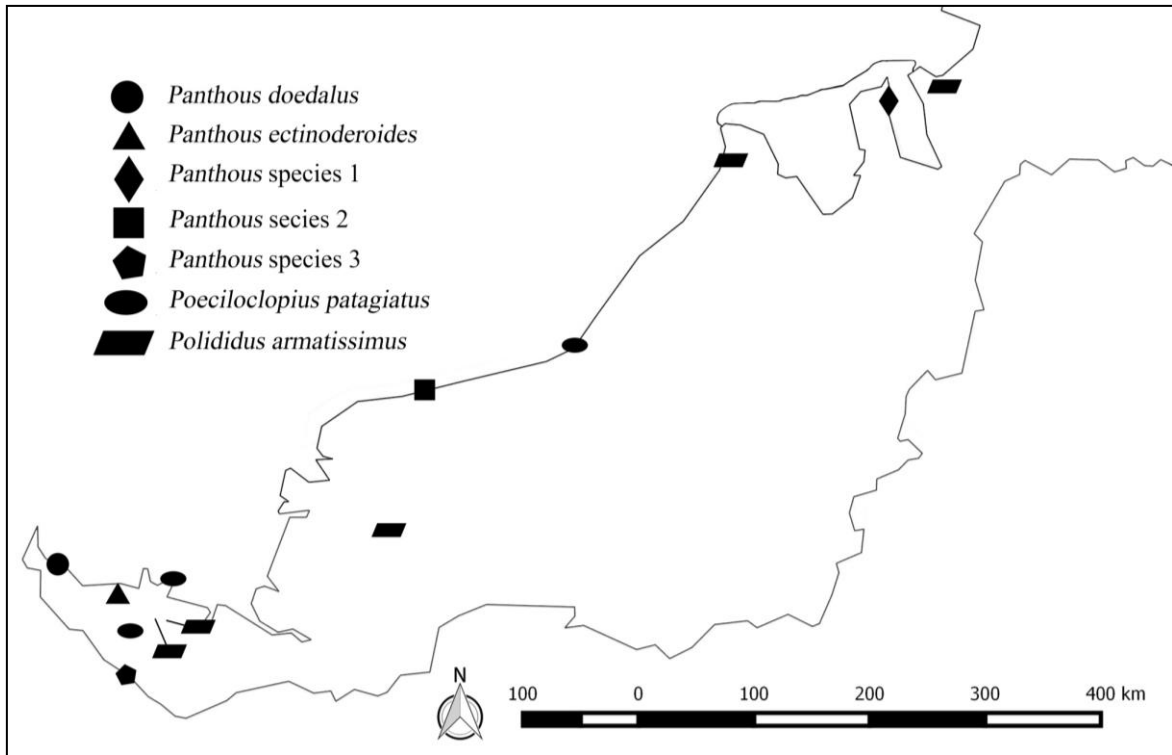


Figure 4.58: Geological distribution map of *P. daedalus*, *P. ectinoderoides*, *Panthous* sp. 1, *Panthous* sp. 2, *Panthous* sp. 3, *P. patagiatus*, and *P. armatissimus* in Sarawak.

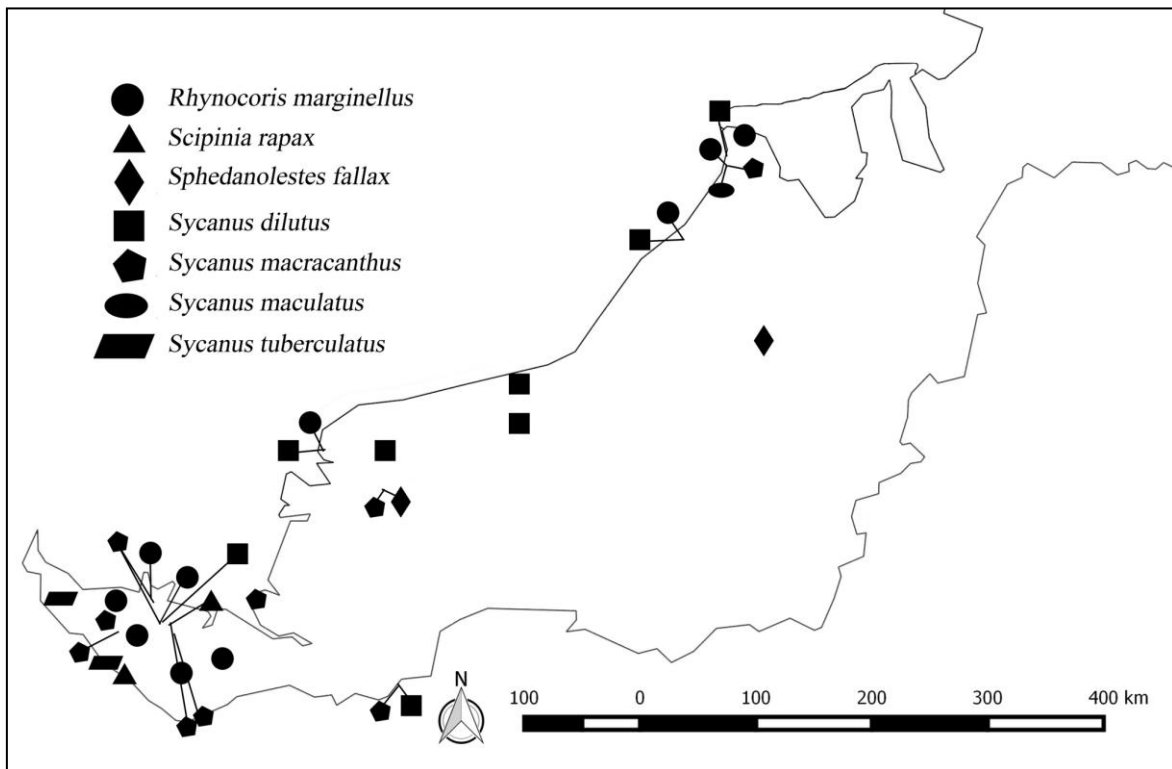


Figure 4.59: Geological distribution map of *R. marginellus*, *S. rapax*, *S. fallax*, *S. dilutus*, *S. macracanthus*, *S. maculatus*, and *S. tuberculatus* in Sarawak.

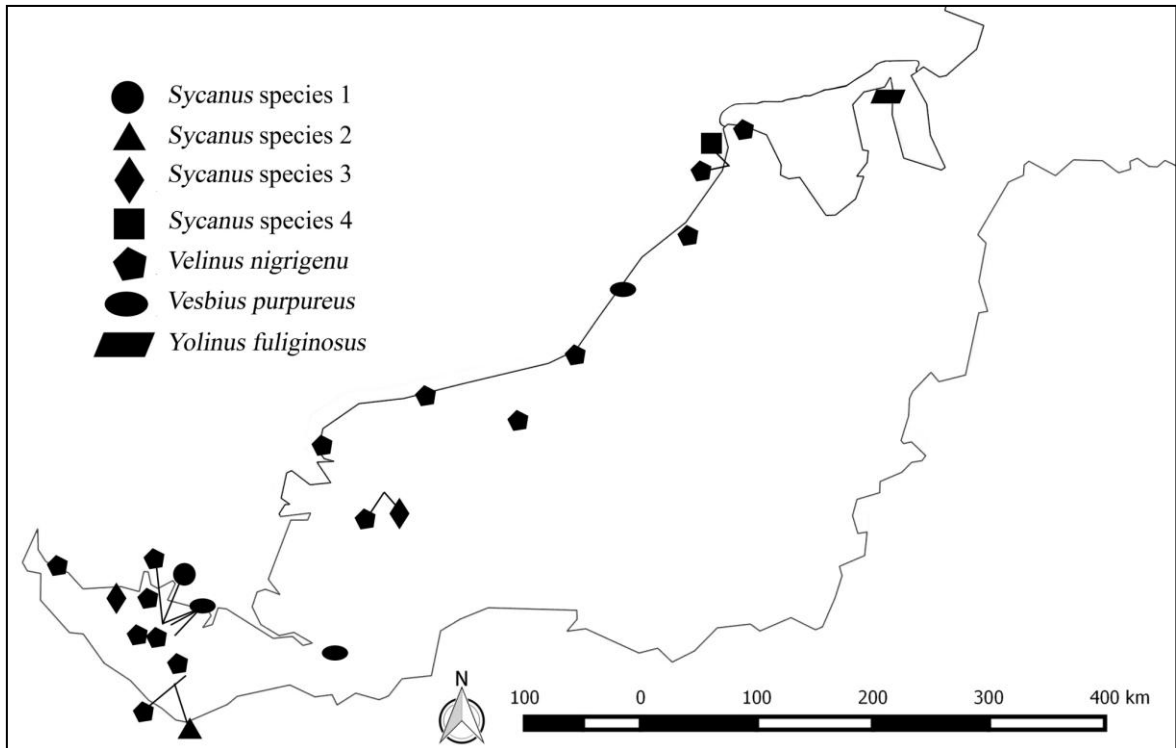


Figure 4.60: Geological distribution map of *Sycanus* sp. 1, *Sycanus* sp. 2, *Sycanus* sp. 3, *Sycanus* sp. 4, *V. nigrigenu*, *V. purpureus*, and *Y. fuliginosus* in Sarawak.

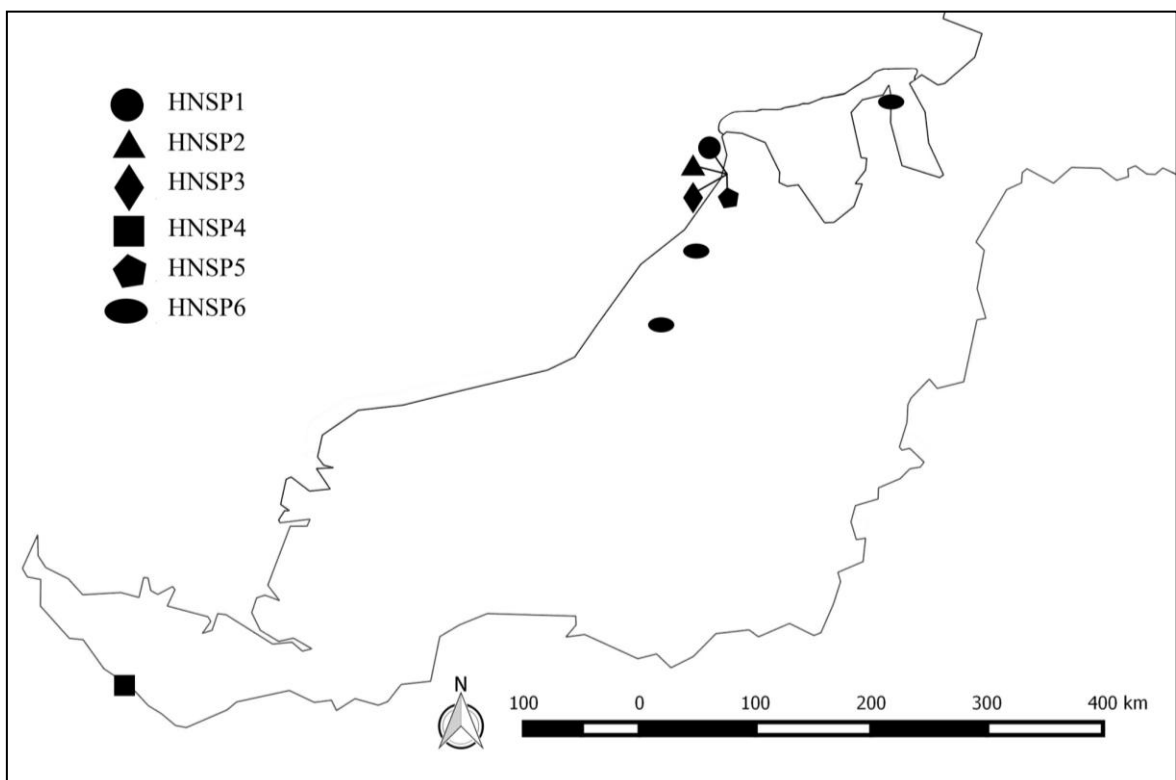


Figure 4.61: Geological distribution map of Harpactorinae sp. 1, Harpactorinae sp. 2, Harpactorinae sp. 3, Harpactorinae sp. 4, Harpactorinae sp. 5, and Harpactorinae sp. 6 in Sarawak.

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CHAPTER 5

GENERAL CONCLUSION

A total of 12 subfamilies, 50 genera, and 101 species were recorded in Sarawak. A comparative morphological structure of all described and undescribed species of Reduviidae has been conducted. A phylogenetic analysis on 101 ingroup and 3 outgroup (Pentatomorpha: Pentatomidae: *Dalpada oculata* and *Dalpada trimaculata* (Halyini), and *Rhynchocoris serratus* (Rhynchocorini)) based on 61 morphological structures using Tree Analysis using New Technology (TNT) software was constructed. Based on the results, the monophyly of Reduviidae is well supported with Pentatomorpha as their outgroup. The results also present the monophyly of Tribelocephalinae, Salyavatinae, and Ectrichodiinae in a clade that also include Physoderinae, Saicinae and Reduviinae (*Acanthaspis quadriannulata*). The monophyly of Harpactorinae with the basal position of Harpactorini in a clade is presented.

In addition, a systematic account is focused on Harpactorinae species in Sarawak. A total of 23 genera and 52 species are described. A key to the Harpactorinae genera is provided based on the comparative morphological structures that also been used in the phylogenetic analysis. Some redescriptions of the species are not specified to male or female due to the limitation and frangibility of the samples. A map is constructed to show the geographical distribution of Harpactorinae species in Sarawak.

The results achieved from this study, statement of the acceptance (or reject) monophyly of certain subfamilies were based on the included taxa in the analysis. The limitations of this study lie in several subfamilies and species that were not included in the study due to their unavailability in Sarawak. A future test based on genitalia or molecular, or both is

recommended to test the relationship or sister-group relationship between the taxa and also for identified the undescribed species (e.g. ENSP, HNSP, SLSP, and STSP). Reduviidae is known as assassin bug, thus a documentation of host plant and specific character used in preying are required for the future study to advance our knowledge of their habit and diet.

APPENDICES

Appendix 1: Character matrix of Reduviidae and outgroup in Sarawak.

Species	Character matrix																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Outgroup																							
<i>Dalpada oculata</i>	2	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	2	2	0	0	0
<i>Dysdercus trimaculata</i>	2	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	2	2	0	0	0
<i>Rhynchocoris serratus</i>	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	2	0	0	0
Centrocnemidinae																							
<i>Neocentrocnemis</i> sp. 1	0	1	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	1	1	1	0	0	1
<i>Neocentrocnemis</i> sp. 2	0	1	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	1	1	1	0	0	1
<i>Neocentrocnemis</i> sp. 3	0	1	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	1	1	1	0	0	1
Ectrichodiinae																							
<i>Ectrychotes colouratus</i>	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0
<i>Neoscadra</i> sp.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0
<i>Santos lugubris</i>	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0
<i>Santos</i> sp. 1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0
<i>Santos</i> sp. 2	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0
<i>Scadra aliena</i>	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	?	?
<i>Scadra costalis</i>	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0
<i>Schottus luteicollis</i>	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1	0
Ectrichodiinae sp.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0
Harpactorinae																							
<i>Agriolestes festivus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 1 continued.

Species	Character matrix																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
<i>Agyrius podagricus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Astinus m_album</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Astinus nebulo</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Astinus pustulata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Astinus</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Astinus</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Blasticus moultoni</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Blasticus</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Campsolomus</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Colpochilocoris horrendus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
<i>Coranus fuscipennis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cosmolestes picticeps</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Epidaus conspersus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Epidaus latispinus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Epidaus validispinus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Epidaus</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Epidaus</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Epidaus</i> sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Euagoras sordidatus</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Eulyes amoena</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
<i>Eulyes</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
<i>Hagia punctoria</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Isyndus heros</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Isyndus heros heros</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Panthous daedalus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 1 continued.

Species	Character matrix																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
<i>Panthous ectinoderoides</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Panthous</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Panthous</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Panthous</i> sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Poeciloclopius patagiatus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Polididus armatissimus</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Rhynocoris marginellus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Scipinia rapax</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Sphedanolestes fallax</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Sycanus dilutus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
<i>Sycanus macracanthus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
<i>Sycanus tuberculatus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
<i>Sycanus</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
<i>Sycanus</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
<i>Sycanus</i> sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
<i>Sycanus</i> sp. 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
<i>Sycanus</i> sp. 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
<i>Velinus nigrigenu</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Vesbius purpureus</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Yolinus fuliginosus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
<i>Harpactorinae</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

Appendix 1 continued.

Species	Character matrix																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Harpactorinae sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Harpactorinae sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Harpactorinae sp. 4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harpactorinae sp. 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Harpactorinae sp. 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Holoptilinae																							
<i>Holoptilus leprosus</i>	2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	1
Peiratinae																							
<i>Ectomocoris atrox</i>	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
<i>Ectomocoris elegans</i>	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
<i>Sirthena flavipes</i>	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
Physoderinae																							
<i>Physoderes curculionis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Reduviinae																							
<i>Acanthaspis quadriannulata</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0
<i>Sminthus singularis</i>	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1	1	0	0	1
<i>Tiarodes</i> sp.	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
<i>Velitra rubropicta</i>	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	0	0	1
Saicinae																							
<i>Polytoxus vagans</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	1	0	?	?
Salyavatinae																							
<i>Lisarda inornata</i>	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	1	1	1	1	1	0
<i>Lisarda umbrosa</i>	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	1	1	1	1	1	0
<i>Salyavata</i> sp.	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	1	1	1	1	1	0
<i>Syberna munita</i>	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	1	0	1	1	0
<i>Valentia apetala</i>	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	1	1	1	1	1	0

Appendix 1 continued.

Species	Character matrix																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Salyavatinae sp. 1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	1	1	1	1	1	0
Salyavatinae sp. 2	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	1	1	1	1	0
Stenopodainae																							
<i>Aulacogenia patalungae</i>	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
<i>Aulacogenia sarawakensis</i>	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0
<i>Canthesancus</i> sp.	0	1	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	1	1	0	0	1	0
<i>Oncocephalus annulipes</i>	0	1	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	0
<i>Oncocephalus cingalensis</i>	0	1	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	0
<i>Oncocephalus sarawakensis</i>	0	1	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	0
<i>Oncocephalus</i> sp. 1	0	1	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	0
<i>Oncocephalus</i> sp. 2	0	1	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	0
<i>Oncocephalus</i> sp. 3	0	1	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0
<i>Pygolampis</i> sp.	1	1	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	0
<i>Sastrapada</i> sp.	0	1	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	0
<i>Staccia diluta</i>	1	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2	2	0	0	0
<i>Thodelmus matangensis</i>	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	?	?
Stenopodainae sp. 1	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0
Stenopodainae sp. 2	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0
Triatominae																							
<i>Triatoma migrans</i>	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0

Appendix 1 continued.

Species	Character matrix																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Tribelocephalinae																							
<i>Opistoplatys</i>	0	1	0	0	0	0	1	1	0	0	0	0	1	1	2	0	0	?	0	1	0	?	?
<i>perakensis</i>																							
<i>Opistoplatys</i> sp.	0	1	0	0	0	0	1	1	0	0	0	0	1	1	2	0	0	1	0	1	0	?	?
<i>Tribelocephala</i> sp. 1	0	1	0	0	0	0	1	2	0	0	0	0	1	1	2	0	0	0	0	1	0	1	0
<i>Tribelocephala</i> sp. 2	0	0	0	0	0	0	1	2	0	0	0	0	1	1	2	0	0	0	0	1	0	1	0

Appendix 1 continued.

Species	Character matrix																						
	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Outgroup																							
<i>Dalpada oculata</i>	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	2	0	0	0
<i>Dysdercus</i>																							
<i>trimaculata</i>	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	2	0	0	0
<i>Rhynchocoris</i>																							
<i>serratus</i>	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	1	0	0	0
Centrocnemidinae																							
<i>Neocentrocnemis</i> sp. 1	0	0	0	0	0	0	2	3	3	3	0	0	0	0	0	0	0	0	3	1	0	0	0
<i>Neocentrocnemis</i> sp. 2	0	0	0	0	0	0	2	3	3	3	0	0	0	0	0	0	0	0	3	1	0	0	0
<i>Neocentrocnemis</i> sp. 3	0	0	0	0	0	0	2	3	3	3	0	0	0	0	0	0	0	0	3	1	0	0	0
Ectrichodiinae																							
<i>Ectrychotes</i>																							
<i>colouratus</i>	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Neoscadra</i> sp.	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0

Appendix 1 continued.

Species	Character matrix																						
	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
<i>Santos lugubris</i>	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Santos</i> sp. 1	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Santos</i> sp. 2	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Scadra aliena</i>	?	0	?	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Scadra costalis</i>	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Schottus luteicollis</i>	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Ectrichodiinae sp.	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Harpactorinae																							
<i>Agriolestes festivus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	3	0	2	0	1
<i>Agyrius podagricus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
<i>Astinus m_album</i>	0	0	0	0	0	0	0	1	2	1	0	0	0	1	0	1	0	0	1	0	0	0	1
<i>Astinus nebulo</i>	0	0	0	0	0	0	0	1	2	1	0	0	0	1	0	1	0	0	0	0	0	0	1
<i>Astinus pustulata</i>	0	0	0	0	0	0	0	1	2	1	0	0	0	1	0	1	0	0	1	0	0	0	1
<i>Astinus</i> sp. 1	0	0	0	0	0	0	0	1	2	1	0	0	0	2	0	1	0	0	1	0	0	0	1
<i>Astinus</i> sp. 2	0	0	0	0	0	0	0	1	2	1	0	0	0	1	0	1	0	0	1	0	0	0	1
<i>Biasticus moultoni</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
<i>Biasticus</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
<i>Campsolomus</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
<i>Colpochilocoris horrendus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	2	0	1
<i>Coranus fuscipennis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
<i>Cosmolestes picticeps</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2	0	1
<i>Epidaus conspersus</i>	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	1	0	0	0	0	0	0	1
<i>Epidaus latispinus</i>	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	1	0	0	0	0	0	0	1
<i>Epidaus validispinus</i>	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	1	0	0	0	0	0	0	1
<i>Epidaus</i> sp. 1	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	1	0	0	0	0	0	0	1
<i>Epidaus</i> sp. 2	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	1	0	0	1	0	0	0	1

Appendix 1 continued.

Species	Character matrix																						
	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
<i>Epidaus</i> sp. 3	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	1	0	0	0	0	0	0	1
<i>Euagoras sordidatus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
<i>Eulyes amoena</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	1
<i>Eulyes</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	1
<i>Hagia punctoria</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
<i>Isyndus heros</i>	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	1	0	0	0	1
<i>Isyndus heros heros</i>	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	1	0	0	0	1
<i>Panthous daedalus</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	2
<i>Panthous ectinoderoides</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	2
<i>Panthous</i> sp. 1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	2
<i>Panthous</i> sp. 2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	2
<i>Panthous</i> sp. 3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	2
<i>Poeciloclopius patagiatus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	1
<i>Polididus armatissimus</i>	0	0	0	0	0	0	0	2	2	2	0	0	0	0	0	1	0	0	0	1	0	0	1
<i>Rhynocoris marginellus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
<i>Scipinia rapax</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
<i>Sphedanolestes fallax</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
<i>Sycanus dilutus</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	3	2	0	0	1
<i>Sycanus macracanthus</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	3	2	0	0	1
<i>Sycanus tuberculatus</i>	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	1	0	0	3	2	0	0	1
<i>Sycanus</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	2	0	0	1
<i>Sycanus</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	3	2	0	0	1
<i>Sycanus</i> sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	1	0	0	3	2	0	0	1

Appendix 1 continued.

Species	Character matrix																						
	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
<i>Sycanus</i> sp. 4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	1	0	0	3	2	0	0	1
<i>Sycanus</i> sp. 5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	3	2	0	0	1
<i>Velinus nigrigenu</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	1
<i>Vesbius purpureus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
<i>Yolinus fuliginosus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	2	0	1
Harpactorinae sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1
Harpactorinae sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1
Harpactorinae sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Harpactorinae sp. 4	0	0	0	0	0	0	0	2	2	2	0	0	0	0	0	1	0	0	0	0	0	0	1
Harpactorinae sp. 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Harpactorinae sp. 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Holoptilinae																							
<i>Holoptilus leprosus</i>	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Peiratinae																							
<i>Ectomocoris atrox</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
<i>Ectomocoris elegans</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0
<i>Sirthena flavipes</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
Physoderinae																							
<i>Physoderes curculionis</i>	1	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	1	0	0	0	0
Reduviinae																							
<i>Acanthaspis quadriannulata</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Sminthus singularis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Tiarodes</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0
<i>Velitra rubropicta</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 1 continued.

Species	Character matrix																						
	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Saicinae																							
<i>Polytoxus vagans</i>	?	0	?	0	0	0	0	0	2	0	0	0	1	0	0	0	0	3	2	0	0	1	0
Salyavatinae																							
<i>Lisarda inornata</i>	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	2	0	0	0
<i>Lisarda umbrosa</i>	1	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	1	2	0	0	0
<i>Salyavata</i> sp.	1	0	0	0	0	0	1	0	2	0	1	0	0	0	0	0	0	0	0	1	0	0	0
<i>Syberna munita</i>	1	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Valentia apetala</i>	1	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	1	0	0	0
<i>Salyavatinae</i> sp. 1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0
<i>Salyavatinae</i> sp. 2	1	0	0	0	0	0	1	0	2	0	1	0	0	0	0	0	0	0	0	1	0	0	0
Stenopodainae																							
<i>Aulacogenia patalungae</i>	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	3	0	0
<i>Aulacogenia sarawakensis</i>	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	3	0	0
<i>Canthesancus gulo</i>	1	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Oncocephalus annulipes</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Oncocephalus cingalensis</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Oncocephalus sarawakensis</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Oncocephalus</i> sp. 1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Oncocephalus</i> sp. 2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Oncocephalus</i> sp. 3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>Pygolampis</i> sp.	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0
<i>Sastrapada</i> sp.	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0
<i>Staccia diluta</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0

Appendix 1 continued.

Species	Character matrix																							
	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	
<i>Thodelmus matangensis</i>	?	0	?	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	2	0	0	0	0	
Stenopodainae sp. 1	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	0	3	0	0	
Stenopodainae sp. 2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	
Triatominae																								
<i>Triatoma migrans</i>	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
Tribelocephalinae																								
<i>Opistoplatys perakensis</i>	?	1	?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Opistoplatys</i> sp.	?	1	?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Tribelocephala</i> sp. 1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
<i>Tribelocephala</i> sp. 2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Appendix 1 continued.

Species	Character matrix														
	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
Outgroup															
<i>Dalpada oculata</i>	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0
<i>Dysdercus trimaculata</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Rhynchocoris serratus</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Centrocnemidinae															
<i>Neocentrocnemis</i> sp. 1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
<i>Neocentrocnemis</i> sp. 2	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
<i>Neocentrocnemis</i> sp. 3	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Ectrichodiinae															
<i>Ectrychotes colouratus</i>	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
<i>Neoscadra</i> sp.	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0

Appendix 1 continued.

Species	Character matrix														
	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
<i>Santos lugubris</i>	0	1	0	0	0	0	0	1	1	1	0	0	0	1	0
<i>Santos</i> sp. 1	0	1	0	0	0	0	0	1	1	1	0	0	0	1	0
<i>Santos</i> sp. 2	0	1	0	1	0	0	0	1	1	1	0	0	0	1	0
<i>Scadra aliena</i>	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
<i>Scadra costalis</i>	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
<i>Schottus luteicollis</i>	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0
<i>Ectrichodiinae</i> sp. 1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0
Harpactorinae															
<i>Agriolestes festivus</i>	0	1	0	2	0	0	0	0	1	0	0	0	0	1	1
<i>Agyrius podagricus</i>	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1
<i>Astinus m_album</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Astinus nebulo</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Astinus pustulata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Astinus</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Astinus</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Biasticus moultoni</i>	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1
<i>Biasticus</i> sp. 1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1
<i>Campsolomus</i> sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
<i>Colpochilocoris horrendus</i>	0	1	0	2	0	0	0	0	1	0	0	0	0	1	1
<i>Coranus fuscipennis</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
<i>Cosmolestes picticeps</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
<i>Epidaus conspersus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Epidaus latispinus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Epidaus validispinus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Epidaus</i> sp. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Epidaus</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Epidaus</i> sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Euagoras sordidatus</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1

Appendix 1 continued.

Species	Character matrix														
	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
<i>Eulyes amoena</i>	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1
<i>Eulyes</i> sp. 1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1
<i>Hagia punctoria</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Isyndus heros</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
<i>Isyndus heros heros</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
<i>Panthous daedalus</i>	0	1	0	2	0	0	0	0	1	0	0	0	0	1	1
<i>Panthous ectinoderoides</i>	0	1	0	1	0	0	0	0	1	0	0	0	0	1	1
<i>Panthous</i> sp. 1	0	1	0	2	0	0	0	0	1	0	0	0	0	1	1
<i>Panthous</i> sp. 2	0	1	0	2	0	0	0	0	1	0	0	0	0	1	1
<i>Panthous</i> sp. 3	0	1	0	0	0	0	0	0	1	0	0	0	0	1	1
<i>Poeciloclopius patagiatus</i>	0	1	0	0	0	0	0	0	1	0	0	0	0	1	1
<i>Polididus armatissimus</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
<i>Rhynocoris marginellus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Scipinia rapax</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
<i>Sphedanolestes fallax</i>	0	1	0	1	0	0	0	0	1	0	0	0	0	1	1
<i>Sycanus dilutus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Sycanus macracanthus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Sycanus tuberculatus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Sycanus</i> sp. 1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
<i>Sycanus</i> sp. 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Sycanus</i> sp. 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Sycanus</i> sp. 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Sycanus</i> sp. 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Velinus nigrigenu</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
<i>Vesbius purpureus</i>	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1
<i>Yolinus fuliginosus</i>	0	1	0	0	0	0	0	0	1	0	0	0	0	1	1
Harpactorinae sp. 1	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1
Harpactorinae sp. 2	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1

Appendix 1 continued.

Species	Character matrix														
	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
Harpactorinae sp. 3	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1
Harpactorinae sp. 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Harpactorinae sp. 5	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1
Harpactorinae sp. 6	0	1	0	1	0	0	0	0	1	0	0	0	1	1	1
Holoptilinae															
<i>Holoptilus leprosus</i>	0	2	0	1	0	0	0	0	2	0	0	0	0	1	0
Peiratinae															
<i>Ectomocoris atrox</i>	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
<i>Ectomocoris elegans</i>	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0
<i>Sirthena flavipes</i>	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Physoderinae															
<i>Physoderes curculionis</i>	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Reduviinae															
<i>Acanthaspis quadriannulata</i>	0	1	0	1	0	0	0	1	1	1	0	0	0	0	0
<i>Sminthus singularis</i>	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0
<i>Tiarodes</i> sp.	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0
<i>Velitra rubropicta</i>	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Saicinae															
<i>Polytoxus vagans</i>	0	1	0	2	0	0	0	?	0	0	0	0	0	0	0
Salyavatinae															
<i>Lisarda inornata</i>	1	0	0	1	0	0	0	1	0	0	1	1	0	0	0
<i>Lisarda umbrosa</i>	1	0	0	1	0	0	0	1	0	0	1	1	0	0	0
<i>Salyavata</i> sp.	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
<i>Syberna munita</i>	0	0	0	0	1	0	0	1	1	0	1	1	0	0	0
<i>Valentia apetala</i>	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0
Salyavatinae sp. 1	1	0	0	0	0	0	0	1	0	0	1	1	0	0	0
Salyavatinae sp. 2	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0

Appendix 1 continued.

Species	Character matrix														
	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61
Stenopodainae															
<i>Aulacogenia patalungae</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Aulacogenia sarawakensis</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Canthesancus gulo</i>	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Oncocephalus annulipes</i>	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>Oncocephalus cingalensis</i>	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>Oncocephalus sarawakensis</i>	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>Oncocephalus</i> sp. 1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>Oncocephalus</i> sp. 2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>Oncocephalus</i> sp. 3	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>Pygolampis</i> sp.	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Sastrapada</i> sp.	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>Staccia diluta</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Thodelmus matangensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stenopodainae sp. 1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Stenopodainae sp. 2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Triatominae															
<i>Triatoma migrans</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tribelocephalinae															
<i>Opistoplatys perakensis</i>	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0
<i>Opistoplatys</i> sp.	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0
<i>Tribelocephala</i> sp. 1	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0
<i>Tribelocephala</i> sp. 2	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0

Appendix 2: Measurements of external morphological structures of Reduviidae species in millimetre (mm). *BodyL*=Body total length; *BodyW*=Body width; *HeadL*=Head total length; *HeadW*=Head width; *LabII*=Labium 2nd segment; *LabIII*=Labium 3rd segment; *LabIV*=Labium 4th segment; *AntSc*=Antennae scape; *AntI*=Antennae 1st segment; *AntII*=Antennae 2nd segment; *AntProL*=Anterior pronotal lobe length; *PostProL*=Posterior pronotal lobe length; *ScuL*=Scutellum length; *ScuW*=Scutellum width.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
CENTROCENEMIDINAE															
<i>Neocentrocnemis</i> sp. 1		23.63	12.44	4.60	2.80	2.16	1.51	0.52	1.31	3.50	2.60	2.36	3.08	2.93	3.84
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Neocentrocnemis</i> sp. 2	Mean	26.23	12.94	5.24	3.08	2.59	1.58	0.89	1.61	5.19	3.15	2.78	3.18	3.13	3.93
	SD	0.81	0.06	0.60	0.78	0.51	0.11	0.30	0.06	0.53	-	0.29	0.25	0.61	0.51
Male	Min	25.66	12.89	4.81	3.02	2.23	1.50	0.68	1.56	4.81	-	2.57	3.00	2.70	3.57
	Max	26.80	12.98	5.66	3.13	2.95	1.65	1.10	1.65	5.56	-	2.98	3.36	3.56	4.29
	N =	2	2	2	2	2	2	2	2	2	1	2	2	2	2
<i>Neocentrocnemis</i> sp. 3		21.77	11.14	4.39	2.61	1.96	1.64	0.87	1.63	3.84	2.52	2.65	2.88	2.62	3.31
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
ECTRICHODIINAE															
<i>Ectrychotes</i> <i>coloratus</i>	Mean	12.43	4.08	2.13	1.59	1.01	0.86	0.43	1.76	2.44	2.23	1.27	1.82	0.94	1.64
	SD	0.95	0.51	0.20	0.07	0.10	0.03	0.05	0.28	0.10	0.13	0.10	0.19	0.15	0.04
Male	Min	11.26	3.36	1.83	1.53	0.92	0.83	0.40	1.47	2.35	2.13	1.15	1.54	0.79	1.58
	Max	13.53	4.57	2.31	1.69	1.12	0.89	0.51	2.04	2.57	2.42	1.38	1.96	1.09	1.67
	N =	4	4	4	4	4	4	4	4	4	4	4	4	4	4
<i>Neoscadra</i> sp.		17.29	5.33	3.53	1.89	2.03	1.12	0.31	3.86	3.36	-	1.52	2.06	1.51	2.31
Male	N =	1	1	1	1	1	1	1	1	1	-	1	1	1	1
<i>Santos lugubris</i>		10.81	3.53	1.75	1.38	0.77	0.81	0.39	0.27	1.67	2.80	0.91	1.45	1.28	1.55
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Santos</i> sp. 1		14.22	4.66	2.17	1.65	1.81	0.90	0.40	0.40	3.44	4.06	1.19	1.79	0.90	2.04
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
<i>Santos sp. 2</i>	Mean	14.73	5.02	2.29	1.74	1.84	0.73	0.35	3.35	3.92	2.46	1.10	1.74	1.19	1.90
Male	SD	0.30	0.28	0.20	0.08	0.04	0.04	0.04	0.13	0.18	0.57	0.02	0.13	0.06	0.07
	Min	14.41	4.63	1.97	1.62	1.74	0.67	0.30	3.19	3.79	1.48	1.06	1.60	1.11	1.79
	Max	15.19	5.33	2.46	1.83	1.95	0.77	0.40	3.50	4.16	2.85	1.11	1.95	1.29	1.97
	N =	5	5	5	5	5	5	5	5	5	5	5	5	5	5
<i>Scadra aliena</i>		12.86	4.39	2.62	1.52	0.86	0.62	0.30	-	-	-	1.29	1.48	1.08	1.55
	N =	1	1	1	1	1	1	1	-	-	-	1	1	1	1
<i>Scadra costalis</i>		12.91	3.95	2.33	1.51	1.28	0.84	0.40	1.81	2.38	-	1.53	1.56	1.13	1.63
Male	N =	1	1	1	1	1	1	1	1	1	-	1	1	1	1
<i>Schottus luteicollis</i>	Mean	11.02	3.27	1.44	1.75	0.46	0.78	0.32	1.06	2.11	-	0.72	1.52	0.78	1.34
	SD	0.43	0.20	0.05	0.10	0.04	0.06	0.04	0.14	0.23	-	0.10	0.11	0.12	0.09
	Min	10.34	2.97	1.37	1.62	0.40	0.73	0.29	0.87	1.92	-	0.57	1.33	0.62	1.16
	Max	11.40	3.55	1.52	1.90	0.50	0.85	0.40	1.18	2.38	-	0.89	1.67	0.93	1.45
	N =	8	8	8	8	7	6	6	4	3	-	8	8	8	8
<i>Ectrichodiinae</i>		22.16	7.71	4.55	2.20	2.13	1.15	0.40	3.41	4.32	2.47	1.91	2.35	2.15	2.49
sp.															
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
HARPACTORINAE															
<i>Agriolestes</i>	Mean	29.95	11.71	6.75	2.36	3.36	5.03	0.65	0.85	5.51	2.61	2.46	3.64	2.11	3.42
<i>festivus</i>	SD	0	0.71	0.37	0.03	0.28	0.37	0.04	0.01	0.12	0.04	0.21	0.23	0.11	0.13
Male	Min	29.95	11.21	6.49	2.34	3.16	4.77	0.64	0.84	5.42	2.58	2.31	3.48	2.03	3.33
	Max	29.95	12.21	7.01	2.38	3.55	5.29	0.66	0.86	5.59	2.64	2.60	3.80	2.18	3.51
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2
<i>Agyrius</i>		14.90	3.15	3.44	1.35	1.81	1.54	0.50	0.22	2.99	2.63	1.44	1.88	1.49	1.59
<i>podagricus</i>	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Male															

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
<i>Astinus m-album</i>	Mean	18.28	6.07	3.60	1.52	2.21	1.25	0.52	0.44	8.63	3.15	1.34	2.28	1.05	1.81
	SD	1.14	1.08	0.28	0.02	0.23	0.14	0.08	0.04	0.98	0.14	0.15	0.32	0.19	0.25
	Min	16.99	5.26	3.25	1.50	1.95	1.07	0.40	0.41	7.59	3.00	1.20	2.02	0.80	1.53
	Max	19.40	7.13	3.83	1.53	2.41	1.41	0.56	0.48	9.53	3.26	1.55	2.73	1.26	2.13
	N =	4	4	4	4	4	4	4	3	3	3	4	4	4	4
	Mean	20.76	7.82	4.12	1.58	2.45	1.43	0.43	0.55	9.51	3.03	1.55	3.00	1.40	2.52
	SD	0.95	0.52	0.21	0.12	0.07	0.05	0.07	0.02	0.66	-	0.09	0.15	0.19	0.05
	Min	19.94	7.69	3.89	1.47	2.40	1.39	0.37	0.53	9.04	-	1.45	2.85	1.28	2.47
	Max	21.80	8.07	4.30	1.71	2.53	1.49	0.51	0.56	9.97	-	1.62	3.14	1.62	2.56
	N =	3	3	3	3	3	3	3	2	2	1	3	3	3	3
<i>Astinus nebulo</i>	Mean	19.98	5.64	3.82	1.66	1.98	1.39	0.52	0.32	9.48	3.26	1.64	2.51	1.02	1.88
	SD	0.83	0.73	0.18	0.11	0.09	0.09	0.16	-	-	-	0.13	0.13	0.12	0.38
	Min	18.78	4.97	3.65	1.57	1.88	1.29	0.34	-	-	-	1.53	2.32	0.93	1.31
	Max	20.57	6.66	4.04	1.81	2.06	1.46	0.64	-	-	-	1.81	2.59	1.19	2.14
	N =	4	4	4	4	3	3	3	1	1	1	4	4	4	4
<i>Astinus pustulatus</i>	Mean	17.87	5.68	3.36	1.56	2.02	1.30	0.42	0.44	8.53	3.20	1.42	2.38	0.85	1.63
	SD	0.69	0.28	0.16	0.07	0.10	0.11	0.07	0.08	0.45	0.06	0.08	0.17	0.24	0.23
	Min	16.69	5.41	3.19	1.45	1.85	1.10	0.34	0.31	7.88	3.11	1.33	2.23	0.64	1.37
	Max	18.76	6.02	3.64	1.63	2.04	1.45	0.52	0.52	9.12	3.26	1.53	2.63	1.14	1.93
	N =	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Mean	19.92	6.45	3.74	1.60	2.00	1.41	0.54	0.49	9.06	3.40	1.50	2.75	0.90	2.13
	SD	0.60	0.58	0.28	0.02	0.17	0.19	0.24	0.06	0.30	0.04	0.17	0.34	0.10	0.38
	Min	19.47	5.57	3.49	1.58	1.80	1.25	0.40	0.44	8.85	3.37	1.33	2.36	0.80	1.77
	Max	20.60	6.93	4.04	1.62	2.13	1.62	0.81	0.53	9.27	3.42	1.67	3.00	1.00	2.53
	N =	3	3	3	3	3	3	3	2	2	2	3	3	3	3

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
<i>Astinus</i> sp. 1 Female	Mean	19.34	6.31	3.58	1.58	2.52	1.96	0.60	0.46	8.43	3.57	1.54	2.78	1.11	2.25
	SD	0.43	0.68	0.44	0.04	0.24	0.34	0.17	0.08	0.93	0.30	0.17	0.10	0.27	0.32
	Min	19.24	5.82	3.24	1.54	2.30	1.56	0.50	0.35	8.13	3.38	1.40	2.69	1.06	2.10
	Max	19.50	7.22	3.89	1.61	2.75	2.21	0.75	0.53	8.65	3.97	1.72	2.84	1.17	2.34
	N =	3	3	3	3	3	3	3	3	3	3	3	3	3	3
<i>Astinus</i> sp. 2 Female		20.00	6.82	4.09	1.59	2.66	1.70	0.42	0.49	9.94	3.72	1.73	2.88	0.67	1.77
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Biasticus moultoni</i> Female	Mean	10.80	2.34	2.36	1.13	1.07	0.98	0.29	0.28	3.05	1.91	0.84	1.61	0.51	1.09
	SD	0.28	0.18	0.01	0.04	0.23	0.18	0.19	0.04	0.04	1.00	0	0.09	0.52	0.58
	Min	10.60	2.21	2.35	1.10	0.90	0.85	0.15	0.30	3.02	1.20	0.84	1.54	0.37	0.68
	Max	10.99	2.46	2.37	1.15	1.23	1.10	0.42	0.25	3.08	2.61	0.84	1.67	0.64	1.50
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2
<i>Biasticus</i> sp. 1 Male Female		10.16	2.57	1.93	1.14	1.06	0.79	0.31	0.30	2.75	-	0.78	1.47	0.87	0.66
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Mean	10.38	3.12	2.30	1.09	0.99	1.11	0.36	0.28	2.77	2.19	0.74	1.61	0.70	0.90
	SD	0.06	0.07	0.10	0.03	0.03	0.04	0.04	0.06	0.13	0.69	0.05	0.19	0.04	0.15
	Min	10.31	3.05	2.20	1.06	0.97	1.08	0.32	0.22	2.62	1.39	0.68	1.40	0.65	0.74
<i>Campsolomus</i> sp. Male	Max	10.42	3.18	2.40	1.11	1.03	1.15	0.40	0.33	2.87	2.62	0.77	1.76	0.72	1.03
	N =	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Mean	14.32	3.36	3.01	1.38	1.04	1.99	0.36	0.32	4.37	1.67	1.29	1.75	1.12	1.22
	SD	0.43	0.16	0.19	0.02	0.16	0.29	0.04	0.03	0.09	0.06	0.10	0.07	0.13	0.07
	Min	13.73	3.20	2.88	1.37	1.07	1.75	0.31	0.30	4.30	1.62	1.16	1.66	0.97	1.13
	Max	14.62	3.51	3.33	1.40	1.14	2.40	0.40	0.34	4.43	1.71	1.39	1.81	1.28	1.29
	N =	4	4	4	4	4	4	4	4	4	4	4	4	4	4

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
<i>Colpochilocoris horrendus</i> Female	Mean	29.76	8.04	6.37	2.14	2.46	4.29	1.58	0.75	6.74	2.94	1.13	3.74	1.79	2.47
	SD	0.71	1.22	0.15	0.03	0.30	0.01	0.03	0.18	0.35	0.01	0.24	0.48	0.34	0.06
	Min	29.26	7.18	6.26	2.12	2.25	4.28	1.56	0.62	6.49	2.93	1.92	5.78	1.55	2.42
	Max	30.26	8.90	6.47	2.16	2.67	4.29	1.60	0.88	6.99	2.94	2.26	6.46	2.03	2.51
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2
<i>Coranus fuscipennis</i>	Mean	9.95	2.90	2.51	1.63	0.92	1.33	0.33	0.29	2.45	-	1.20	1.31	0.71	0.96
	SD	0.57	0.55	0.22	0.22	0.24	0.08	0.06	0.01	0.55	-	0.15	0.11	0.31	0.10
	Min	9.48	2.37	2.34	1.41	0.73	1.23	0.29	0.28	2.06	-	1.02	1.21	0.46	0.81
	Max	10.66	3.65	2.81	1.91	1.18	1.38	0.40	0.30	2.84	-	1.36	1.40	1.15	1.04
	N =	4	4	4	4	3	3	3	2	2	-	4	4	4	4
<i>Cosmolestes picticeps</i> Male	Mean	11.92	2.25	2.55	1.10	1.28	0.29	0.35	0.32	5.64	1.88	1.15	1.54	1.12	1.30
	SD	0.25	0.56	0.20	0.02	0.07	0.10	0.12	0.05	0.23	0.02	0.08	0.11	0.30	0.05
	Min	11.73	1.42	2.34	1.10	1.19	1.18	0.24	0.26	5.34	1.86	1.03	1.44	0.74	1.23
	Max	12.29	2.64	2.81	1.12	1.35	1.43	0.51	0.39	5.86	1.91	1.20	1.67	1.46	1.36
	N =	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Female	Mean	12.07	2.80	2.37	1.19	1.35	1.39	0.32	0.28	5.26	1.51	1.17	1.67	0.93	1.26
	SD	0.84	0.40	0.09	0.15	0.12	0.21	0.05	0.05	0.19	0.31	0.06	0.22	0.14	0.08
	Min	10.75	2.24	2.30	1.10	1.15	1.12	0.22	0.24	5.10	1.10	1.03	1.35	0.67	1.08
	Max	13.11	3.17	2.55	1.16	1.52	1.77	0.40	0.33	5.53	1.77	1.27	1.97	1.06	1.36
	N =	6	6	6	6	6	6	6	4	4	4	6	6	6	6
<i>Epidaus conspersus</i> Female	N =	16.98	4.58	4.31	1.67	1.96	1.73	0.56	0.66	12.07	4.27	1.58	2.83	2.29	2.61
<i>Epidaus latispinus</i> Male	Mean	18.95	3.89	3.65	1.58	1.61	2.07	0.52	0.46	9.86	3.93	1.57	2.71	1.19	2.08
	SD	0.36	0.40	0.04	0.02	0.05	0.35	0.12	0.09	0.72	0.35	0.06	0.21	0.35	0.34
	Min	18.69	3.60	3.62	1.56	1.59	1.82	0.43	0.39	9.35	3.68	1.52	2.56	0.94	1.84
	Max	19.20	4.17	3.68	1.59	1.66	2.32	0.60	0.52	10.37	4.18	1.61	2.85	1.44	2.32
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
<i>Epidaus validispinus</i>		21.53	5.50	3.71	1.68	1.66	1.82	0.53	0.44	12.11	4.68	1.69	3.11	1.13	2.14
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Epidaus sp. 1</i>		15.73	4.15	2.99	1.28	1.38	0.76	0.40	0.26	7.35	2.82	1.05	1.92	0.74	1.09
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Female		23.22	7.63	4.26	1.69	2.41	2.03	0.66	0.51	11.90	-	1.66	3.60	1.55	2.25
	N =	1	1	1	1	1	1	1	1	1	-	1	1	1	1
<i>Epidaus sp. 2</i>	Mean	20.38	4.74	3.87	1.59	1.65	1.42	0.58	0.56	10.30	3.47	1.52	2.51	1.33	1.83
Male	SD	1.80	0.49	0.37	0.29	0.15	0.08	0.08	0.06	1.10	0.48	0.26	0.51	0.04	0.55
	Min	18.93	4.18	3.62	1.42	1.53	1.33	0.49	0.50	9.03	3.13	1.34	2.21	1.28	1.47
	Max	22.40	5.10	4.30	1.93	1.82	1.49	0.63	0.62	10.97	3.81	1.82	3.10	1.36	2.46
	N =	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Female		24.20	7.82	4.37	1.52	1.84	1.78	0.54	0.44	12.03	6.56	1.84	3.71	2.45	2.69
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Epidaus sp. 3</i>		15.73	4.15	2.99	1.28	1.38	0.76	0.40	0.26	7.35	2.82	1.05	1.92	0.74	1.09
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Euagoras sordidatus</i>	Mean	12.63	2.35	2.87	1.21	1.06	1.64	0.37	0.29	7.18	2.99	0.92	1.52	0.82	1.15
	SD	0.40	0.09	0.50	0.04	0.09	0.14	0.09	0.04	0.22	1.39	0.13	0.12	0.13	0.16
Male	Min	11.98	2.18	2.52	1.17	0.92	1.38	0.24	0.22	6.97	2.28	0.70	1.39	0.67	0.93
	Max	12.97	2.45	3.93	1.28	1.15	1.83	0.52	0.35	7.54	5.48	1.05	1.75	1.03	1.25
	N =	7	7	7	7	7	7	7	6	6	5	7	7	7	7
Female	Mean	13.20	2.62	2.63	1.49	1.01	1.93	0.30	0.34	6.80	2.53	1.02	1.78	0.79	1.05
	SD	0.34	0.44	0.34	0.44	0.07	0.08	0.04	0.10	0.37	0.39	0.05	0.15	0.11	0.17
	Min	12.86	2.11	2.29	1.16	0.95	1.84	0.26	0.25	6.53	0.22	0.97	1.62	0.69	0.88
	Max	12.53	2.91	2.97	1.31	1.08	2.00	0.34	0.45	7.23	2.97	1.05	1.91	0.91	1.21
	N =	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W	
<i>Eulyes amoena</i> Male	Mean	29.54	11.88	5.83	2.31	1.60	5.77	0.51	-	-	-	2.45	3.58	2.11	2.59	
	SD	0.70	2.03	0.27	0.08	0.06	0.18	0.03	-	-	-	0.08	0.13	0.32	0.05	
	Min	28.94	9.65	5.52	2.26	1.57	5.57	0.48	-	-	-	2.40	3.45	1.78	2.54	
	Max	30.31	13.63	6.04	2.40	1.66	5.91	0.53	-	-	-	2.55	3.70	2.42	2.60	
	N =	3	3	3	3	3	3	3	1	1	1	3	3	3	3	
	Female	Mean	30.10	11.53	5.56	2.39	1.61	5.57	0.51	0.75	7.50	4.22	2.36	3.56	2.26	3.11
		SD	1.20	0.90	0.32	0.19	0.09	0.46	0.06	-	-	-	0.05	0.46	0.57	0.54
		Min	28.82	10.82	5.30	2.27	1.53	5.07	0.45	-	-	-	2.30	3.03	1.78	2.59
		Max	31.19	12.54	5.92	2.61	1.70	5.99	0.57	-	-	-	2.39	3.84	2.71	3.66
		N =	3	3	3	3	3	3	3	1	1	1	3	3	3	3
<i>Eulyes sp. 1</i> Female		31.49	11.16	5.88	2.50	1.78	6.03	0.67	0.60	7.54	4.09	2.13	3.56	2.46	2.86	
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
<i>Hagia punctoria</i> Male	Mean	13.90	3.65	2.13	1.35	1.07	0.77	0.43	0.35	3.81	2.16	1.10	1.76	0.91	1.57	
	SD	1.09	0.07	0.14	0.09	0.07	0.06	0.05	0.03	0.13	0.35	0.20	0.04	0.06	0.05	
	Min	13.13	3.60	2.03	1.28	1.02	0.73	0.39	0.33	3.72	1.91	0.96	1.73	0.87	1.53	
	Max	14.67	3.70	2.23	1.41	1.12	0.81	0.46	0.37	3.90	2.40	1.24	1.79	0.97	1.60	
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
	Female	Mean	13.91	3.61	2.24	1.34	1.12	0.88	0.44	0.35	3.74	2.11	0.90	2.03	1.00	1.48
		SD	0.52	0.08	0.28	0.01	0.16	0.02	0.14	0.02	0.09	0.01	0.09	0.08	0.06	0.10
		Min	13.54	3.56	2.04	1.33	1.00	0.86	0.34	0.33	3.67	2.10	0.83	1.97	0.96	1.41
		Max	14.27	3.67	2.43	1.34	1.23	0.89	0.54	0.36	3.80	2.11	0.96	2.08	1.04	1.55
		N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2
<i>Isyndus heros</i> Male		19.38	3.89	3.86	1.76	2.12	1.24	0.79	-	-	-	1.60	2.52	0.95	1.80	
	N =	1	1	1	1	1	1	1	-	-	-	1	1	1	1	
	Female		27.32	8.42	4.67	2.18	2.91	1.80	0.59	0.32	9.49	3.63	2.33	3.66	1.37	3.24
N =		1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
<i>Isyndus heros</i>	Mean	27.75	9.30	4.94	2.30	2.99	2.22	0.69	0.63	9.18	3.61	2.57	4.26	2.15	3.17
<i>heros</i>	SD	1.14	1.43	0.35	0.02	0.17	0.35	0.05	0.02	0.30	-	0.12	0.12	0.32	0.52
Female	Min	26.64	7.65	4.54	2.29	2.80	1.82	0.66	0.61	8.97	-	2.49	4.14	1.94	2.57
	Max	28.91	10.12	5.15	2.32	3.12	2.50	0.75	0.65	9.39	-	2.71	4.37	2.52	3.52
	N =	3	3	3	3	3	3	3	2	2	1	3	3	3	3
<i>Panthous daedalus</i>		27.57	10.05	4.20	2.16	1.55	2.42	0.52	0.73	6.06	2.82	2.28	6.44	-	-
	N =	1	1	1	1	1	1	1	1	1	1	1	1	-	-
<i>Panthous ectinoderoides</i>		26.69	7.15	4.41	2.20	1.44	2.55	0.65	0.53	6.32	2.42	2.28	5.20	-	-
	N =	1	1	1	1	1	1	1	1	1	1	1	1	-	-
<i>Panthous sp. 1</i>		24.68	7.04	4.38	2.07	2.01	2.60	0.51	0.65	6.73	2.57	1.94	5.50	-	-
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	-	-
<i>Panthous sp. 2</i>		18.28	4.96	3.18	1.77	0.95	1.26	1.44	0.58	5.10	1.73	1.74	2.47	-	-
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	-	-
<i>Panthous sp. 3</i>		27.45	8.71	4.47	2.27	2.14	2.81	0.62	0.63	6.85	2.35	1.77	6.51	-	-
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	-	-
<i>Poeciclopis patagiatus</i>	Mean	11.82	2.60	2.54	1.19	1.00	1.56	0.45	0.50	3.87	1.50	0.81	1.49	0.65	0.85
	SD	0.16	0.04	0.11	0.04	0.08	0.28	0.07	-	-	-	0.01	0.33	0.08	0.18
Male	Min	11.71	2.57	2.46	1.16	0.94	1.36	0.40	-	-	-	0.80	1.25	0.59	0.72
	Max	11.93	2.63	2.61	1.21	1.06	1.75	0.50	-	-	-	0.82	1.72	0.71	0.97
	N =	2	2	2	2	2	2	2	1	1	1	2	2	2	2
Female	Mean	13.77	4.13	2.85	1.21	1.10	1.63	0.38	0.39	4.16	1.59	0.90	1.79	0.71	1.64
	SD	0.26	0.82	0.12	0.08	0.07	0.03	0.08	0.12	0.26	0.06	0.10	0.10	0.15	0.19
	Min	13.58	3.20	2.76	1.11	1.04	1.60	0.30	0.25	3.92	1.52	0.80	1.69	0.54	1.44
	Max	14.07	4.74	2.98	1.26	1.17	1.66	0.45	0.47	4.44	1.63	1.00	1.89	0.81	1.81
	N =	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
<i>Polididus</i>	Mean	10.55	2.36	1.80	1.07	1.10	0.70	0.33	0.32	4.74	2.66	1.15	1.40	0.99	1.22
<i>armatissimus</i>	SD	0.56	0.20	0.09	0.12	0.04	0.12	0.03	0.02	0.10	0.33	0.03	0.08	0.08	0.21
Male	Min	9.98	2.13	1.73	0.98	1.07	0.60	0.31	0.30	4.65	2.43	1.12	1.32	0.94	0.99
	Max	11.09	2.51	1.91	1.20	1.14	0.84	0.36	0.34	4.85	3.04	1.18	1.47	1.08	1.39
	N =	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Female	Mean	11.14	2.78	1.81	1.25	1.06	0.70	0.39	0.31	4.67	2.65	0.95	1.49	0.97	1.06
	SD	0.60	0.08	0.20	0.03	0.06	0.11	0.01	0.01	0.19	0.59	0.04	0.27	0.14	0.28
	Min	10.71	2.72	1.67	1.23	1.01	0.62	0.38	0.30	4.53	2.23	0.92	1.30	0.87	0.86
	Max	11.56	2.83	1.95	1.27	1.10	0.77	0.40	0.31	4.80	3.06	0.97	1.68	1.07	1.25
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2
<i>Rhynocoris</i>		13.54	4.01	2.95	1.59	1.53	1.46	0.41	0.41	3.89	-	1.02	2.13	0.86	1.18
<i>marginellus</i>															
Male	N =	1	1	1	1	1	1	1	1	1	-	1	1	1	1
Female	Mean	15.21	4.21	3.53	1.70	1.81	1.72	0.52	0.39	4.06	2.02	1.42	2.20	0.96	4.99
	SD	0.53	0.33	0.17	0.05	0.11	0.13	0.03	0.03	0.14	0.13	0.09	0.13	0.10	0.40
	Min	14.70	3.89	3.41	1.66	1.65	1.49	0.49	0.36	3.91	1.89	1.31	2.03	0.83	4.46
	Max	16.05	4.74	3.82	1.78	1.97	1.83	0.56	0.41	4.19	2.14	1.52	2.34	1.08	5.50
	N =	5	5	5	5	5	5	5	3	3	3	5	5	5	5
<i>Scipinia rapax</i>	Mean	9.70	1.66	1.94	0.94	0.78	1.04	0.38	0.35	2.30	0.78	0.83	1.57	0.68	0.89
Male	SD	0.10	0.16	0.12	0.20	0.00	0.08	0.03	-	-	-	0.25	0.18	0.07	0.01
	Min	9.63	1.54	1.85	0.80	0.78	0.98	0.36	-	-	-	0.65	1.44	0.63	0.88
	Max	9.77	1.77	2.02	1.08	0.78	1.09	0.40	-	-	-	1.00	1.69	0.73	0.89
	N =	2	2	2	2	2	2	2	1	1	1	2	2	2	2
<i>Sphedanolestes</i>	Mean	12.01	2.73	2.40	1.33	1.01	1.23	0.37	0.33	4.39	1.59	0.96	1.41	0.77	1.34
<i>fallax</i>	SD	0.24	0.32	0.25	0.04	0.14	0.02	0.01	-	-	-	0.08	0.13	0.14	0.07
Male	Min	11.74	2.52	2.20	1.29	0.88	1.21	0.36	-	-	-	0.89	1.27	0.63	1.28
	Max	12.22	3.09	2.68	1.36	1.15	1.25	0.38	-	-	-	1.05	1.53	0.91	1.41
	N =	3	3	3	3	3	3	3	1	1	1	3	3	3	3

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
Female	Mean	11.95	3.29	2.37	1.34	1.10	1.23	0.44	0.30	4.06	2.06	0.94	1.38	1.03	1.29
	SD	0.42	0.38	0.10	0.06	0.14	0.03	0.09	0.01	0.16	0.12	0.05	0.08	0.09	0.05
	Min	11.56	3.05	2.31	1.27	0.96	1.20	0.36	0.29	3.94	1.93	0.89	1.33	0.97	1.24
	Max	12.39	3.73	2.48	1.39	1.23	1.25	0.53	0.31	4.25	2.14	0.99	1.48	1.14	1.32
	N =	3	3	3	3	3	3	3	3	3	3	3	3	3	3
<i>Sycanus dilutus</i> Male	Mean	21.06	6.98	5.46	1.82	2.68	4.53	0.73	0.46	6.91	2.73	1.55	2.69	1.44	1.63
	SD	0.71	0.49	0.40	0.08	0.16	0.39	0.08	0.11	0.16	0.12	0.18	0.13	0.28	0.13
	Min	20.13	6.44	4.94	1.76	2.55	3.85	0.59	0.30	6.72	2.60	1.27	2.50	0.97	1.45
	Max	21.80	7.67	6.00	1.96	2.95	4.86	0.79	0.53	7.09	2.89	1.73	2.84	1.68	1.76
	N =	5	5	5	5	5	5	5	4	4	4	5	5	5	5
Female	Mean	24.05	7.48	6.06	1.90	2.70	4.60	0.69	0.59	6.89	2.41	1.76	3.24	1.34	1.92
	SD	0.64	0.42	0.39	0.04	0.36	0.63	0.11	0.12	0.12	0.22	0.28	0.23	0.07	0.12
	Min	23.42	7.09	5.70	1.86	2.32	3.66	0.53	0.45	6.74	2.24	1.44	2.93	1.27	1.80
	Max	24.92	8.05	6.62	1.96	3.06	5.03	0.78	0.73	6.99	2.66	2.02	3.44	1.41	2.04
	N =	4	4	4	4	4	4	4	4	4	3	4	4	4	4
<i>Sycanus macracanthus</i> Male	Mean	19.53	7.21	5.09	1.53	2.65	4.11	0.68	0.46	5.92	2.53	1.48	2.45	1.53	2.16
	SD	0.13	0.22	0.14	0.04	0.15	0.02	0.21	0.04	0.40	0.15	0.13	0.16	0.10	0.16
	Min	19.41	7.04	4.98	1.49	2.50	4.08	0.55	0.43	5.64	2.42	1.39	2.35	1.42	1.98
	Max	19.67	7.45	5.24	1.56	2.80	4.12	0.92	0.48	6.20	2.63	1.63	2.63	1.62	2.25
	N =	3	3	3	3	3	3	3	2	2	2	3	3	3	3
Female	Mean	19.60	7.44	5.04	1.51	2.46	3.90	0.60	0.40	5.72	2.91	1.31	2.54	1.46	2.18
	SD	0.25	0.45	0.27	0.03	0.26	0.23	0.17	0.08	0.17	0.62	0.06	0.30	0.17	0.14
	Min	19.33	6.73	4.71	1.48	2.16	3.57	0.40	0.26	5.42	2.20	1.24	2.12	1.20	1.90
	Max	19.90	8.04	5.29	1.58	2.93	4.19	0.82	0.49	5.88	3.50	1.40	2.82	1.67	2.33
	N =	7	7	7	7	7	7	7	6	6	5	7	7	7	7
<i>Sycanus maculatus</i> Male		16.68	5.48	4.56	1.47	2.16	3.22	0.74	0.38	5.47	2.35	1.64	1.92	1.15	2.28
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
<i>Sycanus tuberculatus</i> Female	Mean	19.80	7.76	5.03	1.47	2.29	3.90	0.62	0.52	5.64	2.20	1.04	2.51	0.97	1.86
	SD	0.20	0.17	0.37	0.04	0.04	0.18	0.17	0.10	-	-	0.24	0.04	0.42	0.11
	Min	19.66	7.64	4.77	1.44	2.26	3.77	0.50	0.45	-	-	0.87	2.48	0.67	1.78
	Max	19.94	7.88	5.29	1.50	2.31	4.02	0.74	0.59	-	-	1.21	2.53	1.27	1.93
	N =	2	2	2	2	2	2	2	2	1	1	2	2	2	2
<i>Sycanus</i> sp. 1 Female		18.77	5.00	4.62	1.66	2.47	3.61	0.46	0.33	5.61	3.70	1.24	2.24	1.16	2.14
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Sycanus</i> sp. 2 Female		23.17	9.44	5.90	1.87	2.81	4.91	0.85	0.67	-	-	1.54	2.76	2.16	2.02
	N =	1	1	1	1	1	1	1	1	-	-	1	1	1	1
<i>Sycanus</i> sp. 3 Female	Mean	18.81	7.30	4.99	1.44	2.22	3.50	0.57	0.50	5.81	2.19	1.07	2.25	0.99	1.62
	SD	1.18	0.35	0.08	0.05	0.04	0.37	0.03	0	0.13	0.01	0.20	0.04	0.16	0.04
	Min	17.97	7.05	4.93	1.40	2.19	3.24	0.55	0.50	5.71	2.18	0.93	2.22	0.88	1.59
	Max	19.64	7.54	5.04	1.47	2.24	3.76	0.59	0.50	5.90	2.20	1.21	2.28	1.10	1.64
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2
<i>Sycanus</i> sp. 4 Male		22.90	9.34	5.93	1.83	2.79	4.81	0.78	0.55	7.68	2.71	1.56	2.77	1.00	1.81
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Velinus nigrigenu</i> Male	Mean	18.48	3.63	3.35	1.43	1.52	2.39	0.42	0.40	8.78	3.08	1.27	2.15	1.30	1.71
	SD	0.28	0.23	0.09	0.01	0.13	0.13	0.06	0.03	0.40	0.08	0.12	0.10	0.06	0.10
	Min	17.78	3.35	3.24	1.41	1.36	1.96	0.35	0.27	8.20	2.95	1.10	1.91	1.14	1.40
	Max	19.21	4.20	3.408	1.49	1.82	2.67	0.54	0.50	9.61	3.26	1.57	2.38	1.43	1.94
	N =	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Female	Mean	18.49	3.35	3.44	1.39	1.57	2.29	0.32	0.34	8.01	2.93	1.09	2.16	1.27	1.50
	SD	0.58	0.49	0.28	0.01	0.01	0.07	0.01	0.09	0.50	0.35	0.02	0.15	0.06	0.09
	Min	18.08	3.00	3.24	1.38	1.56	2.24	0.30	0.27	7.66	2.68	1.07	2.05	1.22	1.43
	Max	18.90	3.70	3.63	1.40	1.58	2.34	0.34	0.40	8.37	3.17	1.10	2.26	1.31	1.56
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W	
<i>Vesbius purpureus</i> Male	Mean	7.91	1.97	1.58	1.10	0.58	0.96	0.27	0.24	2.48	1.05	0.51	1.08	0.55	0.79	
	SD	0.37	0.04	0.05	0.06	0.06	0.10	0.05	0.06	0.01	-	0.05	0.06	0.03	0.09	
	Min	7.55	1.93	1.55	1.06	0.51	0.85	0.22	0.20	2.47	-	0.47	1.02	0.53	0.68	
	Max	8.28	2.01	1.64	1.17	0.63	1.03	0.30	0.28	2.49	-	0.57	1.13	0.59	0.85	
	N =	3	3	3	3	3	3	3	2	2	1	3	3	3	3	
	Female	Mean	7.69	1.88	1.54	10.4	0.54	0.87	0.27	0.25	2.20	1.09	0.60	1.05	0.67	0.77
		SD	0.40	0.08	0.04	0.02	0.02	0.05	0.03	-	-	-	0.01	0.07	0.03	0.14
		Min	7.41	1.82	1.51	1.02	0.52	0.83	0.25	-	-	-	0.59	1.00	0.65	0.67
		Max	7.97	1.94	1.56	1.05	0.55	0.90	0.29	-	-	-	0.60	1.10	0.69	0.87
		N =	2	2	2	2	2	2	2	1	1	1	2	2	2	2
<i>Yolinus fuliginosus</i> Female	Mean	23.58	9.56	5.18	2.00	2.85	3.96	0.74	0.60	6.30	-	1.67	2.84	1.78	2.37	
	SD	0.78	1.15	0.17	0.04	0.16	0.08	0.08	-	-	-	1.67	0.04	0.13	0.12	
	Min	23.02	8.74	5.06	1.97	2.74	3.90	0.68	-	-	-	1.60	2.81	1.68	2.28	
	Max	24.12	10.37	5.30	2.03	2.96	4.01	0.79	-	-	-	1.73	2.86	1.87	2.45	
	N =	2	2	2	2	2	2	2	1	1	-	2	2	2	2	
Harpactorinae sp. 1		20.89	5.57	3.30	1.59	2.85	1.56	0.37	0.55	8.70	2.99	1.18	3.41	1.07	2.23	
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Harpactorinae sp. 2		20.37	4.72	3.52	1.60	2.56	1.72	0.94	0.48	8.32	2.94	1.25	2.82	0.88	2.29	
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Harpactorinae sp. 3		19.12	5.12	3.35	1.52	2.29	1.13	0.52	0.66	8.25	4.63	2.15	2.78	1.22	1.60	
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
Harpactorinae sp. 4	Mean	15.19	3.25	3.12	1.35	1.57	2.05	0.50	0.33	7.64	3.80	1.36	1.81	1.51	1.67
	SD	0.04	0.13	0.12	0.02	0.14	0.04	0.13	0.04	0.06	0.61	0.04	0.33	0.07	0.26
	Min	15.16	3.15	3.03	1.33	1.47	2.02	0.40	0.30	7.59	3.37	1.33	1.58	1.46	1.48
	Max	15.22	3.34	3.20	1.36	1.67	2.07	0.59	0.36	7.68	4.23	1.38	2.04	1.56	1.85
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Mean	15.66	3.63	3.10	1.28	1.50	1.70	0.56	0.35	7.64	3.33	1.28	1.80	1.51	1.52
	SD	0.14	0.01	0.13	0.11	0.13	1.14	0.08	0.01	0.14	0.06	0.04	0.45	0.18	0.01
	Min	15.56	3.62	3.00	1.20	1.41	1.60	0.50	0.34	7.54	3.29	1.25	1.48	1.38	1.51
	Max	15.76	3.63	3.19	1.36	1.59	1.80	0.62	0.36	7.74	3.37	1.31	2.12	1.63	1.53
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Harpactorinae sp. 5		16.18	3.20	2.77	1.31	2.06	1.16	0.56	0.27	7.34	-	1.70	2.16	1.13	0.95
Male	N =	1	1	1	1	1	1	1	1	1	-	1	1	1	1
Harpactorinae sp. 6	Mean	13.52	3.15	2.41	1.33	0.82	0.76	0.34	0.43	2.55	1.17	1.09	2.33	0.75	1.40
	SD	0.04	0.64	0.24	0.01	0.15	0.20	0.02	0.08	0.26	0.04	0.07	0.06	0.09	0.36
	Min	13.49	2.70	2.24	1.32	0.71	0.62	0.32	0.37	2.36	1.14	1.04	2.28	0.68	1.14
	Max	13.54	3.60	2.58	1.34	0.92	0.90	0.35	0.48	2.73	1.19	1.14	2.37	0.81	1.65
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Mean	15.14	5.09	2.27	1.32	1.01	0.83	0.38	0.38	2.60	1.31	1.08	2.69	1.15	1.61
	SD	0.11	0.04	0.03	0.02	0.02	0.23	0.04	0.11	0.04	0.11	0.11	0.06	0.01	0.04
	Min	15.06	5.06	2.25	1.30	0.99	0.67	0.35	0.30	2.57	1.23	1.00	2.65	1.14	1.58
	Max	15.22	5.12	2.29	1.33	1.02	0.99	0.41	0.45	2.63	1.38	1.15	2.73	1.15	1.63
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
HOLOPTILINAE															
<i>Holoptilus</i>	Mean	10.33	4.20	1.05	1.71	0.57	0.95	0.40	0.68	4.88	0.96	0.73	1.30	1.12	1.35
<i>leprosus</i>	SD	0.16	0.16	0.24	0.20	0.23	0.08	0.00	0.03	0.12	0.08	0.12	0.01	0.37	0.28
	Min	10.22	4.08	0.88	1.57	0.40	0.89	0.40	0.66	4.79	0.90	0.64	1.29	0.86	1.15
	Max	10.44	4.31	1.22	1.85	0.73	1.01	0.40	0.70	4.96	1.02	0.81	1.31	1.38	1.55
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2
PEIRATINAE															
<i>Ectomocoris</i>	Mean	15.68	3.86	3.29	1.75	0.94	1.82	1.03	1.54	3.13	2.16	2.88	1.42	1.82	2.05
<i>atrox</i>	SD	0.60	0.18	0.20	0.05	0.19	0.21	0.10	0.30	0.28	0.60	0.07	0.15	0.22	0.42
Female	Min	14.87	3.58	2.94	1.68	0.59	1.60	0.92	1.11	2.81	1.49	2.76	1.21	1.42	1.47
	Max	16.54	4.04	3.55	1.83	1.15	2.18	1.18	1.88	3.52	2.71	2.97	1.65	2.05	2.52
	N =	6	6	6	6	6	6	6	6	6	4	6	6	6	6
<i>Ectomocoris</i>	Mean	15.88	4.00	3.26	1.86	1.32	1.86	0.78	1.56	2.99	2.78	3.26	1.48	1.75	2.75
<i>elegans</i>	SD	1.12	0.43	0.28	0.06	0.13	0.19	0.20	1.68	0.44	0.29	0.15	0.08	0.44	0.33
Male	Min	14.73	3.24	2.78	1.78	1.20	1.72	0.58	1.33	2.62	2.47	2.96	1.32	1.13	2.23
	Max	18.24	4.71	3.62	1.93	1.46	2.13	1.08	1.72	2.96	3.31	3.38	1.56	2.37	3.16
	N =	7	7	7	7	7	7	7	7	6	6	7	7	7	7
Female	Mean	17.41	4.67	3.53	2.01	1.43	2.14	0.80	1.36	2.80	2.94	3.47	1.52	1.97	3.09
	SD	0.55	0.41	0.12	0.11	0.27	0.11	0.06	0.11	0.15	0.21	0.17	0.13	0.11	0.15
	Min	16.80	4.20	3.41	1.89	1.19	2.07	0.74	1.26	2.69	2.79	3.27	1.42	1.84	3.00
	Max	17.87	4.92	3.64	2.09	1.72	2.27	0.86	1.48	2.90	3.09	3.59	1.67	2.04	3.27
	N =	3	3	3	3	3	3	3	3	2	2	3	3	3	3
<i>Sirthenea</i>	Mean	18.34	3.30	4.20	2.14	1.09	3.12	1.90	1.13	2.35	1.88	3.07	1.54	2.15	2.27
<i>flavipes</i>	SD	3.19	0.43	0.38	0.11	0.03	0.31	0.31	0.12	0.53	0.16	0.28	0.13	0.46	0.22
Male	Min	11.57	2.58	3.58	1.98	1.06	2.78	1.35	0.96	1.56	1.68	2.78	1.26	1.58	1.99
	Max	20.74	3.78	4.59	2.27	1.13	3.62	2.28	1.26	2.98	2.02	3.42	1.67	2.77	2.58
	N =	7	7	7	7	7	7	7	7	7	4	7	7	7	7

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
Female	Mean	18.94	3.59	4.11	2.14	1.03	2.91	1.84	1.14	2.52	2.19	2.84	1.42	1.89	2.12
	SD	1.65	0.35	0.36	0.11	0.07	0.36	0.14	0.17	0.08	-	0.12	0.09	0.40	0.30
	Min	17.67	3.19	3.71	2.06	0.95	2.61	1.72	0.97	2.44	-	2.75	1.36	1.62	1.77
	Max	20.81	3.85	4.42	2.26	1.09	3.31	2.00	1.30	2.60	-	2.98	1.52	2.34	2.33
	N =	3	3	3	3	3	3	3	3	3	1	3	3	3	3
PHYSODERINAE															
<i>Physoderes curculionis</i>		7.61	3.07	1.84	0.85	0.53	1.16	0.42	0.35	0.68	-	0.65	1.07	0.83	0.80
Male	N =	1	1	1	1	1	1	1	1	1	-	1	1	1	1
REDUVIINAE															
<i>Acanthaspis quadriannulata</i>	Mean	21.15	6.60	3.47	2.24	1.72	1.58	0.50	0.51	2.87	4.74	2.36	2.48	2.55	2.28
	SD	0.39	0.23	0.25	0.01	0.01	0.01	0	0.01	0.23	0.34	0.16	0.03	0.57	0.02
	Min	20.87	6.44	3.29	2.23	1.71	1.57	0.50	0.50	2.70	4.50	2.24	2.46	2.14	2.26
	Max	21.42	6.76	3.64	2.24	1.73	1.58	0.50	0.52	3.03	4.98	2.47	2.50	2.95	2.29
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2
<i>Sminthus singularis</i>	Mean	13.47	3.92	2.08	1.50	0.85	0.75	0.44	0.44	3.31	2.87	1.58	2.11	1.59	1.93
	SD	0.27	0.20	0.11	0.12	0.04	0.04	0.04	0.05	0.14	0.25	0.31	0.15	0.16	0.20
	Min	13.16	3.76	2.00	1.41	0.81	0.71	0.41	0.39	3.18	2.69	1.23	1.95	1.48	1.71
	Max	13.61	4.14	2.21	1.64	0.89	0.79	0.49	0.48	3.46	3.05	1.83	2.23	1.77	2.11
	N =	3	3	3	3	3	3	3	3	3	2	3	3	3	3
Female	Mean	13.64	4.13	2.01	1.41	0.91	0.92	0.45	0.54	2.83	2.43	1.47	1.91	1.70	1.81
	SD	0.44	0.30	0.04	0.11	0.11	0.09	0.08	0.21	0.34	-	0.04	0.05	0.35	0.18
	Min	13.33	3.92	1.98	1.33	0.83	0.85	0.39	0.39	2.59	-	1.44	1.87	1.45	1.68
	Max	13.95	4.34	2.03	1.49	0.98	0.98	0.50	0.68	3.07	-	1.50	1.94	1.94	1.94
	N =	2	2	2	2	2	2	2	2	2	1	2	2	2	2
<i>Tiarodes</i> sp.		21.72	7.70	5.29	2.46	2.61	3.09	1.02	0.64	2.29	1.04	2.07	2.55	2.01	3.46
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
<i>Velitra rubropicta</i>	Mean	20.49	6.80	3.88	2.57	1.71	1.94	0.74	0.62	4.59	3.94	2.66	2.87	3.03	3.17
	SD	0.48	0.18	0.04	0.12	0.14	0.07	0.01	0.04	0.20	-	0.16	0.23	0.02	0.17
Male	Min	20.15	6.67	3.85	2.48	1.61	1.89	0.73	0.59	4.45	-	2.54	2.71	3.01	3.05
	Max	20.83	6.93	3.91	2.65	1.81	1.99	0.74	0.64	4.73	-	2.77	3.03	3.04	3.29
	N =	2	2	2	2	2	2	2	2	2	1	2	2	2	2
Female	Mean	20.25	6.65	3.77	2.56	1.58	1.51	0.60	0.59	4.47	4.51	2.74	2.77	2.99	3.42
	SD	0.51	0.18	0.14	0.04	0.27	0.34	0.14	0.13	0.25	-	0.30	0.34	0.09	0.22
	Min	19.63	6.49	3.65	2.49	1.20	1.10	0.43	0.43	4.22	-	2.54	2.39	2.86	3.16
	Max	20.88	6.90	3.91	2.58	1.81	1.85	0.75	0.73	4.71	-	3.17	3.07	3.08	3.61
	N =	4	4	4	4	4	4	4	4	3	1	4	4	4	4
SAICINAE															
<i>Polytoxus vagans</i>		10.01	1.78	1.04	0.74	0.40	0.54	0.35	-	-	-	0.91	1.07	0.56	0.56
	N =	1	1	1	1	1	1	1	-	-	-	1	1	1	1
SALYAVATINAE															
<i>Lisarda inornata</i>	Mean	13.20	4.28	1.86	1.32	1.00	0.80	0.30	1.40	2.17	1.95	1.13	1.69	1.48	1.32
Female	SD	0.14	0.69	0.11	0.04	0.04	0.08	0	0.01	0.07	-	0.04	0.18	0.01	0.07
	Min	13.10	3.79	1.78	1.29	0.97	0.74	0.30	1.39	2.12	-	1.10	1.56	1.47	1.27
	Max	13.30	4.76	1.93	1.35	1.03	0.85	0.30	1.41	2.22	-	1.15	1.82	1.49	1.37
	N =	2	2	2	2	2	2	2	2	2	1	2	2	2	2
<i>Lisarda umbrosa</i>		13.30	4.73	1.68	1.38	1.00	0.94	0.48	1.56	1.83	2.35	1.34	2.02	1.13	1.68
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		15.24	6.00	2.21	1.76	1.92	0.94	0.35	0.79	2.31	1.95	1.55	1.94	1.34	2.09
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Salyavata sp.</i>		14.50	4.41	1.68	1.56	1.18	0.67	0.47	0.23	3.23	4.70	1.14	1.30	1.11	1.35
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
<i>Syberna munita</i> Male	Mean	12.58	3.78	1.75	1.51	0.63	0.75	0.38	0.41	2.46	5.18	1.22	1.72	1.00	1.49
	SD	0.18	0.13	0.38	0.10	0.19	0.15	0.09	0.07	0.07	0	0.10	0.20	0.23	0.15
	Min	12.37	3.68	1.31	1.40	0.41	0.58	0.28	0.34	2.40	5.18	1.15	1.59	0.84	1.32
	Max	12.71	3.93	1.99	1.58	0.74	0.85	0.45	0.47	2.54	5.18	1.34	1.95	1.26	1.62
	N =	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Female	Mean	13.31	5.01	1.45	1.72	0.75	0.74	0.37	0.46	2.44	-	1.43	1.63	1.10	1.58
	N =	1	1	1	1	1	1	1	1	1	-	1	1	1	1
<i>Valentia apetala</i> Male	Mean	16.41	5.06	2.07	1.79	0.94	0.81	0.54	0.45	3.35	6.04	1.21	2.41	1.62	1.88
	SD	0.27	0.28	0.32	0.04	0.06	0.01	0.20	0.01	0.16	0.07	0.01	0.01	0.13	0.18
	Min	16.22	4.86	1.84	1.76	0.90	0.80	0.40	0.44	3.24	6.00	1.20	2.40	1.52	1.75
	Max	16.60	5.25	2.29	1.81	0.98	0.82	0.68	0.45	3.46	6.08	1.21	2.41	1.71	2.01
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2
<i>Salyavatinae sp.</i> 1		13.18	3.79	1.87	1.30	0.91	0.46	0.27	1.48	2.02	-	1.25	1.55	1.20	1.22
Male	N =	1	1	1	1	1	1	1	1	1	-	1	1	1	1
<i>Salyavatinae sp.</i> 2		17.49	5.57	1.72	1.75	1.10	1.16	0.20	3.51	5.14	2.10	1.33	1.23	2.60	1.73
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
STENOPODAINAE															
<i>Aulacogenia sarawakensis</i> Female		16.39	4.56	3.08	1.53	0.87	2.35	1.41	1.24	1.54	-	1.83	1.51	1.61	1.73
	N =	1	1	1	1	1	1	1	1	1	-	1	1	1	1
<i>Aulacogenia sp.</i> Male		15.30	4.18	2.98	1.32	1.31	0.62	0.63	1.25	1.72	1.06	1.54	1.50	1.58	1.34
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Canthesancus gulo</i> Female		28.17	7.68	4.59	2.47	1.94	1.58	1.51	0.70	5.19	6.55	2.56	3.27	1.79	2.42
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
<i>Oncocephalus annulipes</i>		16.01	3.01	2.82	1.80	1.36	1.07	0.97	1.89	-	-	1.60	1.87	1.49	1.69
Male	N =	1	1	1	1	1	1	1	1	-	-	1	1	1	1
Female		15.36	3.20	2.96	1.76	1.40	1.12	0.66	1.67	3.86	-	1.58	1.81	1.63	1.62
	N =	1	1	1	1	1	1	1	1	1	-	1	1	1	1
<i>Oncocephalus cingalensis</i>		17.59	3.88	3.00	1.86	1.47	1.39	0.75	1.54	3.70	1.40	1.90	1.48	1.83	1.72
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Oncocephalus lineosus</i>		14.16	3.18	2.42	1.39	1.08	1.00	0.50	0.70	2.11	-	1.68	1.05	1.33	1.57
Male	N =	1	1	1	1	1	1	1	1	1	-	1	1	1	1
<i>Oncocephalus sarawakensis</i>	Mean	13.37	3.35	2.22	1.52	1.00	0.89	0.33	1.58	3.18	-	1.62	1.03	1.49	1.40
	SD	0.58	0.23	0.05	0.12	0.08	0.05	0.02	0.16	0.12	-	0.13	0.07	0.02	0.03
Male	Min	12.57	3.20	2.16	1.35	0.89	0.83	0.30	1.35	3.00	-	1.50	0.93	1.46	1.36
	Max	13.81	3.68	2.29	1.61	1.08	0.94	0.35	1.69	3.26	-	1.78	1.07	1.51	1.43
	N =	4	4	4	4	4	4	4	4	4	-	4	4	4	4
<i>Oncocephalus sp. 1</i>		16.63	3.90	3.30	1.76	0.77	0.98	0.41	1.24	2.42	-	1.98	0.77	1.52	1.37
	N =	1	1	1	1	1	1	1	1	1	-	1	1	1	1
<i>Oncocephalus sp. 2</i>		19.02	4.75	3.70	1.82	1.50	1.62	0.30	1.33	2.89	0.48	2.10	1.32	1.41	1.85
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Pygolampis sp.</i>		15.75	1.76	2.28	1.07	1.34	0.44	0.32	0.80	-	-	2.07	0.88	1.05	1.21
Male	N =	1	1	1	1	1	1	1	1	-	-	1	1	1	1

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
Female	Mean	16.27	2.00	2.22	1.14	1.53	0.49	0.30	0.69	1.52	-	2.05	1.13	0.84	1.16
	SD	0.89	0.18	0.16	0.10	0.03	0.05	0.01	0.06	0.62	-	0.49	0.22	0.12	0.07
	Min	15.26	1.82	2.11	1.03	1.51	0.43	0.30	0.64	1.12	-	1.74	0.96	0.75	1.10
	Max	16.96	2.17	2.40	1.22	1.56	0.53	0.31	0.76	2.23	-	2.61	1.37	0.98	1.24
	N =	3	3	3	3	3	3	3	3	3	-	3	3	3	3
<i>Sastrapada</i> sp.		18.14	2.97	2.88	1.20	1.61	0.99	0.45	1.27	-	-	2.13	1.45	1.42	1.33
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Staccia diluta</i>	Mean	7.75	1.65	1.60	0.83	0.74	0.76	0.71	0.15	0.84	-	0.82	0.90	0.57	0.62
	SD	0.50	0.25	0.26	0.07	-	-	-	0	0.14	-	0.13	0.21	0.04	0.08
	Min	7.39	1.47	1.40	0.77	-	-	-	0.15	0.74	-	0.72	0.75	0.54	0.56
	Max	8.10	1.83	1.79	0.88	-	-	-	0.15	0.94	-	0.91	1.04	0.60	0.67
	N =	2	2	2	2	1	1	1	2	2	-	2	2	2	2
<i>Thodelmus matangensis</i>	Mean	23.09	3.41	4.74	1.60	1.69	1.62	0.68	-	-	-	2.01	2.05	1.46	1.36
	SD	1.59	0.02	0.57	0.09	0.32	0.47	0.11	-	-	-	0.11	0.08	0.35	0.02
	Min	21.96	3.37	4.34	1.53	1.46	1.29	0.60	-	-	-	1.93	1.99	1.21	1.34
	Max	24.21	3.44	5.14	1.66	1.91	1.95	0.75	-	-	-	2.09	2.11	1.70	1.37
	N =	2	2	2	2	2	2	2	-	-	-	2	2	2	2
Stenopodainae sp. 1	Mean	12.65	4.76	1.77	1.86	1.02	0.79	0.59	1.42	2.21	0.70	1.54	1.08	1.40	1.38
	SD	0.80	0.28	0.05	0.25	0.18	0.28	0.13	0.13	0.24	-	0.17	0.14	0.29	0.01
	Min	12.08	4.56	1.73	1.68	0.89	0.59	0.50	1.33	2.04	-	1.42	0.98	1.19	1.37
	Max	13.21	4.96	1.80	2.03	1.15	0.98	0.68	1.51	2.38	-	1.66	1.18	1.60	1.39
	N =	2	2	2	2	2	2	2	2	2	1	2	2	2	2
Stenopodainae sp. 2		21.94	5.13	3.63	1.50	2.33	0.69	0.41	4.27	5.38	1.65	2.57	1.65	2.05	1.21
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Appendix 2 continued.

Species		Body L	Body W	Head L	Head W	Lab II	Lab III	Lab IV	Ant Sc	Ant I	Ant II	Ant ProL	Post ProW	Scu L	Scu W
TRIATOMINAE															
<i>Triatoma rubrofasciata</i>		24.87	10.16	4.46	2.24	1.27	2.37	0.78	0.66	3.05	2.21	1.95	3.20	2.95	3.75
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TRIBELOCEPHALINAE															
<i>Opistoplatys perakensis</i>		8.70	3.11	1.94	0.88	-	-	-	-	-	-	0.71	0.42	0.67	0.91
<i>Opistoplatys</i> sp. 1	N =	1	1	1	1	-	-	-	-	-	-	1	1	1	1
		8.17	2.78	1.74	0.80	0.85	0.41	0.29	0.78	0.65	-	0.46	0.71	0.96	1.07
<i>Tribelocephala</i> sp. 1	N =	1	1	1	1	1	1	1	1	1	-	1	1	1	1
Male		9.55	3.26	1.77	1.09	0.83	0.97	0.30	0.20	1.76	1.94	0.78	0.80	0.92	0.95
<i>Staccia diluta</i>	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Mean	7.75	1.65	1.60	0.83	0.74	0.76	0.71	0.15	0.84	-	0.82	0.90	0.57	0.62
	SD	0.50	0.25	0.26	0.07	-	-	-	0	0.14	-	0.13	0.21	0.04	0.08
	Min	7.39	1.47	1.40	0.77	-	-	-	0.15	0.74	-	0.72	0.75	0.54	0.56
	Max	8.10	1.83	1.79	0.88	-	-	-	0.15	0.94	-	0.91	1.04	0.60	0.67
<i>Tribelocephala</i> sp. 2	N =	2	2	2	2	1	1	1	2	2	-	2	2	2	2
	Mean	16.48	5.29	3.83	1.58	1.55	1.45	0.56	3.16	2.12	2.10	1.02	1.53	1.16	1.47
	SD	0.53	0.18	0.04	0.03	0.02	0.16	0.08	0.24	0.13	0.45	0.04	0	0.09	0.10
Male	Min	16.10	5.16	3.80	1.56	1.53	1.33	0.50	2.99	2.03	1.78	0.99	1.53	1.09	1.40
	Max	16.85	5.41	3.86	1.60	1.58	1.56	0.61	3.33	2.21	2.42	1.05	1.53	1.22	1.54
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Appendix 3: Measurements of external morphological structures of Reduviidae species in millimetre (mm). *Hem*=Hemelytra; *ForFem*=Fore femur; *ForTib*=Foretibiae; *ForTar*=Fore tarsus; *MidFem*=Midfemur; *MidTib*= Midtibiae; *MidTar*=Midtarsus; *HinFem*=Hindfemur; *HinTib*=Hindtibiae;*HinTar*=Hindtarsus.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
CENTROCNE MIDINAE														
Neocentrocnemis sp. 1		14.84	4.26	3.89	1.56	4.45	4.44	1.57	7.61	-	-	1.54	1.24	1.08
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
Neocentrocnemis sp. 2	Mean	16.75	4.92	4.71	2.02	5.40	5.85	2.40	8.55	10.66	2.78	1.31	1.06	1.04
	SD	0.67	0.66	0.17	0.17	0.08	0.22	0.06	0.62	0.28	0.10	0.19	0.06	0.01
Male	Min	16.27	4.45	4.59	1.90	5.34	5.69	2.35	8.11	10.46	2.71	1.17	1.01	1.03
	Max	17.22	5.38	4.83	2.14	5.46	6.00	2.44	8.98	10.85	2.85	1.44	1.10	1.04
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2
Neocentrocnemis sp. 3		14.01	4.38	3.77	1.58	4.49	4.56	1.91	7.71	9.34	2.16	1.21	1.01	0.93
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
ECTRICHODIINAE														
Ectrychotes coloratus	Mean	8.43	2.50	2.64	1.23	2.58	2.64	1.40	3.95	3.63	2.00	0.62	0.56	0.52
	SD	0.37	0.16	0.11	0.62	0.19	0.20	0.21	0.25	0.15	1.00	0.02	0.03	0.11
Male	Min	8.08	2.35	2.47	1.20	2.32	2.37	1.15	3.76	3.42	1.90	0.60	0.53	0.40
	Max	8.90	2.72	2.71	1.25	2.77	2.84	1.57	4.32	3.78	2.12	0.65	0.60	0.66
	N =	4	4	4	3	4	4	4	4	4	3	4	4	4
Neoscadra sp.		12.39	4.42	3.96	-	4.33	3.63	-	5.72	5.85	-	0.76	0.71	0.68
Male	N =	1	1	1	-	1	1	-	1	1	-	1	1	1
Santos lugubris		7.63	2.25	2.92	1.06	2.89	2.34	1.14	3.88	4.24	1.22	0.48	0.45	0.29
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1

Appendix 3 continued.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
Santos sp. 1		9.72	3.12	3.17	1.06	3.37	3.21	0.90	4.62	5.00	1.54	0.64	0.51	0.40
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
Santos sp. 2	Mean	10.26	3.35	3.39	1.07	3.32	3.42	1.03	5.05	5.41	1.35	0.55	0.46	0.32
Male	SD	0.29	0.14	0.21	0.09	0.06	0.07	0.14	0.23	0.25	0.13	0.05	0.07	0.03
	Min	3.24	3.24	3.07	0.97	3.27	3.34	0.79	4.83	5.05	1.13	0.49	0.37	0.30
	Max	3.57	3.57	3.65	1.21	3.42	3.49	1.14	5.42	5.71	1.43	0.51	0.54	0.37
	N =	5	5	5	5	5	5	5	5	5	5	5	5	5
Scadra aliena		7.92	2.43	2.43	0.70	2.74	2.38	0.93	3.82	4.29	-	0.58	0.50	0.31
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
Scadra costalis		8.16	2.64	2.79	1.64	2.92	2.88	1.42	4.15	4.21	1.88	0.56	0.52	0.44
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
Schottus luteicollis	Mean	6.96	1.58	1.69	0.91	1.54	1.87	0.88	3.11	3.19	0.96	0.48	0.47	0.28
	SD	0.43	0.83	0.89	0.48	0.81	0.87	0.41	1.63	1.73	0.51	0.25	0.25	0.15
	Min	6.24	1.24	1.41	0.81	1.20	1.73	0.84	2.65	2.75	0.80	0.42	0.42	0.25
	Max	7.56	1.72	1.90	1.02	1.80	2.01	0.92	3.49	3.59	1.15	0.51	0.51	0.31
	N =	8	5	3	3	3	2	2	5	4	3	5	3	5
Ectrichodiinae sp. 1		14.65	4.88	5.06	1.46	4.81	4.50	1.50	7.26	7.76	2.03	0.76	0.74	0.56
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
HARPACTORINAE														
Agriolestes festivus	Mean	18.56	7.10	7.80	1.71	6.62	7.90	1.52	8.03	11.03	1.66	1.15	0.95	0.97
	SD	1.23	0.41	0.07	0.04	0.30	0.19	0.25	0.17	0.50	0.24	0.03	0.01	0.04
Male	Min	18.49	6.97	7.79	1.70	6.61	7.71	1.42	7.99	10.77	1.64	1.13	0.94	0.93
	Max	18.62	7.22	7.80	1.71	6.62	8.08	1.62	8.07	11.28	1.67	1.16	0.95	1.00
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2

Appendix 3 continued.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
<i>Agyrius podagricus</i>		8.78	4.33	3.91	-	4.14	4.85	0.44	5.36	6.96	0.71	1.02	0.47	0.45
Male	N =	1	1	1	-	1	1	1	1	1	1	1	1	1
<i>Astinus m-album</i>	Mean	11.92	6.89	6.59	0.71	5.64	6.64	0.75	7.46	10.02	0.94	0.79	0.38	0.38
	SD	0.71	0.47	0.29	0.14	0.16	0.41	0.04	0.46	0.52	0.07	0.10	0.02	0.02
Male	Min	10.98	6.44	6.16	0.60	5.50	6.32	0.70	6.92	9.52	0.89	0.66	0.36	0.35
	Max	12.67	7.54	6.79	0.87	5.86	7.23	0.79	7.96	10.75	0.99	0.90	0.40	0.39
Female	N =	4	4	4	4	4	4	4	4	4	4	4	4	4
	Mean	13.42	7.38	7.27	0.86	6.61	7.42	0.83	8.22	10.83	0.91	0.91	0.43	0.41
	SD	0.76	0.32	0.26	0.03	0.17	0.31	0.07	0.39	0.52	0.10	0.05	0.02	0.03
	Min	12.66	7.04	7.11	0.84	6.41	7.09	0.78	7.94	10.26	0.82	0.86	0.42	0.38
	Max	14.17	7.67	7.57	0.84	6.73	7.71	0.91	8.67	11.27	1.02	0.96	0.46	0.43
	N =	3	3	3	3	3	3	3	3	3	3	3	3	3
	Mean	13.09	6.97	6.43	0.76	5.82	6.64	0.94	7.75	10.15	1.01	0.87	0.40	0.38
<i>Astinus nebulo</i>	SD	0.41	0.16	0.22	0.39	0.43	3.32	0.49	3.88	5.08	0.58	0.08	0.04	0.19
	Min	12.59	6.84	6.17	0.68	5.20	6.61	0.82	7.54	9.83	0.99	0.82	0.34	0.34
	Max	13.53	7.19	6.69	0.88	6.19	6.68	1.14	8.05	10.43	1.02	0.99	0.42	0.41
	N =	4	4	4	3	4	4	3	3	3	2	4	4	3
<i>Astinus pustulatus</i>	Mean	11.62	6.42	6.31	0.71	5.24	6.17	0.74	7.30	8.44	0.84	0.68	0.39	0.36
	SD	0.31	0.31	0.37	0.10	0.33	0.29	0.13	0.29	1.09	0.14	0.09	0.05	0.05
Male	Min	11.21	6.03	5.79	0.59	4.90	5.84	0.61	7.08	6.53	0.66	0.57	0.34	0.31
	Max	11.91	6.81	6.64	0.83	5.71	6.53	0.93	7.68	9.09	0.99	0.80	0.47	0.43
	N =	5	5	5	5	5	5	5	5	5	4	5	5	5

Appendix 3 continued.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
Female	Mean	12.75	6.84	7.07	0.83	5.97	6.81	0.73	8.19	10.24	0.90	0.80	0.41	0.41
	SD	0.58	0.37	0.24	0.06	0.45	0.37	0.06	0.48	0.58	0.12	0.06	0.07	0.04
	Min	12.10	6.58	6.80	0.78	5.48	6.40	0.68	7.68	9.59	0.78	0.73	0.33	0.37
	Max	13.23	7.26	7.24	0.89	6.37	7.10	0.77	8.64	10.71	1.02	0.83	0.45	0.42
	N =	3	3	3	3	3	3	3	3	3	3	3	3	3
<i>Astinus</i> sp. 1 Female	Mean	12.88	7.31	6.87	0.93	5.86	6.64	0.85	7.70	10.01	1.09	0.84	0.48	0.47
	SD	0.41	0.23	0.46	0.18	0.03	0.42	0.31	0.20	0.10	0.73	0.14	0.16	0.18
	Min	12.42	7.04	6.50	0.78	5.67	6.21	0.60	7.37	9.78	1.03	0.76	0.35	0.32
	Max	13.21	7.52	7.15	1.04	6.20	6.91	1.04	8.08	10.34	1.14	0.98	0.58	0.58
	N =	3	3	3	3	3	3	3	3	3	2	3	3	3
<i>Astinus</i> sp. 2 Female		12.97	7.69	7.44	0.89	6.59	7.13	0.94	8.26	10.53	0.83	0.85	0.48	0.41
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Biasticus moultoni</i> Female	Mean	6.69	3.19	3.42	0.62	2.64	3.40	0.64	3.66	4.45	0.94	0.37	0.34	0.32
	SD	0.21	0.01	0.46	0.01	0.06	0.24	0.03	0.21	0.06	0.04	0	0.01	0.04
	Min	6.54	3.18	3.09	0.61	2.60	3.07	0.61	3.51	4.41	0.91	0.37	0.33	0.29
	Max	6.83	3.19	3.74	0.63	2.68	3.73	0.66	3.81	4.49	0.97	0.37	0.34	0.35
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2
<i>Biasticus</i> sp. 1 Male Female		6.60	2.79	3.38	0.63	2.75	3.13	0.32	3.26	4.31	0.67	0.35	0.31	0.30
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
	Mean	6.64	2.61	3.33	0.69	2.80	2.99	0.46	3.30	4.19	0.66	0.36	0.37	0.34
	SD	0.14	0.16	0.17	0.14	0.08	0.19	0.21	0.19	0.13	0.03	0.01	0.05	0.07
	Min	6.52	2.47	3.14	0.63	2.75	2.77	0.32	3.14	4.06	0.63	0.35	0.31	0.30
	Max	6.79	2.79	3.46	0.85	2.89	3.13	0.71	3.51	4.31	0.68	0.37	0.40	0.42
	N =	3	3	3	3	3	3	3	3	3	3	3	3	3

Appendix 3 continued.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
<i>Campsolomus</i> sp.	Mean	8.98	4.44	5.23	1.40	3.63	4.60	1.19	5.07	6.68	1.33	0.56	0.49	0.42
	SD	0.38	0.34	0.26	0.01	0.11	0.42	0.05	0.24	0.27	0.07	0.03	0.02	0.01
	Male	Min	8.67	3.99	4.99	1.39	3.47	4.20	4.81	6.45	1.27	0.53	0.47	0.41
		Max	9.48	4.79	5.58	1.40	3.69	5.17	5.28	6.97	1.41	0.59	0.51	0.42
		N =	4	4	4	4	4	4	4	4	4	4	4	4
	Female	Mean	9.25	4.56	5.38	1.50	3.60	4.56	5.00	6.47	1.29	0.59	0.52	0.45
		SD	0.23	0.12	0.52	0.06	0.30	0.14	0.45	0.02	0.05	0.01	0.01	0.06
		Min	9.08	4.47	5.01	1.46	3.38	4.46	4.66	6.45	1.25	0.58	0.51	0.41
		Max	9.41	4.64	5.74	1.54	3.81	4.66	5.29	6.48	1.32	0.59	0.53	0.49
		N =	2	2	2	2	2	2	2	2	2	2	2	2
<i>Colpochiloris horrendus</i>	Mean	19.53	7.50	8.28	1.77	7.54	9.37	1.88	9.72	12.66	1.90	0.91	0.85	0.81
	SD	0.72	0.14	0.03	0.09	0.17	0.21	0.09	0.01	0.25	0.06	0.06	0.04	0.01
	Min	19.02	7.40	8.26	1.70	7.42	9.22	1.81	9.70	12.48	1.85	0.86	0.82	0.80
	Female	Max	20.04	7.60	8.30	1.83	7.66	9.51	9.73	12.84	1.94	0.95	0.88	0.81
		N =	2	2	2	2	2	2	2	2	2	2	2	2
<i>Coranus fuscipennis</i>	Mean	5.54	2.83	2.73	0.73	2.33	2.59	0.73	3.85	4.06	1.00	0.37	0.39	0.38
	SD	0.49	0.01	0.34	0.16	0.12	0.25	0.04	0.16	0.18	0.03	0.01	0.01	0.01
	Min	5.16	2.66	2.51	0.63	2.20	2.48	0.70	3.52	3.95	0.98	0.36	0.38	0.37
	Max	6.26	3.30	2.94	0.83	2.45	2.70	0.76	4.32	4.24	1.02	0.38	0.39	0.38
		N =	4	4	4	2	4	2	4	3	2	2	2	2
<i>Cosmolestes picticeps</i>	Mean	7.85	4.12	4.99	1.05	3.89	4.59	1.07	4.70	6.20	1.14	0.46	0.41	.37
	SD	0.33	0.34	0.25	0.06	0.19	0.32	0.13	0.37	0.14	-	0.01	0.01	0.04
	Male	Min	7.48	3.71	4.64	1.00	3.66	4.18	4.25	6.01	-	0.45	0.39	0.33
		Max	8.14	4.55	5.18	1.12	4.10	4.92	5.14	6.34	-	0.47	0.42	0.41
		N =	4	4	4	3	4	4	4	4	1	4	4	4

Appendix 3 continued.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
Female	Mean	8.15	4.13	4.95	1.01	3.75	4.48	1.01	4.76	6.24	1.15	0.47	0.44	0.38
	SD	0.29	0.14	0.24	0.11	0.25	0.22	0.04	0.32	0.04	0.16	0.02	0.03	0.05
	Min	7.72	3.88	4.55	0.87	3.34	4.22	0.92	4.31	6.17	0.98	0.41	0.39	0.32
	Max	8.37	4.28	5.25	1.15	4.12	4.85	1.08	5.15	6.47	1.36	0.51	0.48	0.46
	N =	6	6	6	5	6	6	5	6	6	5	6	6	6
<i>Epidaus conspersus</i>		14.69	10.05	9.72	0.96	8.98	9.39	1.07	10.82	13.45	1.09	0.57	0.33	0.23
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Epidaus latispinus</i>	Mean	11.51	8.35	7.73	0.84	6.92	7.63	0.91	9.36	10.64	1.06	0.58	0.43	0.45
	SD	0.04	0.05	0.16	-	0.37	0.04	-	0.16	0.59	0.01	0.13	0.01	0.11
Male	Min	11.93	8.31	7.62	-	6.66	7.70	-	9.24	10.22	1.05	0.48	0.43	0.37
	Max	11.98	8.38	7.84	-	7.18	7.55	-	9.47	11.06	1.06	0.67	0.41	0.53
	N =	2	2	2	1	2	2	1	2	2	2	2	2	2
<i>Epidaus validispinus</i>		14.38	9.77	8.94	1.02	7.68	8.00	0.98	10.46	12.47	1.03	0.58	0.41	0.48
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Epidaus sp. 1</i>		9.63	5.29	5.20	-	4.62	4.59	0.63	6.84	7.70	0.70	0.44	0.25	0.24
Male	N =	1	1	1	-	1	1	1	1	1	1	1	1	1
Female		15.27	10.08	9.22	1.15	7.90	9.22	1.21	11.31	13.31	0.87	0.88	0.49	0.50
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Epidaus sp. 2</i>	Mean	12.97	7.92	7.96	0.92	6.88	7.12	0.94	9.30	10.01	1.15	0.76	0.44	0.42
	SD	0.95	0.77	0.45	0.10	1.08	0.98	0.07	0.65	1.00	0.16	0.21	0.12	0.11
Male	Min	12.32	7.07	7.50	0.85	5.67	5.99	0.86	8.59	9.30	1.04	0.60	0.35	0.34
	Max	14.06	8.57	8.40	1.04	7.76	7.72	0.99	9.87	10.72	1.26	1.00	0.57	0.54
	N =	3	3	3	3	3	3	3	3	2	2	3	3	3

Appendix 3 continued.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
Female		15.64	9.83	8.95	1.08	7.78	9.05	1.00	11.08	11.26	1.32	1.00	0.46	0.45
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Epidaus sp. 3</i>		15.04	7.45	7.26	0.89	5.36	5.92	1.11	8.67	9.48	1.28	0.95	0.54	0.46
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Euagoras sordidatus</i>	Mean	8.03	5.84	5.60	0.95	5.11	4.96	0.90	6.98	8.08	0.94	0.39	0.32	0.33
	SD	0.52	0.32	0.22	0.07	0.52	0.35	0.05	0.42	0.26	0.09	0.02	0.04	0.02
Male	Min	7.50	5.20	5.38	0.94	4.57	4.50	0.82	6.25	7.80	0.78	0.35	0.24	0.31
	Max	8.89	6.23	6.03	1.03	5.14	5.36	0.95	7.42	8.50	1.05	0.42	0.35	0.35
	N =	7	7	7	6	7	7	6	7	7	7	7	7	7
Female	Mean	8.27	5.53	5.42	0.97	4.92	4.99	0.89	7.40	8.10	1.02	0.41	0.34	0.32
	SD	0.25	0.42	0.15	0.06	0.26	0.57	0.13	0.39	0.64	0.12	0.01	0.03	0.02
	Min	8.00	5.07	5.25	0.92	4.75	4.49	0.80	7.00	7.56	0.89	0.40	0.31	0.30
	Max	8.49	5.88	5.53	1.01	5.22	5.61	0.98	7.78	8.81	1.12	0.42	0.37	0.34
	N =	3	3	3	2	3	3	2	3	3	3	3	3	3
<i>Eulyes amoena</i>	Mean	20.06	8.13	9.27	1.63	7.87	10.14	1.92	9.77	12.92	1.88	0.85	0.84	0.82
	SD	0.38	0.35	0.15	0.26	0.26	0.19	0.13	0.37	0.56	0.12	0.02	0.03	0.03
Male	Min	19.72	7.93	9.10	1.34	7.68	10.00	1.77	9.41	12.44	1.75	0.84	0.81	0.80
	Max	20.47	8.53	9.37	1.84	8.17	10.35	2.01	10.15	13.54	1.99	0.87	0.86	0.86
	N =	3	3	3	3	3	3	3	3	3	3	3	3	3
Female	Mean	20.39	8.20	8.98	1.74	8.20	9.85	1.68	8.79	13.60	1.90	0.84	0.77	0.73
	SD	1.14	0.40	0.15	0.23	0.17	0.33	0.16	0.99	0.05	-	0.01	0.07	0.10
	Min	19.25	7.95	8.81	1.57	8.05	9.48	1.56	7.82	13.56	-	0.83	0.70	0.65
	Max	21.53	8.66	9.10	1.90	8.39	10.08	1.79	9.79	13.63	-	0.84	0.84	0.84
	N =	3	3	3	2	3	3	2	3	2	1	3	3	3
<i>Eulyes sp. 1</i>		20.80	8.86	9.89	1.80	8.28	10.44	1.64	9.79	13.51	1.76	0.88	0.87	0.86
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1

Appendix 3 continued.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
<i>Hagia punctoria</i>	Mean	9.61	4.14	5.45	0.68	3.66	5.15	0.76	4.66	6.91	0.85	0.57	0.48	0.46
	SD	0.95	0.47	0.46	0.04	0.53	0.23	0.29	0.49	0.62	0.06	0.05	0.01	0.04
	Min	8.93	3.81	5.12	0.65	3.28	4.99	0.57	4.31	6.47	0.80	0.53	0.47	0.43
	Max	10.28	4.47	5.77	0.71	4.03	5.31	0.98	5.00	7.35	0.89	0.60	0.48	0.49
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2
	Mean	9.95	3.77	5.01	0.66	3.45	4.59	0.94	4.93	6.72	0.87	0.52	0.47	0.46
	SD	0.10	0.29	0.03	0.04	0.35	0.23	0.01	0.06	0.05	-	0.06	0.06	0.01
	Min	9.88	3.56	4.99	0.63	3.20	4.42	0.93	4.88	6.68	-	0.48	0.43	0.45
	Max	10.02	3.97	5.03	0.68	3.70	4.75	0.94	4.97	6.75	-	0.56	0.51	0.47
	N =	2	2	2	2	2	2	2	2	2	1	2	2	2
<i>Isyndus heros</i>		12.09	6.45	6.47	1.69	5.99	6.24	1.81	8.19	9.17	1.75	0.73	0.62	0.56
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
Female		18.15	8.39	8.56	1.70	7.14	8.00	2.02	10.35	12.94	2.16	1.08	1.05	0.85
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Isyndus heros heros</i>	Mean	18.00	8.37	9.53	2.25	6.85	8.54	2.10	10.96	13.62	2.22	1.04	0.97	0.87
	SD	0.43	0.39	0.38	0.10	0.82	0.43	0.50	0.33	0.86	0.06	0	0.05	0.02
	Min	17.53	7.96	9.19	2.18	6.30	8.20	1.78	10.64	13.03	2.18	1.04	0.93	0.86
	Max	18.38	8.74	9.94	2.32	7.80	9.03	2.68	11.30	14.60	2.26	1.04	1.02	0.90
	N =	3	3	3	2	3	3	3	3	3	2	3	3	3
<i>Panthous daedalus</i>		19.00	7.17	7.73	1.99	6.67	7.56	2.19	9.37	10.44	2.29	1.22	0.96	1.08
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Panthous ectinoderoides</i>		17.58	6.82	7.28	1.35	5.81	5.83	-	7.95	10.74	2.33	1.00	0.85	0.94
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1

Appendix 3 continued.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
<i>Panthous</i> sp. 1		16.42	6.41	7.68	1.77	6.09	7.82	1.92	8.31	10.29	2.07	1.10	0.96	1.00
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Panthous</i> sp. 2		11.63	5.12	5.44	1.45	5.00	5.14	1.57	6.33	7.18	1.77	1.04	0.82	0.82
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Panthous</i> sp. 3		18.41	6.62	7.89	1.78	6.30	7.60	1.78	7.98	11.42	1.92	0.99	0.83	0.80
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Poeciclopis patagiatus</i>	Mean	7.83	3.64	4.01	0.69	3.29	3.49	0.79	4.41	5.58	-	0.29	0.28	0.28
	SD	0.15	0.32	0.35	0.02	0.87	0.08	0.09	-	-	-	0.04	0.03	-
Male	Min	7.72	3.41	3.76	0.67	2.67	3.43	0.72	-	-	-	0.26	0.26	-
	Max	7.93	3.86	4.26	0.70	3.90	3.54	0.85	-	-	-	0.32	0.30	-
	N =	2	2	2	2	2	2	2	1	1	-	2	2	1
Female	Mean	8.67	4.16	4.42	0.75	3.47	3.88	0.74	4.63	5.84	0.78	0.38	0.34	0.32
	SD	0.29	0.09	0.19	0.09	0.16	0.15	0.08	0.16	0.14	0.08	0.04	0.03	0.02
	Min	8.40	4.06	4.38	0.65	3.33	3.71	0.67	4.44	5.68	0.73	0.34	0.32	0.31
	Max	8.97	4.24	4.62	0.81	3.62	3.99	0.83	4.73	5.92	0.87	0.42	0.37	0.34
	N =	3	3	3	3	3	3	3	3	3	3	3	3	3
<i>Polididus armatissimu</i> s	Mean	7.23	4.57	4.20	0.74	3.54	3.40	0.78	4.87	5.66	0.90	0.53	0.40	0.33
	SD	0.46	0.40	0.25	0.01	0.17	0.19	0.03	0.15	0.38	0.07	0.09	0.07	0.03
	Min	6.74	4.12	3.91	0.73	3.39	3.25	0.76	4.74	5.41	0.82	0.46	0.34	0.31
Male	Max	7.66	4.87	4.35	0.74	3.73	3.61	0.82	5.04	6.10	0.96	0.63	0.48	0.36
	N =	3	3	3	3	3	3	3	3	3	3	3	3	3

Appendix 3 continued.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
Female	Mean	7.16	4.62	3.95	0.92	3.45	3.36	0.71	4.54	5.46	0.86	0.45	0.38	0.32
	SD	0.52	0.50	0.47	0.07	0.29	0.05	0.21	0.20	0	-	0.04	0.02	0.01
	Min	6.79	4.26	3.62	0.87	3.24	3.32	0.56	4.40	5.46	-	0.42	0.37	0.31
	Max	7.52	4.97	4.28	0.97	3.65	3.39	0.86	4.68	5.46	-	0.48	0.39	0.33
	N =	2	2	2	2	2	2	2	2	2	1	2	2	2
<i>Rhynocoris marginellus</i>		7.78	4.58	5.13	0.99	3.88	4.61	1.08	5.16	6.77	1.30	0.55	0.48	0.40
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
Female	Mean	8.69	4.60	5.38	1.10	3.87	4.80	0.90	5.71	7.30	1.46	0.61	0.52	0.50
	SD	0.58	0.77	0.19	0.27	0.23	0.11	0.13	0.24	0.21	0.16	0.06	0.02	0.04
	Min	7.88	3.34	5.12	0.91	3.50	4.68	0.78	5.45	7.10	1.22	0.57	0.50	0.45
	Max	9.40	5.21	5.59	1.29	4.12	4.93	1.04	6.09	7.64	1.58	0.71	0.54	0.56
	N =	5	5	5	2	5	5	3	5	5	4	5	5	5
<i>Scipinia rapax</i>	Mean	5.85	3.20	2.73	0.63	2.43	2.22	0.85	2.69	2.87	0.86	0.51	0.23	0.35
	SD	0.08	0.31	-	-	0.47	-	-	0.44	-	-	0.01	-	0
Male	Min	5.79	2.98	-	-	2.10	-	-	2.38	-	-	0.50	-	0.35
	Max	5.90	3.42	-	-	2.76	-	-	3.00	-	-	0.51	-	0.35
	N =	2	2	1	1	2	1	1	2	1	1	2	1	2
<i>Sphedanolestes fallax</i>	Mean	7.97	3.69	4.23	0.68	3.60	4.68	0.75	4.31	6.33	0.85	0.49	0.47	0.45
	SD	0.07	0.13	0.26	0.23	0.17	0.32	0.02	0.05	0.23	0.09	0.03	0.05	0.05
Male	Min	7.89	3.57	3.93	0.52	3.41	4.48	0.74	4.26	6.06	0.78	0.45	0.43	0.40
	Max	8.03	3.83	4.35	0.84	3.73	5.05	0.77	4.35	6.47	0.91	0.51	0.52	0.49
	N =	3	3	3	2	3	3	3	3	3	2	3	3	3

Appendix 3 continued.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
Female	Mean	7.61	3.90	4.24	0.71	3.63	4.33	0.78	4.24	6.11	0.80	0.48	0.45	0.42
	SD	0.83	0.24	0.34	0.04	1.02	0.31	0.08	0.12	0.51	0.05	0.02	0.04	0.03
	Min	6.90	3.74	4.00	0.67	2.54	4.07	0.70	4.11	5.78	0.74	0.46	0.41	0.39
	Max	8.53	4.17	4.63	0.74	4.55	4.67	0.86	4.35	6.70	0.82	0.50	0.48	0.45
	N =	3	3	3	2	3	3	3	3	3	3	3	3	3
<i>Sycanus dilutus</i>	Mean	13.07	6.80	7.88	1.20	6.23	7.06	1.15	8.16	10.18	1.14	0.56	0.52	0.50
	SD	0.60	0.28	0.35	0.09	0.48	0.29	0.15	0.20	0.46	0.13	0.05	0.02	0.04
	Min	12.34	6.44	7.43	1.10	5.70	6.67	1	7.94	9.57	1.05	0.50	0.49	0.46
	Max	13.87	7.11	8.22	1.28	6.83	7.37	1.31	8.40	10.81	1.36	0.63	0.54	0.56
	N =	5	5	5	3	4	4	4	5	5	5	5	4	5
Female	Mean	14.82	6.90	7.91	1.21	6.34	7.61	1.26	8.43	10.77	1.29	0.60	0.55	0.57
	SD	0.27	0.25	0.46	0.16	0.38	0.52	0.09	0.32	0.40	0.22	0.01	0.07	0.05
	Min	14.45	6.54	7.44	1.03	6.04	7.20	1.18	7.99	10.31	1.12	0.58	0.47	0.52
	Max	15.03	7.07	8.47	1.32	6.76	8.19	1.36	8.76	11.24	1.61	0.61	0.61	0.63
	N =	4	4	4	3	3	3	3	4	4	4	4	3	4
<i>Sycanus macracanthus</i>	Mean	11.80	5.59	6.22	1.09	5.07	6.13	1.03	7.02	8.67	1.01	0.49	0.46	0.47
	SD	0.23	0.13	0.20	-	0.22	0.15	0.15	0.56	0.14	-	0.02	0.02	0.02
	Min	11.61	5.44	6.01	-	4.82	5.98	0.90	6.55	8.55	-	0.48	0.45	0.46
	Max	12.06	5.67	6.40	-	5.25	6.28	1.19	7.64	8.82	-	0.51	0.48	0.49
	N =	3	3	3	1	3	3	3	3	3	1	3	3	3
Female	Mean	11.74	5.53	6.13	0.93	5.16	5.99	0.92	7.04	8.48	1.05	0.43	0.42	0.43
	SD	0.45	0.33	0.19	0.11	0.20	0.21	0.11	0.28	0.19	0.11	0.04	0.06	0.07
	Min	11.13	5.13	5.93	0.88	4.92	5.66	0.74	6.49	8.29	0.90	0.38	0.36	0.34
	Max	12.35	6.11	6.46	1.08	5.53	6.26	1.01	7.28	8.83	1.16	0.49	0.51	0.53
	N =	7	7	7	5	7	7	6	7	6	6	7	7	7

Appendix 3 continued.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
<i>Sycanus mculatus</i>		9.45	4.97	5.80	0.95	4.63	5.60	0.99	6.47	7.86	0.87	0.31	0.40	0.30
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Sycanus tuberculatus</i>	Mean	12.39	5.71	6.40	0.83	5.48	6.17	0.93	7.26	8.79	1.03	0.39	0.37	0.39
	SD	0.02	0.23	0.27	-	0.21	0.38	0.06	0.10	0.12	-	0	0.01	0.07
Female	Min	12.37	5.55	6.21	-	5.33	5.90	0.88	7.19	8.70	-	0.39	0.36	0.34
	Max	12.40	5.87	6.59	-	5.62	6.44	0.97	7.33	8.87	-	0.39	0.37	0.44
	N =	2	2	2	1	2	2	2	2	2	1	2	2	2
<i>Sycanus sp. 1</i>		12.18	5.79	6.19	-	4.41	5.31	-	7.58	8.37	-	0.30	0.47	0.44
Female	N =	1	1	1	-	1	1	-	1	1	-	1	1	1
<i>Sycanus sp. 2</i>		14.45	7.69	8.43	-	7.63	8.35	1.15	9.43	11.25	1.48	0.53	0.50	0.47
Female	N =	1	1	1	-	1	1	1	1	1	1	1	1	1
<i>Sycanus sp. 3</i>	Mean	11.60	5.75	6.23	0.89	5.34	5.98	3.75	6.75	8.42	0.84	0.34	0.38	0.39
	SD	0.96	0.13	0.13	0.08	0.54	0.70	0.13	0.63	0.88	0.18	0.01	0.02	0.01
Female	Min	10.92	5.65	6.13	0.83	4.95	5.48	0.65	6.30	7.80	0.71	0.33	0.36	0.38
	Max	12.28	5.84	6.32	0.94	5.72	6.48	0.84	7.19	9.04	0.97	0.35	0.39	0.40
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2
<i>Sycanus sp. 4</i>		13.84	6.84	8.39	1.00	6.49	8.43	1.15	9.17	1.09	1.07	0.54	0.48	0.52
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Velinus nigrigenu</i>	Mean	12.31	6.59	7.35	1.42	5.83	6.74	1.21	7.73	9.39	1.33	0.51	0.43	0.46
	SD	0.09	0.21	0.21	0.08	0.12	0.27	0.12	0.23	0.21	0.15	0.03	0.02	0.04
Male	Min	12.10	6.18	6.94	1.26	5.56	6.13	1.10	7.18	9.24	1.01	0.41	0.38	0.37
	Max	12.41	7.14	7.82	1.55	6.11	7.05	1.47	8.32	9.80	1.68	0.62	0.57	0.54
	N =	8	8	8	8	8	8	8	8	8	8	8	8	8

Appendix 3 continued.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
Female	Mean	12.14	6.64	7.05	1.28	6.08	6.50	1.18	7.51	9.16	1.18	0.57	0.45	0.50
	SD	0.42	0.02	0.35	0.06	0.83	0.04	0.11	0.06	0.18	-	0.04	0.11	0.01
	Min	11.84	6.62	6.80	1.23	5.49	6.47	1.10	7.46	9.03	-	0.54	0.37	0.49
	Max	12.43	6.65	7.30	1.32	6.66	6.53	1.25	7.55	9.28	-	0.59	0.52	0.50
	N =	2	2	2	2	2	2	2	2	2	1	2	2	2
<i>Vesbius purpureus</i>	Mean	4.96	2.16	2.87	0.65	2.11	3.08	0.56	2.93	4.36	0.59	0.31	0.31	0.31
	SD	0.50	0.09	0.02	0.01	0.12	0.25	0	0.11	0.12	0.03	0.01	0.01	0.02
	Min	4.47	2.08	2.84	0.65	1.99	2.89	0.56	2.83	4.24	0.55	0.30	0.31	0.29
	Max	5.46	2.26	2.88	0.66	2.23	3.36	0.56	3.05	4.47	0.61	0.32	0.32	0.33
	N =	3	3	3	3	3	3	2	3	3	3	3	3	3
Female	Mean	5.20	2.28	3.28	0.61	2.20	3.31	0.49	2.94	4.62	0.55	0.30	0.31	0.32
	SD	0	0.02	0.10	0.04	0.13	0.26	-	0.13	0.35	0.04	0.01	0.01	0
	Min	5.20	2.26	3.21	0.58	2.10	3.12	-	2.85	4.37	0.52	0.29	0.30	0.32
	Max	5.20	2.29	3.35	0.63	2.29	3.49	-	3.03	4.87	0.58	0.30	0.31	0.32
	N =	2	2	2	2	2	2	1	2	2	2	2	2	2
<i>Yolinus fuliginosus</i>	Mean	15.18	5.69	6.60	1.25	5.64	7.38	1.22	7.57	10.50	1.25	0.69	0.65	0.64
	SD	0.05	0.55	0.14	-	0.01	0.51	0.35	0.14	0.29	0.04	0.02	0.01	0.01
	Min	15.14	5.30	6.50	-	5.63	7.02	0.97	7.47	10.29	1.22	0.67	0.64	0.63
	Max	15.21	6.08	6.70	-	5.64	7.74	1.46	7.67	10.70	1.27	0.70	0.66	0.65
	N =	2	2	2	1	2	2	2	2	2	2	2	2	2
Harpactorin ae sp. 1		13.89	6.76	7.14	-	5.81	6.54	0.77	7.77	10.22	1.33	1.29	0.42	0.43
Male	N =	1	1	1	-	1	1	1	1	1	1	1	1	1
Harpactorin ae sp. 2		13.45	5.79	6.43	0.78	5.75	6.38	0.75	7.41	9.07	0.94	0.95	0.41	0.38
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1

Appendix 3 continued.

Species		Hem	Length								Width				
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem	
Harpactorin ae sp. 3		13.53	6.65	6.41	-	5.30	6.36	0.99	7.04	9.23	0.95	1.06	0.36	0.37	
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	
Harpactorin ae sp. 4		Mean	9.46	6.39	6.03	0.73	5.51	6.11	0.86	7.74	9.03	0.87	0.47	0.33	0.37
	SD	0.11	0.23	0.09	0.11	0.16	0.05	0.19	0.11	0.52	0.16	0.07	0.04	0.04	
Male	Min	9.38	6.22	5.96	0.65	5.39	6.07	0.72	7.66	8.66	0.76	0.42	0.30	0.34	
	Max	9.54	6.55	6.09	0.80	5.62	6.14	0.99	7.82	9.39	0.98	0.52	0.35	0.40	
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	
Female	Mean	9.77	5.91	5.82	0.72	5.33	5.90	0.82	7.39	9.63	0.79	0.52	0.33	0.34	
	SD	0.02	0.04	0.18	0.15	0.21	0.18	0.03	0.03	0.27	0.13	0.01	0.01	0.04	
	Min	0.75	5.88	5.69	0.61	5.18	5.77	0.80	7.37	9.44	0.69	0.51	0.32	0.31	
	Max	0.78	5.93	5.94	0.82	5.47	6.03	0.84	7.41	9.82	0.88	0.53	0.34	0.36	
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	
Harpactorin ae sp. 5		10.36	4.90	5.46	0.74	4.31	5.05	0.82	5.57	7.77	0.90	0.80	0.37	0.35	
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	
Harpactorin ae sp. 6		Mean	8.86	2.98	4.20	1.05	2.92	4.27	1.00	4.11	6.07	1.09	0.60	0.57	0.54
	SD	0.36	0.38	0.16	0.09	0.49	0.27	0.11	0.10	0.17	0.03	0.04	0.01	0.02	
Male	Min	8.60	2.71	4.09	0.98	2.57	4.08	0.92	4.04	5.95	1.07	0.57	0.56	0.52	
	Max	9.11	3.25	4.31	1.11	3.26	4.46	1.08	4.18	6.19	1.11	0.62	0.57	0.55	
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	
Female	Mean	10.28	3.30	4.05	1.00	2.88	4.27	1.05	4.17	6.22	1.13	0.55	0.55	0.51	
	SD	0.46	0.12	0.01	0.14	0.12	0.06	0.06	0.18	0.16	0.07	0.04	0.03	0.09	
	Min	9.95	3.21	4.04	0.90	2.79	4.22	1.00	4.03	6.11	1.08	0.52	0.53	0.44	
	Max	10.60	3.38	4.06	1.10	2.96	4.31	1.09	4.30	6.33	1.18	0.58	0.57	0.57	
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2	

Appendix 3 continued.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
HOLOPTILINAE														
<i>Holoptilus leprosus</i>	Mean	7.87	2.01	1.82	0.60	2.12	2.80	0.77	2.95	5.98	0.89	0.38	0.26	0.25
	SD	0.05	0.11	0.03	0.14	0.07	0.07	0.04	0.01	0.06	0.17	0.01	0.01	0.00
	Min	7.83	1.93	1.80	0.50	2.07	2.75	0.74	2.94	5.94	0.77	0.37	0.25	0.25
	Max	7.90	2.08	1.84	0.70	2.17	2.85	0.80	2.96	6.02	1.01	0.39	0.26	0.25
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2
PEIRATINAE														
<i>Ectomocoris atrox</i>	Mean	10.42	3.87	4.10	1.38	3.68	3.43	1.93	6.01	6.38	3.07	0.94	0.73	0.57
	SD	0.32	0.32	0.17	0.27	0.20	0.16	0.22	0.38	0.41	0.11	0.07	0.07	0.04
	Min	10.08	3.44	3.90	1.07	3.41	3.14	1.79	5.53	5.71	3.01	0.84	0.66	0.51
	Max	11.01	4.32	4.35	1.80	3.89	3.56	2.31	6.44	6.79	3.24	1.02	0.82	0.62
	N =	6	6	6	6	6	6	5	5	5	4	6	6	5
<i>Ectomocoris elegans</i>	Mean	9.97	3.83	3.84	1.55	3.42	3.24	2.29	5.49	6.08	2.91	1.04	0.79	0.56
	SD	0.45	0.42	0.45	0.37	0.33	0.31	0.19	0.16	0.27	0.37	0.06	0.06	0.05
	Min	9.52	3.43	3.23	1.09	2.94	2.84	1.98	5.29	5.60	2.10	0.95	0.70	0.50
	Max	10.85	4.74	4.31	2.16	4.01	3.67	2.57	5.74	6.34	3.26	1.11	0.88	0.66
	N =	7	7	7	7	7	7	7	7	7	7	7	7	7
Female	Mean	10.82	4.20	3.29	1.82	3.98	3.18	2.26	5.78	6.45	2.78	1.07	0.83	0.52
	SD	0.91	0.34	0.14	-	0.06	0.24	0.33	0.42	0.31	0.32	0.05	0.08	0.05
	Min	10.15	3.83	3.17	-	3.94	3.01	1.95	5.31	6.09	2.55	1.04	0.78	0.47
	Max	11.86	4.51	3.44	-	4.05	3.46	2.61	6.14	6.64	3.00	1.13	0.92	0.57
	N =	3	3	3	1	3	3	3	3	3	2	3	3	3

Appendix 3 continued.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
<i>Sirthenea flavipes</i> Male	Mean	11.55	3.83	3.56	1.50	3.07	3.60	2.13	4.91	6.07	3.02	0.86	0.47	0.50
	SD	0.47	0.41	0.22	0.29	0.39	0.43	0.31	0.43	0.34	0.21	0.08	0.05	0.07
	Min	10.95	3.20	3.20	1.22	2.56	2.66	1.83	4.22	5.51	2.78	0.73	0.40	0.40
	Max	12.16	4.43	3.89	2.01	3.49	3.83	2.29	5.35	6.51	3.26	0.96	0.56	0.57
	N =	7	7	7	7	7	7	6	7	7	6	7	7	7
	Mean	11.28	3.83	3.64	1.37	2.93	3.77	2.10	5.06	6.09	3.17	0.85	0.45	0.49
	SD	0.70	0.58	0.23	0.31	0.04	0.13	0.35	0.38	0.20	0.33	0.15	0.03	0.08
	Min	10.47	3.33	3.43	1.08	2.88	3.62	1.85	4.75	5.86	2.94	0.69	0.42	0.41
	Max	11.74	4.46	3.89	1.69	2.99	4.03	2.34	5.49	6.23	3.40	0.98	0.47	0.57
	N =	3	3	3	3	3	3	2	3	3	2	3	3	3
PHYSODERINAE														
<i>Physoderes curculionis</i> Male		4.24	1.56	1.46	0.42	1.45	1.66	0.51	1.76	-	-	0.43	0.46	0.38
	N =	1	1	1	1	1	1	1	1	-	-	1	1	1
REDUVIINAE														
<i>Acanthaspis quadriannulata</i> Female	Mean	14.65	5.76	5.61	2.14	5.59	6.22	2.22	7.59	8.19	2.70	1.28	1.25	1.06
	SD	0.78	0.01	0.53	0.21	0.48	0.22	0.01	0.04	0.47	0.16	0.04	0.01	0.01
	Min	14.09	5.74	5.23	1.99	5.25	6.06	2.21	7.56	7.85	2.58	1.25	1.24	1.05
	Max	15.20	5.76	5.98	2.29	5.93	6.37	2.23	7.62	8.52	2.81	1.31	1.26	1.06
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2
<i>Sminthus singularis</i> Male	Mean	9.17	3.19	3.13	1.06	3.02	2.82	1.12	4.49	3.90	1.30	1.07	0.78	0.61
	SD	0.55	0.13	0.14	0.01	0.46	0.34	0.11	0.08	0.17	0.24	0.05	0.11	0.04
	Min	8.83	3.10	3.04	1.05	2.65	2.49	1.00	4.44	3.73	1.03	1.03	0.66	0.56
	Max	9.80	3.34	3.30	1.07	3.53	3.17	1.22	4.58	4.06	1.47	1.13	0.88	0.64
	N =	3	3	3	2	3	3	3	3	3	3	3	3	3

Appendix 3 continued.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
Female	Mean	9.14	3.16	3.28	1.26	3.42	2.85	1.05	4.51	3.96	1.31	0.98	0.68	0.55
	SD	0.33	0.42	0.31	0.07	0.16	0.18	0.01	0.18	0.11	-	0.02	0.08	0.11
	Min	8.90	2.86	3.06	1.21	3.31	2.72	0.99	4.38	3.88	-	0.96	0.62	0.47
	Max	9.37	3.45	3.50	1.31	3.53	2.97	1.11	4.64	4.04	-	0.99	0.74	0.62
	N =	2	2	2	2	2	2	2	2	2	1	2	2	2
<i>Tiarodes</i> sp.		13.54	3.89	4.55	1.42	3.81	4.19	1.64	5.04	5.95	-	1.20	1.04	0.75
Female	N =	1	1	1	1	1	1	1	1	1	-	1	1	1
<i>Velitra rubropicta</i>	Mean	13.10	4.49	4.52	1.68	4.25	4.00	1.66	6.75	7.01	1.90	1.48	1.22	0.94
	SD	0.60	0.25	0.45	0.16	0.05	0.39	0.04	0.02	0.08	0.17	0.04	0.02	0.01
Male	Min	12.67	4.31	4.20	1.57	4.21	3.68	1.63	6.73	6.95	1.78	1.45	1.20	0.93
	Max	13.52	4.66	4.84	1.79	4.28	4.23	1.68	6.76	7.06	2.02	1.50	1.23	0.95
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2
Female	Mean	13.26	4.19	4.63	1.95	4.33	4.07	1.74	6.01	6.99	1.89	1.41	1.14	0.85
	SD	0.32	0.31	0.60	0.20	0.35	0.38	0.22	0.49	0.52	0.15	0.14	0.08	0.14
	Min	13.25	4.01	4.21	1.75	3.96	3.66	1.60	5.58	6.62	1.67	1.26	1.04	0.74
	Max	13.86	4.65	5.52	2.13	4.79	4.55	2.06	6.69	7.76	2.00	1.58	1.20	1.05
	N =	4	4	4	4	4	4	4	4	4	4	4	4	4
SAICINAE														
<i>Polytoxus vagans</i>		6.82	-	-	-	-	-	-	3.68	3.97	0.57	-	-	0.19
	N =	1	-	-	-	-	-	-	1	1	1	-	-	1
SALYAVATINAE														
<i>Lisarda inornata</i>	Mean	8.42	3.04	3.21	0.50	3.32	3.54	0.58	4.95	5.36	-	0.53	0.51	0.54
	SD	0.50	0.16	0.23	-	0.11	0.37	0.07	0.13	0.49	-	0.01	0.04	0
Female	Min	8.06	2.93	3.05	-	3.24	3.28	0.53	4.86	5.01	-	0.52	0.48	0.54
	Max	8.77	3.15	3.37	-	3.40	3.80	0.63	5.04	5.70	-	0.54	0.54	0.54
	N =	2	2	2	1	2	2	2	2	2	-	2	2	2

Appendix 3 continued.

Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
<i>Lisarda umbrosa</i>		8.80	3.47	3.75	-	4.04	3.97	0.66	5.47	5.60	-	0.56	0.51	0.51
Male	N =	1	1	1	-	1	1	1	1	1	-	1	1	1
Female		10.08	3.71	4.05	1.07	4.18	4.57	0.53	5.49	6.72	1.04	0.65	0.55	0.54
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Salyavata</i> sp.		10.18	4.46	4.22	0.87	4.22	5.24	-	6.12	6.29	-	0.50	0.41	0.42
	N =	1	1	1	1	1	1	-	1	1	-	1	1	1
<i>Syberna munita</i>	Mean	8.32	4.00	3.22	1.64	4.30	4.47	1.09	5.95	6.44	1.18	0.40	0.39	0.39
	SD	0.17	0.21	0.31	0.96	0.03	0.19	0.14	0.40	0.34	0.09	0.02	0.03	0.04
Male	Min	8.18	3.82	2.95	0.61	4.34	4.29	1.00	5.56	6.14	1.09	0.37	0.35	0.34
	Max	8.51	4.23	3.56	1.03	3.29	4.67	1.25	6.36	6.80	1.26	0.41	0.41	0.41
	N =	3	3	3	3	3	3	3	3	3	3	3	3	3
Female	Mean	9.59	3.94	3.52	0.77	4.98	4.74	1.05	6.30	6.95	1.13	0.48	0.42	0.45
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
	Mean	12.10	4.36	4.29	-	5.38	5.33	1.09	7.31	7.64	1.14	0.47	0.49	0.49
<i>Valentia apetala</i>	SD	0.29	0.08	0.02	-	0.02	0.12	0.14	0.49	0.18	0.28	0.01	0.01	0.08
	Min	11.89	4.30	4.27	-	5.36	5.24	0.99	7.07	7.51	0.94	0.46	0.48	0.43
Male	Max	12.30	4.42	4.30	-	5.39	5.41	1.19	7.54	7.76	1.33	0.47	0.50	0.54
	N =	2	2	2	-	2	2	2	2	2	2	2	2	2
<i>Salyavatinae</i> sp. 1		8.93	2.96	3.42	0.68	3.02	3.40	0.85	4.64	5.44	1.35	0.63	0.55	0.57
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Salyavatinae</i> sp. 2		13.09	5.13	4.74	1.30	5.32	6.41	1.15	7.36	8.44	1.45	0.46	0.41	0.45
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1

Appendix 3 continued.

Species		Hem	Length								Width				
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem	
STENOPODAINAE															
<i>Aulacogenia sarawakensis</i>		9.38	2.95	3.49	0.75	3.33	3.03	0.79	4.34	4.90	0.82	0.41	0.47	0.54	
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	
<i>Aulacogenia sp.</i>		8.88	2.29	2.68	0.61	3.12	3.16	0.58	4.11	4.70	0.47	0.40	0.42	0.45	
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	
<i>Canthesancus gulo</i>		19.26	10.89	10.22	1.21	10.10	9.42	1.67	16.29	17.87	3.28	0.82	0.83	0.51	
Female	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	
<i>Oncocephalus annulipes</i>		Mean	10.44	4.27	3.83	1.41	4.89	4.82	1.22	8.40	10.05	1.65	0.72	0.30	0.31
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	
Female		9.92	3.44	3.66	1.49	4.17	4.49	1.03	7.96	9.45	1.75	0.70	0.33	0.45	
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	
<i>Oncocephalus cingalensis</i>		11.48	3.91	4.10	1.42	5.02	4.46	-	7.93	9.40	1.54	0.79	0.43	0.42	
Female	N =	1	1	1	1	1	1	-	1	1	1	1	1	1	
<i>Oncocephalus lineosus</i>		8.62	3.11	3.92	1.18	3.63	2.97	1.04	5.47	5.96	1.35	1.19	0.31	0.34	
Male	N =	1	1	1	1	1	1	1	1	1	1	1	1	1	

Appendix 3 continued.

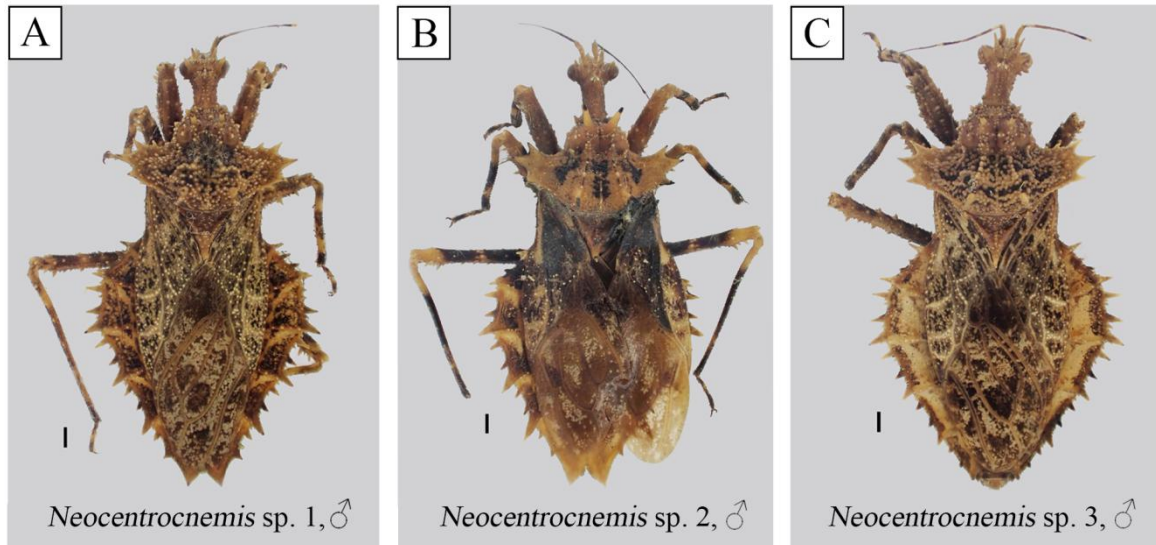
Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
<i>Oncocephalus sarawakensis</i>	Mean	8.91	3.26	3.35	1.36	3.55	3.48	0.99	5.75	6.98	1.34	0.70	0.29	0.29
	SD	0.15	0.34	0.37	1.05	0.30	0.32	0.12	0.36	0.47	0.25	0.06	0.06	0.04
	Min	8.79	2.77	2.80	1.24	3.26	3.21	0.82	5.26	6.43	1.05	0.61	0.24	0.25
	Max	9.10	3.48	3.57	1.40	3.97	3.88	1.08	6.00	7.43	1.51	0.74	0.35	0.33
	N =	4	4	4	4	4	4	4	4	4	4	4	4	4
<i>Oncocephalus</i> sp. 1		8.98	3.40	2.48	1.13	4.14	3.14	0.89	5.68	5.64	1.34	1.15	0.50	0.47
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Oncocephalus</i> sp. 2		10.64	4.32	4.37	1.33	4.37	5.05	0.98	8.32	9.95	1.45	1.29	0.34	0.54
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Pygolampis</i> sp.		7.34	2.99	2.64	0.80	1.85	2.13	0.96	3.65	3.80	1.20	0.52	0.20	0.24
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
	Mean	8.68	3.17	2.67	1.01	2.13	2.05	1.09	3.88	3.78	1.42	0.52	0.21	0.24
	SD	0.61	0.27	0.10	0.30	0.43	0.68	0.07	0.05	0.42	0.31	0.05	0.03	0.02
	Min	8.28	2.91	2.59	0.68	1.69	1.27	1.02	3.83	3.40	1.08	0.47	0.19	0.22
	Max	9.38	3.45	2.78	1.28	2.54	2.47	1.16	3.93	4.24	1.68	0.56	0.24	0.25
	N =	3	3	3	3	3	3	3	3	3	3	3	3	3
<i>Sastrapada</i> sp.		8.81	4.24	3.36	1.01	4.23	4.39	0.95	7.06	8.60	1.05	0.75	0.28	0.28
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1

Appendix 3 continued.

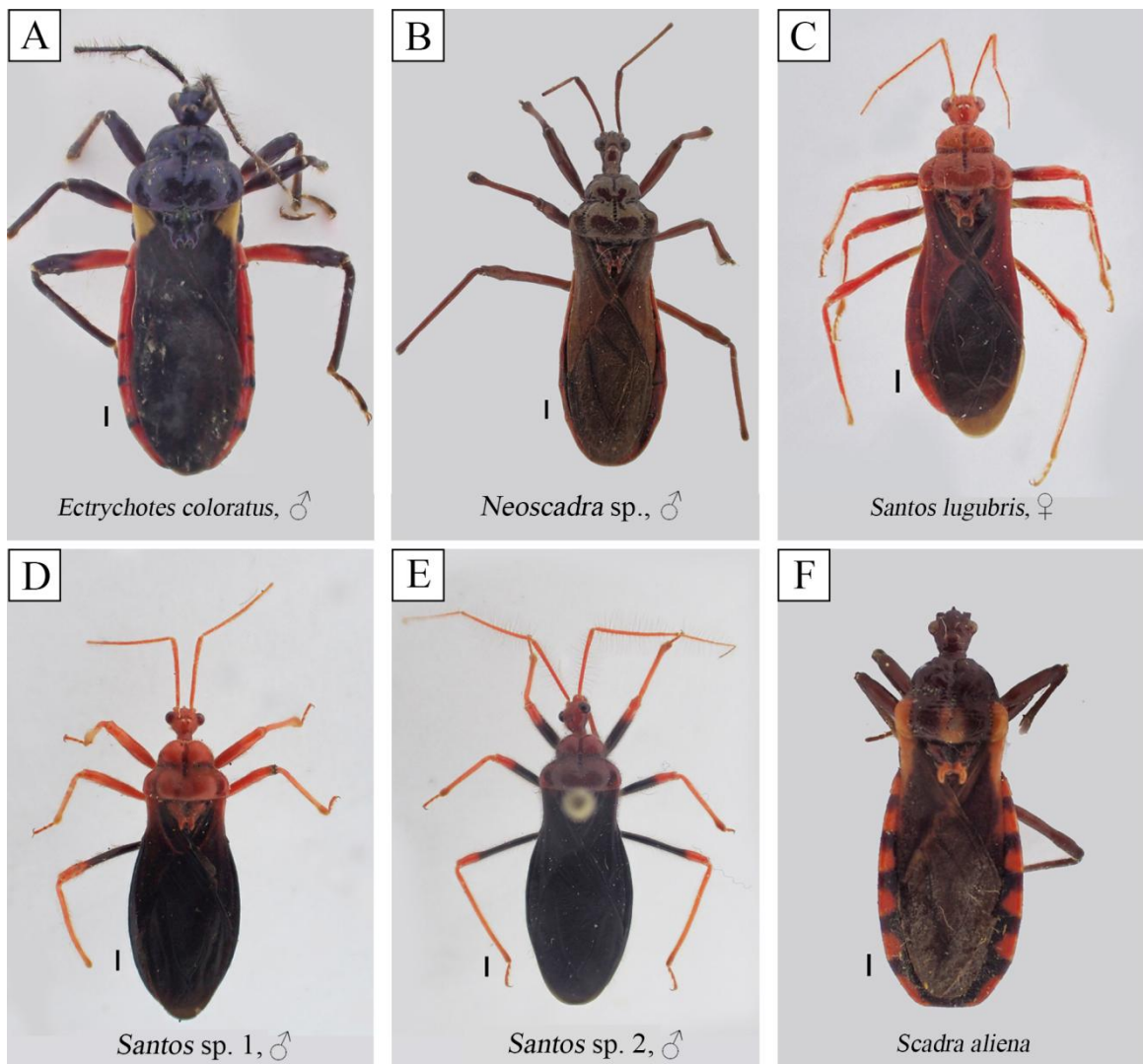
Species		Hem	Length									Width		
			For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem
<i>Staccia diluta</i>	Mean	4.83	2.21	1.92	0.57	1.87	1.92	0.67	2.84	3.03	-	0.33	0.30	0.28
	SD	0.40	0.22	0.03	0.03	0.13	0.12	-	-	-	-	0.02	0.01	-
	Min	4.55	2.05	1.90	0.55	1.77	1.83	-	-	-	-	0.31	0.29	-
	Max	5.11	2.36	1.94	0.59	1.96	2.00	-	-	-	-	0.34	0.31	-
	N =	2	2	2	2	2	2	1	1	1	-	2	2	1
<i>Thodelmus matangensis</i>	Mean	14.43	6.69	6.23	1.44	6.95	6.23	1.46	11.10	-	-	0.47	0.44	0.46
	SD	1.87	0.40	0.20	-	0.21	0.16	-	0.53	-	-	0.08	0.06	0.06
	Min	13.10	6.41	6.09	-	6.80	6.12	-	10.72	-	-	0.41	0.40	0.42
	Max	15.75	6.97	6.37	-	7.09	6.34	-	11.47	-	-	0.52	0.48	0.50
	N =	2	2	2	1	2	2	1	2	-	-	2	2	2
<i>Stenopodainae</i> sp. 1 Male	Mean	8.22	3.58	3.22	0.86	3.78	3.65	0.83	5.07	5.73	1.11	0.69	0.32	0.31
	SD	0.75	0.11	0.43	0.04	0.09	0.27	0.07	0.68	0.45	-	0.07	0.04	0.03
	Min	7.69	3.50	2.91	0.83	3.71	3.46	0.78	4.59	5.41	-	0.64	0.29	0.29
	Max	8.75	3.66	3.52	0.89	3.84	3.84	0.88	5.55	6.04	-	0.74	0.34	0.33
	N =	2	2	2	2	2	2	2	2	2	1	2	2	2
<i>Stenopodainae</i> sp. 2 Female		11.64	5.45	4.54	0.85	5.31	5.21	0.90	9.83	12.29	1.18	0.65	0.54	0.52
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
TRIATOMINAE														
<i>Triatoma rubrofasciata</i>		16.26	4.25	4.13	1.55	5.25	4.76	1.48	5.83	7.52	1.50	0.96	0.92	0.88
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1

Appendix 3 continued.

Species	Hem	Length									Width			
		For Fem	For Tib	For Tar	Mid Fem	Mid Tib	Mid Tar	Hin Fem	Hin Tib	HinTar	For Fem	Mid Fem	Hin Fem	
TRIBELOCEPHALINAE														
<i>Opistoplatys perakensis</i>		5.72	-	-	-	-	-	-	-	-	-	-	-	-
	N =	1	-	-	-	-	-	-	-	-	-	-	-	-
<i>Opistoplatys</i> sp. 1		5.60	1.49	1.61	0.67	1.50	1.54	0.74	2.14	2.41	0.88	0.26	0.26	0.26
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Tribelocephala</i> sp. 1		6.45	2.01	1.99	0.84	2.01	1.97	0.76	2.61	3.08	0.98	0.25	0.24	0.27
	N =	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Tribelocephala</i> sp. 2	Mean	10.50	3.27	3.27	1.02	3.55	3.44	0.97	4.82	5.29	1.07	0.43	0.40	0.41
	SD	0.59	0.59	0.26	0.09	0.37	0.07	0.01	0.64	0.18	0.08	0.02	0.01	0.04
Male	Min	10.08	2.85	3.08	0.95	3.29	3.39	0.96	4.36	5.16	1.01	0.40	0.39	0.38
	Max	10.91	3.68	3.45	1.08	3.81	3.49	0.98	5.27	5.41	1.13	0.45	0.40	0.42
	N =	2	2	2	2	2	2	2	2	2	2	2	2	2



Appendix 4: Habitus photograph of Centrocnemidinae species. Scale = 1 mm.



Appendix 5: Habitus photograph of Ectrichodiinae species. Scale = 1 mm.



Appendix 5: Habitus photograph of Ectrichodiinae species. Scale = 1 mm. Contd.



Appendix 6: Habitus photograph of Holoptilinae species. Scale = 1 mm.



Appendix 7: Habitus photograph of Peiratinae species. Scale = 1 mm.



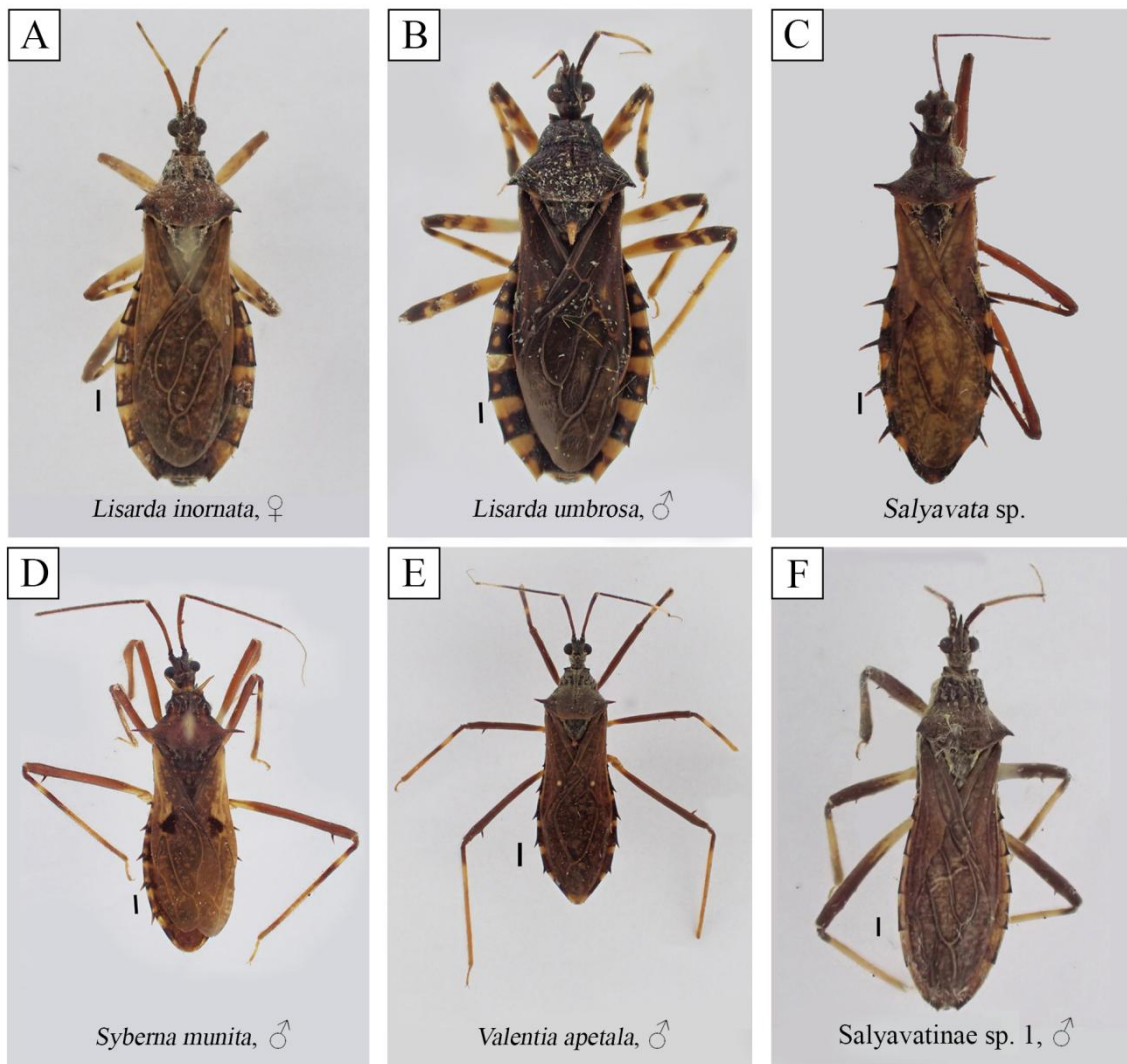
Appendix 8: Habitus photograph of Physoderinae species. Scale = 1 mm.



Appendix 9: Habitus photograph of Reduviinae species. Scale = 1 mm.



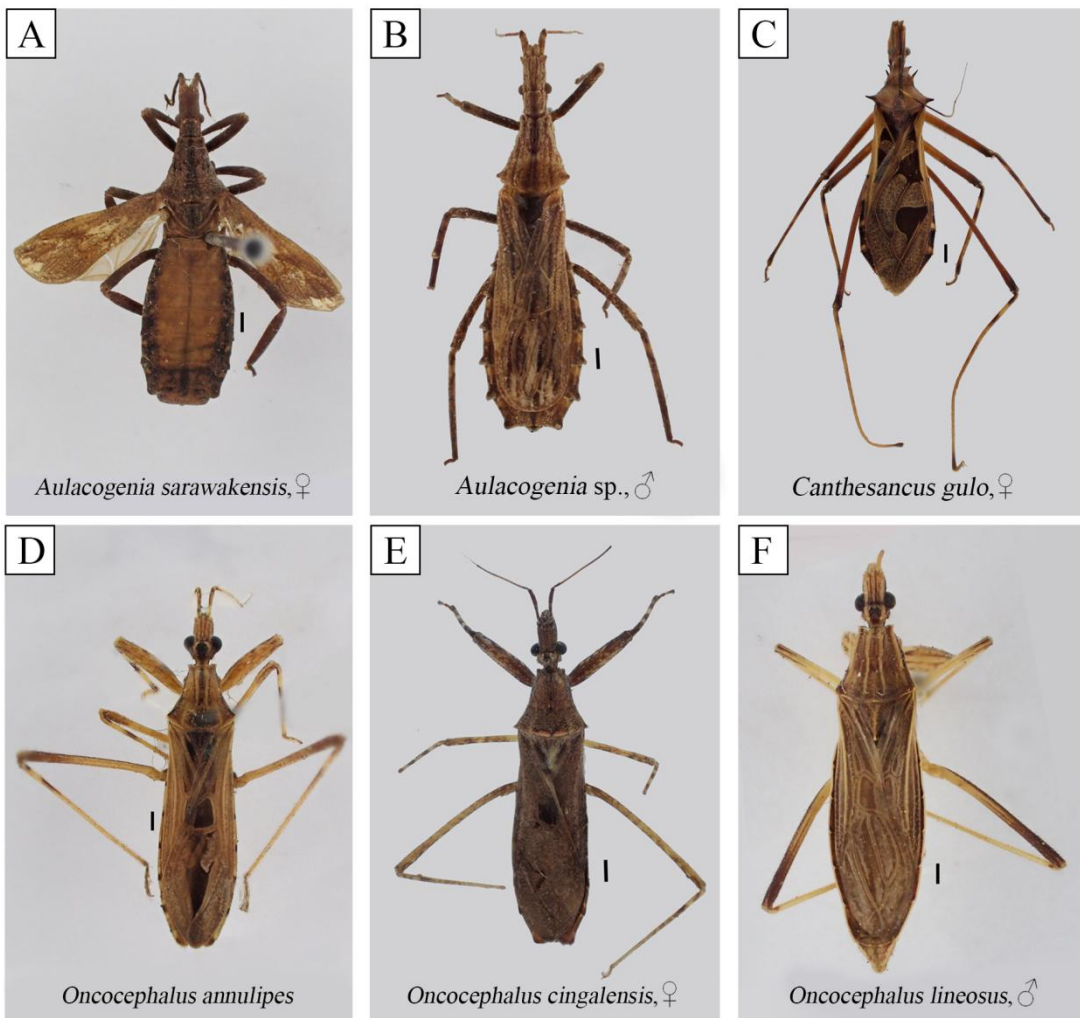
Appendix 10: Habitus photograph of Saicinae species. Scale = 1 mm.



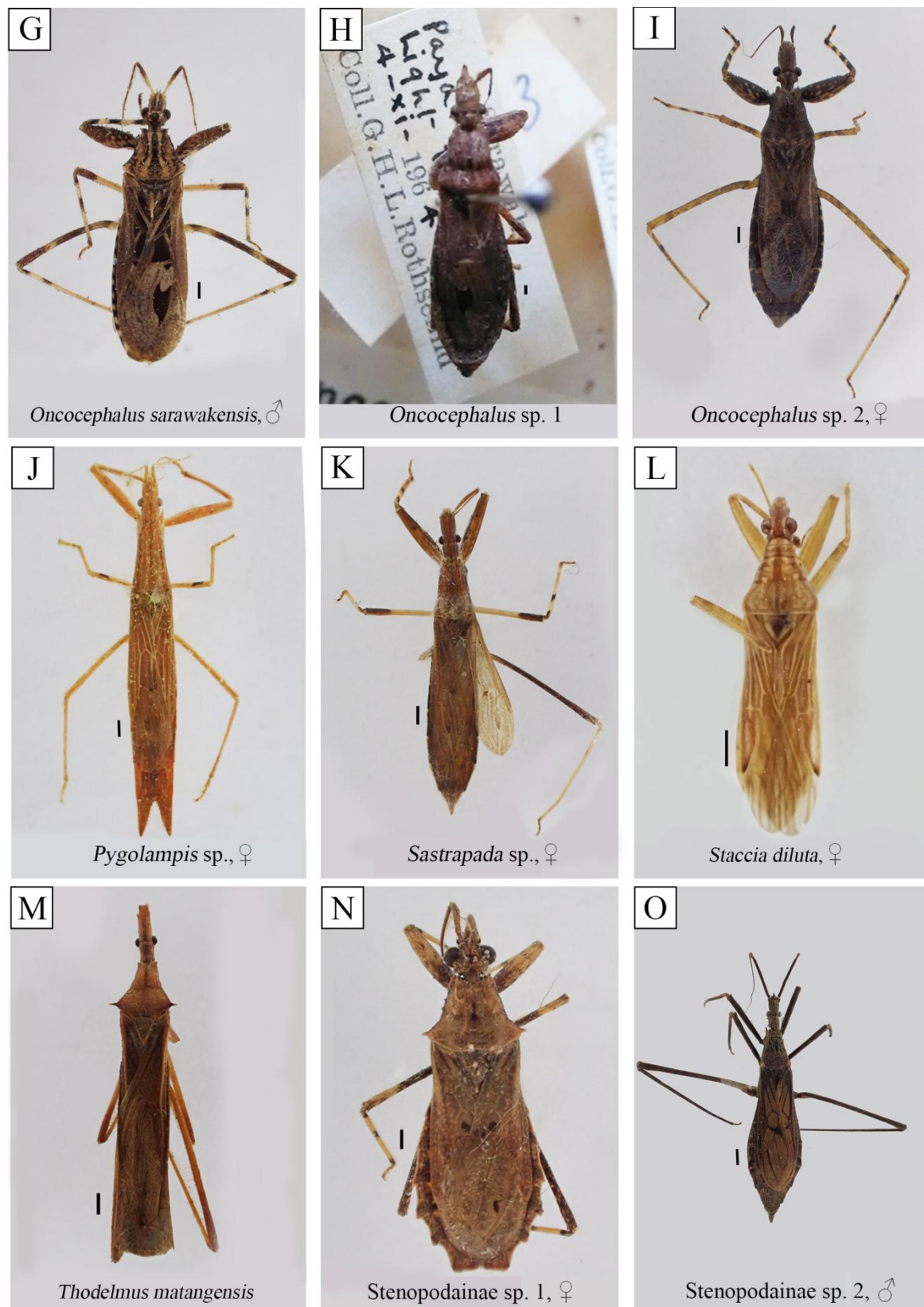
Appendix 11: Habitus photograph of Salyavatinae species. Scale = 1 mm.



Appendix 11: Habitus photograph of Salyavatinae species. Scale = 1 mm. Contd.



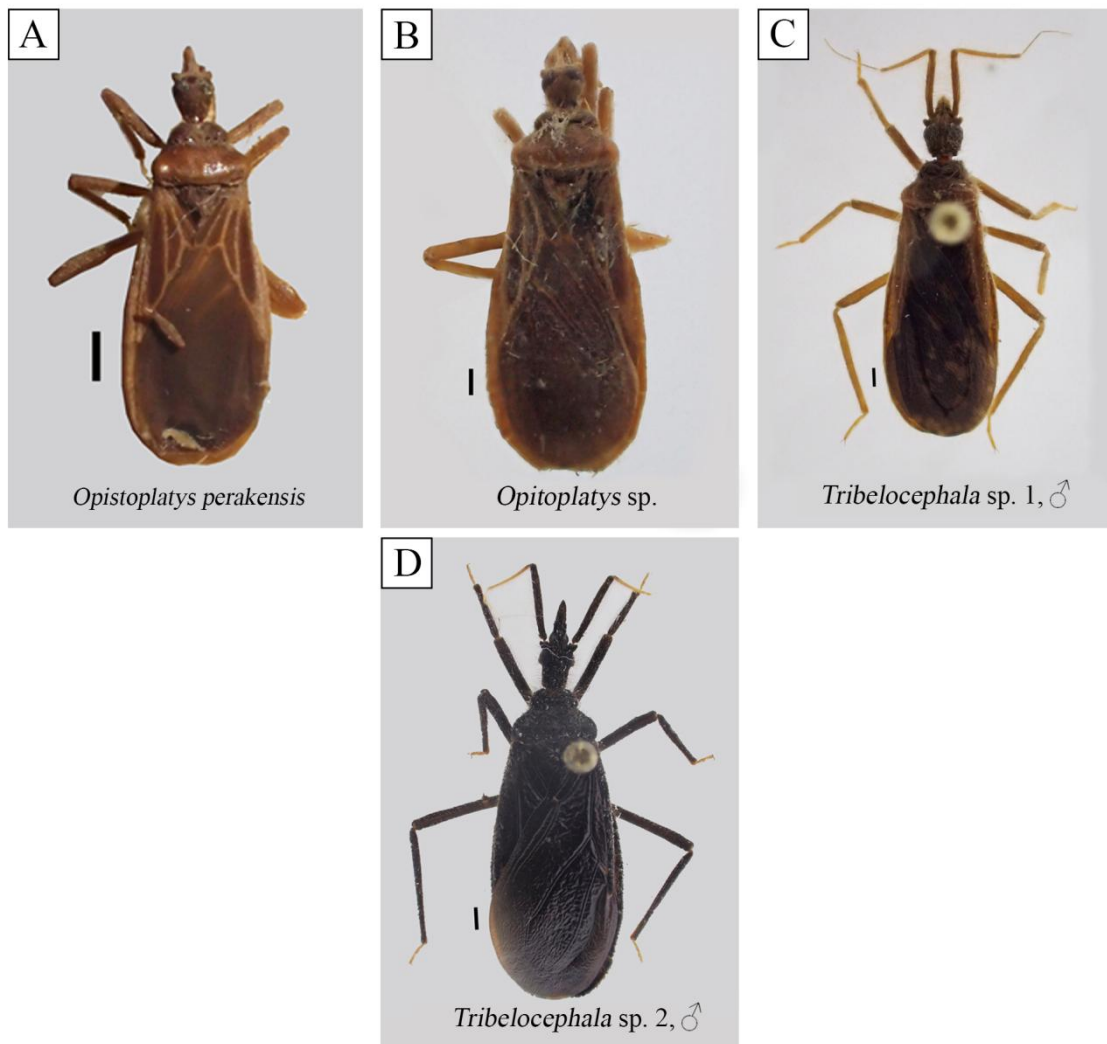
Appendix 12: Habitus photograph of Stenopodainae species. Scale = 1 mm.



Appendix 12: Habitus photograph of Stenopodainae species. Scale = 1 mm. Contd.



Appendix 13: Habitus photograph of Triatominae species. Scale = 1 mm.



Appendix 14: Habitus photograph of Tribelocephalinae species. Scale = 1 mm.