Faculty of Resource Science and Technology

DIVERSITY OF TRUE BUGS (HEMIPTERA: HETEROPTERA) IN MOUNT SERAMBU, BAU, SARAWAK

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DIVERSITY OF TRUE BUGS (HEMIPTERA: HETEROPTERA) IN MOUNT SERAMBU, BAU, SARAWAK

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DECLARATION

I hereby declare that no portion of this dissertation has been submitted in support of an application for another degree of qualification of this or any other university or institution of higher learning.

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LIST OF ABBREVIATIONS

PAST	Paleotological Statistics
In	Natural log
H’	Index of species diversity
Pi	Proportion of total belong to *i*th species

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Diversity of True Bugs (Hemiptera: Heteroptera) in Mount Serambu, Bau, Sarawak

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ABSTRACT

A study on heteropterans diversity was conducted in Mount Serambu, Bau, Sarawak from 19th January until 29th January 2013 and 4th February until 16th February 2013. The aims of this study were to investigate the diversity of the true bugs at Mount Serambu, Bau and to establish database of true bugs for future references. A total of 531 individuals from 49 species were captured by using Modified Pennsylvania light traps, beating and handpicking methods. Shannon (H') indices showed that species diversity was highest at lower elevation (H'=2.441) compared to upper elevation (H'=1.651). The abundant of individuals was higher at lower elevation with a total of 441 individuals compared to upper elevation with only 90 individuals. The most abundant species captured was *Leptocorisa* sp. with relative abundance 27.9 % and followed by *Leptocorisa acuta* with 25.8%. The most diverse family recorded was Alydidae with 308 individuals (58%) and followed by Coreidae with 57 individuals (11%). In terms of number of species captured, the most abundant family assigned to Reduviidae with a total 16 species (32.7%).

Keywords: Heteropterans, Mount Serambu, species diversity, relative abundance

ABSTRAK

Kepelbagaian Heteropteran di Gunung Serambu, Bau, Sarawak telah dijalankan bermula daripada 19 Januari hingga 29 Januari dan 4 Februari hingga 16 Febuari 2013. Objektif kajian ini adalah untuk mengkaji kepelbagaian 'true bugs' di Gunung Serambu dan membina pangkalan data untuk rujukan di masa hadapan. Sejumlah 531 individu mewakili 49 spesis telah berjaya ditangkap menggunakan kaedah perangkap cahaya Modified Pennsylvania, teknik memukul dan menggunakan tangan. Berdasarkan Shannon (H') indeks, kepelbagaian spesis lebih tinggi di kawasan rendah (H'=2.441) berbanding di kawasan tinggi (H'=1.651). Kelimpahan individu juga lebih tinggi di kawasan rendah dengan jumlah individu sebanyak 441 individu berbanding kawasan tinggi dengan hanya 90 individu. Peratusan spesis yang paling banyak ditangkap adalah Leptocorisa sp. iaitu sebanyak 27.9% dan diikuti oleh spesis Leptocorisa acuta dengan 25.8%. Famili yang paling banyak direkodkan oleh Alydidae iaitu sebanyak 308 individu (58%) dan di ikuti oleh famili Coreidae sebanyak 57 individu (11%). Berdasarkan bilangan spesis yang ditangkap, famili yang paling tinggi adalah Reduviidae dengan jumlah 16 spesis (32.7%).

Kata kunci: Heteropterans, Gunung Serambu, kepelbagaian spesis, kelimpahan relatif

CHAPTER 1

INTRODUCTION

Biodiversity is a measure of the numbers of species that form the community. Measurement of biodiversity help providing the information on distribution, richness and relative abundance that required for the conservation purposes, ecology studies and also phylogenetic measure (May, 1988; Maguran, 1988; Raven and Wilson, 1992; Humphries *et al*., 1995; Blackmore, 1996).

The Heteroptera or commonly known as true bugs currently considered a suborder of Hemiptera which are ecologically one of the most diverse groups of hemimetabolous insects. Heteroptera composed of 38,000 known species of 75 families and the majority of these families occur throughout the world with the exception of Antarctica (Schuh and Slater, 1995). According to Stys and Kerzhner (1975), the suborder Heteroptera has been separated into seven infraorders which two of them are primarily aquatic (Gerrromorpha and Nepomorpha), one semiaquatic (Leptopodomorpha) and the remaining four terrestial (Enicocephalomorpha, Dipssocoromorpha, Cimicomorpha and Pentatomorpha). The largest families of the true bugs are Miridae or plant bugs that consist of 10,000 known species and followed by Reduviidae (assassin bug) consist of 7000 species (Schuh and Slater, 1995). The main characteristics that distinguish the suborder Heteroptera with the other group are the structure of the wing which the forewings are partially

sclerotised and the hind wing partially membranous, a piercing sucking labium that arises anteriorly on the head, four to five segmented antennae, possesses a large well-developed scutellum and paired metathoracic scent glands in adults, and dorsal abdominal scent glands in nymphs (Schuh and Slater 1995).

The suborder of Heteroptera was easily recognized accordingly to their habitat and feeding type (Schuh and Slater, 1995). Most of the heteropterans are phytopagy which feed on all part of seed plant. Miridae, Pentatomidae, Lygaeidae and Rhopalidae are the example of plant feeding Heteroptera. Despite numerous phytopagy heteropterans, the majority of families are predaceous upon insects and other arthropods such as Reduviidae (Schuh and Slater, 1995). There are some hematophagy heteropterans which lives as parasites of birds and mammals such as bed bug family, Cimicidae (Schuh and Slater, 1995).

Although Heteroptera regularly cause harmful to humans and plant damage, however there are variety ways which heteropteran can economically benefit to human and their environment such as biological control agent, predatory of insect pest and also as bio-indicator to the environmental pollution. A research done by Elsey and Stinner (1971) figured out that *Jalysus wickhami* is an important predator of aphids and the eggs of Lepidoptera on tobacco. Apart from that, the Heteroptera are also important in conservation biology purposes. The aquatic and semi-aquatic bugs (Gerromorpha, Nepomorpha and Leptopodomorpha) are well known for their role as water quality indicator (Jansson, 1987). Many aquatic bugs such as *Microvelia pulchella* Westwood was used to control the population of mosquitoes (Miura and Takashi, 1987) and also act as predators of rice planthoppers (Reissig *et al.*, 1985). The

heteropterans also has economic importance as act as bio-indicator to environmental pollution. Nummelin *et al*. (1998) were stated that the Finnish water strider was a suitable bio-indicator for heavy metal studies around steel factory in Southern Finland.

A billion of dollars that losses each year to crops caused by Heteroptera, perhaps the most single important reason to study this diverse suborder. Unfortunately, the diversity or species composition of Heteroptera in Malaysia are still lacking specifically in Sarawak if compared to other countries. A more study on Heteroptera diversity in Malaysia is needed in order to know the exact number of Heteroptera coexisting on earth.

The aims of this study are:

i. To study the diversity of true bugs in Mount Serambu, Sarawak.
ii. To establish the database of true bugs in Mount Serambu for future references.

The hypotheses of this study are:

H_O: There are no significant differences between upper and lower elevation.

H_A: There are significant differences between upper and lower elevation.

CHAPTER 2

LITERATURE REVIEW

2.1 Diversity study

The effect of forest use on the diversity and community structure of Heteroptera had been investigated in Lama Forests reserve in southern Benin by Attignon *et al*. (2004). Five methods were used to collect the samples which are funnel pitfall traps, ground photo-electors, Malaise traps, flight traps and sweep net. Nine habitat were monitored over 12 months which are semi-deciduous forest, lowland forest, dry forest, abandoned settlements, *Chromolaena odorata* thicket, young teak plantation, old teak plantation, firewood plantation and isolated forest. From the studies, 893 heteropterans were collected representing 104 species in 16 families. The most abundant species recorded is *Stenocoris southwordi* with 304 individuals and the greatest number of species was observed in family Reduviidae.

Lambdin *et al*. (2003) had carried out the study of diversity of the true bugs (Hemiptera: Heteroptera) on Arnold Air Force Base, Tullahoma, Tennessee. Nine diverse habitats were monitored on the 15,816 ha Arnold Air Force Base in Tennessee over one year study. Species were sampled using nine collection methods (beat sheet, canopy fogging, direct hand-picking or aerial netting, leaf litter, light trap, Malaise trap, Manitoba trap, pitfall trap, and sweep-net). Two different

measurements (Berger-Parker and Shannon diversity index) were used to assess species diversity and dominance. From the studies, 1,360 specimens of true bugs were collected representing 97 species in 22 families from nine sites. Four families (Pentatomidae, Lygaeidae, Reduviidae, and Coreidae) constituted 50% of all species collected, while 75.2% of all specimens were from families Lygaeidae, Miridae, Pentatomidae, and Tingidae.

A checklist study of aquatic and semi-aquatic bugs from Pulau Tioman had been carried out by Yang *et al.* (1997). From the study, 33 species from 25 genera of eight families were recorded. Three new species were recorded for Peninsular Malaysia namely *Stenobates biroi, S. insularis* and *Hebrus nereis*. *Rhagovelia sumatrensis, Metrocoris nigrofasciodes, Ptilomera tigrina* and *Perittopus breddini* were the commonest species found and followed by *Rheumatogonus intermedius, Ventidius modulatus* in some forest habitats. Small numbers of *Limnogonus fossarum, Tenagogonus ciliatus, T. femoratus* and *Rhagadotarsus kraepelini* are scattered in some areas of stagnant or slow flowing waters as well as the brackish environment. In the estuarine habitats the common species found were *Ventidus modulatus, S. insularis, S. biroi, Xenobates* spp. and *H. nereis.*

2.2 Economic importance of Heteroptera biodiversity

The Hemiptera was considered as the fifth largest order and the suborder Heteroptera containing half of the estimated 90, 000 species (Cassis *et al*., 2006). In most studies the phytophagus bugs are commonly known as the agricultural pest. However, in the biological point of view, they are also beneficial as predator and feed on destructive insect. Family Anthocoridae (Lattin, 2000), Geocoridae (Sweet, 2000), Miridae

(Wheeler, 2001) Nabidae (Braman, 2000), Reduviidae (Ambrose, 2000) and Pentatomidae (De Clercq, 2002), mostly consist of many predatory species. Besides that, Heteroptera also considered important in conservation biology purposes. Many aquatic and semi-aquatic bugs are well known as their role as water quality indicator (Jansson, 1987). Besides, they also helping in mosquito control and become the food resources for fish (Menke, 1979). Overall, Heteroptera is important as plant feeding, bloodsucking parasites, invertebrates' predator and water quality indicator in the environment.

2.3 Collecting equipments and techniques

Based on published literature, specific sampling methods are indeed needed to sample different arthropod taxa. This is because biodiversity of insects is strongly influence by the sampling method used. A comparison of various sampling methods for evaluation the biodiversity of Heteroptera in birch forest was done by Kula and Bryja (2002). Four methods (photoelectors, soil traps, shaking down and light trap) were applied in three localities in birch forest at the same time. The quantitative and qualitative properties of Heteroptera taxa were compared. The effectively of sampling method was assessed using the rarefaction method and revealing the high species richness obtained from light trap as compared from shaking and photoelectors.

Deciding the suitable sample method was important because different sampling method will access different component of the fauna and these component may differ in number of species (Basset *et al*., 1997). Light trapping is the best method to sample flying insect as all insect are attracted to light. In biodiversity of Heteroptera,

Leston (1957) suggested that the heteropterans families were most amenable to light trap. This suggestion also been supported by Hodkinson and Casson (1991) where they figured out that high species richness was caught using the light trap. However, the abundance of specimen at light is significantly influence by weather, lunar light and vegetation (Beck and Linsenmair, 2006).

CHAPTER 3

MATERIALS AND METHODS

3.1 Study Site

This study was conducted in Mount Serambu, Bau, Sarawak (N 01º 25’ 48.1”, E 110º 13’ 20.0”) (Figure 3.1). This hill was once visited by the great naturalist, A.R, Wallace and he was stayed for three weeks (Wallace, 1869). The hill was formerly covered entirely with mixed dipterocarp forest, with small patches of heath forest on the exposed rocky peaks. This mixed dipterocarp forest type was dominated by trees of family Dipterocarpaceae. The upper slopes of the hill colonized by *Arenga* palms, bamboo trees and other large tree species meanwhile at lower part of the hill is an abandoned orchard that consist of variety fruit plants and flowering plants. Besides, the forest understory consists of herbaceous with a proliference of fern, aroids and *Amorphophallus.*

Figure 3.1. Location of Mount Serambu, Bau Sarawak (Source: Google maps).

3. 2 Field Sampling

Two sampling period were carried out with a total 22 days from 19th January until 29th January 2013 and 4th February until 16th February 2013. The Heteroptera was collected by using two Modified Pennsylvania light traps, beating and handpicking method.

Two Modified Pennsylvania light trap with 160 watt mercury vapour lamp were set up for 11 nights at lower elevation. The light traps were place at two different sites which are site A (N 01.43099 E110.22774, 48 m) (Figure 3.2) and site B (N 01.43001 E 110.22214, 51 m) (Figure 3.3) for six hours durations. The distance between two light traps was about 20 m each other.

Figure 3.2. Site A (lower elevation).

Figure 3.3. Site B (lower elevation).

While at upper elevation two Modified Pennsylvania light traps were also set up for 11 nights at two different sites which are site A (N 01.43039 E 110. 22142, 328 m) (Figure 3.4) and site B (N 01.43001 E 110.22145, 330 m) (Figure 3.5) for six hours duration.

Figure 3.4. Site A (upper elevation).

Figure 3.5. Site B (upper elevation).

According to Upton (1991), the best time of beating were done early or late in the day and in the cooler weather when insect are least active. For the 22 days of sampling periods, two men powers were used to collect the samples by using beating and handpicking method. The beating time was done for two hours in the early morning and for two hours late in the day.

3.3 Sorting, Preservation and Identification

Each collected samples were placed in killing jar that contain 75% chloroform. The specimens were immediately sorted individually according to their morpho-species. Once the specimen has been sorted, the representative samples were pinned on mounted points with labelling indicating locality, date, method and name of the species. The rest were placed in vial filled with 75% ethanol as wet specimen. Identification was done using the keys by Schuh and Slater (1995), referring voucher specimen from Sarawak museum and also from website BugGuide.net.

3.4 Statistical Analysis

As for data analysis, the calculator PAST program (Ryan *et al*., 1995) was used to calculate both the Shannon-Weaver Information Function and Species Evenness. To determine whether the diversity values are significantly different diversity t-test was also be calculated.

The two calculated indices are:

(a) Shannon-Weaver Information Function which combines the number of species present and evenness into a single index.

Formula: $D = -\Sigma\ pi \ln pi$

i = an index number for each species present in a sample

pi = ni/N = the number of individuals within a species (ni) divided by the total number of individuals (N) present in the entire sample

ln = natural log

The value of D is highest when species are equally abundant

(b) Species Evenness which separates the effect of different population sizes (numbers of individuals within species) from simple species diversity (number of species).

Formula: E = eD/s

e = 2.7 (= constant)

D = the value of the Shannon-Weaver Information Function

s = number of species in sample (simple species diversity)

Relative abundance was used to determine the species diversity and their number in certain area. The formula for relative abundance was as follow:

$P_i = (n_i \times 100) / N$

Where n_i = total number of individual per species

N = overall number of captured individual

CHAPTER 4

RESULTS

4.1 Diversity of Heteroptera at Mount Serambu, Bau, Sarawak

A total of 531 individuals comprising of 49 species from 31 genera representing nine families were collected throughout 22 days of sampling in Mount Serambu (Table 4.1). Ninety individuals representing 19 species were captured at upper elevation meanwhile a total of 441 individuals representing of 37 species were captured at lower elevation (Table 4.2). The most abundant species captured was *Leptocorisa* sp. with relative abundance 27.9 % and followed by *Leptocorisa acuta* with 25.8% (Table 4.3).

Table 4.1. The number of species based on family and subfamily, the number and relative abundance of species and individuals of Heteroptera fauna recorded at Mount Serambu, Bau, Sarawak.

Family/ Subfamily	Species		Individuals	
	Total Number	Relative Abundance (%)	Total Number	Relative Abundance (%)
Coreidae				
Coreinae	7	14.28	37	6.97
Unknown	6	12.24	10	2.07
Reduviidae				
Harpactorinae	9	18.37	61	11.49
Stenopodinae	1	2.04	7	1.32
Acanthaspidinae	1	2.04	1	0.19
Ectrichodinae	1	2.04	1	0.19
Unknown	4	8.16	4	0.75
Pentatomidae				
Asopinae	2	4.08	6	1.13
Unknown	5	10.20	10	1.88
Alydidae				
Alydinae	3	6.12	308	58.0
Rhopalidae				
Rhopalinae	1	2.04	26	4.89
Pyrrhocoridae				
Pyrrchororinae	4	8.16	21	3.95
Unknown	2	4.08	6	1.13
Lygaeidae				
Calobathristinae	1	2.04	18	3.39
Acanthosomidae				
Acanthosomatinae	1	2.04	4	0.75
Tessaratomidae				
Pentatomoidea	1	2.04	1	0.19
		100		**100**
Total				
Number of individuals			**531**	
Number of species	**49**			

Table 4.2. List of Heteroptera and relative abundance (RA) of each species at upper and lower elevation.

Family/ Species	Study site		Total Number	RA %
	Upper	Lower		
Coreidae				
Homoecerus limpatipennis	10	1	11	2.1
Acanthocoris scaber	1	8	9	1.7
Homoecerus angulatus	1	0	1	0.2
Dalader acuticosta	2	0	2	0.4
Zicca sp.	0	20	20	3.8
Notobitus sp.	0	1	1	0.2
Species 1	1	0	1	0.2
Species 2	1	0	1	0.2
Species 3	1	0	1	0.2
Species 4	1	0	1	0.2
Species 6	0	3	3	0.6
Species 7	0	1	1	0.2
Species 8	0	5	5	0.9
Reduviidae				
Eulyes amaena	1	1	2	0.4
Rhychocoris flagiatus	1	0	1	0.2
Harpactor flavus	1	21	22	4.1
Syncanus collars	1	0	1	0.2
Ectinoderus sp.	1	0	1	0.2
Oncocephalus annulipes	0	7	7	1.3
Velinus nigrigenu	0	9	9	1.7
Cosmolestes picticeps	0	3	3	0.7
Vesbius sanguinosus	0	2	2	0.4
Velitra vulnerans	0	1	1	0.2
Santhosia lugulris	0	1	1	0.2
Endochus sp.	0	20	20	3.8
Species 5	1	0	1	0.2
Species 9	0	1	1	0.2
Species 10	0	1	1	0.2
Species 11	0	1	1	0.2
Pentatomidae				
Nezara viridula	4	0	4	0.8
Hippotiscus scutellatus	2	0	2	0.4
Species 12	0	6	6	1.1
Species 13	0	1	1	0.2
Species 14	0	1	1	0.2
Species 15	0	1	1	0.2
Species 16	0	1	1	0.2
Alydidae				
Leptocorisa acuta	55	82	137	25.8
Leptocorisa sp.	0	148	148	27.9
Riptortus serripes	0	23	23	4.3
Rhopalidae				
Species 17	0	26	26	4.9