Faculty of Resource Science and Technology

SYSTEMATICS AND PHYLOGENY OF THE TRIBE HARPACTORINI (HETEROPTERA: REDUVIIDAE: HARPACTORINAE) OF SARAWAK

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LIST OF ABBREVIATIONS

Agr.	Agriculture
ARC	Semengoh Agriculture Research Centre
F.R.	Forest
FRC	Forest Research Centre of Forest Department Sarawak
G.	Gunung
Kpg.	Kampung
N.P.	National Park
Rd.	Road
R.P.	Recreational Park
S'gang	Simangang
S'jan	Simunjan
Sg.	Sungai
Sp.	Species
UC	Unknown collector
UD	Unknown date
UL	Unknown locality
UNIMAS	Universiti Malaysia Sarawak
UIRC	Universiti Malaysia Sarawak Collection
UPGMA	Unweighted Pair Group Method with Arithmetic Mean

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Systematics and Phylogeny of the Tribe Harpactorini (Heteroptera: Reduviidae: Harpactorinae) of Sarawak

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ABSTRACT

This study records and discusses the entomological collection in Sarawak, with reference to voucher specimens of the Subfamily Harpactorinae (Heteroptera: Reduviidae) from UNIMAS Zoological Museum, Faculty of Resource Science and Technology, Agricultural Research Centre, Sarawak and Forest Research Centre. A total of 388 specimens comprising 18 genera and 35 species of Harpactorini were evaluated. *Cosmolestes picticeps* dominated other species in the number of 90 specimens which represented 23.2% of the total number of specimens and it is also the most abundant species from the three repositories. *C. picticeps, Eulyes amoena, Isyndus heros* and *Rhynocoris marginellus* were recorded from all the three repositories, hence this indicates that they are considered as the common species encountered in the collections. Most of the Harpactorini recorded from Sarawak were collected from lowland dipterocarp forest and peat swamp forest. Systematic accounts of every species and distribution maps of the species examined are presented.

Keywords: Systematic, Phylogeny, Harpactorinae, Harpactorini, Sarawak.

ABSTRAK

Penyelidikan ini merekod dan membincangkan koleksi entomologi di Sarawak, dengan merujuk kepada baucar spesimen daripada subfamili Harpactorinae (Heteroptera: Reduviidae) dari Muzium Zoologi UNIMAS, Fakulti Sains Sumber dan Teknologi, Pusat Penyelidikan Pertanian, Sarawak dan Pusat Penyelidikan Perhutanan. Seramai 388 specimen yang terdiri daripada 18 genus dan 35 spesies Harpactorini telah dikaji. Cosmolestes picticeps didominasi spesies lain dalam bilangan 90 individu yang mewakili 23.2% daripada jumlah bilangan spesimen dan ia juga adalah spesies yang paling banyak dari tiga repositori. C. picticeps, Eulyes amoena, Heros Isyndus dan Rhynocoris marginellus direkodkan daripada ketiga-tiga repositori, maka ini menunjukkan bahawa mereka dianggap sebagai spesies yang biasa dihadapi dalam koleksi. Kebanyakan Harpactorini direkodkan daripada Sarawak telah dikumpulkan dari hutan dipterokap tanah rendah dan hutan paya gambut. Akaun sistematik setiap spesies dan peta taburan spesis diperiksa dibentangkan.

Kata kunci: *Sistematik, Phylogeny, Harpactorinae, Harpactorini, Sarawak.*

1.0 INTRODUCTION

Insects (Class Insecta) are the most diverse and widely distributed animal in the world where they cover a huge range of habitats including land and freshwater. Some members of each family have similar appearance and occur in the same habitat (Hill & Abang, 2010). Insecta are divided into 29 orders (Richards & Davies, 1977; Gullan & Cranston, 1994; Triplehorn & Johnson, 2005; Hill & Abang, 2010) with close to 925,000 named species (Grimaldi & Engel, 2005) and order Hemiptera is one of the most diverse group of insects. Hemiptera is then further divided into two suborders, which are Homoptera that consists of all phytophagous plant bugs and Heteroptera that contain mostly predacious and some blood sucking types (Hill & Abang, 2010).

The suborder Heteroptera, or commonly known as true bugs, are a type of insect which are distinctively spread throughout the world of different habitats (Hill & Abang, 2010). This group of insects have a unique scent gland arrayed on tergites three through seven nymph stage and by a reduced tentorium but the most recognizable characteristic is the hemelytrous forewings which have a corium on the anterior half and a membranous distal half (Grimaldi & Engel, 2005). There are around 38,000 species of Heteroptera recorded within 75 families in the world (Schuh & Slater, 1995).

One of the families in suborder Heteroptera, Reduviidae, or commonly refer as assassin bugs, is a large family of predators that mostly feed on blood or other insects (Louis, 1974; Cobben, 1978; McGavin, 2000; Weirauch & Cassis, 2006; Hodgson & Patterson, 2007). They are represented in tropical rainforest, semiarid zone and scrub jungle but commonly found in tropical rainforest (Ambrose, 2006). Several Reduviidae species are well-known urban species which feed on household insects and blood of mammals including rats and human (Hill & Abang, 2010).

Systematics and phylogeny study is important nowadays in recognizing the species so that precaution method on those pest species will be controlled. The subfamily Harpactorinae consists more than 2,800 known species in the world and more than 320 genera (Weirauch *et al.,* 2014) and it is known as the largest subfamily of Reduviidae, consists predominantly of generalist predators (Readio, 1927; Louis, 1974). The tribal classification of Harpactorinae has been in flux, with six tribes (Apiomerini, Diaspidiini, Ectinoderini, Harpactorini, Rhaphidosomini, and Tegeini), but others also accepting Dicrotelini as a separate tribe (Weirauch *et al.*, 2014). The tribe Harpactorini is the largest tribe in Harpactorinae with a worldwide distribution; Apiomerini are restricted to the New World; Diaspidiini and Rhaphidosomini are Afrotropical; Ectinoderini are restricted to the Oriental region; while Dicrotelini and Tegeini occur in the Old World tropics (Weirauch, 2012). Sadly, the database of systematics and phylogeny studies and detailed description on Reduviidae especially on the subfamily Harpactorinae are limited in Borneo. Besides that, so far no study has examined the timing of key transitions within Reduviidae (Hwang & Weirauch, 2012). According to Chai and Tomokuni (2003), Harpactorinae is the most poorly studied subfamily as it is least medically or economically important compared to other subfamilies. Therefore, the main objective of this research is to study the taxonomy of the tribe Harpactorini in Sarawak based on morphological characteristics. Secondly, it was aimed at studying the phylogenetic relationship of tribe Harpactorini in Sarawak by constructing a phylogenetic tree.

2.0 LITERATURE REVIEW

2.1 Importance of Reduviidae

Reduviidae is a huge group of predaceous bugs which feed on other insects and some species feed on human blood as well. Bierle *et al.* (2002) stated that the body colour of reduviid is commonly bright coloured but some of them are blackish or brownish in colour. The most distinctive feature of this bug is the elongated head with neck-like structure connecting the head and thorax with a short, three-segmented sucking mouthpart where the tip of the mouth fits into a stridulatory groove in the prosternum between their hairy and spiny front legs (Bierle *et al.*, 2002). According to Meyer (2009), the abdomen of reduviid is much wider than the rest of the body and exposes the segment behind the wings.

This type of predaceous bug not only consume on blood, they feed on other insects as well. One of the commonly known diseases transmitted by reduviid is the Chagas disease. The potentially life-threatening Chagas disease is one of the 17 neglected tropical diseases with about 7-8 million people infected worldwide (World Health Organization, 2014). According to Chiang and Chiang (2007), Chagas disease or American trypanosomiasis is transmitted through the feces of Triatominae, the vector of a flagellate parasite *Trypanosoma cruzi,* as it defecates on the host. This disease infects muscle, and such infection leads to heart and/or digestive disorders (Chiang *et al.*, 2013). Triatominae sometimes known as kissing bugs due to their feeding habitat where they are nocturnal and prefer to bite on soft tissue such as lips (Bierle *et al.*, 2002). Apart from that, Grimaldi and Engel (2005) mentioned that another blood feeder, *Rhodnius,* is a common subject used in physiological research.

Surprisingly, some reduviids play an important role in biological control of pest in agriculture as they are insectivorous that feed on nymph or adult of other insects such as Hymenoptera, Orthoptera, Isoptera and Lepidoptera. Brown *et al.* (2011) claimed that the most common and beneficial genera are *Zelus* and *Sinea* which usually control whiteflies, lygus and other smaller insects.

2.2 Systematics and Phylogeny of Reduviidae

Biological taxonomy provides the principles and methods for constructing classifications to sort organisms into species, and also to provide the principles for classifying taxa into more inclusive taxa (Ereshefsky, 2007). According to Ereshefsky (2007), classifications are the products of taxonomy while systematics is the study of the relationship between organisms and their taxa in the natural world. Ideally, the results of systematics determine the principles of taxonomy, which classify the organic world. The result is presented in a tree-like diagram called a dendrogram that shows two cases or clusters indicates the level of similarity between them (Vandev & Tsvetanova, 2014).

Generally, the most important systematic group is the family in ecological studies. In Hill and Abangs' (2010) view, species within a family unit mostly bear a common feather resemble to each other, have the same life cycles and occupy similar ecological niches, trophic level, and as well as the same position in local food wed. There are a few well-established families which have distinctive subfamilies with taxonomic differences and causes confusion as they are morphologically similar.

Reduviidae are relatively old, with one fossil that has been attributed to the Reduvioidea (Reduviidae and Pachynomidae) from the Early Jurassic and three reduviids specimens from the Early Cretaceous (Shcherbakov, 2007). Hwang and Weirauch (2012) stated that, fossils that can be reliably classified to subfamily, tribe, or genus are predominantly from Dominican and Baltic amber (Miocene – Eocene) and offer little insight into the evolutionary timing of major lineage diversification events within Reduviidae.

Reduviids are the largest terrestrial bugs which consist around 6,800 described species (Froeschner & Kormilev, 1989; Maldonado, 1990; Hwang & Weirauch, 2012) and up to 23 subfamilies namely Bactrodinae, Cetherinae, Centrocneminae, Chryxinae, Ectrichodiinae, Elasmodeminae, Emesinae, Hammacerinae, Harpactorinae, Holoptilinae, Manangocorinae, Peiratinae, Phimophorinae, Phymatinae, Physoderinae, Reduviinae, Saicinae, Salyavatinae, Sphaeridopinae, Stenopodainae, Triatominae, Tribelocephalinae, and Vesciinae (Schuh & Slater, 1995).

2.3 Role of Natural History Museums

According to Suboh (2008), natural history is meant by the study of living organisms and their natural habitat or environment, by dealing with the discovery, naming, documentation and classifying them according to their taxonomy. Suboh (2008) also pointed out that natural history museums play an important role of preserving and safeguarding types of specimen with full information for each specimen including their scientific names, dates and localities of collection, and description of their natural habitat. Thus, this allow scientists to study the geographical distribution, habitat, behavior and history of each species by comparing species from different period of time and locality, and also to find out the changes in biodiversity, environment,evolution, population genetics, pesticide use and so on (Suboh, 2008; Viscardi, 2011).

Moreover, as Suarez and Tsutsui (2004) mentioned, numbers of museums and academic institutions has been maintaining first-rate biological collections, ranging from preserved whole organisms to DNA libraries, gene bank and tissue or cell lines. All these biological materials serve as a study reference for public health and safety, environmental contaminations, agriculture and forestry, faunal change, biological invasion, taxonomy and systematic, theory of evolution, climate change, conservation evaluation and management, economics and so on (Suarez & Tsutsui, 2004). Natural history museums also house the collections of voucher specimens whether they are wet or dry specimens which are examples of plants and animals collected during biological recording or other research (Viscardi, 2011). These specimens physically proof that research has been conducted and the specimens carry important and accurate information like time and locality of collection.

2.4 Previous Studies of the Family Reduviidae

2.4.1 Overseas Studies

A study on the genetic population of a secondary vector of Chagas disease in Bolivia, *Triatoma sordida* group 1, by multi-locus enzyme electrophoresis was conducted by Noireau *et al.* (1999). A total of 253 nymphal and adult specimens were collected from seven neighbouring localities in the Velasco Province, Department of Santa Cruz. They proposed that the relatively low genetic variability for this species rates polymorphism of 0.20 and the absence of genetic disequilibrium detected within the seven localities was demonstrated. A geographical structuration shows between localities with distances greater than 20 km apart. They even found out that *T. sordida* presents a relatively reduced dispersive capacity, its panmictic unit is wider compared with *T. infestans* although the genetic distances between *T. sordida* populations were correlated with geographic distance.

Lastly, they concluded that the gene flow between geographic populations of *T. sordida* provides an efficient framework for effective vigilance and control protocols.

Next, a research conducted by Zhao *et al.* (2009) in China found a new species of Harpactorinae. They proposed and erected a new monotypic genus, *Iocoris*, to accommodate an undescribed unique species, *Iocoris nodulifemoralis* sp. nov. (Reduviidae: Harpactorinae) from China. This study has become a key to distinguish the new genus from other closely related genera. The dorsal habitus and other diagnostic characters are illustrated in the study. The type specimens are currently preserved in the Entomological Museum of China Agricultural University, Beijing.

A new data about Harpactorinae was updated in Argentina by Coscaron and Martin-Park (2011). The research was conducted in Argentina discover a new Harpactorinae. *Harpactor distinguendus* is mentioned for the first time for this country. This work includes a result of studied material of Reduviidae that belongs to the Museo de La Plata (Argentina).

Recently, Chlond and Banar (2013) describing a new genus of Harpactorinae found in south-west Madagascar (Zombitse-Vohibasia National Park and Isalo National Park). *Myrmicella verticospinosa* gen. et sp. nov., was described based on two male specimens and two female specimens. Three specimens were collected by sifting the leaf litter, and one female was collected using yellow pan traps. The genitalia structures of both sexes are described and illustrated.

Furthermore, Weirauch and Zhang (2013) presented the first comprehensive molecular phylogeny of Harpactorini correlation of novel predation strategy with accelerated evolution of predatory leg morphology using five gene segments (28S D2, D3–D5, 16S, COI, and Deformed). They demonstrated the correlation of a putative key innovation, the sticky trap predation strategy, with accelerated rates of morphological evolution of the predatory fore leg in assassin bugs by employing comparative phylogenetic methods. The study comprises 229 taxa which included 72 genera and 195 species of Harpactorini, representing almost 30% of the generic diversity of the tribe and covering all major zoogeographical regions (Afro-tropical, Palearctic, Oriental, Australasian, Nearctic, and Neotropical).

Other than that, Weirauch *et al.* (2014) proposed an illustrated identification key to assassin bug subfamilies and tribes. The key is complemented by taxon treatments that provide diagnostic features, notes on taxonomy and distribution for all 25 subfamilies including Harpactorinae, a comment on taxa occurring in Canada, natural history notes, and a short bibliography.

2.4.2 Local studies

Rédei (2007) proposed a new genus of tribelocephaline assassin bugs from Borneo. He described *Enigmocephala deinorhyncha* gen. n., sp. n. (Heteroptera: Reduviidae: Tribelocephalinae: Tribelocephalini) based on an apterous female found in Borneo. The new genus differs sharply from all other genera within the subfamily Tribelocephalinae by its unique labium. On top of that, he presented a key for the identification of the genera of Tribelocephalini. Genus *Acanthorhinocoris* is transferred from Tribelocephalini to Opistoplatyini.

Ahamad (2013) studied the diversity of Heteroptera in Mount Serambu, Bau, Sarawak. A total of 531 individuals from 49 species were caught using modified Pennsylvania light traps, beating and hand picking method. Her result showed that the most diverse family was Alydidae which consisting of 308 individuals (58%), followed by Coreidae with 57 individuals (11%) and the most abundant family recorded was Reduviidae with 16 species (32.7%).

A research conducted by Salleh (2014) based on voucher specimens at Forest Research Centre (Forest Department Sarawak), Sarawak Biodiversity Centre, Semongok Agriculture Research Centre and UNIMAS Insect Reference Collection (Faculty of Resource Science and Technology, Universiti Malaysia Sarawak) evaluated a total of 267 specimens comprising 15 genera and 29 species of the tribe Harpactorini (subfamily Harpactorinae). The result showed that *Polididus armatissimus* is the most abundant species with 74 individuals which is 28% of total individual. While, *Panthous daedalus, Yolinus fuliginosus, Isyndus heros* and *Euagoras plagiatus* were assumed as rare species in the study which represented by one specimen each.

Furthermore, Azhari (2014) conducted a study on heteropterans species composition at Kubah National Park, Sarawak. Samples were collected using modified Pennsylvania light trap, beating and handpicking techniques. A total of 594 individuals comprising 19 species of heteropterans were recorded from the study. The most abundant species captured was *Systelloderes* sp. with a relative abundance of 86.70% and the most diverse family in terms of species captured was Pentatomidae and Miridae with respectively four species each (21.05%).

3.0 MATERIALS AND METHODS

3.1 Materials

This study was based on an examination of voucher specimens of Harpactorinae deposited at three repositories in Sarawak, namely UNIMAS Insect Reference Collection, Faculty of Resource Science and Technology (UIRC), Semongok Agriculture Research Centre (ARC) and Forest Research Centre of Forest Department Sarawak (FRC).

A total of 388 specimens were recorded and described in this study with 18 genera and 35 species. Collecting data such as scientific name, locality, collecting date and collector's name were recorded. From these voucher specimens, a comparative morphological study to describe species was done based on an examination of external characters. These include the description of colouration, body structure from antenna, head, thorax, hemelytra, abdomen, appendages and body surface. Specimens were examined using Motic SMZ-168 series stereo microscope. Representative for each species were photographed using digital camera Fujiflim EXR. The records provided useful information in analysing the abundance, range and distribution pattern of Harpactorini in Sarawak.

3.2 Phylogeny Analysis

The characteristics and similarities among species and genera were identified and turned into characters or variables creating a Unweighted Pair Group Method with Arithmetic Mean (UPGMA) tree using Jaccard's Coefficient to run a Cluster analysis via Multivariate Statistical Package (MVSP) Version 3.2 software. UPGMA is the classification of objects on the basis of their pairwise similarities in relevant descriptor variables (Legendre & Legendre, 1998). Cluster analysis divide studied objects into discrete groups based on the characteristics or variants of the objects. Jaccard's Coefficient is a simple and often effective approach to measuring the similarity of objects, and the result is easier to interpret. 42 variants or characters were identified in this study (Table 3, refer to APPENDIX III) to classify and to place the objects (species) in matrix (Table 4, refer to APPENDIX IV). The morphological characteristic were described based on Weirauch *et al.* (2014). *Amorbus rubiginosus* (Family Coreidae) was chosen as the outgroup for this analysis.