Heart of Borneo Series 8

Monograph of Expeditions

LONG BANGA & ADJACENT AREAS






HEART OF BORNEO INITIATIVE

Forest Department Sarawak

HEART OF BORNEO SERIES 8

MONOGRAPH OF EXPEDITIONS

LONG BANGA & ADJACENT AREAS

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PREFACE

This monograph of expeditions gives us a sight on the findings of the Scientific Expedition to Long Banga Communal Forest in 2016, and unpublished reports from other HoB Scientific Expeditions.

This book is the eight series in Heart of Borneo publication under the Heart of Borneo Initiative for Sarawak. This monograph consists of thirteen papers and one project report. Nine papers and a report from Long Banga, two papers on diversity of plants (genus *Alpinia* and *Mapania*) from the HoB areas (in general) and one each from Tama Abu PF and Ulu Baleh National Park.

Other reports from Long Banga Communal Forest were published in the beautiful pictorial, the coffee table book entitled, "*The Heart of Borneo Series 4: Long Banga – Where the Beats Goes on"* published in 2017.

EDITORS

MESSAGE

Bismillahir-Rahmannir-Rahim, Selawat dan Salam Ke Atas Nabi Muhammad SAW

Assalamualaikum Warahmatullahi-wabarakatuh

I am honoured to be given privilege of writing the message for this publication, *Heart of Borneo Series 8: Monograph of Expeditions – Long Banga and its Adjacent Areas*. I should, first of all congratulates the International Affair Division, the Heart of Borneo Initiative for Sarawak Project for successfully organised the Long Banga Scientific Expedition. Secondly, to all parties who involved in the Longa Banga Scientific Expedition for their collaborations and commitments.

Part of the findings of the Long Banga scientific expedition have been published in beautiful pictorial book, *Heart of Borneo Series 4: Long Banga – Where the Beat Goes on.* The papers presented herein also includes the findings from other localities within the Heart of Borneo project areas, wherein never been presented in any seminars or published in books or journals.

The committee and editorial team deserve much credit for the time and effort put in the success of this book published. Special appreciations go to all the valued contributors who have been courteous to provide paper and photos which concluded into meaningful publication.

Datu Hamden Bin Haji Mohammad
Pengarah Hutan
Jabatan Hutan Sarawak

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PHYSICO-CHEMICAL QUALITY OF SURFACE WATER WITHIN LONG BANGA CATCHMENTS

Nur Bazilah Ismail[1], Mohd. Zalek Saie[1], Robin Setin[1], Ahmad Zaidi Keria[1], Umar Abang[1], , Kamirin Mujio[1], Bilhan Deli[1], Muaish Sait[2], Dr Geoffery James Gerusu[2]

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Abstract

Assessment of physico-chemical water quality of Long Banga upper catchment in Heart of Borneo area, Sarawak was conducted during Scientific Expedition 2016. The purpose was to ascertain the water quality level within these highland catchments. The results were compared with Malaysia Interim National Water Quality Standards (INWQS) standard for water quality. Results showed positive levels to aquatic life in general, with high dissolved oxygen concentrations with an average of 7.1 mg/L and also less conductivity, TDS and TSS in all sampling points. Water samples results from Sg. Ano revealed slight variation of high concentration of COD which falls under Class III of water quality standards compared to other streams. High concentration of COD might be attributed to production of organic acids during breakdown of organic matter. Generally, the results obtained indicated that the physico-chemical properties of all 27 sampling points within Long Banga catchment was characterized as unpolluted and conserved in its natural state.

Keywords: *Water quality, physiochemical parameters, Long Banga catchment, Heart of Borneo, Sarawak.*

Introduction

Safe and clean water is vital for ecosystems and civilizations worldwide. In other words, water is an essential resource that sustains life on earth,

changes in the natural quality and distribution of water have ecological impacts that can be sometimes be devastating. About 97% of our raw water supply for agricultural, domestic and industrial needs are derived from surface water sources primarily rivers (Lim, 2008). Considering the prevalence of forests as drinking water source areas, management activities that can potentially affect water quality are often a concern to the public.

The Sarawak sector of the Heart of Borneo initiatives is sited along its border with Indonesian Kalimantan, Brunei Darussalam and Sabah stretching from Batang Ai in the south-west to Merapok in the north-east (Lawas District). It covers an area 2.1 million ha or some 16.4% Sarawak land's area including the interior parts of six Divisions, namely Sri Aman, Sarikei, Sibu, Kapit, Miri and Limbang (Ainon & Yanti, 2008). Long Banga, Ulu Baram is one of the areas that covered under Heart of Borneo initiatives and it is located at 437 m above sea level and near to Kalimantan, Indonesia border. The area is mountainous and several peaks nearby reach 1000 m. According to the local people of Long Banga, their main water resource comes from Sg. Ano catchment. Thus, forest in the catchment area should not be disturbed by any means and need to be preserved as they are the repository of natural heritage besides their association with rivers which are important water resources (Ministry of Natural Resources and Environment).

In Malaysia, the use of the Interim National Water Quality Standards (INWQS) is enforced by the Department of Environment (Uzzell, 1989). The main purpose of INWQS is to classify rivers into classes within the water quality parameters. The classes ranged from Class I to V (I, IIA, IIB, III, IV, and V). It is an important standardization measurement that is most helpful in assessing and monitoring surface water.

As the surrounding local communities living around the study area and consume stream water directly as drinking and other domestic purposes, thus it is vital to determine the physico-chemical characteristics of these surface water quality within Heart of Borneo catchment. Considering this study provides a good knowledge of the qualities of surface water and its suitability for daily household usage. Therefore; this preliminary study was formulated to determine the quality of the surface water by assessing the levels of some physico-chemical parameters, which justifies the quality of safe and clean water.

Materials and Methods

Study Sites

There are nine streams involved in this study; namely Sg. Puak, Sg. Ma'o Kecil, Sg. Ma'o Besar, Sg. Sekuan, Sg. Baleh, Sg. Pesi, Sg. Kebok, Sg. Sena, and Sg. Ano. Those study sites are shown in Figure 1.

Water Quality Parameters

This preliminary study involves nine water quality parameters. A multi instrument parameter Eutech Cyberscan Handheld PCD650 was used at every sampling point to measure pH, temperature, conductivity, and total dissolved solids meanwhile dissolved oxygen was determined by using portable and handheld multi-parameter water quality meter model WQC-24 (DKK-TOA) for *in-situ* reading. Turbidity was measured using portable turbidimeter Thermo Scientific Eutech TN-100.

A few water samples were collected and brought back to the laboratory for further analysis which involves parameters like ammoniacal nitrogen, chemical oxygen demand, and total suspended solids. Ammoniacal nitrogen was tested by using HACH method meanwhile chemical oxygen demand and

total suspended solids were analyzed following the Standard Methods (APHA). All the analyses were done in triplicates.

The results of water quality in the study were then classified based on Interim National Water Quality Standards (INWQS) procedures.

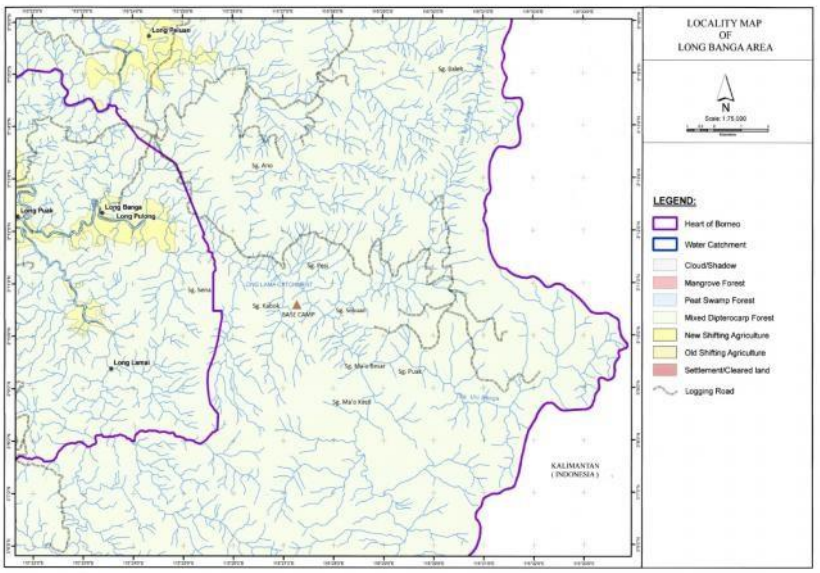

Figure 1. Map of Long Banga, Sarawak

Table 1 listed the nine streams chosen as sampling stations as well as the simple characteristics of each station. Generally, the flow of the streams in the study sites was quite swift, semi clear water, the bottom rocks and the banks lined with boulders and rocks. The shore vegetation consists of riverine forest with mixed hilly dipterocarp trees. Table 2 presents water quality data obtained during expedition and laboratory analysis.

Table 1. Characteristics of sampling points observed within Long Banga catchment

Streams	Description
Sg. Puak	Swift flowing, semi clear water, rocky bottom
Sg. Ma'o Kecil	Swift flowing, clear water, rocky bottom
Sg. Ma'o Besar	Swift flowing, clear water, rocky bottom
Sg. Sekuan	Swift flowing and semi clear water, rocky bottom, some parts with small waterfalls
Sg. Pesi	Slow flowing, clear water, rocky bottom
Sg. Kabok	Swift flowing, semi clear water, rocky bottom
Sg. Sena	Slow flowing, semi clear water, rocky bottom
Sg. Ano	Slow flowing, partially covered by forest canopy at the downstream.
	Swift flowing, rocky bottom, has waterfall at the upper stream (Arol Ano Waterfall)
Sg. Baleh	Swift flowing, semi clear water, rocky bottom

Table 2. Average water quality parameters in the streams of Long Banga

Stream	Parameter / Results								
	○ C	pH	NTU	DO	Cond	TDS	TSS	COD	NH_3N
Sg. Puak	24.5	8.1	11.96	7.0	73.64	69.50	40.67	34.56	0.06
Sg. Ma'o Kecil	22.6	8.1	2.43	8.7	147.3	14.00	3.33	47.60	0.04
Sg. Ma'o Besar	23.3	8.15	3.07	8.5	75.0	70.79	2.67	43.25	0.06
Sg. Sekuan	22.4	7.72	20.9	9.1	68.23	64.42	14.67	34.56	0.12
Sg. Baleh	22.9	7.53	26.73	4.0	50.66	47.81	22.67	46.08	0.05
Sg. Pesi	22.0	7.53	24.63	7.1	85.62	80.80	37.33	40.09	0.05
Sg. Kabok	22.1	7.70	5.43	6.9	72.47	68.55	8.0	34.56	0.08
Sg. Sena	23.8	7.34	8.2	6.8	61.48	58.00	7.33	46.08	0.13
Sg. Ano	21.9	7.22	10.34	5.8	18.2	17.18	22.22	51.84	0.15

**NTU (Turbidity); DO (mL/g); Cond = Conductivity; TDS (mL/g); TSS (mL/g); COD (mL/g); NH_3N (mL/g)*

Interim National Water Quality Standards (INWQS) is a preliminary means of assessing a river which it provides a number that pollutant should not exceed. The INWQS defined six classes (I, IIA, IIB, III, IV, and V) based in the descending order of water quality vis-à-vis Class I being the "best" and Class V being the "worst". INWQS for each river are shown in Table 3 below:

Table 3. INWQS for streams of Long Banga

Stream	Parameter / Results								
	○ C	pH	NTU	DO	Cond	TDS	TSS	COD	NH_3N
Sg. Puak	N	I	IIA	I	I	I	IIA	IIB-III	I
Sg. Ma'o Kecil	N	I	I	I	I	I	I	IIB-III	I
Sg. Ma'o Besar	N	I	I	I	I	I	I	IIB-III	I
Sg. Sekuan	N	I	IIA	I	I	I	I	IIB-III	I
Sg. Baleh	N	I	IIA	III	I	I	I	IIB-III	I
Sg. Pesi	N	I	IIA	I	I	I	IIA	IIB-III	I
Sg. Kabok	N	I	I	IIA	I	I	I	IIB-III	I
Sg. Sena	N	I	IIA	IIA	I	I	I	IIB-III	IIA
Sg. Ano	N	I	IIA	IIB	I	I	I	III	IIA

In-situ and physico-chemical parameters

To get a better comparison between all streams, data was interpreted in graph as shown in Figure 2 to 9.

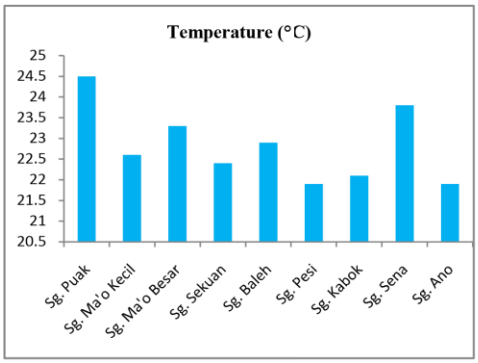

Figure 2: Average temperature

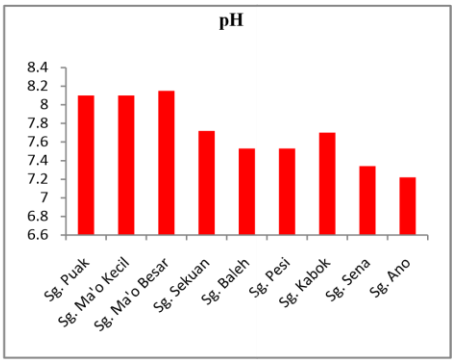

Figure 3: Average pH

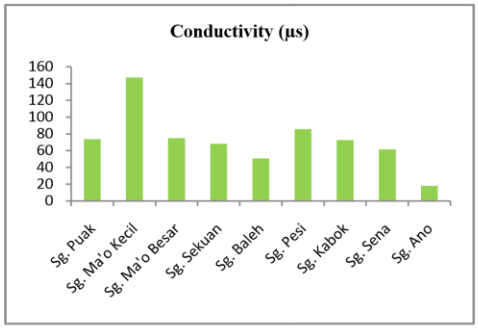

Figure 4: Average conductivity

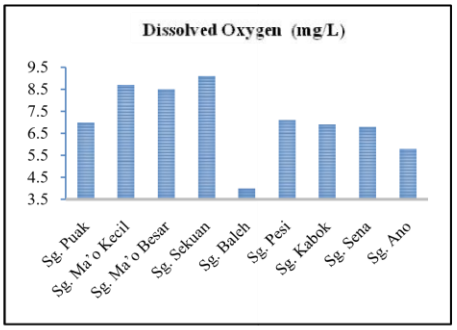

Figure 5: Average dissolved oxygen

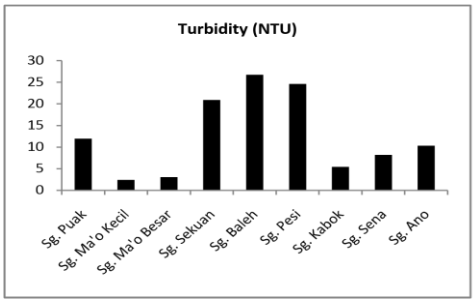

Figure 6: Average turbidity

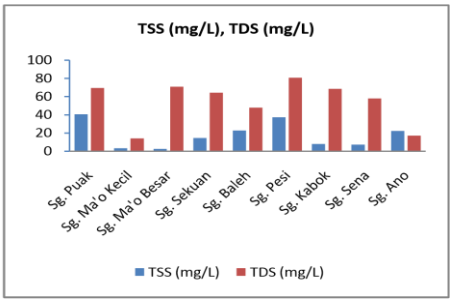

Figure 7: Average TSS and TDS

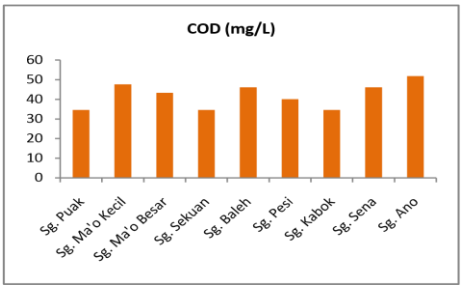

Figure 8: Average COD

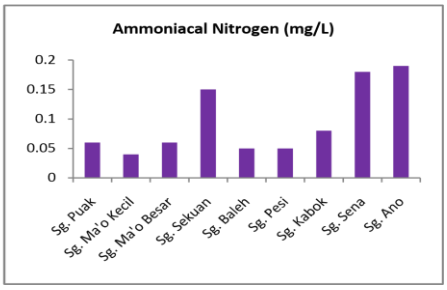

Figure 9: Average ammoniacal nitrogen

This study revealed that the average temperature for all catchments were between 21.9°C and 24.5°C. Sg. Ano showed the lowest water temperature meanwhile Sg. Puak is the highest with reading 24.5°C. This condition is considered normal for water body despite the differences in temperature range. Sg. Ano located in forested areas and this forest canopy provides cover for water body hence the low temperature while the exposed water body had resulted in the higher water temperature.

pH is one of the common water quality tests performed and it is a measurement used to measure water acidity (Miroslav et al. 2007). The pH of a water body is very important in determining its water quality since it affects other chemical reaction (UNESCO-IHE). The concentration ranges of hydronium ions suitable for the existence of most biological life is narrow, typically between pH 6 to 9 (Nor Asmizah et al. 2014). In this study, the pH value for catchments ranged at 7.22 to 8.15. Based on the INWQS, all the streams showed an average pH level within class I and considered not polluted.

The dissolved oxygen within nine monitored small catchments within Heart of Borneo were generally considered as high concentrations with an average of 7.1 mg/L of dissolved oxygen. Five catchments were classified in Class I which represent excellent condition of oxygen rate. These results indicated that these five small catchments considered as healthy forested catchment areas with high DO concentrations availability within the streams system. Furthermore, the present of two species from Family Calopterygidae were found along Sg. Puak as a vital bio-indicator of a clean water of these catchments. One of the damselfly species was identified as *Matronoides cyaneipennis* which considered only can be found and tolerate with clean

water system. Two catchments were classified in Class IIA (Sg. Kabok and Sg. Sena) and Sg. Ano was categorized under class IIB.

The DO results gained from Sg. Ano however contradicted with temperature reading as it gave lowest temperature whereby, the colder the water, the more oxygen it can hold. Thus, low dissolved oxygen found within these catchments suggested to be affected by slow flowing or temporarily stagnant water condition of certain areas along the Sg. Ano stream system. Sg. Baleh revealed the lowest DO concentration and was classified in Class III which consider as moderate water quality. This finding was suggested caused by more openness canopy cover that might be due to previous logging activities within this catchment area.

Other parameter tested was turbidity. Turbidity is caused by particles suspended or dissolved in water that scatter light making the water appear murky or cloudy. From the result above; Sg. Baleh revealed the highest turbidity reading among all streams. This finding was supported by lowest dissolved oxygen reading measured from this catchment. As turbidity is affected by the presence of dissolved and suspended solids, the total dissolved solids result coincides with turbidity. Overall, all streams showed turbidity index within Class I and Class IIA.

The total suspended and dissolved solids result also fall under Class I and Class IIA. Natural processes in forested areas such as landslides and channel erosion can affect water quality by creating temporarily increased concentrations of sediments[7]. The main source of solids in natural waters is water, rainfall, and soil erosion by wind (Miroslav et al. 2007). Although people often think that clean water is clear, even unpolluted water can have

dissolved or suspended particles that may lessen its clarity but do not diminish its quality.

In this study, the chemical oxygen demand (COD) results ranged from 34.56 mg/L to 51.84 mg/L. COD is a measurement of the oxygen required to oxidize soluble and particulate organic matter in water[1] and it is often used as an alternate to BOD due to shorter length of testing time. Sg. Ano recorded the highest COD concentration (51.84 mg/L) which probably means high amount of oxidizable organic material compare to the other streams. This result revealed that slow movement or temporarily stagnant water condition of stream water may cause high oxidization activities within the stream system.

The only nutrient parameter tested in this study was ammoniacal nitrogen (NH_3N). A form of inorganic nitrogen, ammoniacal nitrogen is a measure for the amount of ammonia which is a toxic pollutant. The average amount of ammoniacal nitrogen in all streams were recorded between 0.04 mg/L to 0.15 mg/L. Sg. Ano showed the highest concentration (0.15 mg/L) and this could be due to decomposition of organic matter. However, as it falls under Class IIA according to INWQS, the river still considered as not polluted. Most of the streams showed no significant pollution with concentrations less than 0.1 mg/L which is an expected value for natural and undisturbed water bodies.

Conclusion

It is important to realize that even without any human interference, there is no “distilled water” flowing through a river. There will always be non-zero “background” concentrations of many substances, resulting from natural processes. For instance, mountainous streams which are continuously eroding

the rocks over which they flow, and as such carry some of the eroded materials with them (Harr & Fredriksen, 1988). Natural water quality varies from place to place, with the seasons, the climate, and with the types of soils and rocks through which water moves.

Based on our initial findings and analyses with supported by the INWQS classification, the water quality of upper streams in Long Banga catchments, Heart of Borneo is still at positive level. The undisturbed forest of Long Banga is vitally important for maintaining the good condition of river water. Forest area must be protected, as it provides the function of watershed area that supplies a clean and undisturbed water to be used by human. It is recommended that continuous monthly or yearly monitoring is conducted to collect water quality information. This long-term monitoring is needed to track water quality changes over time.

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SURVEY OF SMALL MAMMALS AND PRIMATES FROM LONG BANGA, ULU BARAM, SARAWAK

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Abstract

Surveys on small mammals and non-human primate species were conducted at Long Banga, Ulu Baram, Sarawak, from the 22nd to 31st of August 2016. On average, 20 mist nets, four of the four-bank harp traps, 50 pit-fall traps, and 100 cage traps were deployed at newly established trails. Non-human primates were recorded based on sightings and vocalizations along selected transects. A total of 30 species of small mammals from the Order Chiroptera (Bats – 22 species), Rodentia *(Rodents – 4 species, Mouse – 1 species, Squirrel – 1 species),* Scandentia *(Treeshrew -1 species), and* Eulipotyphla *(Moonrat – 1 species) were recorded. The three species of non-human primates that were sighted were Long-tailed Macaque, Northern-Gray Gibbon, and Hose's Langur. The Small Woolly Bat (*Kerivoula intermedia*) and Sabah Giant Rat (*Leopoldamys sabanus*) were the most abundant volant and non-volant small mammals recorded, respectively. The Borneo Fruit Bat (*Aethalops aequalis*) captured in Long Banga represent an important new locality record for this montane endemic species, which is known from only very few localities in Sarawak. This survey formed the first baseline information for small mammals and non-human primates in Long Banga, Ulu Baram, Sarawak.*

Keywords: *Borneo, Diversity, Inventory, Mammals, New Locality Record.*

Introduction

The Heart of Borneo (HoB) is a multinational initiative involving Malaysia, Indonesia, and Brunei Darussalam to conserve the transboundary tropical forests in Borneo and to enhance sustainable development for the welfare of the local people in the island (Sarawak Forest Department, 2006). Long Banga, Ulu Baram that is located about 300 km away from Miri, is a rural area dominated by the Kayan, Kenyah and Saban ethnic groups (Figure 1) (Horn, 2015). Their settlements, which situated very near to Indonesian Kalimantan, can only be reached using 4WD vehicles via logging roads or using small aircraft to Long Banga STOLport.

With a mountainous geographic structure, Long Banga, at the height of approximately 4,000 ft above sea level, is surrounded by primary and secondary montane mixed-dipterocarp forest, logged areas, hill forest, and valley. The active logging activities near Long Banga and adjacent areas (Long Peluan and Lio Matoh) had caused forest fragmentation and divided the forest into small patches (Gerusu & Ismail, 2017). In most areas, the population of mammalian species might probably decrease due to habitat loss caused by the logging activities as well as forest conversion for agricultural purposes. However, the information on many mammalian species, their distribution, and ecological status are still unknown.

To date, no data has been recorded from Long Banga, despite the vast forested area. To maintain forest sustainability and to plan for future conservation management of Long Banga, a scientific expedition to document the biological diversity was organized by the Forest Department Sarawak in August 2016. The expedition aimed to raise awareness among local

communities about the importance of that area and to preserve flora and fauna existed within their vicinity. This scientific expedition provides an opportunity for our team to document the diversity of volant and non-volant small mammals to assess the future needs for conservation of this HoB area.

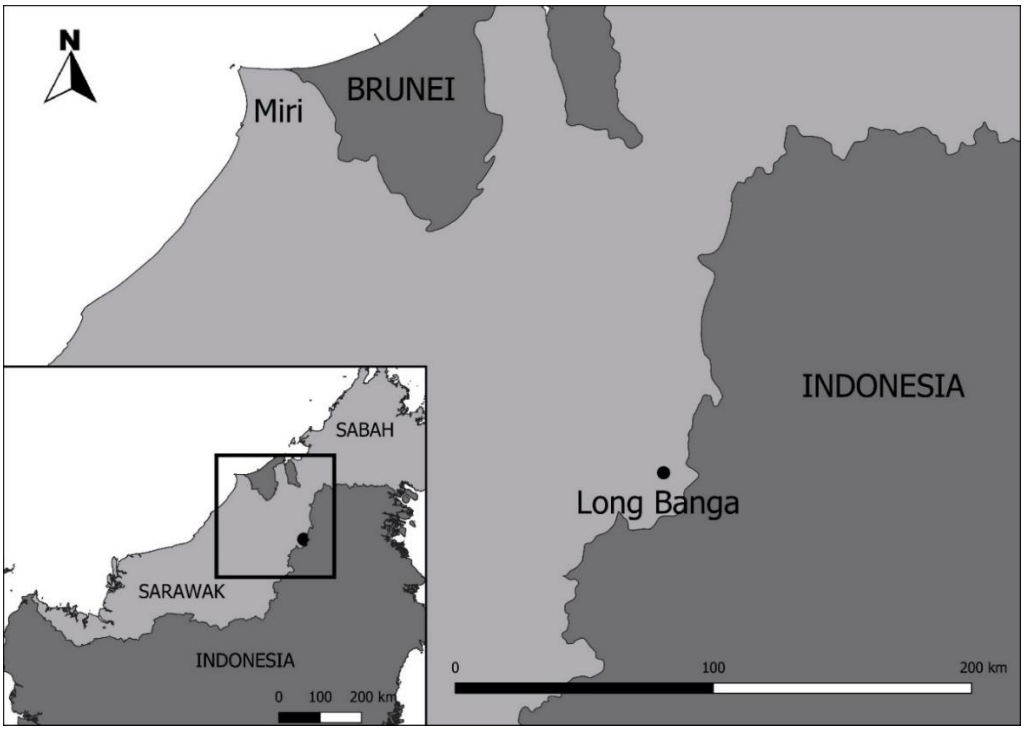

Figure 1: The map of Long Banga, Ulu Baram, Sarawak.

Methodology

Volant and non-volant mammals trapping methods

A total of 20 units of four-shelf mist-nets and four of the four-bank harp traps were used to trap bats. Mist-nets and harp traps were set across trails, streams, and in front of boulders. The mist-nets and harp traps were checked every 15 minute intervals from 1830 until 2100 hours. The traps were kept open and checked at 0630 hours on the following morning. The traps were relocated

every two days to different trails and sampling locations, to cover more areas within the expedition site. Whereas, to capture the non-volant small mammals (rodents and scandents), a total of 100 cage traps were used. Cage traps were baited with banana and deployed along selected trails with a 3m interval between each trap. Cage traps were also set up at nearby village to record species that inhabited within human settlement areas. All traps were checked twice per day at 0900 and 1600 hours, and the baits were changed every two to three days. For primates, surveys were carried out using the line transects method. Species were identified through sighting and vocalization.

Sample collections and identification

Species identification of all animals was made following Payne *et al.* (1985), Francis (2008), and Phillipps and Phillipps (2016). The standard morphological measurements of small mammals were taken using a digital calliper and weighed using Pesola scales. Species representatives were euthanized using chloroform and preserved in 70% ethanol as wet voucher specimens. All collected specimens were deposited in UNIMAS Zoological Museum.

Primate survey

Primate survey was done at three selected sites, namely Forest Trail 9, Lubang Batu Trail, and base camp area by direct observation and detection of vocalization. The survey was carried out starting from 0630 to 1130 in the morning, and from 1600 to 1900 in the evening. The time was chosen as it is the prime time for the primate to actively going out foraging for foods. GPS reading of the primates spotting locations was recorded. The species was identified following Payne *et al*. (1985), Francis (2008), and Phillipps and Phillipps (2016).

Results and Discussion

Non-volant small mammals

A total of 22 non-volant small mammal individuals from four families and eight species were recorded throughout the sampling period. The four families that were recorded were Muridae, Erinaceidae, Tupaiidae, and Sciuridae. The most abundant species was Sabah Giant Rat (*Leopoldamys sabanus*), with eight individuals followed by Whitehead's Maxomys (*Maxomys whiteheadi*) with seven individuals (Table 1).

Table 1. The list of non-volant small mammals recorded in Long Banga. For the IUCN status, LC indicates Least Concern and VU= Vulnerable.

Species	Common name	IUCN Status	No. of individuals
Family: Muridae			
Leopoldamys sabanus	Sabah Giant Rat	LC	8
Maxomys whiteheadi	Whitehead's Maxomys	VU	7
Mus castaneus	Asian House Mouse	LC	1
Sundamys muelleri	Muller's Rat	LC	1
Rattus tanezumi	Asian House Rat	LC	2
Family: Erinaceidae			
Echinosorex gymnurus	Moonrat	LC	1
Family: Tupaiidae			
Tupaia longipes	Plain Treeshrew	LC	1
Family: Sciuridae			
Callosciurus notatus	Plantain Squirrel	LC	1

Two individuals of Asian House Rat (*Rattus tanezumi*) were caught while the Asian House Mouse (*Mus castaneus*), Muller's Rat (*Sundamys muelleri*), Moonrat (*Echinosorex gymnurus*), Plain Treeshrew (*Tupaia longipes*) and Plantain Squirrel (*Callosciurus notatus*) were captured as singletons. These eight species belong to four families, namely Muridae (*L. sabanus, M. whiteheadi, M. castaneus, S. muelleri*, and *R. tanezumi*), Tupaiidae (*T.*

longipes), Sciuridae (*G. simus*), and Erinaceidae (*E. gymnurus*). Species accumulation curve showed an increasing trend indicating that more species are expected to be recorded within the same site, with an extended sampling period (Figure 2).

The Whitehead's Maxomys (*M. whiteheadi*)) was listed as Vulnerable in the IUCN 2020 assessment list (Ruedas, 2016). Whitehead's Maxomys (*M. whiteheadi*) showed decreasing population trend and are currently threatened by habitat loss and urbanization. Logging and land conversion are the main threat to this species due to changes in the landscape (Ruedas, 2016). This species was found to inhabit logged forest twice as much as in virgin forest (Wells and Bagchi, 2005).

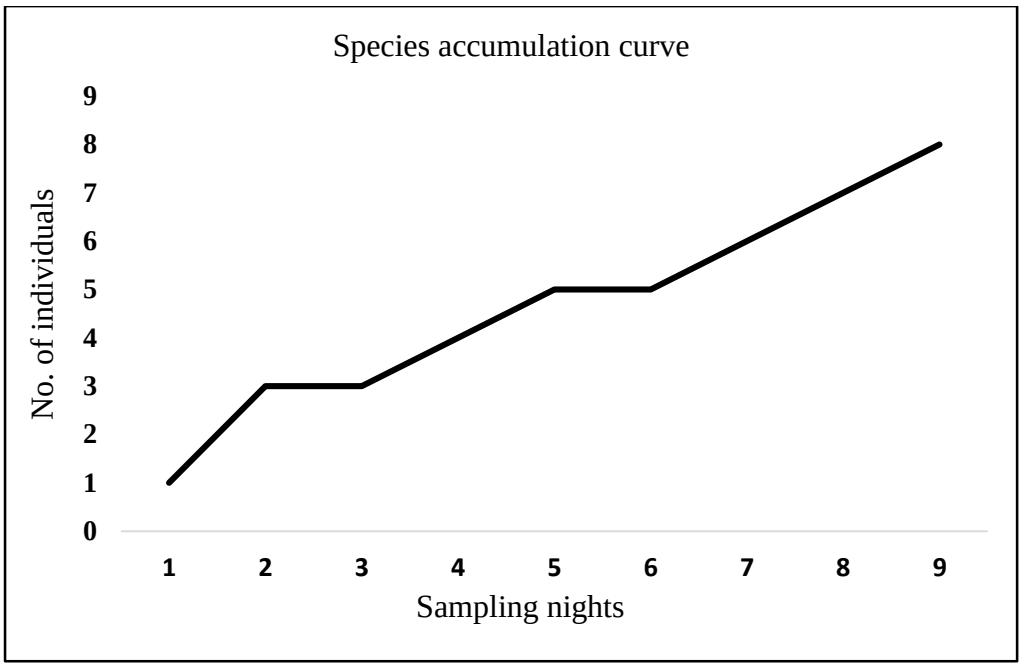

Figure 2: The species accumulation curve of non-volant small mammals captured in Long Banga.

Volant small mammals

For bats, a total of 81 individuals representing 22 species from seven families were recorded in Long Banga throughout the expedition (Table 2). Those seven families were Emballonuridae, Hipposideridae, Megadermatidae, Nycteridae, Pteropodidae, Rhinolophidae, and Vespertilionidae. The highest number of species were from family Vespertilionidae with eight species, followed by six species from Pteropodidae, Rhinolophidae with three species, Hipposideridae with two species and one species each for Megadermatidae, Nycteridae and Emballonuridae.

Table 2. The list of volant small mammals recorded in Long Banga. For the IUCN status, LC = Least Concern, VU = Vulnerable, and DD = Data Deficient.

Species	Common name	IUCN Status	No. of individuals
Family: Pteropodidae			
Aethalops aequalis	Borneo fruit bats	LC	2
Balionycteris maculata	Spotted winged fruit bats	LC	4
Cynopterus brachyotis	Lesser Dog-faced Fruit Bat	LC	7
Macroglossus minimus	Dagger-toothed Long-nosed Fruit Bat	LC	7
Megaerops ecaudatus	Temminck's Tailless Fruit Bat	LC	5
Penthetor lucasi	Lucas's Short-nosed Fruit Bat	LC	2
Family: Hipposideridae			
Hipposideros cervinus	Fawn-colored Leaf-nosed Bat	LC	10
Hipposideros galeritus	Cantor's Leaf-nosed Bat	LC	9
Family: Megadermatidae			
Megaderma spasma	Lesser False Vampire	LC	1
Family: Nycteridae			
Nycteris tragata	Malayan Slit-faced Bat	NT	1
Family: Rhinolophidae			
Rhinolophus borneensis	Bornean Horseshoe Bat	LC	1
Rhinolophus luctus	Woolly horseshoe bat	LC	1
Rhinolophus trifoliatus	Trefoil Horseshoe Bat	LC	2
Family: Vespertilionidae			
Glischropus tylopus	Common Thick-thumbed Bat	LC	1

Kerivoula hardwickii	Hardwicke's woolly bat	LC	1
Kerivoula intermedia	Small woolly bat	NT	11
Kerivoula minuta	Least woolly bat	NT	1
Kerivoula papillosa	Papillose woolly bat	LC	5
Murina suilla	Brown tube-nosed bat	LC	1
Myotis muricola	Nepalese whiskered	LC	3
Family: Emballonuridae			
Emballonura alecto	Small Asian sheath-tailed bat	LC	5

The most abundant species is *Kerivoula intermedia* with 11 individuals. There are nine species with only one individual recorded namely *Glischropus tylopus, K. hardwickii, K. minuta, Megaderma spasma, Myotis ridleyi, Nycteris tragata, Rhinolophus borneensis* and *R. luctus*. The species accumulation curve showed an increasing trend that did not reach asymptote on the last sampling day. We hypothesize that more bats species can potentially be recorded with extended sampling days. Most of the species that were recorded are those that are commonly found in secondary forests. However, the record of Dusky Fruit Bat (*Penthetor lucasi*), members from family Hipposideridae (Leaf-nosed bat), and Rhinolophidae (Horseshoe bat) indicate that our sampling sites may be close to caves or large boulders which potentially harbour other cave dweller species not recorded here. The Borneo Fruit Bat (*Aethalops aequalis*) is a montane endemic species (Phillips and Phillips, 2016). This species has a limited range and only inhabit areas of altitude not lower than 600 meters above sea level (Tingga & Abdullah, 2012). Its population trend is currently unknown due to the scarcity in their records. Further studies on the distribution, abundance, natural history, and threats are urgently needed. Long Banga is the new distribution record for this species and indicates a much broader distribution range in Borneo. The presence of *A. aequalis* in this area suggested that the ecological factor of Long Banga

provides suitable habitat and environment for this species. Future inventory in the area might allow for more individuals to be recorded.

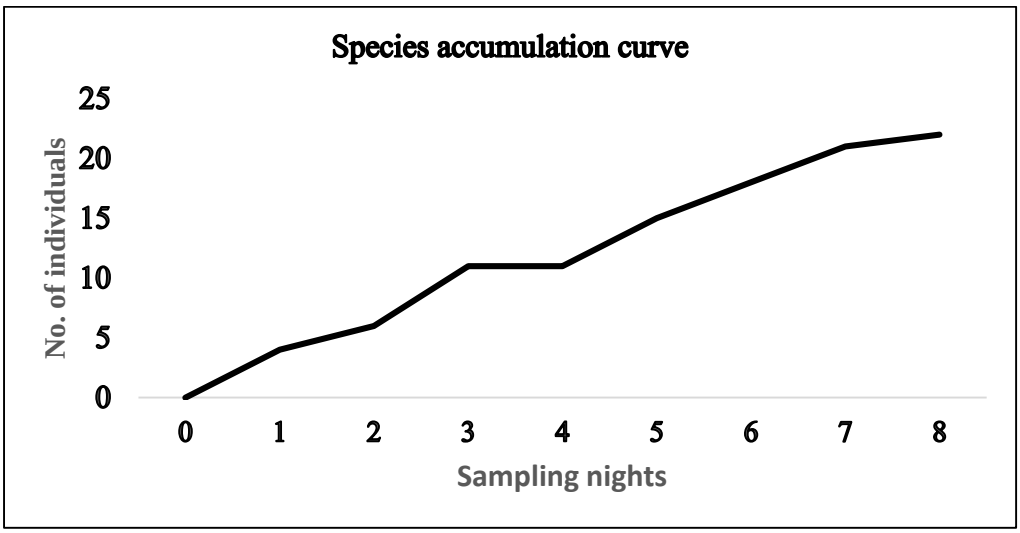

Figure 3. The species accumulation curve of volant small mammals captured in Long Banga.

Primates

Three primate species were recorded from the nine days of direct observation sampling along the transect. The recorded species were Long-tailed macaque (*Macaca fascicularis*), Northern-Gray Gibbon (*Hylobates funereus*), and Hose's langur (*Presbytis hosei*). Photos were only available for the long-tailed macaque, while no photos were taken for other recorded species due to long distance.

Long-tailed macaque (*Macaca fascicularis*) from the family Cercopithecidae is a widespread species across Southeast Asia, including Malaysia, Bangladesh, Myanmar, Thailand, Laos, Vietnam, Cambodia, Sumatra, and Philippines (Fooden, 1995; Wheatley, 1999; Liedigk *et al*., 2015). This species

is a diurnal primate, socially active, and well-adapted to various kinds of environments, i.e., primary and secondary forest, coastal areas, disturbed habitat, as well as human settlements. Being a generalist feeder, the long-tailed macaque feeds on various species of fruits, plants, insects, small crabs, and fungi. Having a large incisor and canine teeth helps them to forage on large-seeded fruits efficiently, thus plays a vital role in the ecosystem for seed dispersal (Lucas & Corlett, 1998; Albert *et al*., 2013). The macaques are often considered a pest because of their aggressive behaviour, i.e., attacking humans for food. Unlike other places, the long-tailed macaques in Long Banga were unfamiliar to human existence and leap away the moment they encounter humans coming into their foraging areas.

The rare and endemic *Hylobates funereus* is commonly known as the Northern-gray gibbon or North-Borneo gibbon and categorized under the family Hylobatidae. It can be found in the northern and eastern regions of Borneo (Marshall & Marshall, 1976). They live in a monogamous social system that consists of a mated pair and their offspring. Northern-gray gibbon is the most productive seed dispersal agent because of the large number of fruit intake and defecates the seeds over a broad home range (Corlett, 2017). They can disperse the seeds approximately 100 meters away from the parent plant (McConkey & Chivers, 2007). The current population trend of Northern-gray gibbon is decreasing and listed as Endangered by the IUCN Red List and Appendix I in CITES. They are threatened due to habitat loss and illegal wildlife trade (Geissmann & Nijman, 2008). In Long Banga, the presence of this species was detected through loud vocalization, noticed at the dense forest very near to the Kalimantan border.

The Hose's Langur, *Presbytis hosei*, is a rare and endemic species to Borneo, distributed only in the northern part of the island. The langur possesses unique morphological characteristics that make them easily identified. They have grey dorsal pelage and white colouration on the ventral side, with paler colouration at below part of the tail than the upper part (Groves, 2001). The population of Hose's langur primarily inhabit the primary and secondary forest and being strictly folivores, but occasionally feed on seeds (Payne *et al.*, 1985). A group of Hose's langur was found at the Lubang Batu trail, at the elevation of about 600 meters above sea level. They were not used to the presence of humans and considered us as threats. This might be due to the hunting pressure faced by the species, killed for the bezoar stones in the stomach that are used in traditional medicines (Nijman, 2005). However, there was no record of illegal hunting by the local people in Long Banga.

Conclusion

Long Banga is a forest area that serves as a habitat for many small mammals and primates species. Its location that is quite far from the urban area, allows the ecosystem to function without much disturbance. Both of our survey on volant and non-volant small mammals suggested that more species are expected to be recorded if the sampling days are extended. The highlights of this study are the record of the montane endemic Borneo Fruit Bat (*Aethalops aequalis*), rare endemic Northern-Gray Gibbon (*Hylobates funereus*) and Hose's langur (*Presbytis hosei*). All these species are rare, and maintaining the ecosystem integrity of the area is very crucial for the conservation and management of these species.

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Appendices

Figure 4: An individual of Sabah Giant Rat (*Leopoldamys sabanus*) captured in Long Banga.

Figure 5: Muller's Rat (*Sundamys muelleri*) recorded at Long Banga.

Figure 6: Whitehead's Maxomys (*Maxomys whiteheadi*) found in Long Banga.

Figure 7: Bats species from family Pteropodidae (1. *Cynopterus brachyotis*; 2. *Macroglossus minimus*; 3. *Balionycteris maculata*; 4. *Megaerops ecaudatus*; 5. *Aethalops aequalis*; 6. *Penthetor lucasi*).

Figure 8: Bats species from family Vespertillionidae (1. *Kerivoula intermedia*; 2. *Kerivoula suilla*; 3. *Myotis ridleyi*; 4. *Glischropus* tylopus). Not in picture: *Kerivoula minuta*, *Kerivoula papillosa*, *Kerivoula hardwickii* and *Myotis muricola*.

Figure 9: Bats species from family Rhinolophidae (1. *Rhinolophus luctus*; 2. *Rhinolophus trifoliatus*; 3. *Rhinolophus borneensis*).

Figure 10: Bats species from family Hipposideridae (1. *Hipposideros galeritus;* 2. *Hipposideros cervinus*).

Figure 11 (left): *Megaderma spasma* from family Megadermatidae
Figure 12 (right): *Nycteris tragata* from family Nycteridae

Figure 13: *Emballonura alecto* from family Emballonuridae

Figure 14: Long-tailed macaque (*Macaca fascicularis*) spotted in Long Banga

DRAGONFLIES AND DAMSELFLIES OF LONG BANGA, SARAWAK

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Abstract

Records of dragonflies and damselflies collected from at several locations in Long Banga, Sarawak on 22-31 August 2016 are presented. A total of 59 species from 14 families were recorded, of which 28 were damselfly species and 31 were dragonfly species. The species list was dominated by family Libellulidae with 26 species. Interesting species recorded were Rhinocypha spinifer, Vestalis beryllae, Coeliccia compioni, Hylaeothemis clementia, Idionyx montana and Rhyothemis regia.

Introduction

Dragonflies and damselflies collectively known as Odonata are one of the oldest insect groups in the world. It first appeared on the earth in Carboniferous Period around 300 million years ago, and it is 50 million years earlier than the dinosaurs. Generally, Odonata has a slender body with a pair of big compound eyes and two pairs of membranous wings. In many parts of Sarawak, the dragonflies and damselflies are called as *kelontet*. Odonata is always associated with fresh water bodies such as rivers, streams, ponds, lakes, waterfalls, canals, swamps, marshes, paddy fields etc. as the Odonata larvae live in the fresh water. Therefore, Odonata forms an important biological component for freshwater ecosystem.

Close to 6000 Odonata species are distributed throughout the world (Dijkstra et al. 2013). In Malaysia, more than 390 species have been recorded (Orr 2003, 2005), with the state of Sarawak containing more than 280 species (Dow per. comm.). With an altitude above 450 m at Upper Baram, Long Banga is located within the Heart of Borneo in the state of Sarawak. Various aquatic habitats including forest streams, rivers, waterfalls, forest swamps, ponds and open marshes can be found in Long Banga and its surrounding areas. Sungai Puak and Sungai Sekuan are the major rivers in this area. The Odonata fauna from the adjacent Usun Apau National Park (Dow et al. 2015) and Sungai Sii and Ulu Moh (Dow & Ngiam 2015) in Upper Baram have been recorded. However, I am not aware of any Odonata record of Long Banga from published literature. A field survey was carried during the Long Banga Scientific Expedition on 20 August–2 September 2016. Here I present the Odonata results from the field survey.

Materials and Methods

Sampling was done on 22–31 August 2016 at around Sungai Puak, Sungai Sekuan, Sungai Moa, Sungai Paley and their tributaries (Table 1). Many grassy ponds and pools are present by the logging road sides, and these aquatic habitats are good spots for Odonata. Adult Odonata was collected using handheld nets. Specimens were preserved with acetone treatment and dried in silica gel. Classification of Odonata follows Dijkstra et al. (2013). The material collected is held in the Centre for Insect Systematics at Universiti Kebangsaan Malaysia. Specimens were identified to species with the aid of a microscope, by reference to the relevant literatures, and direct comparison with materials from other places.

Results and Discussion

Within the 10 days of field survey (22−31 August 2016), a total of 59 species from 14 families were recorded, of which 28 are damselfly species and 31 are dragonfly species (Table 2). The number of species being recorded is high considering the short period of field survey. This is mainly due to the presence of various aquatic habitats in Long Banga, such as forest streams, swamps, waterfall and grassy ponds. Dow et al. (2015) also recorded 55 species in 11 days from the adjacent area Usun Apau. Similar results were also obtaining by Dow and Ngiam (2015) from the adjacent Ulu Moh (57 species in 8 days) and Sungai Sii (65 species in 9 days). This indicates that the Upper Baram area is rich in Odonata fauna.

The species list was dominated by family Libellulidae with 26 species (Table 2). *Euphaea subnodalis* (Figure 1E) with its black body and metallic blue-green wings is abundant at swift flowing Sungai Puak and Sungai Sekuan. The red colour winged dragonflies *Neurothemis fluctuans* (Figure 1C), *Neurothemis ramburii* and *Neurothemis terminata* as well as the small blue damselfly *Xiphiagrion cyanomelas* (Figure 1D) were found in abundant at grassy ponds and pools by logging road side. Small streams and swamps in the shady forest were dominated by *Coeliccia nigrohamata* (Figure 1H).

Interesting species recorded from the field survey were *Rhinocypha spinifer*, *Vestalis beryllae*, *Coeliccia compioni*, *Hylaeothemis clementia*, *Idionyx montana* and *Rhyothemis regia*. They are rare or uncommon forest species. All these species were also recorded from the adjacent Usun Apau, Sungai Sii or Ulu Moh except *I. montana* (Dow & Ngiam 2015; Dow et al. 2015). A male specimen of *I. montana* was caught by mist nest at location B and a female was caught using handheld net at location D (Table 2). The mist

nest was set up by the bird group during the Scientific Expedition. A few female individuals of *Idionyx* (no male specimen) were caught at Usun Apau and Ulu Moh (Dow & Ngiam 2015; Dow et al. 2015). It is impossible to identify female individuals down to species without male specimen, and therefore the female specimens from Usun Apau and Ulu Moh were labelled as *Idionyx* species. *R. spinifer* (Figure 1F) is an endemic species to Borneo, and it occurs in highland forest streams. During the field survey, it was spotted at locations C and H with altitude >800 m. *V. beryllae* and *C. compioni* are also endemic to Borneo. Only one individual of *V. beryllae* was spotted at location B. However, *C. compioni* (Figure 1G) was present in good number in streamlets at locations C and D. A few individuals of *H. clementia* were spotted in forest swamp next to Sungai Puak at location B. The first published record of *R. regia* in Borneo is from Sabah (Chung et al. 2013), and the first published record for Sarawak is from Sungai Sii (Dow & Ngiam 2015). Long Banga is the second site for *R. regia* in Sarawak. A few male individuals of *R. regia* were spotted at grassy ponds by the logging road at location F.

In general, Long Banga is rich in Odonata fauna, and it is a refuge for some of the rare and endemic species. The Odonata always enchants the aquatic habitats in Long Banga and its surrounding areas. We have every good reason to protect and conserve the forest habitats of Long Banga and its surrounding areas for the survival of these fascinating species.

Acknowledgement

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Table 1. Sampling locations in Long Banga

Location	Description of aquatic habitat
A	Sungai Sekuan; rocky; leading to a small hydro-electric dam; altitude at the dam is 880 m.
B	Sungai Puak; rocky; small water pools by the river.
C	Trail to Udau Waterfall, crossing a few streamlets and slow flowing streams; altitude at the waterfall is 794 m.
D	A tributary to Sungai Sekuan before the small hydro-electric dam.
E	Sungai Mao Kecil; a tributary to Sungai Pauk; altitude 640 m.
F	Logging road leading to camp site with a few ponds and small streams by road side.
G	Sungai Paley; on the way to Bario from Long Banga; altitude 900 m.
H	A small stream by road side on the way to Bario from Long Banga; altitude 1100 m.

Table 2. Odonata species recorded from Long Banga. Refer Table 1 for location. Number indicates number of specimens collected. / indicates species observed with no specimen collected.

No.	Species	Location							
		A	B	C	D	E	F	G	H
	Family Devadattidae								
1	*Devadatta clavicauda* Dow, Hamalainen & Stokvis, 2015	1			1				
2	*Devadatta somoh* Dow, Hamalainen & Stokvis, 2015			2					1
	Family Calopterygidae								
4	*Neurobasis longipes* Hagen, 1887		1						
5	*Vestalis amaryllis* Lieftinck, 1965			1	1	1			
6	*Vestalis beryllae* Laidlaw, 1915		/						
	Family Chlorocyphidae								
7	*Heliocypha biseriata* (Selys, 1859)			1	1				
8	*Rhinocypha aurofulgens* Laidlaw, 1931		3		1				
9	*Rhinocypha spinifer* Laidlaw, 1931			2					1
	Family Euphaeidae								
10	*Euphaea subnodalis* (Laidlaw, 1915)		3	3				3	2
11	*Euphaea subcostalis* (Selys, 1873)		3	5					

	Family Lestidae							
12	*Orolestes wallacei* (Kirby, 1889)	1	1					
	Family Philosinidae							
13	*Rhinagrion borneense* (Selys, 1886)			2				
	Family Coenagrionidae							
14	*Agriocnemis femina* (Brauer, 1868)		3					
15	*Argiocnemis rubescens rubeola* Selys, 1877					1		
16	*Ceriagrion bellano* Laidlaw, 1915	5	/			/		
17	*Pseudagrion pilidorsum* (Brauer, 1868)				1	4		
18	*Stenagrion dubium* (Laidlaw, 1912)			1	3			
19	*Teinobasis laidlawi* Kimmins, 1936		1					
20	*Xiphiagrion cyanomelas* (Selys, 1876)		3	4		5	2	2
	Family Platycnemididae							
21	*Coeliccia compioni* Laidlaw, 1918			1	3			
22	*Coeliica nigrohamata* Laidlaw, 1918	/	1	5	2			
23	*Coeliccia* sp.			7				1
24	*Copera vittata* (Selys, 1863)		1	3				
25	*Prodasineura dorsalis* (Selys, 1860)		1					
26	*Prodasineura hyperythra* (Selys, 1886)		1	3				

	Family Platystictidae							
27	*Drepanosticta rufostigma* (Selys, 1886)	1		8		1		
28	*Drepanosticta versicolor* Laidlaw, 1913		1					
	Family Aeshnidae							
29	*Indaeschna grubaueri* (Forster, 1904)	1						
	Family Macromiidae							
30	*Macromia corycia* Laidlaw, 1922			1	2			
31	*Macromia ?euterpe* Laidlaw, 1915		1					
	Family Synthemistidae							
32	*Idionyx montana* Karsch, 1891	1		1				
	Family Gomphidae							
33	*Ictinogomphus decorates melaenops* (Selys, 1858)					1		
	Family Libellulidae							
34	*Agrionoptera insignis* (Rambur, 1842)	1						
35	*Brachydiplax chalybea* Brauer, 1868				2	/		
36	*Camacinia gigantean* (Brauer, 1867)					2		
37	*Cratilla lineata* (Brauer, 1878)	1						

38	*Cratilla metallica* (Brauer, 1878)		/	1					
39	*Diplacodes trivialis* (Rambur, 1842)					1			
40	*Hylaeothemis clementia* Ris, 1909		1						
41	*Lyriothemis cleis* Brauer, 1868		1						
42	*Neurothemis fluctuans* (Fabricius, 1793)	1	1						
43	*Neurothemis ramburii* (Brauer, 1866)	1	/				/	/	
44	*Neurothemis terminata* Ris, 1911	2	2		1		/	/	
45	*Onychothemis cocinnea* Lieftinck, 1953		1						
46	*Orthetrum chrysis* (Selys, 1891)	1							
47	*Orthetrum glaucum* (Brauer, 1865)	1	1		1		/	/	
48	*Orthetrum pruinosum schneideri* Forster, 1903	/	2				/	/	
49	*Orthetrum sabina* (Drury, 1770)	/	1						
50	*Orthetrum testaceum* (Burmeister, 1839)	/	1				/	/	
51	*Pantala flavescens* (Fabricius, 1798)	1							
52	*Rhyothemis regia regia* (Brauer, 1867)						/		
53	*Rhyothemis triangularis* Kirby, 1889						2		
54	*Tetrathemis irregularis hyalina* Kirby, 1889		1				1		
55	*Tramea phaeoneura* Lieftinck, 1953						1		
56	*Trithemis aurora* (Burmeister, 1839)	/	1				/	/	
57	*Trithemis festiva* (Rambur, 1842)	/	1					/	
58	*Tyriobapta torrida* Kirby, 1889		1						
59	*Zygonyx iris errans* Lieftinck, 1953	/	2						
	Total number of species	16	35	17	13	5	18	9	4

Figure 1. Photos of Odonata species captured in Long Banga. A. *Orthetrum pruinosum*, B. *Agrionoptera insignis*, C. *Neurothemis fluctuans*, D. *Xiphiagrion cyanomelas*, E. *Euphaea subnodalis*, F. *Rhinocypha spinifer*, G. *Coeliccia compioni*, and H. *Coeliccia nigrohamata*.

PALMS OF LONG BANGA

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Abstract

Arecaceae or sometimes known as Palmae is a family of flowering plant belonging to the monocot order, Arecales. It comprising 200 genera and 3000 species to be found throughout equatorial, tropical, and subtropical areas of the world, most of which are restricted to tropical or subtropical climates where they feature as a very peculiar element of the landscape. They have had an important role in humans throughout much of history. The growth habit of palms is usually a straight, unbranched stem, and rarely a dichotomous branching stem or a creeping vine-like habit (liana). Another feature peculiar to this family is that the stem reaches its ultimate growth in diameter before it starts its growth in height and palms lack of secondary growth. Surveys in the Long Banga scientific expedition areas were made to record the palms diversity. The surveys were conducted along the established trails that includes a wide array of habitats. Field data were recorded and herbarium specimens were collected for further verification. A total of 19 species from 8 genera of palms were recorded. The genus Areca, Calamus *and* Licuala *were the most predominance palms along the trails recorded.*

Keywords*: Arecaceae, Long Banga, Sarawak, Heart of Borneo*

Introduction

This oldest monocot flowering plant family (Janssen & Bremer, 2004), Arecaceae belongs to the Arecales order. Palms family are easily distinguished with their unbranched stem and a large crown of leaves, rarely in acaulescent

species or creeping habits and dichotomously branching. Two methods of growth of palms: solitary or clustered (Dransfield & Uhl, 2008).

Harold Emery Moore, an American botanist, in his paper, "*The Major Groups of Palms and Their Distribution*" presented the outline of his classification of the family where he classified those palms into 15 major groups by their general morphological characteristic (Moore, 1973). Later, Dransfield and Uhl (2008) simplified and put them into five subfamilies. The keys to the subfamilies had made as below:

***Key to subfamilies**:*

1. Ovary fruit covered in imbricate scales; flowers hermaphroditic or unisexual, but only rarely dimorphic, arranged singly or in dyads or rarely in cincinni ……..…… **Calamoideae**
1. Ovary and fruit glabrous, or with peltate or basifixed scales, hair, corky warts, or spines, but not with imbricates scales; flower hermaphroditic or unisexual, often dimorphic, borne singly or in triads or in pairs derived from triads, or in cincinni ……...… **2**

2 Pistillate flowers are borne in a terminal head, each flower with 3(-4) free, large, asymmetrical carpels and 6-minute perianth segments; staminate flowers crowded on spikes at the tips of the inflorescence branches, below the pistillate head, each flower with 6 linear distinct perianth segments and 3 anthers borne on a solid stalk ….... **Nypoideae**

3 Pistillate flowers not borne in a terminal head, or if so, then plants dioecious and flowers multi-parted; staminate flowers with stamens filaments free or variously connate, very rarely forming a solid stalk…….…….… **3**

4 Leaves splitting along adaxial folds to give induplicate segments or leaflets, the leaf palmate or pinnate, or bipinnate, rarely splitting between folds or along abaxial folds (and then the leaf always palmate), or entire but with apical lobbing representing very short induplicate segments ……..……..…… **Coryphoideae**

3 Leaves splitting along abaxial folds to give reduplicate leaflets, the leaf always pinnate, or entire bifid, pinnately ribbed ……..……... **4**

4 Flowers usually unisexual and the plants dioecious, rarely hermaphroditic, borne singly or in monopodial cluster ……..…….…… **Ceroxyloideae**

5 Flowers always unisexual, the plants always monoecious, rarely dioecious, the flowers borne in groups of 3 (triads), each with pistillate and 2 staminate flowers, or in groups derived from triads, very rarely in longitudinal lines (acervuli), even more rarely by reduction solitary…….……... **Arecoideae**

With a total of 202 genera and consist of approximately 2600 species all over the world, the palms are considered as among economical important plant families. Many species are being economical important crops, for instance, the palm oil (*Elaeis guineensis* Jacq.), coconut (*Cocos nucifera* L.) and Sago (*Metroxylon sagu* Rottb.) and hundreds of species are being used as decoration plants and landscape elements. The palms can be found mostly throughout tropical and subtropical regions and survive through hot and moist climates. Palms have been widely used as palaeo-indicators for warm and humid climates (Morley, 2003).

Malaysia comprises of 58 genera or approximately 25% of the total palm genera, however, received less attention by the local researchers. For example,

since the last account by Whitmore (Whitmore, 1998) no recent updates on the palms species from Peninsular Malaysia are available. As in Borneo, 28 genera were recorded from Kubah National Park and considered as the richest site in the world for palms taxa (Christenhusz & Bying, 2016: Dransfield & Uhl, 2008).

Materials and methods

The surveys were conducted along the established trails (Trail 1, 7, 12, 13, 15 and 16 also include a riverine of Sungai Bale) and most of the time we walked off the track. Only fertile specimens were collected and herbarium preparation is following the standard protocols as suggested by Bridson and Forman (1992) and Dransfield (1979; 1992) for rattans collection. Habitats were recorded and images of crucial parts were photographed.

Results and Discussion

The Table below is listing all the palms collected and recorded from Long Banga areas. Three sub-families of palms were identified as Arecoideae, Calamoideae and Coryphoideae occurred in the Long Banga. A total of 24 palms species were sighted along the trails and only19 of them were collected. The subfamily Calamoideae was the most predominant here. Most of the species from this subfamily that we sighted were not produce either fruit or flower which difficult for us to identify to the lower taxa. Most of the members in this sub-family (particularly from the genus *Calamus*, *Ceratholobus*, *Daeomonorops*, *Korthalsia* and *Plectocomia*) have special climbing organs called flagella and easily distinguish by looking at the overlapping scales covered fruit and ovary. Life history of this family might be hepaxanthic or pleonanthic. They may seem similar to each other. But the difference of thorns

developments and the development of the flagellum. As in Figure 1, show the variety plant genera pattern in Calamoideae subfamily.

Table 1: Palms species recorded

Sub-family	**Species**	**Vernacular name**
Arecoideae	*Areca minuta*	Pinang hutan
	Areca sp.2	
	Areca sp.3	
	Areca sp.4	
	Areca sp.5	
	Arenga hookeriana (Becc.) Whitmore	
	Arenga pinnata (Wurmb) Merr.	
	Arenga undulatifolia Becc.	
Calamoideae	*Calamus* sp.1	Rotan
	Calamus sp.2	Rotan
	Calamus sp.3	Rotan
	Caryota no Becc.	Aping
	Ceratholobus kingianus	Rotan
	Cocos nucifera L.	Kelapa
	Daemonorops sp	Rotan
	Licuala sp.1	Biris
	Licuala sp.2	Palas
	Nenga pumila (Blume) H. Wendl.	Pinang gajah
	Oncosperma horridum	Nibong
	Plectocomia elongata Mart. ex Blume	
	Plectocomia mulleri Blume	
	Rhapis excelsa (Thunb.) A. Henry	Rhapis
Coryphoideae	*Rosytonea regia* (Kunth) O.F. Cook	Royal Palm
	Salacca affinis Griff.	Ridan

The second dominance sub-family here is Coryphoideae which consist of most palmate-leaved palms. All the induplicate-leaved palms are belonging to this group (Dransfield, 2008). Arecoideae sub-family has been known as the most diverse family among the sub-families. Both these Coryphoideae and Arecoideae sub-families mostly found as solitary except for *Oncosperma horridum* here we found habit in clustered.

Ever since no scientific palm documentation has been conducted in the Long Banga before, the number of species collected here was considered moderately rich. It is expected that many rattans to be discovered as many areas are being disturbed either by the human destructions or by nature. However, we only managed to collect only six taxa of rattans from these areas. Another reason why our palms specimen collection was low because of many palms or rattans that we encountered were bearing neither flowers nor fruits. Unfortunately for an amateur like us, without fruits or flowers, it is hard for us to identify the palms. Few exotic palms also recorded in the Long Banga settlement area. For examples, the Royal Palm (*Roystonea regia* (Kunth) O.F. Cook), the Lady Palm (*Rhapis excelsa* (Thunb.) A. Henry), *Eleais guineensis* and *Cocos nucifera* were planted as crops or ornamental.

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Figure 1; Genera and species of Calamoideae found in Long Banga: a. *Plectocomia* sp. b. *Korthalsia* sp. c. *Salacca affinis*. d. *Calamus* sp. e. Flower of *Calamus* sp.

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ORCHIDS OF LONG BANGA

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Abstract

A total of 150 specimens were collected from 6 sites (3 trails and 3 non-trails) in Long Banga forests and they were identified into 118 species. Most of the species documented were epiphytes including an endemic giant orchid, Dimorphorchis lowii and a member of the most appreciated orchid as agricultural crop, Vanilla cf. havilandii. In addition, 15 terrestrials and 3 saprophytes namely Aphyllorchis montana, Cystorchis stenoglossa and Gastrodia javanica were also documented during the study. Seventeen species were identified as new records for Sarawak.

Introduction

Long Banga is a remote sub-montane forest located in Ulu Baram, Sarawak. The virgin forest is characterized by similar vegetation as in Bario Highland (Beaman *et al*. 2001) and relatively low ambient temperature as been compared to other regions in the state. A small community of Saban tribe who acted as the guardian of the forest described that this ecological complex to be rich in flora and fauna and haboured many orchid species. However, illegal forest exploitation and excessive logging had caused rapid deterioration to the orchid habitat.

A scientific expedition via the Heart of Borneo (HOB) initiative in Long Banga had allowed first assessment to its orchid diversity in the selected sites in two different habitats; inland forest and riverine. The objective is to identify the specimens collected to its respective taxa and habit. This paper aimed to serve as a preliminary documentation on the orchid species inventory of Long Banga for future conservation needs.

Materials and Methods

Field sampling was carried out from 21st August 2016 to 1st September 2016 in several study sites which were; a) Trail 12, b) Trail 15, c) Trail 16, d) Sungai Puak and e) Sungai Sekuan. The collected orchids were identified into their respective taxa based on their morphological characters and habits. The specimens were processed into herbarium specimens and the living specimens were transplanted in a glasshouse in UPMKB, Bintulu, for further identification.

Results

A total of 150 specimens were collected from 6 sites (3 trails and 3 non-trails) and were identified into 118 species and consisted of 100 epiphytes, 15 terrestrials, and 3 saprophytes. 100 specimens were identified into their respective taxa which 18 specimens were only identified into their genera level as the floral structure were lacking upon assisting the identification. The findings were listed in **Table 1** and flowering specimens collected are shown in **Plate 1 and 2**. **Figure 1** showed the number of species found in the respective vegetation types and **Figure 2** showed the number of species according to growth habits.

Fifty-five orchid species were found in inland montane forest, and 66 orchid species were found in riverine forest. In inland montane forest, the highest numbers of orchid were observed in Trail 15 and 12 with 54 orchid species. *Bulbophyllum, Coelogyne,* and *Dendrobium* were noted as the key genera in the area. In addition, 3 saprophytes, *Aphyllorchis montana, Cystorchis stenoglossa* and *Gastrodia javanica* were also found along the trails that signified high organic materials content in the soil. In Trail 16, a giant endemic species to Borneo, *Dimorphorchis lowii*, and a member of *Vanilla* that is responsible for the production of vanillin, *Vanilla* cf. *havilandii* were discovered. *Apostasia wallichii*, *Claderia viridiflora*, *Eulophia pulchra*, *Macodes petola*, *Nephelaphyllum pulchrum*, *Plocoglottis javanica*, and *Tropidia pedunculata* are terrestrial orchids which were also discovered along trail 12, 15, and 16. Meanwhile, in riverine forest, the highest number of orchids were collected from riverbank of Sungai Sekuan. The diversity of orchid collected from Sungai Sekuan was represented mostly by genus *Dendrobium* and *Eria*.

Table 1 An Inventory List of Orchids Collected in Long Banga

No	Species	Habit	Trails			Non-trails			J.J Wood and P.J. Cribb (published in 1994)	T.E Beaman *et al*. (2001)	K.G. Pearce (2006)
			15	12	16						
			IM		IMR	RS	RSK	RSP			
1	*Agrostophyllum cyathiforme* J.J.Sm.	Epiphyte			/				/	/	/
2	*Agrostophyllum longifolium*(Blume) Rchb.f.	Epiphyte						/	/	/	
3	*Agrostophyllum majus* Hook.f.	Epiphyte	/						/	/	/
4	*Agrostophyllum stipulatum* (Griff.) Schltr.	Epiphyte	/						/	/	/
5	*Aphyllorchis montana* Rchb.f.	Saprophyte	/						/	/	
6	*Apostasia nuda* R.Br.	Terrestrial			/				/	/	
7	*Apostasia wallichii* R.Br.	Terrestrial			/				/	/	
8	*Appendicula ovalis* (Schltr.) J.J.Sm. ex Mansf.*	Epiphyte			/						
9	*Appendicula reflexa* Blume	Epiphyte						/	/	/	
10	*Appendicula torta* Blume	Epiphyte					/		/	/	/
11	*Appendicula undulata* Blume	Epiphyte	/				/		/	/	/
12	*Arundina graminifolia* (D.Don) Hochr.	Terrestrial				/	/		/	/	
13	*Bromheadia scirpoidea* Ridl.	Epiphyte	/				/		/	/	
14	*Bryobium pudicum (Ridl.) Y.P.Ng & P.J.Cribb*	Epiphyte	/				/		/		
15	*Bulbophyllum* sp.1	Epiphyte	/								
16	*Bulbophyllum* sp.2	Epiphyte	/								

17	*Bulbophyllum* sp.3	Epiphyte	/											
18	*Bulbophyllum* sp.4	Epiphyte	/											
19	*Bulbophyllum* sp.5	Epiphyte	/											
20	*Bulbophyllum* sp.6	Epiphyte	/											
21	*Bulbophyllum* sp.7	Epiphyte	/											
22	*Bulbophyllum apodum* Hook.f.	Epiphyte				/			/		/			
23	*Bulbophyllum flavescens* (Blume) Lindl.	Epiphyte					/		/		/		/	
24	*Bulbophyllum medusae* (Lindl.) Rchb.f.	Epiphyte				/			/		/			
25	*Bulbophyllum membranaceum* Teijsm. & Binn.	Epiphyte				/			/		/			
26	*Bulbophyllum purpurascens* Teijsm. & Binn.	Epiphyte		/					/		/			
27	*Bulbophyllum uniflorum* (Blume) Hassk.	Epiphyte	/						/		/			
28	*Bulbophyllum vaginatum* (Lindl.) Rchb.f.	Epiphyte					/		/		/			
29	*Bulbophyllum viridescens* Ridl.	Epiphyte					/		/					
30	*Calanthe* cf. *taenioides**	Terrestrial					/							
31	*Callostylis rigida* Blume	Epiphyte	/			/			/		/			
32	*Ceratostylis ampullacea* Kraenzl.	Epiphyte				/			/					
33	*Ceratostylis gracilis* Blume	Epiphyte	/			/			/					
34	*Chelonistele sulphurea* (Blume) Pfitzer	Epiphyte	/						/		/		/	
35	*Cirrhopetalum* sp.1 (flowering)	Epiphyte	/											

36	*Claderia viridiflora* Hook.f.	Terrestrial	/				/				/			/		
37	*Cleisostoma discolor* Lindl.	Epiphyte							/		/			/		
38	*Coelogyne* cf. *dayana*	Epiphyte	/								/			/		
39	*Coelogyne* cf. *testacea*	Epiphyte	/								/			/		
40	*Coelogyne* sp.1 (white flower)	Epiphyte	/													
41	*Coelogyne* sp.2 (yellowish-orange flower)	Epiphyte	/													
42	*Coelogyne* sp.3	Epiphyte	/													
43	*Coelogyne* sp.4	Epiphyte							/							
44	*Coelogyne* sp.5	Epiphyte							/							
45	*Coelogyne* sp.6	Epiphyte							/							
46	*Coelogyne* sp.7	Epiphyte							/							
47	*Coelogyne* sp.8	Epiphyte							/							
48	*Coelogyne foerstermannii* Rchb.f.	Epiphyte							/					/		
49	*Coelogyne swaniana* Rolfe	Epiphyte					/				/			/		/
50	*Coelogyne tomentosa* Lindl.	Epiphyte			/						/			/		
51	*Collabium simplex* Rchb.f.	Terrestrial					/							/		
52	*Cymbidium dayanum* Rchb.f.	Epiphyte					/				/			/		
53	*Cymbidium rectum* Ridl.	Epiphyte					/		/		/			/		
54	*Cystorchis stenoglossa* Schltr.*	Saprophyte			/											
55	*Dendrobium* cf. *calicopis**	Epiphyte	/													
55	*Dendrobium* cf. *roseatum**	Epiphyte	/		/											
57	*Dendrobium crumenatum* Sw.	Epiphyte					/		/							
58	*Dendrobium fimbriata* Lindl.	Epiphyte	/				/		/		/			/		
59	*Dendrobium indivisum* (Blume) Miq.	Epiphyte	/				/				/			/		/

60	*Dendrobium kentrochilum* Hook.f.*	Epiphyte					/					
61	*Dendrobium laciniosum* Ridl. *	Epiphyte			/							
62	*Dendrobium luxurians* J.J.Sm.	Epiphyte			/				/		/	
63	*Dendrobium planibulbe* Lindl.	Epiphyte					/		/			
64	*Dendrobium plicatile* Lindl.	Epiphyte	/			/			/		/	
65	*Dendrobium roseatum* Ridl.*	Epiphyte				/						
66	*Dendrobium salaccense* (Blume) Lindl.	Epiphyte			/				/		/	
67	*Dendrochilum pallidiflavens* Blume	Epiphyte	/			/	/		/		/	/
68	*Dendrochilum simile* Blume	Epiphyte							/			
69	*Dienia ophrydis* (J. Koenig) Seidenf.	Terrestrial				/	/		/		/	
70	*Dimorphorchis lowii* (Lindl.) Rolfe	Epiphyte			/				/		/	
71	*Dipodium* cf. *pictum*	Epiphyte	/						/		/	/
72	*Eria* cf. *atrovinosa*	Epiphyte	/			/			/			
73	*Eria* cf. *bractascens*	Epiphyte	/			/			/		/	
74	*Eria* sp.	Epiphyte			/							
75	*Eria earine* Ridl.*	Epiphyte				/	/					
76	*Eria mucronata* Lindl.*	Epiphyte	/			/						
77	*Eria nutans* Lindl.	Epiphyte	/						/		/	/
78	*Eria pilifera* Ridl.*	Epiphyte			/	/						
79	*Eulophia pulchra* (Thouars) Lindl.	Terrestrial			/				/			
80	*Flickingeria pallens* (Kraenzl.) A.D.Hawkes *	Epiphyte			/		/					
81	*Gastrodia javanica* (Blume) Lindl.	Saprophyte	/						/		/	
82	*Liparis* sp. (purple leaves)	Epiphyte	/									

83	*Liparis barbata* Lindl. *	Epiphyte		/								
84	*Liparis elegans* Lindl.	Epiphyte	/					/		/		
85	*Liparis lacerata* Ridl.	Epiphyte					/	/		/		
86	*Liparis rhombea* J.J.Sm.	Epiphyte					/	/				
87	*Liparis viridiflora* (Blume) Lindl.	Epiphyte					/	/		/		
88	*Macodes petola* (Blume) Lindl.	Terrestrial		/				/		/		
89	*Mycaranthes latifolia* Blume	Epiphyte	/					/				
90	*Mycaranthes oblitterata* Blume	Epiphyte	/					/		/	/	
91	*Nephelaphyllum* cf. *pulchrum*	Terrestrial		/				/		/		
92	*Nephelaphyllum pulchrum* Blume	Terrestrial					/	/		/		
93	*Oberonia* cf. *ciliolate*	Epiphyte		/				/		/		
94	*Oberonia* cf. *intermedia**	Epiphyte					/					
95	*Oberonia brachystachys* Lindl.*	Epiphyte	/			/	/					
96	*Oberonia dissitiflora* Ridl.*	Epiphyte		/								
97	*Octarrhena* sp.	Epiphyte	/			/						
98	*Phaius indigoferus* Hassk.	Terrestrial		/								
99	*Phaius tankervilleae* (Banks) Blume	Terrestrial			/			/		/	/	
100	*Pholidota* cf. *imbricata*	Epiphyte	/					/		/		
101	*Pholidota imbricata* Lindl.	Epiphyte		/				/		/		
102	*Phreatia plantaginifolia* (J.Koenig) Ormerod	Epiphyte				/	/			/		
103	*Pinalia densa* (Ridl.) W.Suarez & Cootes	Epiphyte	/			/		/		/		
104	*Plocoglottis javanica* Blume	Terrestrial	/					/				
105	*Podochilus lucescens Blume*	Epiphyte	/			/		/		/		

106	*Pomatocalpa diffusum* Breda	Epiphyte	/		/		/	/	/		/	
107	*Pteroceras* sp.	Epiphyte			/							
108	*Sarcostoma javanica* Blume	Epiphyte	/								/	
109	*Taeniophyllum* cf. *palladiflorum**	Epiphyte	/									
110	*Thelasis macrobulbon* Ridl.	Epiphyte	/				/		/			
111	*Thelasis micrantha* (Brongn.) J.J.Sm.	Epiphyte						/	/		/	
112	*Thrixspermum calceolus* (Lindl.) Rchb.f.	Epiphyte						/	/		/	
113	*Thrixspermum centipeda* Lour.	Epiphyte	/								/	
114	*Trichotosia ferox* Blume	Epiphyte							/		/	/
115	*Trichotosia gracilis* (Hook.f.) Kraenzl.	Epiphyte	/				/		/		/	
116	*Trichotosia velutina* (Lodd. ex Lindl.) Kraenzl.	Epiphyte	/						/		/	
117	*Tropidia pedunculata* Blume	Terrestrial	/						/		/	
118	*Vanilla* cf. *havilandii*	Epiphyte			/				/			

Notes: IM - Inland montane vegetation; **IMR** - Inland Montane & Riverine vegetation; **RS –** Roadside; **RSK** - Riverine (Sungai Sekuan); **RSP** - Riverine (Sungai Puak)

**New Record to Sarawak*

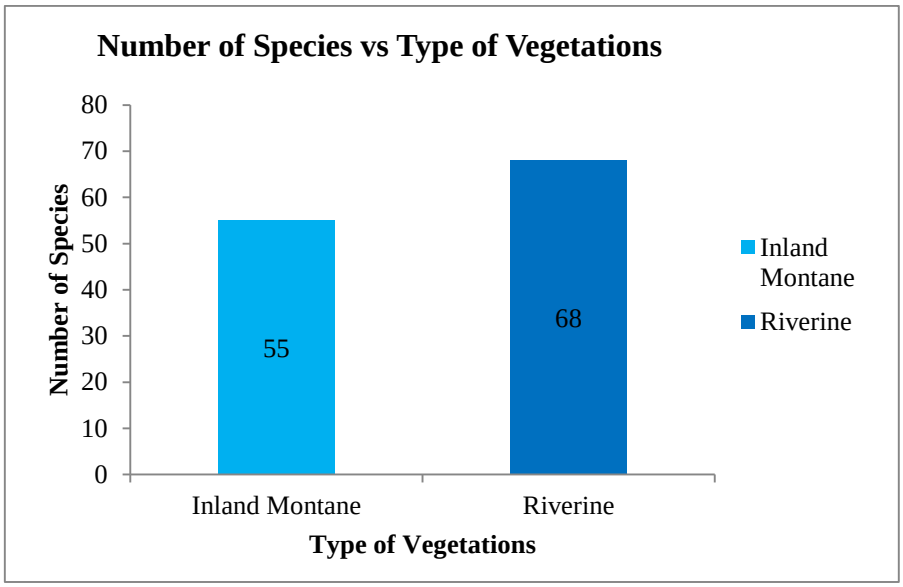

Figure 1 Number of Orchid Species in Different Types of Vegetations

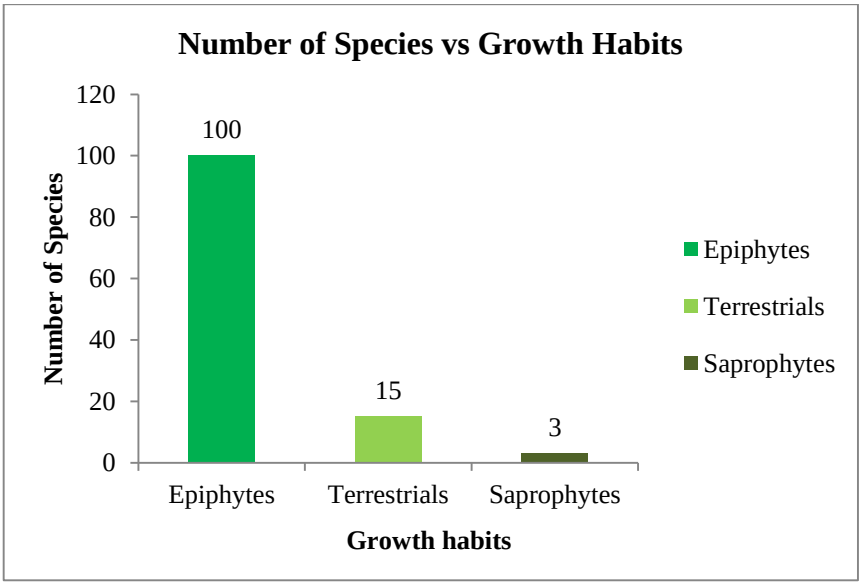

Figure 2 Number of Orchid Species with Different Types of Growth Habits

Discussion

More orchids were found in the riverine forest compared to the inland montane forest (**Figure 1**). Based on the finding, a conclusive idea can be drawn is that the inland forest more susceptible to forest destruction, and the resulted extreme climate change gives more detrimental effect to those inhabitants in the inland forest compared to the riverine forest. The moisture level in the riverine forest is equally ideal as in primary inland forest as it is constantly moisturized by the flowing stream, and the deep shade provided by wide branching of the riverine trees has made environment seems to be favorable for the moisture-lover plant such as mosses, to grow in; and so, do the orchids. The height and size of the riverine trees which the orchids grew in is average; even so, the orchids were abundant.

Certainly, this shows there is no sign that the orchids in the riverine forest is being affected by flood which increases the chance of survival and pollination. Nonetheless, the primary or untouched inland forest is still harboring a great diversity of orchid species. The low temperature during day and night with a high precipitation gives moisture to soil in the inland forest, and not to mention the thick layer of humus that covers the ground which certainly provides the nourishment to the terrestrial orchids as well as the microorganism. This factor led to the discovery of the saprophytic orchids which do not carry chlorophyll and they gain food from the organic matters on the forest floor and through the help of the mycorrhizal fungi. Inclusively, there are still 18 specimens of the discovered orchids are still not being identified to species level yet. This would be most probably because of the lacking in floral structures or otherwise it can be narrowed to a conclusion that these species are new to science. In contrast to the previous studies carried by J.J Wood and P.J. Cribb (first published 1994), T.E Beaman *et al*. (2001), and K.G. Pearce

(2006), 17 species of the collected species are currently not in their records, and these species are listed as the new records for Sarawak.

Conclusion and Recommendation

The collection of 118 orchid species only represents a very small percentage of the total area of Long Banga forest. Even so, 17 species found are listed as the new records for Sarawak including several species within the unidentified specimens with the probability to be pronounced as new species to science. There could be more to be discovered. The low temperature and high humidity level in both of the riverine and inland montane forest provides the fitting environment for the orchids to thrive in. It is very important to keep this pristine environment to be protected to ensure the survival of the precious orchids, and also other organisms. In response to threats to orchid species, the integrated conservation approaches adopted including the Heart of Borneo (HoB) initiative is highly recommended to be continued.

Acknowledgements

We would like to extend our appreciation to the agencies and people who have contributed directly and indirectly towards making the publication possible. First, we would like to acknowledge Universiti Putra Malaysia for providing the funds through the research grant, Sarawak Forestry Department for the invitation and also for the cooperation that have been given in providing us with the logistics, transportations, meals, and guides. Also, we would like to thank the Ketua Kampung of Long Banga and his people upon their blessing and great support during the expedition. We would not be able to explore the forest and come out with the finding without their experience and skills.

PLATE 1 Orchids in inland forest and their habits: A) *Cystorchis stenoglossa*, terrestrial; B) *Aphyllorchis montana*, saprophyte; C) *Gastrodia javanica*, saprophyte; D) *Dendrobium indivisum*, epiphyte; E) *Podochilus lucescens*, epiphyte; F) *Bulbophyllum uniflorum*, epiphyte; G) *Coelogyne* sp., epiphyte; H) *Bulbophyllum* sp., epiphyte; I) *Bulbophyllum* sp., epiphyte; J) *Coelogyne* sp., epiphyte; K) *Oberonia brachystachys*, epiphyte; L) *Liparis elegans*, epiphyte; M) *Agrostophyllum stipulatum* , epiphyte; N) *Plocoglottis javanica*, terrestrial.

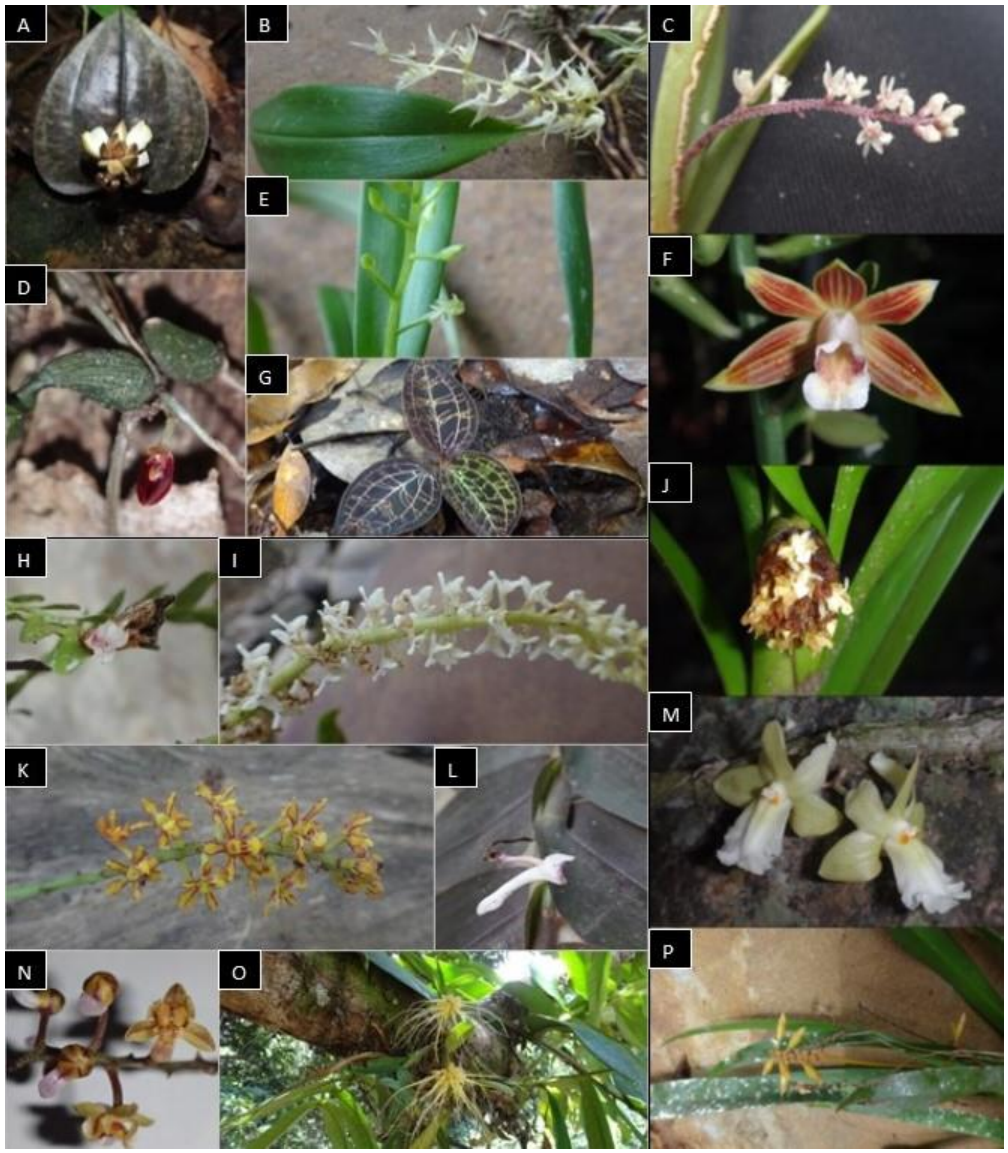

PLATE 2 Orchids in riverine forest and their habits: A. *Nephelaphyllum pulchrum*, terrestrial; B) *Bulbophyllum flavescens*, epiphyte; C) *Bryobium pudicum*, *epiphyte;* D) *Bulbophyllum membranaceum*, epiphyte; E) *Liparis viridiflora*, epiphyte; F) *Phaius indigoferus*, terrestrial; G) *Macodes petola*; terrestrial; H) *Appendicula torta*, epiphyte; I) *Bulbophyllum* sp. J) *Agrostophyllum majus*, epiphyte; K) *Pomatocalpa diffusum*, epiphyte; L) *Appendicula undulata*, epiphyte; M) *Dendrobium roseatum*, epiphyte; N) *Cleisostoma discolor*, epiphyte; O) *Bulbophyllum vaginatum*, epiphyte; P) *Thelasis micrantha*, epiphyte.

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GINGERS OF LONG BANGA, ULU BARAM, SARAWAK

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Abstract

Zingiberaceae species are a diverse group of rhizomatous, aromatic perennial herbs with the centre of diversity in South-east Asia. The Zingiberaceae diversity in the Long Banga, Miri, Sarawak documented in this paper is a result of the survey during the Heart of Borneo (HoB) Scientific Expedition, 20th August to 2nd September 2016. A total of 64 species belong to 11 genera and three tribes were collected and recorded. The tribe Alpinieae represented by seven genera and 26 species predominates followed by the tribe Zingiberaea (three genera, 11 species). The tribe Globbeae is solely represented by Globba with four taxa. Amomum dimorphum *M.F. Newman,* Etlingera brevilabrum *(Val.) R.M. Sm.,* Etlingera coccinea *(Blume) S. Sakai & Nagam.,* Globba atrosanguinea *Teijsm. & Binn.,* Hornstedtia havilandii *(K. Schum.) K. Schum.,* Plagiostachys albiflora *Ridl. and* Zingiber griffithi*i are considered as common.*

Keywords*: gingers, Zingiberaceae, Long Banga, Ulu Baram, Sarawak*

Introduction

Zingiberaceae species are rhizomatous, perennial herbs which are aromatic in any or all of its plant parts. The family Zingiberaceae comprises of

58 genera [includes five recently described genera; *Johalia* C.K. Lim (Lim, 2015), *Kedhalia* C.K. Lim (Lim, 2009), *Perakalia* C.K. Lim (Lim, 2016), *Myxochlamys* and *Newmannia*) and more than 1600 species worldwide with epicenter of species diversity in South-east Asia. Malaysia harbours almost 40% of the world genera and close to 30% of the world taxa (Ibrahim *et al.* 2011). Of these, 20 genera are known to be from Sarawak with over 220 species, includes the genus *Haniffia*, a new geographical record for Sarawak that recently discovered from Kuching Division (Wong *et al.* 2014). Zingiberaceae is diverse in its habit and habitat thriving in shaded forests, in mixed dipterocarp, kerangas, peat swamp, limestone, riverine habitat, secondary forests or alluvial forests with few species in montane and mangrove forests. Majority of the species are terrestrial with some species are occurring as epiphytes on the tree trunks or branches and as well as lithophytes on the rock surfaces.

The Long Banga Scientific Expedition site was located at 2°N and 115.3833°E just near to the Kalimantan border. The areas are mountainous and a majority of the altitudes are more than 400 m above sea level with the highest peaks is between 600–700 m. There is no scientific expedition or botanical excursion has been conducted in the Long Banga areas before, therefore the data of this survey is considered new information from this area. Although there are few scattered reports on the flora from the nearby areas such as Pulong Tau National Park, Linau Selaan Forest Reserve, Usun Apau National Park and the Kelabit Highland areas (including Bario and Gunung Murud), the microclimates of those areas might differs from the Long Banga areas.

Materials and Methods

The field survey was conducted during the scientific expedition from 20th Sept to 2nd Oct 2015. About eight transect trails were surveyed including Sg. Balle. At each locality surveyed, the Zingiberaceae species was recorded and collected for herbarium specimens and photographs were taken; some living collections were also made and planted at UNIMAS greenhouse for *ex-situ* conservation in UNIMAS. The herbarium collection methods were followed by the standard herbarium method by Bridson and Forman (1992). Occasionally at few sites, the ginger species were not collected but recorded as present. Identification of specimens and classifications were based on various keys, monographs and revisions. Duplicates of the herbarium specimens were deposited at the Forest Department Sarawak (SAR). As for the species, which were suspected to be new to science, these were brought back to UNIMAS to be propagated for further investigations.

Results and Discussion

As a total, 64 taxa from 11 genera (Figure 1) and 3 tribes that included 48 identified taxa from 10 genera and 16 unidentified taxa from nine genera were enumerated during the surveys. Of the 30 identified taxa, two are new to science and undergo further investigations (manuscript being prepared). Of the 11 genera encountered from this expedition, *Amomum* has the highest representative with 13 taxa recorded followed by *Etlingera* and *Globba* with 10 and eight species correspondingly. In contrast, *Boesenbergia* and *Etlingera* with 11 species each were the most predominant in the Lanjak Entimau Wildlife Sanctuary (LEWS) and followed by *Amomum* and *Alpinia* with nine and seven species respectively (Ibrahim *et al.* 2011). The tribe *Alpinieae* dominates (7 genera, 26 species) followed by *Zingibereae* (3 genera, 11

species) and the *Globbeae* represented by a single genus, *Globba* with eight taxa recorded.

Etlingera brevilabrum (Val.) R.M. Sm., *E. coccinea* (Blume) S. Sakai & Nagam., *Amomum dimorphum* M.F. Newman and *Hornstedtia havilandii* (K. Schum.) K. Schum. were the most common ginger species recorded by the roadsides and on the hilly slopes of disturbed areas in the Long Banga. Whereas, *Globba atrosanguinea* Teijsm. & Binn., *Plagiostachys albiflora* Ridl. and *Zingiber griffithii* were the most three frequent gingers recorded along with the riverine and shaded areas in the Long Banga. The interesting finding from this expedition is the discovery of two new gingers species; *Plagiostachys* sp. nov. and *Zingiber* sp. nov. The new *Plagiostachys* differ from other taxa by a small stature plant with none mucilaginous inflorescence and yellow flowers. Furthermore, the leaflets are narrow unicostate and presence of stilt roots, appearances similar to certain species of genus *Amomum* and *Geostachys.* Whilst the new *Zingiber* is also small size ginger and very attractive with numerous fusiform spikes.

The number of Zingiberaceae species recorded in this expedition was the second highest after the LEWS among the five surveyed areas in HoB Project. The different climatic environments probably one of the factors that influence the number of gingers recorded in this area higher than other places. Almost half of the gingers here were found in the secondary forests or disturbed areas while other places such as Ulu Sungai Mentawai, Payeh Maga and Ulu Baleh National Park were preponderance in the primary forests. In addition, most of the gingers species in Sarawak are flowering during the period between March – April and September – October (Ibrahim *et al.* 2011). Therefore, without flowers and fruits, it is almost difficult to identify even up to genus level except

with prominent characters such as *Zingiber*. All members in the genus *Zingiber* readily distinguished from others by the reddish colour of lowermost of pseudostem and pulvinus petiole.

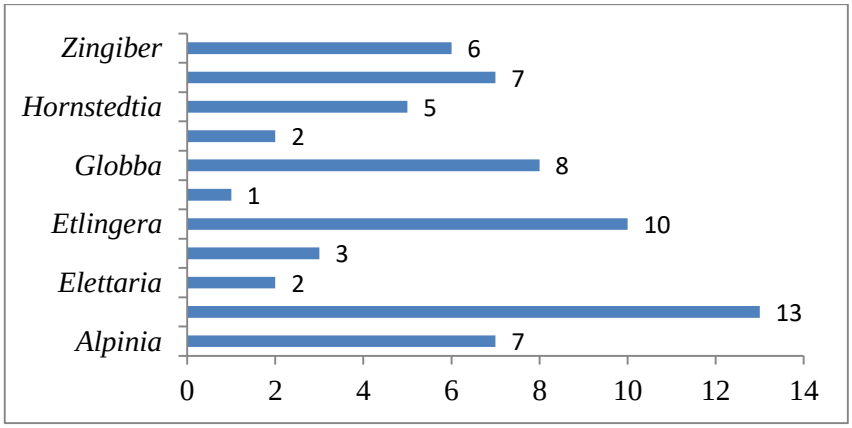

Figure 1: Number of species for each genus (Zingiberaceae) recorded from Long Banga areas.

Within a short survey period, we still managed to collect more than 60 gingers taxa, which indicate that the Long Banga is rich with gingers species. The number of gingers recorded accounting for 55% of the total genera and about 32% of species recorded for Sarawak. Compares with other localities within the HoB areas, the LEWS was the most diverse with 83 species from 15 genera followed by Long Banga and Paya Maya with 64 and 55 species respectively (Figure 2).

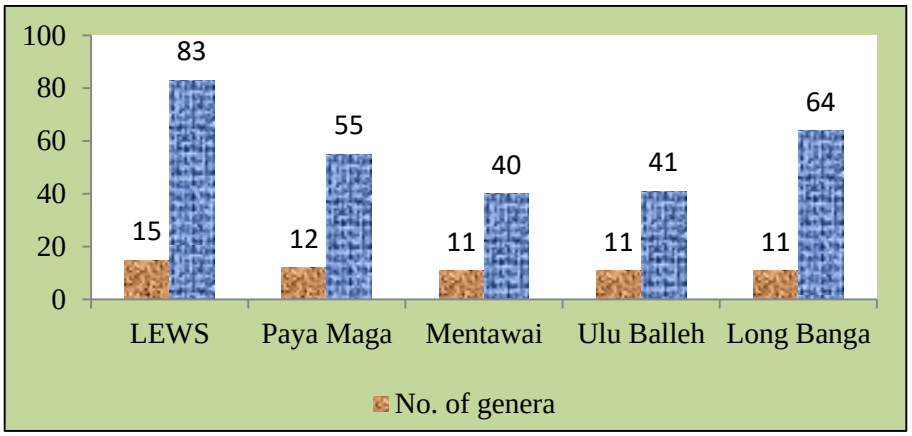

Figure 2: comparison of diversity of gingers in the Heart of Borneo areas.

Conclusion

It has become very clear during the study that the diversity of gingers in the Heart of Borneo (HoB) Sarawak is very rich and new gingers species can still be encountered. This shows that there are still lots to be done and learnt about the family Zingiberaceae in Sarawak. It is estimated that the number of gingers in Sarawak might be reaching more than 250 species (current enumeration is 220 species) with many areas are yet to be explored.

Acknowledgement

The authors would like to thank the organizer of the 2016 Long Banga Scientific Expedition, the Forest Department of Sarawak (FDS) and for Universiti Malaysia Sarawak (UNIMAS) for the facilities, accommodations and supports. Thanks also to Ahmad Ampeng, Ishak Hashim, Marzuki Bujang for theirs helps in the field. Not forgetting the local guides who helped us, Mr. Joseph Lawing, Mr. Elia and Mr. Johnny. Sincere thanks to Mr. Sapuan Ahmad, Prof Emeritus Dato Dr Haji Mohamed Abdul Majid and Prof Syukor Mohd Noor.

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Appendix 1. The List of Gingers from the Long Banga, Ulu Baram, Miri, Sarawak

Alpinia cf. aquatica (Retz.) Roscoe
Alpinia beamanii R.M. Sm.
Alpinia glabra Ridl. var. *glabra*
Alpinia ligulata K. Schum.
Alpinia nieuwenhuizii Valeton
Alpinia sp.6
Alpinia sp.7

**Amomum anomalum* R.M. Sm. – [genus *Sulettaria*]
**Amomum borealiborneense* I.M. Turner – [genus *Sundamomum*]
**Amomum calyptratum* S. Sakai & Nagam. – [genus *Sundamomum*]
**Amomum dimorphum* M.F. Newman – [genus *Sulettaria*]
**Amomum durum* S. Sakai & Nagam. – [genus *Sundamomum*]
**Amomum laxisquamosum* K. Schum. – [genus *Sundamomum*]
**Amomum cf. longipenduculatum* R.M. Sm. – [genus *Sundamomum*]
**Amomum aff. uliginosum* Ridl.
**Amomum hansenii* R.M. Sm. – [genus *Sundamomum*]
**Amomum* sp.10
**Amomum* sp.11
**Amomum* sp.12 (*A. hansenii* R.M. Sm.?)
**Amomum* sp.13

Elettaria kapitensis S. Sakai & Nagam.
Elettaria sp.2 (probably *E. longituba* (Ridl.) Holttum)

Elettariopsis kerbyi R.M. Sm.
Elettariopsis sp.2 (corrugated leaves)
Elettariopsis sp.3 (broad leaves and pungent smell)

Etlingera barioensis A.D. Poulsen
Etlingera brachychila (Ridl.) R.M. Sm.
Etlingera brevilabrum (Valeton) R.M. Sm.
Etlingera coccinea (Blume) S. Sakai & Nagam.
Etlingera elatior (Jack) R.M. Sm.
Etlingera foetens (Blume) R.M. Sm.
Etlingera longipetiolata (B.L. Burtt & R.M. Sm.) R.M. Sm.
Etlingera rubromarginata A.D. Poulsen & Mood
Etlingera velutina (Ridl.) R.M. Sm.
Etlingera sp.10 (probably *E. baramensis* S. Sakai & Nagam.)

Geostachys sp.1

Globba atrosanguinea Teijsm. & Binn.
Globba brachyanthera K. Schum.
Globba franciscii Ridl.
Globba muluensis R.M. Sm.
Globba propinqua Ridl.
Globba pumila Ridl.
Globba tricolor (Ridl.) R.M. sm.
Globba sp.8

Hedychium borneense R.M. Sm.
Hedychium muluense R.M. Sm.

Hornstedtia havilandii (K. Schum.) K. Schum.
Hornstedtia phaeochoana (K. Schum.) K. Schum.
Hornstedtia scyphifera (J. Koenig) Steud.
Hornstedtia pininga var. *borneense* R.M. Sm.
Hornstedtia sp.5

Plagiostachys albiflora Ridl.
Plagiostachys bracteolata R.M. Sm.
Plagiostachys crocydocalyx (K. Schum.) B.L. Burtt & R.M. Sm.
Plagiostachys roseiflora Julius & A. Takano
Plagiostachys strobilifera (Baker) Ridl.
Plagiostachys sp. nov.
Plagiostachys sp.7

Zingiber martinii R.M. Sm.
Zingiber pachysiphon B.L. Burtt & R.M. Sm.
Zingiber pseudopungens R.M. Sm.
Zingiber sp. nov.
Zingiber sp.5 (small ginger with broad leaves – probably *Z. griffithii* Baker)
Zingiber sp.6

**segregated into few genera, based on current classification (de Boer et al. 2018).*

DIVERSITY OF *AMOMUM* ROXB. (ZINGIBERACEAE) IN LONG BANGA, ULU BARAM, SARAWAK*

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Abstract

Borneo is the third-largest island in the world and rich in flora and fauna. Particularly, Sarawak is a home for more than 200 gingers species with more than 30 percent are endemic. Among many genera, Amomum is the largest genus in Sarawak with more than 30 species recorded. Under the Heart of Borneo Project, a scientific expedition was conducted at Long Banga, Ulu Baram from 22nd August to 2nd September 2016. This study aims to collect and record the diversity of the genus Amomum from the Long Banga area. The surveys were conducted along the six established trails in the scientific expedition site. Only the fertile specimens that bearing flowers or fruits or both were collected for herbarium specimen for further verification. A total of 14 species were collected and recorded in the Long Banga area with Trail Sungai Balleh was the most diverse with Amomum species.

Keywords*: Amomum, Zingiberaceae, Long Banga, Sarawak, Heart of Borneo*

** Current classification has segregated Amomum species into few genera based on the molecular and field evidences – editors.*

Introduction

Zingiberaceae is the largest family in the order Zingiberales with 53 genera and approximately 1600 known species of aromatic perennial herbs with creeping horizontal or tuberous rhizomes. They are distributed throughout tropical Africa, America and Asia with the epicenter of species diversity believed to be Southeast Asia. Being the third largest island and a home for one of the oldest forest in the world, Borneo is very rich with flora and fauna. Among the common plants found in every corner in the island are the ferns, orchids, palms and gingers. There are 20 genera and more than 220 species of gingers have been recorded from Sarawak with *Etlingera*, *Amomum*, *Hornstedtia* and *Zingiber* are the commonest genera found.

The genus *Amomum* Roxb. consists of 150 – 180 species, is the second-largest genus after *Alpinia* Roxb. in Southeast Asia (Xia *et al.* 2004). The generic name *Amomum* was originated from two Greek words, "*a*" mean without and "*momos*" mean harm, *without harm,* probably referring to Indian spice plant (Meekiong *et al.* 2017). Latest account by Lamb *et al.* (2013) listed about 30 *Amomum* species were recorded from Borneo. However, the genus is still poorly studied, particularly in Sarawak. The existence information is relied on excellent documentation by Smith (1982, 1986 and 1989) and by Sakai and Nagamasu (1998) and since then, this ginger group is almost neglected. During our field excursions for the *Amomum* of Sarawak Project, we encountered more than 30 taxa and hence we estimated that the number for Sarawak probably reach 50 taxa. This paper is to report the diversity of *Amomum* species recorded from the Long Banga areas

Materials and Methods

Study Site

The study was conducted at the Long Banga, Ulu Baram (2ºN 115.3833ºE) near the Kalimantan border (Indonesia). The area is mountainous with the majority are more than 430 m altitudes. The surveys were conducted at eight trails established by the Sarawak Forest Department. The areas surveyed included old secondary forest, kerangas forest, logged-over and riparian habitats.

Methodology

Plant collections were made during the Long Banga scientific expedition (22nd August to 2nd September 2016) with field notes and photographs. Only fertile samples (bearing fruits or flowers or both) were collected and examined. Specimens processing followed methods recommended in Bridson and Forman (1992). Voucher specimens were deposited in the Herbarium of Universiti Malaysia Sarawak (HUMS). Living plants were brought back and planted in the greenhouse of Universiti Malaysia Sarawak for germplasm and further verification.

Identification

Species were identified according to the current morphological species concept. The identification was carried out in the HUMS and Herbarium of Sarawak Forest Department (SAR) and available references.

Results and Discussion

A total of 14 species of *Amomum* were recorded during the Long Banga Scientific Expedition (Table 1). However, only six specimens were identified up to species level and the rest were can not be verified due to incomplete

specimens (no inflorescences) or unable to identify due to lacks of references and poor herbarium specimens condition in the herbaria.

Table 1: List of *Amomum* collected in Long Banga

Species	Location
A. anomalum R.M. Sm.	Trail 5
A. calyptratum S. Sakai & Nagam.	Trail 7
A. durum S. Sakai & Nagam.	Sg. Balle
A. dimorphum M.F. Newman	Sg. Balle, Trail 5
A. flavoalbum R.M. Sm.	Trail 15, Trail 16
A. hansenii R.M. Sm.	Trail 16
Amomum sp.2 (? *A. borealiborneense*)	Trail 15
Amomum sp.5 (?*A. laxisquamosusm*)	Trail 17
Amomum sp.6	Trail 17
Amomum sp.8 (*aff. A. uliginosum*)	Trail 1
Amomum sp.10 (*cf. A. longipenduculatum*)	Sg. Balle
Amomum sp.11 (*aff. A. sceletescens*	Sg. Balle
Amomum sp.12	Sg. Balle
Amomum sp.13	Sg. Balle

Amomum can be distinguished by its unique characteristics. It has elongating inflorescence, absence of involucre sterile bracts, the uniform, fairly large and often persistent but never thick floral bracts, usually tubular bracteole, broad yellow and white labellum with small red markings. The

anther crest is usually distinctly trilobed. It also has two distinct types of fruit, capsulate and fleshy spiny berry (Holttum, 1950).

Among the species found were includes *A. calyptratum* S. Sakai & Nagam., *A. durum* S. Sakai & Nagam. and *A. dimorphum* M.F. Newman which were encountered in Lambir National Park by Sakai and Nagamasu (1998). *Amomum calyptratum* can be distinguished by its open bracteole and a lanceolate rather than the clawed and bilobed labellum. Large labellum (functions as a platform) and orange color of the flower attracts pollinators such as *Amegilla* bees to pollinate. The most interesting character for *A. dimorphum* is that it has two kinds of flowers; hermaphrodite and male on the same inflorescence. Thus, epithet "*dimorphum*" was given to this species. ‘

Plate 4 shows a large showy, brown colour fruits of *A. durum* which is a remarkable characteristic for this species. It can easily be recognized even though there is no flower present. *Amomum durum* has a hard and rough surface of the fruit wall. As reported by Sakai and Nagamasu (1998), *A. durum* has a common flower of *Amomum*, creamy white flower and it is pollinated by halictid bees.

Plate 1: *A. calyptratum* inflorescence

Plate 2: *A. dimorphum* inflorescence

Plate 4: *A. durum* infructescence

Plate 5: Surface features of *A. durum* infructescence

Plate 3: *A. dimorphum* infructescence

Other than that, we discovered *A. hansenii* R.M. Sm. where the type location is in Ulu Belaga, 7th Division of Sarawak. The most outstanding

characteristics for *A. hansenii* is it spines tipped bracts of the inflorescence similarly to *A. pungens* R.M. Sm. However, *A. pungens* has a quite large inflorescence, lanceolate rather than linear leaves when compared to *A. hansenii*. The flowers of *A. hansenii* are white flower with yellow at the median of the labellum. In addition, *A. anomalum* R.M. Sm. also has its unique characteristic where the fruits are olive-shaped with brown colour. Besides, the fruit also develops simultaneously where its flower differs with other species in *Amomum*. This species widely distributed in Sarawak and Sabah where it can be found at a higher elevation, 1350 m at Crocker Range (Lamb *et al.* 2013).

Plate 6: *A. hansenii* inflorescence

Plate 7: *A. anomalum* infructescence

Furthermore, Plate 8 and 9 shows *A. flavoalbum* R.M. Sm. and *Amomum* sp. 6 where both showed similar morphologically characteristics. Nevertheless, a preliminary investigation on the anther crest and stigma indicated that the two species differed (Plate 10 and Plate 11). However, some

of the species are yet to be identified since there is no enough information for identifications. For example, *Amomum* sp.12 was mistakenly identified as *A. longipenduculatum* R.M. Sm. at first, as they have a similar type of fruit, fleshy fruits with persistent calyx. But, the shape of fruit for *A. longipedunculatum* (rounded with persistent calyx) is distinct from *Amomum* sp. 12 (a conical shape with persistent calyx). Additionally, during field observations, it is noted that *Amomum* sp. 12 has wax at the pseudostem similar to *A. oliganthum* K. Schum.

Plate 15: *Amomum* sp. 12 infructescence

Plate 16: Waxy pseudostem of *Amomum* sp. 12

Plate 17: *Amomum* sp. 8 infructescence

Interestingly, we found a species with *rambutan*-liked fruit type at the Trail 1. Somehow, we cannot identify it to lower rank due to insufficient data (no flowers were collected during the trip). This type of fruit is commonly found in the northern part of Peninsular Malaysia and the southern part of

Thailand. According to C.K Lim (*via pers. comm.*), he believed that this species is allied to *A. uliginosum* J. Koenig, which can be found in aforementioned regions.

Conclusion

With 14 taxa recorded, *Amomum* diversity in the Long Banga areas is considered as rich which is about 46.7% from the total number reported from Borneo. Due to the flowering season has over; many specimens collected only with fruits which difficulty to identify up to lower rank. More field works are needed to get comprehensive data on the genus *Amomum* from this area.

Acknowledgement

Special thanks to Sarawak Forest Department, the organizers of Long Banga Scientific Expedition 2016 for giving us the opportunity to participate in this expedition. Thanks also to local people of Long Banga and Long Peluan (Ilya, Joseph, Johnny and Elton Parran) who helps us during the expedition. Thanks also due to Universiti Malaysia Sarawak for facilities, accommodation and support. Sincere thanks to Hanirol Ahmad Sah and Mohd Izzudin.

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NOTES ON *MAPANIA LATIFOLIA* UITTIEN (CYPERACEAE) FROM LONG BANGA, SARAWAK

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Abstract

Cyperaceae is one of the largest family in the Monocotyledon plant group consisting of 106 genera and approximately 5600 species throughout the world. Mapania *is among the important understory genus in this family. To-date about 40 species of* Mapania *have been recorded for Sarawak that includes 13 newly described species.* Mapania latifolia *is one of four species with foliaceous involucral bract recorded in Southeast Asia and its distributed in Peninsular Malaysia and Borneo. This species tends to show tremendous variations among the populations from different elevations and localities. This preliminary study is to investigate the variation of M. latifolia from Long Banga and to compare it with the collections from other places in the Heart of Borneo project areas.*

Keywords*: Mapania latifolia, Cyperaceae, Long Banga, Heart of Borneo, Sarawak, Borneo*

Introduction

The genus *Mapania* Aublet is an important element of the understory ecosystem in tropical rainforests of Borneo. Borneo represents higher diversity with 40 species recorded including 13 newly described species found in

Sarawak (Miraadila, 2018). This genus is broadly distributed in tropical regions, occurring in Central and South Amerika, Western and Central Africa, Seychelles, parts of tropical Asia, Malesia, the Pacific Islands and northern Australia (Simpson, 1992). Genus *Mapania* which comprises 86 species worldwide (Shabdin *et al.*, 2013; Govearts *et al.* 2007) belong to Cyperaceae, the sedges family.

Mapania latifolia was first described by Uittien in 1935 based upon the specimen collected by Richards from Mount Dulit, Long Kapa, Miri (Uittien, 1935). This species was unique among all the Sarawak's species by the only species that have leafy bract, was analysed and discussed in this paper.

Materials and Methods

The surveys were conducted along the transects and riverine of Sungai Buta.

Results and Discussion

A total of 20 specimens were collected from Long Banga areas that consisting of seven species including *M. latifolia* and one unidentified species (new species, closed to *M. palustris*).

The Species

***Mapania latifolia* Uittien, Fig. 1**

Rec. Trav. Bot. Neerl. 32 (1935): 199. Type: MALAYSIA, Sarawak, Miri Division, near Long Kapa, Mount Dulit, 31 Aug 1932, *Richards 1556* (holo: K).

Description: Robust, stoloniferous. *Culm* solitary, erect, central, 20–42 cm x 1.8–4.2 mm, trigonous to subtriquetrous, angular, densely scabrid-pubescent particularly near apex, green. *Leaves* basal, up to 100 cm or more long; leaf-blade linear-oblong or oblong, 21–57 x 3–5.6 cm, apex abruptly narrowed, broadly obtuse to rounded, cuspidate, base abruptly narrowed into pseudopetiole, coriaceous, mid-green, 3-nerved, secondary nerves indistinct, flat in cross-section, indistinctly septate-nudulose when dry, margins entire to scabrid near apex; pseudopetiole 21–33 x 0.4–1 cm; sheath lanceolate, 8–11.5 x 1.7–2.4 cm, apex ± abruptly narrowed, coriaceous, dull reddish. *Involucral bracts* 3, foliaceous, linaer-oblong or oblong, ovate-lanceolate to lanceolate, 2.5–22 (-102) x 1–6.8 cm, basal bracts longest, apex abruptly narrowed, cuspidate, spreading, coriaceous, mid-green, margins scabrid, the longest bracts with a pseudopetiole 6–6.5 x 1 cm. *Inflorescence* terminal, ± globose, 2.5–4 cm wide, dark brownish, with 9–30 or more spikes; spikes elliptic, 1.3–1.7 x 0.4 cm, acute, distinct; spicoid bracts oblong, 7–7.5 (-8) x 1.8–3.3 mm, obtuse to ± rounded, coriaceous, dark reddish-brown, fringed with short hairs around apex, nerves indistinct; floral bracts 6, free, lowest 2 bracts linear, 7–8 (-8.5) x 1–1.8 mm, acute or truncate, mid- to dark reddish brown, keel wingless, densely hispid, upper bracts linear, 7.2–8 (-8.5) x 0.5–0.8 mm, acute or truncate, glabrous, flat; staminate flowers 3 per spicoid, anthers linear-oblong, 1.4–2 mm long, cream, filaments up to 8.5 mm long; stigma branches 3; style 4–4.4 mm long, dark reddish-brown. *Fruit* ellipsoid to ovoid, 2.8–5 x 1.9–2.3 mm, apex apiculate, base stipitate; exocarp succulent, thin, without sculpturing, dull mid- to dark brown, costae absent.

Ecology and Distribution: undisturbed lowland mixed dipterocarp forest, frequently found in damp and wet places near to the streams or river banks. Endemic to Borneo, widely distributed in the island.

Notes: Without inflorescence, this species could be mistakenly identified as *Mapania cuspidata* as it also having petiolate leaves but with inflorescence, this species easily recognize because of the presence lower foliage bracts.
Conservation status: Not threatened, common in the primary lowland mixed dipterocarp forests.

Discussion

Specimens of *M. latifolia* from various collection within the Heart of Borneo project (including in herbaria) were compared. Generally, the plant appearances, particularly the length of petiole and number of spikes per inflorescence showed significantly difference among the populations and locations. The specimens from a higher altitude (400 m above sea level) tend to have longer petioles (range 30 – 55 cm long) and high number of spikes per inflorescence (20 – 50, or more). For example, specimens collected from Sg. Buta (Long Banga) was the longest petiole among the specimens with an average length 50 cm long and great number of spikes, average 45 spikes per inflorescences.

Whereas, the plants from lower altitudes (below 400 m above sea level) having shorter petioles (c. 15 – 33 cm) and the low number of spikes per inflorescence (10 – 25). For instance, specimens collected from Lanjak Entimau Wildlife Sanctuary were the shorter petioles with average 25 cm long and low number of spikes, average 18 spikes per inflorescences.

The intraspecific variations of *M. latifolia* need to be further investigated as many characteristics showed distinctive measurement, number and colouration. It is suggested that the study should be ing abroad as this species also occur in Peninsular Malaysia.

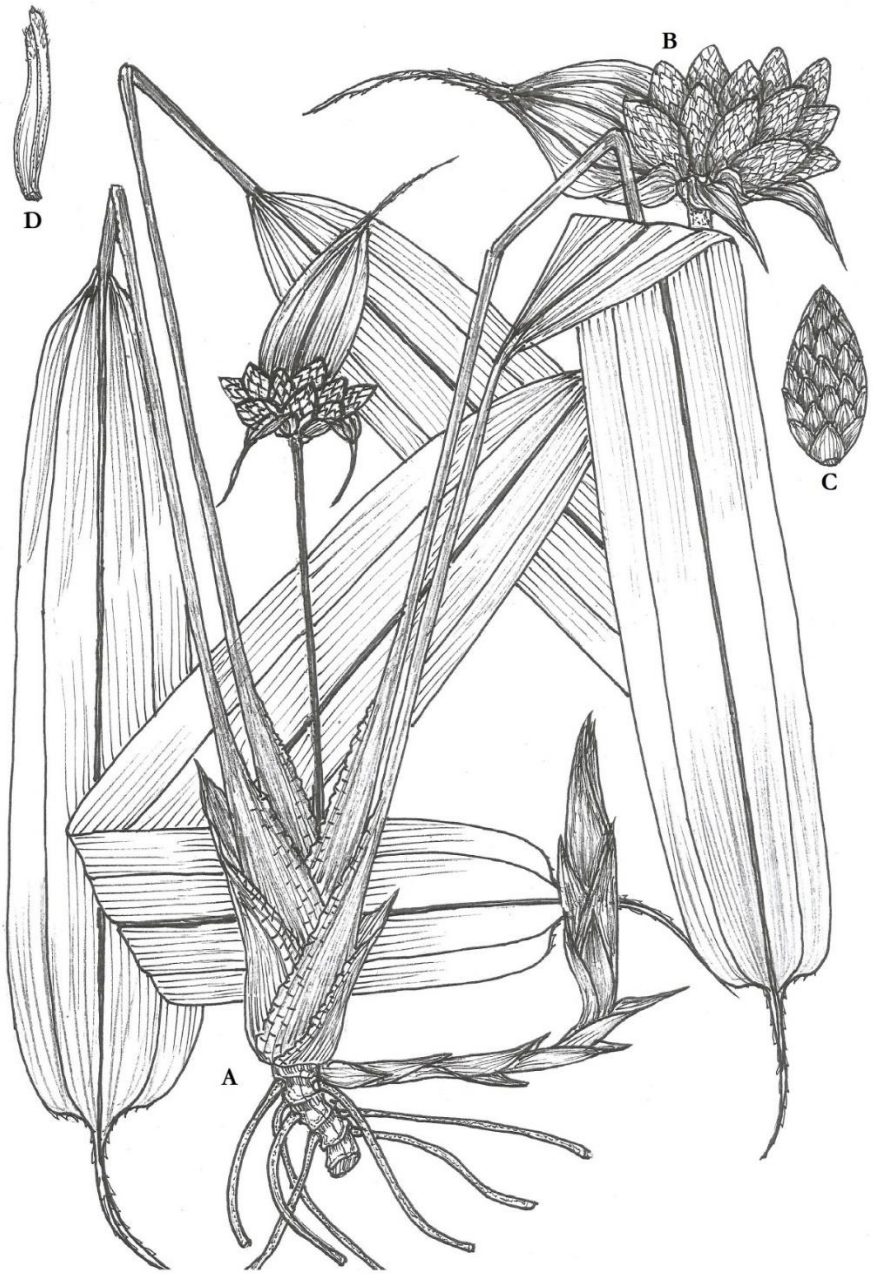

Figure 1. ***Mapania latifolia*** Uittien. **A**: whole plant and habit; **B**: inflorescence, capitate capitulum with foliage bract; **C**: spike; **D**: unopened spicoid [Drawing by Meekiong, K.].

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NOTES ON THE *RIZANTHES LOWII* (BECC.) HARMS. (RAFFLESIACEAE) FROM LONG BANGA

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Abstract

The family Rafflesiaceae is a parasitic plant consisting of three genera, Sapria and Rizanthes, and the biggest flower in the world, genus Rafflesia. During the Long Banga Scientific Expedition, the surveys were conducted in almost all transects/trails to record the occurrence of any members of Rafflesiaceae in the areas. Only one species of Rizanthes was recorded with healthy populations from two transects/trails (approx. 100 buds). The presence of Rizanthes lowii in the areas indicates the forest of Long Banga is still undisturbed. A brief taxonomic description is included herein.

Introduction

The family Rafflesiaceae, is a parasitic family consisting of three genera, viz. *Sapria* (1 species), *Rafflesia* (28 species) and *Rhizanthes* (3 species). The genus *Mitrastemon,* previously was a member of Rafflesiaceae, has been separated as an owned family, Mitrastemonaceae. The genus *Rafflesia* is chiefly conferred and almost well documented, while the other two sister genera are not much discussed due to a smaller number of species and specific geo-location. *Sapria,* is a rare genus but widely distributed in the eastern Himalayas (from India eastward to Indo-China and part of China. Currently,

four species have been reported, viz. *S. himalayana, S. myanmarensis, S. poilanei* and *S. ram*

The flower of the parasitic genus, *Rhizanthes* Dumortier is still poorly known as the only comprehensive revision of the genus was done about 30 years ago. Lots need to be learnt about this medusae-like appearance flower, such as taxonomic, ecology and pollination.

Rizanthes lowii (Becc.) Harms

In *Fedde, Rep.* 36: 287 (1934); *Brugmansia lowii* [sic] Beccari, *Atti Soc. Ital. Sci. Nat.* 11: 198 (1868); *Rizanthes lowi* (Becc.) Harms, emend. Meijer, *Blumea* 33: 337 (1997); Bazinger, *Nat. Hist. Bull. Siam Soc.* 43: 337 (1195); 44: 113 (1996); *Rizanthes lowii* [sic] (Becc.) Harms: Meijer, *Fl. Males.* 13: 39 (1997); Banziger & Hansen, *Nat. Hist. Bull. Siam Soc.* 48: 126 (2000).

Description **(male flower)**: Bud circumference at anthesis 150–220 mm (average 190 mm). Flower unisexual. Tepal 80–140 mm long, 8–21 mm wide, caudal appendages 70–90 mm long (total span of flower – include cauda: 245–435 mm). Basal $^{1}/_{3}$–$^{2}/_{3}$ of tepal length covered by bristles which sparsely set, denser opposite globular head. Tuft hairs 6 – 10 mm long (or longer up to 14 mm long). Distal $^{1}/_{3}$–$^{2}/_{3}$ of tepal length covered by strongly branched, ramenta 0.5–1.5 mm long, 23–92 mm long. Column 12–18 mm, style 4–8 mm high and 10–15 mm wide; globular head 6.8–8.2 mm, ampulla wall 7–7.8 mm, diameter 17–23 mm. Colour of tepal base brownish radial lines, gradually darker, brownish to reddish-brown with whiteish speckles, caudal appendages reddish brown.

Discussion

Rizanthes lowii is an endemic species to Borneo. It widely distributed throughout the island, in Brunei, Kalimantan, Sabah and Sarawak. This species is a common species in the lowland of mixed dipterocarp forests, hill forest and limestone habitat, particularly on damp and wet places, near to the streams or rivers.

Two healthy populations were recorded from the Long Banga scientific expedition areas (approx. 100 buds). The buds and flowers recorded were slightly larger from populations from Lanjak Entimau Wildlife Sanctuary (LEWS) and from Dered Krian National Park (Gunung Ropih – Meekiong, *pers. com*), but all the characteristics are similar. It was also observed that the buds were eaten by the wild boars and rats (maybe due to the striking colour, reddish brown that similar to the jungle fruits). The populations in Long Banga are the new record for the Murud complex areas.

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Bud approx. 2–3 weeks

(left) matured bud (approx. 23 – 25 weeks) (right) rotten buds

Rizanthes lowii - full bloom after 1 day

REPORT FOR LONG BANGA, UPPER BARAM, SARAWAK

Project title: Documentation of selected higher plants in Long Banga, Ulu Baram, Sarawak.

Project Objective(s)

1. Documentation and inventory of selected higher plants (trees) in Long Banga, Ulu Baram, Sarawak; and
2. Generate preliminary checklist of general flowering and fruiting trees.

Scope

Inventory of selected trees in Long Banga, Ulu Baram, Sarawak (especially Actinidiaceae, Sapotaceae, and Ericaceae) and general flowering and fruiting trees.

Introduction

Long Banga is in the complex areas of Heart of Borneo rainforest, as a third largest of stretch in rainforest in South East Asia. The flora survey during Scientific Expedition Long Banga, Ulu Baram was carried out between August to September 2016 in mixed dipterocarp forest which extended to lower montane with the highest altitude 1,200 m asl. The area had not been botanically explored before, and this expedition provided a great opportunity not only to collect general flowering and fruiting sample, but also to find any interesting plants in Long Banga.

Methodology

Field trip

a) Study site: Long Banga, Ulu Baram, Sarawak with different type of vegetation

b) Duration: from 21st August – 2nd September 2016

c) Detailed specimens' collection;

(i) All specimens collected were made as herbarium specimen and were kept in Herbarium Sarawak (SAR) and Herbarium Kepong (KEP), FRIM; and

(ii) Field observations and photography record - To capture growth habits such as morphological characters, habitat, ecology and distribution data, and to obtain photographic record.

Specimen identification

All collections were identified in the Herbarium Forest Research Institute Malaysia (FRIM) and Sarawak Herbarium by using the key characters in the reference books, comparing the specimens with the authenticated herbarium collections and discussion with plant experts.

Results

- A total of 165 collections of trees and treelets which includes 155 species in 53 genera and 35 families, were collected during the expedition.
- About 15 collections of *Saurauia* (Actinidiaceae), with approximately five identified species has been collected during the expedition in a different trails of Long Banga.
- There are still species pending to identify into the species level due to no herbarium specimen in KEP herbarium to do a comparison.
- Two papers has been published:
  a) Syahida-Emiza, S., Syazwani, A., Rafidah, A.R., Nor-Ezzawanis, A.T. & Ummul-Nazrah, A.R. 2018. Heart of Borneo: Exploring the beauty of Long Banga, Sarawak. Conservation Malaysia Bulletin 28: 1–3.

b) Ummul-Nazrah, A.R., Rafidah, A.R., Syahida-Emiza, S., Syazwani, A., Nor-Ezzawanis, A.T., Fakhrullah-Haziq, H., Mohd. Hairul, M.A. & Angan, A. 2017. A Preliminary Checklist of Selected Tree/Treelet from Long Banga, Marudi, Sarawak. A paper presented at Seminar Heart of Borneo Scientific Expedition Long Banga, Sarawak, 3-4 May 2017, Hotel Imperial Kuching, Sarawak.

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Saurauia cf. *hooglandii*

Saurauia planchonii

List of specimens collected from Long Banga expedition

prefix	number	family	species	trail
FRI	82114	Actinidiaceae	*Saurauia planchonii*	Trail 8
FRI	82117	Actinidiaceae	*Saurauia planchonii*	Trail 12
FRI	82146	Actinidiaceae	*Saurauia planchonii*	Trail 16, Sg Puak
FRI	82150	Actinidiaceae	*Saurauia subcordata*	Trail 16, Sg Puak
FRI	82151	Actinidiaceae	*Saurauia planchonii*	Trail 16, Sg Puak
FRI	82163	Actinidiaceae	*Saurauia cf. hooglandii*	Trail 8
FRI	82169	Actinidiaceae	*Saurauia cf. hooglandii*	Trail 15
FRI	82182	Actinidiaceae	*Saurauia cf. hooglandii*	Trail 9
FRI	82199	Actinidiaceae	*Saurauia planchonii*	Off-trail, near Sungai Puak
FRI	66974	Actinidiaceae	*Saurauia* sp.	Trail Sungai Puah (to Trail 16)
FRI	66990	Actinidiaceae	*Saurauia* sp.	
FRI	86339	Actinidiaceae	*Saurauia tewensis*	Trail 5
FRI	83836	Actinidiaceae	*Saurauia planchonii*	Trail 8
FRI	83853	Actinidiaceae	*Saurauia planchonii*	Trail 12
FRI	83862	Actinidiaceae	*Saurauia* sp.	Villagers trail

ALPINIA OF HEART OF BORNEO, SARAWAK

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Abstract

This paper reports on the diversity of genus Alpinia *in the Heart of Borneo (HoB), which were recorded at five selected localities, namely Lanjak Entimau Wildlife Sanctuary (LEWS), Long Banga, Mentawai (Mulu National Park), Payeh Maga and Ulu Baleh National Park (UBNP). A total of fourteen taxa have been recorded with three undetermined taxa. The known species are;* A. amentacea, A. aquatic, A. beamanii, A. epiphytica, A. glabra *var.* glabra, A. glabra *var.* reticulata, A. hansenii, A. havilandii, A. ligulata, A. nieuwenhuizii, *and* A. tamacuensis. *The LEWS and Long Banga had the highest species recorded with eight and seven species respectively. Mentawai with five species, UBNP (4 species) and Payeh Maga had the lowest* Alpinia *species recorded with only two species. Most of the* Alpinia *species were commonly found along forest margins, wetlands and along with water courses which altitude below 800m.* Alpinia. aquatica *which have been recorded from Long Banga area at an altitude above 800 m was considered has a new altitudinal record for this species. All species that being found were endemic in Sarawak except for* A. havilandii *that was found at UBNP, was a new record for Sarawak. This species was originally described and recorded only from Sabah. The Sarawak HoB areas was considered rich with* Alpinia *with 14 taxa were recorded.*

Keywords: *Heart of Borneo, Sarawak, Alpinia, Zingiberaceae*

Introduction

Alpinia is the largest genus in the ginger family with approximately 230 species throughout the world. The genus is named after Prospero Alpino, a 17th-century Italian botanist who specialized in exotic plants (Poulsen, 2006). These species mostly occur in tropical and subtropical climates and are native to Asia, Australia and the Pacific Islands. Species of the genus are known generally as ginger-lilies. There are 14 species of *Alpinia* was currently recorded in Sarawak such *as A. amentacea, A. epipphytica, A. aquatic, A. argentea, A. beamanii, A. capitellata, A. glabra, A. hansenii, A. ligulata, A. martini, A. microlophon, A. nieuwenhuizii, A. ptychanthera, and A. tamacuensis*. However, the number of *Alpinia* species might be increase as many taxa are still in-determination and many areas are yet to be explored.

Generally, *Alpinia* plants can grow up to 3 m tall and growing in clumps at lowland to highland forests. Rhizomes of this species are usually fleshy and bearing horizontal leafy shoots. Leaves are either elliptic to elliptic-oblong, asymmetric, with or without petiole between blade and sheath, with well-developed ligules. The surfaces of the leave are either hairy or glabrous, some with stiff-hairs at the margin, apex usually acuminate-caudate, and the leaf base is mostly cuneate, while a few are cordate (Holttum, 1950). The flowers of *Alpinia* are very conspicuous and having variable colours such as white, pink, maroon, or yellowish with streaks or spots on the labellum. It is normally arranged in cincinni in the axil of primary bracts, with or without secondary bracts (Larsen *et al.*1999).

Materials and Methods

Field surveys were conducted by the second author at five different localities including Lanjak Entimau Wildlife Sanctuary (LEWS), Mentawai

(Mulu National Park), Payeh Maga, Ulu Balleh National Park (UBNP) and Long Banga from the year 2008 until the recent Scientific Expedition in 2016. At each area surveyed, the *Alpinia* species were recorded and collected as herbarium specimens and photographed. The herbarium collection was prepared following the standard herbarium methods by Bridson and Forman (1992). Identification of specimens was conducted at the Forest Department of Sarawak Herbarium (SAR) and Herbarium of Universiti Malaysia Sarawak (HUMS) and from books, monographs and available literature.

Results and Discussion

From the surveys 11 *Alpinia* taxa viz. *A. amentacea, A. aquatic, A. beamanii, A. epiphytica, A. glabra var. glabra, A. glabra var. reticulate, A. hansenii, A. havilandii, A. ligulata, A. nieuwenhuizii,* and *A. tamacuensis* and three undetermined species (*Alpinia* sp.12 sp. nov, *Alpinia* sp.13 and *Alpinia* sp. 14 were recorded and enumerated. There were eight species from LEWS, and seven, five, two and four species respectively from Long Banga, Mentawai (Mulu National Park), Payeh Maga and UBNP (Table 1).

Table 1: *Alpinia* species recorded at five different localities

Species	LEWS	Long Banga	Mentawai, Mulu National Park	Payeh Maga	UBNP
Alpinia amentacea	√				
*Alpinia aquatic***		√	√		
Alpinia beamanii	√	√			
Alpinia epiphytica	√				

Alpinia glabra var. *glabra*	√	√	√	√	√
Alpinia glabra var. *reticulata*	√				√
Alpinia hansenii	√				
*Alpinia havilandii**					√
Alpinia ligulata		√	√		
Alpinia nieuwenhuizii	√	√	√		√
Alpinia tamacuensis			√	√	
Alpinia sp.12 (sp. nov.)	√				
Alpinia sp.13		√			
Alpinia sp.14		√			
Total	**8**	**7**	**5**	**2**	**4**

Most of the *Alpinia* species were commonly found along forest margins, wetlands and along with watercourses which altitude below 800m above sea level. However, *A. aquatica* which have been recorded from Long Banga area at the altitude above 800 m was considered as a new altitudinal record for this species. All species that being found were endemic in Sarawak except for *A. havilandii* that was found at UBPNP, was a new record for Sarawak. This species was originally described and recorded only from Sabah. A total of 14 taxa recorded made the HoB areas considered as rich with *Alpinia*. It is believed that the number of *Alpinia* taxa might be increasing as the Heart of Borneo Project is still ongoing and many areas are still being yet to be explored.

Plate 1: *Alpinia amantaceae*

Plate 2: *Alpinia epiphytica*

Plate 3: *Alpinia aquatica*

Plate 4: *Alpinia glabra* **var.** *glabra*

Plate 5: *Alpinia beamanii*

Plate 6: *Alpinia havilandii*

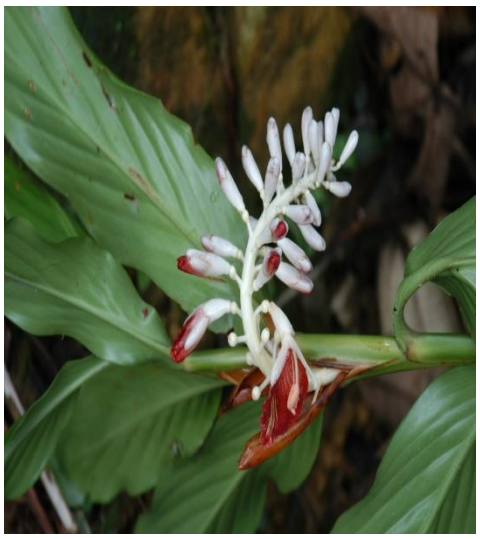

Plate 7: *Alpinia hansenii*

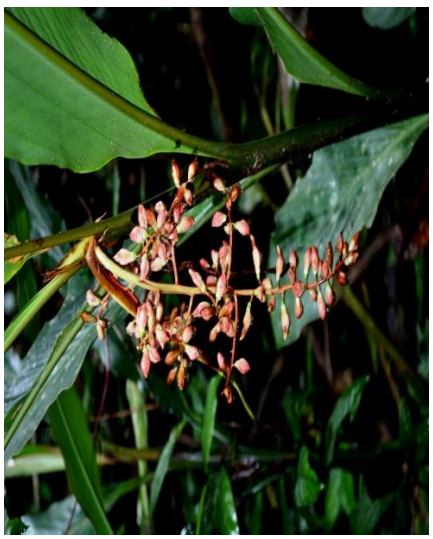

Plate 8: *Alpinia ligulata*

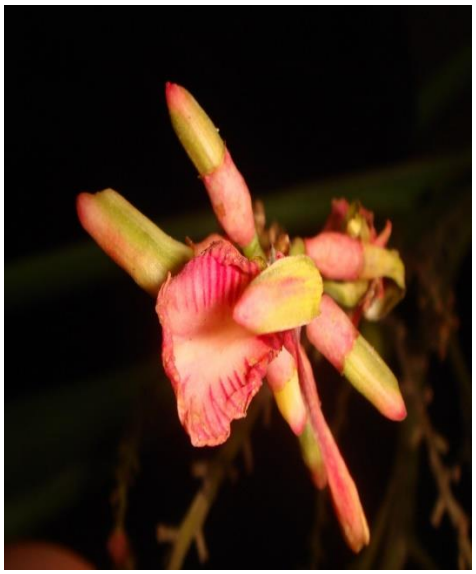

Plate 9: *Alpinia niuewenhuizii*

Plate **10:** *Alpinia* sp.12 (sp. nov)

Plate 11: *Alpinia tamacuensis*

Acknowledgement

We would like to thank the committee of the Heart of Borneo (HoB) Initiative Project who invited us to join the Scientific Expeditions since 2008 until the latest 2016. We also would like to extend our gratitude to the Universiti Malaysia Sarawak (UNIMAS) and Forest Department Sarawak (FDS) for the facilities and accommodations. Special thanks to the staffs of Faculty of Resource Science and Technology, Research Development and Innovative Department (RDID, FDS) and the local peoples who helped during the expeditions.

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COMPARISON ON THE OCCURRENCES OF THE GENUS *MAPANIA* AUBLET (CYPERACEAE) FROM THE HEART OF BORNEO (HoB)

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Abstract

A comparison on the occurrences of the genus Mapania, family Cyperaceae from four selected areas of the Heart of Borneo (HoB) Project; namely Lanjak Entimau Wildlife Sanctuary (LEWS), Ulu Mentawai, Mulu National Park (UMMNP), Ulu Baleh National Park (UBNP) and Long Banga, Ulu Baram, Miri were conducted from the year 2008 until 2016. A total of 29 taxa representing by 24 species and 3 in-determined species were collected and identified from the four selected areas. The number recorded was considered high with 58.5% of the total number recorded for Sarawak. Only three taxa, viz. M. cuspidata var. cuspidata, M. meditensis *and* M. palustris *were recorded occurred in all four selected sites. Whilst,* M. sapuniana, M. ballehensis, M. kipas *and* M. mirae *were identified as hyper-endemic;* M. sapuniana *from LEWS and the following three were from UBNP.*

Keywords*: Cyperaceae, Mapania, Lanjak Entimau Wildlife Sanctuary, Ulu Mentawai Mulu National Park, Ulu Balleh National Park, Long Banga*

Introduction

Cyperaceae is the third largest family in the monocotyledons and seventh-largest family in the angiosperms with 106 genera and 5387 species (Govaerts *et al.* 2007; Shabdin & Meekiong, 2012). They form a huge morphologically diverse, geographically widespread, and economically important family (Naczi, 2005). The genus *Mapania* first described by Aublet in 1775 and allies form one of the two branches at the base of the Cyperaceae phylogenetic tree (Shabdin & Meekiong, 2012). This genus is widely distributed in tropical regions from Central and South America, Western and Eastern Africa, Seychelles, parts of tropical Asia, Indonesia, Malaysia, the Pacific Islands and Northern Australia (Simpson, 1992; Meekiong *et al.* 2011). The *Mapania* species are an important component of the herb layer in tropical rainforests and is valued as an ethnobotanical plant for the indigenous folks. Several *Mapania* species are known to be used in basket and mat-making, while others are known to local people for medicinal purposes such as fever remedy.

Simpson (1992) recorded only 25 species from Sarawak with 12 of them are endemic. Subsequently, Shabdin *et al.* (2013a, 2013b) added two species, *M. sapuaniana* and *M. multiflora* and followed by another two species by Shabdin *et al.* (2016) and Miraadila and Shabdin (2016); *M. kadimiana* and *M. meekiongii* respectively to make a total of 29 species for Sarawak. Later, Miraadila *et al.* (2016a, 2016b) added another 11 new species and one new record into the list to make a total of 40 species. Current account for the genus *Mapania* is comprising of 122 species worldwide and the greatest diversity in the genus occurs in Borneo of which 70% of the total number of species are endemic (Miraadila *et al*. 2016a). However, knowledge on the *Mapania* in

Borneo, particularly the pastoral forests of the so-called the Heart of Borneo areas of Sarawak is limited due to lack of studies.

Materials and Methods

Mapania samples were collected from Lanjak Entimau Wildlife Sanctuary (LEWS) during the recce trips and scientific expedition in 2008; from Ulu Mentawai (including Ulu Sg. Mendalam) of Mulu National Park (UMMNP) in 2012 expeditions, from Ulu Baleh National Park (UBNP) in 2015 scientific expedition and Long Banga in a recent expedition (2016). The samples were identified in the Sarawak Forestry Department Herbarium (SAR), Herbarium of Universiti Malaysia Sarawak (HUMS) and books, monographs and other available references.

Results and Discussion

A total of 29 taxa representing by 24 species and three in-determined species were collected and identified from the four selected areas of the HoB project areas. The number recorded was considered high with 70% of the total number recorded for Sarawak. List of the species and comparison on the occurrences of the species from the four selected areas were showed in Table 1. The number of *Mapania* from Long Banga was the lowest among the four selected sites with only seven species recorded compared with UBNP with ten species, UMMNP and LEWS with 15 and 16 respectively. The occurrences however, show great variances within the four locations. Out of 29 total taxa, only three taxa were recorded to be occurred in all locations, viz. *M. cuspidata* var. *cuspidata, M. meditensis* and *M. palustris.* Whilst four of the species were recognized as hyper-endemic; *M. sapuaniana* only recorded from Sg. Joh of the LEWS and *M. ballehensis, M. kipas* and *M. mirae* from UBNP.

Field observations suggest that the number of *Mapania* species from the two locations, UBPNP and Long Banga are lower compared to LEWS and UMMNP because of environmental factors. Most of the surveyed areas in both locations were either old secondary forests or disturbed due to the logging activities. While the LEWS and UMMNP were pristine and undisturbed forests. The results support that the *Mapania* species are herbaceous dwelling well in the deep shaded or damp and humid places near streams or river bank of undisturbed forests. Another factor that might influence the number of species is the altitudinal factor. LEWS and UMMNP were considered lowland with most of the surveyed areas were positioned below 400 m altitudes, whereas UBPNP and Long Banga were located above 400 m altitudes.

However, it is presumed that an altitudinal might as well play a role of species differentiation. For example, four species from the UBPNP, *M. angustifolia, M. ballehensis, M. kipas* and *M. mirae* were collected at above 400 m altitudes and never encountered below.

It was concluded that the occurrences of the genus *Mapania* from the four selected localities of the HoB areas were considered diverse and high density with 24 species out of 41 total numbers of species recorded in Sarawak (Appendix 1). We strongly believed that the number of species from the HoB areas probably higher as many places is yet to be surveyed.

Table 1: Comparison on occurrences of the *Mapania* species from four selected areas in the Heart of Borneo (HoB Project); Long Banga, LEWS UMMNP and UBNP.

***Mapania* species**	**Long Banga**	**UMMNP**	**LEWS**	**UBNP**
M. angustifolia Uittien				√
M. ballehensis Miraadila, Shabdin & Meekiong				√
M. bancana (Miq.) Benth. & Hook.f. ex B.D. Jackson		√		
M. borneensis Merr.			√	
M. caudata Kuk	√			√
M. cuspidata (Miq.) Uitten var. *angustifolia*		√	√	
M. cuspidata (Miq.) Uitten var. *cuspidata*	√	√	√	√
M. cuspidata (Miq.) Uitten var. *petiolata*		√	√	
M. debilis C.B. Clarke ex Ridl.		√		
M. enodis (Merr.) C.B. Clarke			√	
M. hispida D.A. Simpson		√		
M. kipas Miraadila, Shabdin & Meekiong*				√
M. latifolia Uitten	√	√	√	
M. longiflora C.B. Clarke			√	
M. meditensis D.A. Simpson	√	√	√	√
M. mirae Shabdin & Meekiong*				√

M. monostachya Uitten		√		√
M. obscurifolia D.A. Simpson			√	
M. palustris (Hassk. ex Steud) F.-Vill. var. *palustris*	√	√	√	√
M. richardsii Uitten			√	
M. sapuaniana Shabdin*			√	
M. squamata (Kurz.) C.B. Clarke	√			
M. sessilis Merr.		√	√	
M. sumatrana (Miq.) Benth. ssp. *pandanophylla* (F. Muell.) D.A. Simpson			√	
M. tenuiscapa C.B Clarke		√		
M. wallichii C.B. Clarke		√	√	√
Mapania sp. nov.1 (*closed to M. palustris*)	√			
Mapania sp.42			√	
Mapania sp.43		√		
Total No. of species	**7**	**15**	**16**	**10**

Acknowledgement

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A PROVISIONAL ACCOUNT OF THE ORCHIDS OF THE ULU BALEH NATIONAL PARK, KAPIT, SARAWAK

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Abstract

The diversity of orchids was surveyed at several localities in the Baleh National Park, in Southeast Sarawak adjacent to the international border between Malaysia and Indonesia (Kalimantan). A total of 75 species, representing 36 genera, was collected. Most of the species were epiphytic. Terrestrial species included Bromheadia finlaysoniana, Corymborkis veratrifolia, Plocoglottis acuminata *and the saprophytic* Lecanorchis malaccensis. Arundina graminifolia *and* Dendrobium hosei *were very common.*

Keywords: *orchids, Ulu Baleh National Park, diversity*

Introduction

The Baleh National Park lies in Southeast Sarawak, adjacent to the international border between Malaysia and Indonesia (Kalimantan). A Scientific Expedition to the UBNP is a part of Heart of Borneo (HoB) Initiative Project. The HoB is a project by the tri-lateral nations that share the island of Borneo; Brunei Darussalam, Indonesia and Malaysia. The primary focus of this project is to protect the heart of Borneo rainforests; the single largest stretch of rainforest left standing in South East Asia, the third largest rainforest on earth and perhaps the most diverse with biological

(Meekiong *et al*. 2017). A study conducted in the national park had the objective of producing an inventory of the orchid species in the area.

Materials and Methods

Study Area

The study area was the Baleh National Park in Southeast Sarawak, adjacent to the international border between Malaysia and Indonesia (Kalimantan). The area includes elevations up to 810 m a.s.l. and is mostly covered by degraded hill mixed dipterocarp and secondary forest after logging and includes alluvial forest in low-lying areas and flood plains as well as riverine habitats.

A team comprising members of Universiti Malaysia Sarawak (UNIMAS) and the Institute of Biodiversity and Environmental Conservation, UNIMAS, collected orchids at random along and near streams in the national park area, covering an area of approximately eight km^2, from November 12 to 21 2015. Orchid habitats and specimens were also photographed. Standard herbarium collection methods (Bridson & Forman, 1992) were used and specimens deposited at the Herbarium of Universiti Malaysia Sarawak (HUMS). Taxa were identified concerning the collections at the Forest Department Sarawak Herbarium (SAR) and Herbarium of Universiti Malaysia Sarawak (HUMS) and the literature, specifically Vermeulen (1991), Seidenfaden and Wood (1992), Chan *et al*. (1994), Wood (1997) and Wood (2003).

Results and Discussion

Henry Nicholas Ridley published the first enumeration of the orchids of Borneo, listing 160 species from Sarawak (Ridley, 1896). Ames (1921) added 130 species to make a total of 290 species from Sarawak. Later, Wood and Cribb (1994) published a checklist of orchids of Borneo including 676 taxa from Sarawak. The most recent checklist of orchids of Sarawak (Beaman *et al*. 2001) added a further 343 taxa to make a total of 1,019 taxa for Sarawak.

The provisional list of orchid taxa from the Baleh National Park area in this paper is based on the field survey and observations during the Ulu Baleh Scientific Expedition 2015 and as well as reports in the literature (e.g. Beaman *et al*. 2001; Hose, 1893; Mjoberg, 1925).

The field survey at the Baleh National Park resulted in the collection of a total of 75 species, representing 36 genera (about 6% of Sarawak's orchids). The most specious genus in the proposed national park area was *Bulbophyllum,* with eight species, followed by *Coelogyne* and *Dendobium,* each with seven species and *Agrostophyllum* and *Eria* with five and four species, respectively. Twenty-two genera were represented by a single species each.

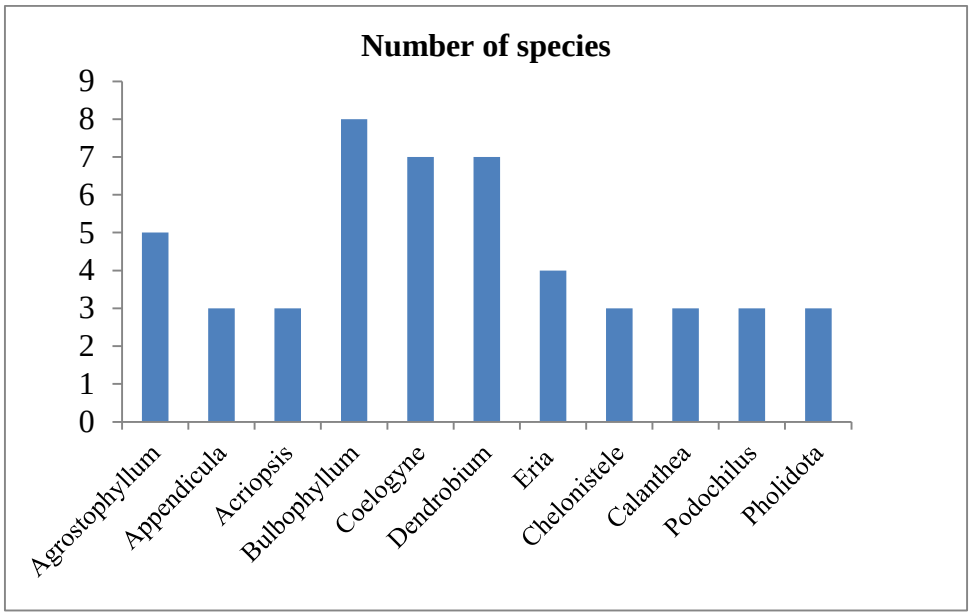

Figure 1. The eleven most specious orchid genera recorded in the park area

The cooler and more humid stream habitats (up to about 10 m from the river) exhibited a richer diversity of orchids than non-stream habitats. Many epiphytic orchids grow on tree trunks and branches by the streams, along with many other epiphytic plants including ferns and mosses. *Dendrobium hosei*, epiphytic orchid with white flowers and a sweet scent, was blooming on branches along the streams. Another epiphytic orchid found at most of the stream sites was *Grammatophyllum speciosum*, the giant or tiger orchid, that can grow up to 2 m and bear 20 to 30 flowers on a single inflorescence.

The non-stream habitats, being slightly drier and warmer, supported fewer orchid species. Most of the orchids found in this habitat were terrestrial species such as *Plocoglottis acuminata*, *Collabium simplex* and *Corymborkis veratrifolia*. Most of the terrestrial orchids were growing on sandy soil covered with humus and dead leaves. A fascinating saprophytic

orchid, *Lecanorchis malaccensis*, which has no leaves but only an inflorescence and infructescence, was found at riverbanks on a shaded slope.

Conclusion

The Baleh National Park exhibits a very rich orchid diversity, with 6% of Sarawak's orchid species and many yet to be described taxa. The national park must be preserved to minimize the disturbance or destruction of the habitat of the surviving species. The number of orchid taxa in Sarawak is still increasing as many areas yet to be surveyed, particularly areas in the central and southern parts of Sarawak.

Acknowledgements

We would like to thank Universiti Malaysia Sarawak the (UNIMAS), Forest Department of Sarawak (FDS) and Institute of Biodiversity and Environmental Conservation (IBEC) (UNIMAS) for facilities and accommodation during the expedition. Thanks also go to Sarawak Energy Berhad (SEB) and the World Wildlife Fund (WWF- Malaysia) for the support provided. Appreciation is also due to the management and staff of the Honour Elite Camp and the local people involved in the expedition and all UNIMAS and IBEC staff.

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List Orchid species recorded from the Baleh National Park

***Acriopsis* Blume**

A. densiflora Lindl. var. *borneensis* (Ridl.) Minderh. & de Vogel
A. liliifolia (J. Koenig) Seidenf. var. *liliifolia*
A. liliifolia (J. Koenig) Seidenf. var. *auriculata* (Minderh. & de Vogel) J.J. Wood

***Agrostophyllum* Blume**

A. cyathiforme J.J. Sm.
A. glumaceum Hook. f.
A. laterale J.J. Sm.
A. stipulatum (Griff.) Schltr. subsp. *bicuspidatum* (J.J. Sm.) Schuit.
A. tenue J.J. Sm.

***Appendicula* Blume**

A. alba Blume
A. cornuta Blume
A. cristata Blume

***Arundina* Rich.**

A. graminifolia (D. Don) Hochr. var. *graminifolia*

Ascidiera

A. longifolia (Hook. f.) Seidenf.

***Bromheadia* Lindl.**

B. alticola Ridl.
B. finlaysoniana (Lindl.) Miq.
B. graminea Kruiz. & de Vogel

***Bulbophyllum* Thouars**

B. disjunctum Ames & C. Schweinf.
B. hirtulum Ridl.
B. laxiflorum (Blume) Lindl.
B. succedaneum J.J. Sm.
B. uniflorum (Blume) Hassk.
Bulbophyllum sp.6
Bulbophyllum sp.7
Bulbophyllum sp.8

***Calanthe* R. Br.**

C. kemulensis J.J. Sm.
C. pulchra (Blume) Lindl.
C. speciosa (Blume) Lindl.

***Chelonistele* Kraenzl.**

C. amplissima (Ames & C. Schweinf.) Carr
C. brevilamellata (J.J. Sm.) Carr
C. sulphurea (Blume) Pfitzer var. *sulphurea*

***Coelogyne* Lindl.**

C. asperata Lindl.
C. compressicaulis Ames & C. Schweinf.
C. echinolabium de Vogel

C. gibbifera J.J. Sm.
C. monilirachis Carr
C. moultonii J.J. Sm.
Coelogyne sp.7
***Collabium* Blume**
C. simplex Rchb.f.
***Corymborkis* Thouars.**
C. veratrifolia (Reinw.) Blume
***Dendrobium* Sw**
D. bifarium Lindl.
D. connatum (Blume) Lindl.
D. corallorhizon J.J. Sm.
D. crumenatum Sw.
D. hosei Ridl.
Dendrobium sp.6
Dendrobium sp.7
***Dendrochilum* Blume**
D. longipes J.J. Sm.
D. simplex J.J. Sm.
***Dilochia* Lindl.**
D. rigida (Ridl.) J.J. Wood
***Dimorphorchis* Rolfe**
D. lowii (Lindl.) Rolfe var. *lowii*
***Epigeneium* Gagnep.**
E. geminatum (Blume) Summerh.
***Eria* Schltr.**
E. farinosa Ames & C. Schweinf.
E. hyacinthoides (Blume) Lindl.
E. javanica (Sw.) Blume
E. robusta (Blume) Lindl.
Flickingeria* A.D. Hawkes
F. luxurians (J.J. Sm.) A.D. Hawkes
***Grammatophyllum* Blume**
G. speciosum Blume
***Lecanorchis* Blume**
L. malaccensis Ridl.
***Liparis* Rich.**
L. gibbosa Finet
***Macodes* Lindl.**
M. petola (Blume) Lindl.
***Mischobulbum* Lindl.**
M. scapigerum (Hook. f.) Schltr.
***Nephelaphyllum* Blume**
N. aureum J.J. Wood

***Nervilia* Comm. ex Gaudich.**
N. borneensis (J.J. Sm.) Schltr.
***Phalaenopsis* Blume**
P. maculata Rchb. f.
***Pholidota* Benth.**
P. gibbosa (Blume) Lindl. Ex de Vriese
P. sulcata J.J. Sm.
***Plocoglottis* Blume**
P. acuminata Blume
P. borneensis Ridl.
***Podochilus* Schltr.**
P. lucescens Blume
P. marsupialis Schuit.
P. microphyllus Lindl.
***Robiquetia* Gaudich.**
R. pinosukensis J.J. Wood & A.L. Lamb
***Spiranthes* Rich.**
S. sinensis (Pers.) Ames
***Thecopus* Seidenf.**
T. maingayi (Hook. f.) Seidenf.
***Vanilla* Plumier ex Mill.**
V. abundiflora J.J. Sm.
***Vrydagzynea* Blume**
V. albida (Blume) Blume
***Zeuxine* Lindl.**
Zeuxine sp.

*current classification under the genus *Dendrobium*

SMALL MAMMALS AND PRIMATES OF TAMA ABU PERMANENT FOREST, MIRI, SARAWAK

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Abstract

Small mammal and primates survey were conducted at Tama Abu Permanent Forest (PF), Miri from 14th until 24th of August 2017. This survey aimed to record the diversity of small mammals (particularly from the Order Chiroptera, Insectivora, Rodentia and Scandentia) and primates. Standard trapping methods for small mammals were carried out using four of the four-bank harp traps, 10 four-shelf mist-nets, and 95 cage traps. Primates survey was done using line transect. Overall, this survey recorded 11 species of small mammals and a species of primate throughout the 11 sampling days. Order Chiroptera was recorded with the highest number of species (six families; 9 species), followed by Order Rodentia (one species) and order Scandentia (one species). The most abundant species was set by Hipposideros cervinus *(n=34) from the Order Chiroptera. Data presented in this survey is the first list of Tama Abu's small mammals and primates. This data provide insights into the population trends at the regional and local scale that can assist in preparing management plans for Tama Abu PF.*

Keywords: *Chiroptera, Diversity, Insectivora, Primate, Rodentia, Scandentia*

Introduction

Being the largest state in Malaysia, Sarawak is covered by more than 80% of the forest. This geographical feature contributed to the high

biodiversity of plants and animals (Jason & Shozon, 2013). Many unique species had been discovered, however, there are more to be explored. Tama Abu PF (3.5603° N, 115.3269° E) which is located in the rural area of Miri Division, Sarawak is one of the biodiversity hotspots (Cranbrook, 2008). To date, only selected biological data has been collected from the area. However, nothing is known about the mammalian diversity from the area except for the adjacent area known as Long Banga. Location of Tama Abu PF within the Upper Baram Range that is close to the Indonesian border with logging road access using 4wd vehicle pose a great challenge to a biologist to reach to this area and conduct biological surveys. The Scientific Expedition to the Heart of Borneo (HoB) program in Tama Abu PF has become a good platform to enable researchers from the various field of studies to collect biological data and provides the information needed by the authorities for a better management strategy of the biological resources and species conservation in Tama Abu PF, Sarawak.

Methodology

Study area

Tama Abu PF is a mountainous area which located near to Long Banga, Raan Ngela, and Long Aar local settlements. The distance of Tama Abu PF is approximately 130 km away from Miri town. It is only accessible by using four-wheel drive vehicles and takes about 10 hours to reach the area from Miri town. Tama Abu PF is mainly covered by a primary forest and surrounded by secondary forest. However, the area seems to be affected by massive forest clearance due to logging activities. Thus, the study was only focusing on the primary forest and the adjacent areas of Tama Abu.

The sampling sites were divided into eight transects which covered with primary mixed dipterocarp forest at the edge of the mountains.

Trapping methods

A total of 10 units of four-shelf mist-nets and four of the four-bank harp traps were used to trap the volant small mammals (bats). Mist-nets and harp traps were set at potential bat flyways across trails, small streams and near water-bodies along Trail 5, 6, 8 and near the campsite. The mist-nets and harp traps were checked every 15 minute intervals from 1830 until 2130 hours and at 0630 hours on the following morning. The traps were relocated every two days to avoid habituation and increase chances to capture unrecorded species. Additionally, hand nets were used to capture bats found at their roosting sites under the rock boulders and on the tree branches. Meanwhile, a total of 95 cage traps were used to capture non-volant small mammals which include rodents and scandents. Cage traps were baited with either banana or salted fish and deployed along trail 5 and 6 with the 3m interval between each trap. It was checked twice a day at 0900 and 1700 hours and the bait were changed every two days. As for primates, surveys were carried out using line transects along Trail 1, 3, 4, 5, 6 and 8. Species were identified through sighting and vocalization.

Sample collections and identification

Captured individuals were identified using keys from Payne et al. (2007) and Phillipps and Phillipps (2016). The standard morphological measurements of small mammals were measured using a digital caliper and weighed using Pesola scales. Bats age stages were identified by observing the epiphyseal – diaphyseal fusion on metacarpals (Kunz & Parsons, 1988).

Species representatives were euthanized using chloroform and preserved in 70% ethanol as wet voucher specimens. Tissue samples from vouchers specimens (liver and pectoral muscle) were extracted and preserved in 95% ethanol. The wet voucher specimens were deposited in UNIMAS Zoological Museum. Duplicate samples for Sarawak Forest Department were also collected and deposited in Research, Development, and Innovation Division (RDID) laboratory.

Results and Discussion

A total of 11 species of small mammals comprised of three Orders (Chiroptera, Rodentia, and Scandentia) from eight genera and a species of primate were recorded in this survey (Table 1). Out of the total, nine species of bats were recorded. One species each from the Order Scandentia and Rodentia were recorded representing the non-volant small mammals. Only one Primate species from the family Hylobatidae sighted during the survey. Among all the species encountered, four species are Bornean endemic which are *Hipposideros dyacorum*, *H. sabanus*, *Rheithrociurus macrotis* and *Hylobates funereus*.

Volant small mammals (Bats)

A total of five families of bats (Order Chiroptera) were documented; namely Emballonuridae, Hipposideridae, Pteropodidae, Rhinolophidae, and Vespertilionidae. The highest number of species was recorded from family Hipposideridae (four species), followed by Pteropodidae (two species). Family Rhinolophidae, Emballonuridae, and Vespertilionidae was recorded with one species each. *Hipposideros cervinus* (family: Hipposideridae) is the most abundant species with 34 captured individuals (64.15%), followed

by *Emballonura alecto* (family: Emballonuridae) with four captured individuals (7.54%). There were three species recorded as singletons namely, *H. dyacorum*, *H. sabanus* and *R. trifoliatus*. From the nine bats species listed, seven species were listed as Least Concern and two species as Near Threatened in the IUCN Red List.

The record *of H. sabanus* is a highlight of this survey as it is a rare species in Borneo with a very little information on its distribution in Sarawak. This species is also known as *Hipposideros doriae* (Peter, 1871) with the common name as a Bornean leaf-nosed bat and can easily be distinguished from other species from the family of Hipposideridae owing to lack of septa on the posterior noseleaf (Payne et al. 2007). This species has an extensive record throughout Borneo, which includes Crocker Range, Brunei, Lawas, Mount Penrissen and at both Central and East Kalimantan. Recent capture in Tama Abu PF proves that this species can be found in a less disturbed primary forest. Being a rare species of forest roosting bat, this mammal is believed to continue decline due to logging activities, forest fires, and transformation of forest into agricultural land. Since this species is showing diminishing population trend, attention should be given to manage and conserve this species as it is a forest-dependent bat.

Non-volant small mammals

The non-volant small mammals sampling recorded only two species each from Order Rodentia and Order Scandentia. Only a species from Order Rodentia (*Sundamys muelleri*) was caught in cage traps from Trail 5. Our survey at Trail 1, recorded *Rheithrociurus macrotis* through sighting. It is a noteworthy finding from Tama Abu PF and also a highlight of this survey.

This Tufted Ground Squirrel can be identified easily from its bushy tail as it is unique for the species (Phillipps & Phillips, 2016). However, this species is rare and can only be found in hill forest. This species was previously recorded in Pulong Tau, Gunung Penrissen, and Usun Apau in Sarawak and records in Tama Abu PF will serve as a new record for this species in Sarawak.

Primate

The primate survey recorded only one species with a sighting of the North Borneo Gibbon (*Hylobates funereus*) from Trail 5. The Hylobates *funereus* is listed as Endangered in IUCN Red List of Threatened Species. This species is a diurnal and monogamous primate that lives in a small family group. Generally, gibbons are the second most common primates after langurs found in the virgin forest. The North Borneo Gibbon is well known for having largest range among other gibbons in Borneo. In Sarawak, the species range is recorded to be along the Batang Lupar River, Samunsam and Lanjak Entimau (Phillipps & Phillipps, 2016). The occurrence of this species in Tama Abu will be another new record for Sarawak. Their main diet on fruits has made them become a good seed disperser (McConkey, 2000). The loud territorial call of this species indicates their refusal in leaving its territories unoccupied (Phillipps & Phillips, 2016).

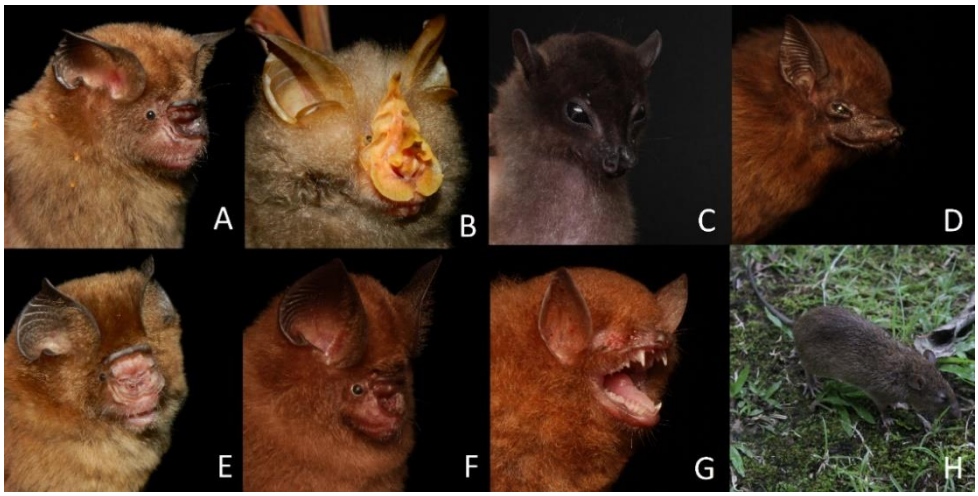

Fig. 1: Species photo (A: *Hipposideros cervinus*, B: *Rhinolopus trifoliatus*, C: *Balionycteris maculata*, D: *Emballonura alecto*, E: *Hipposideros galeritus*, F: *Hipposideros dyacorum*, G: *Kerivoula intermedia*, H: *Sundamys muelleri*).

Table 1. List of species recorded in Tama Abu PF, Miri.

#	Order	Species	IUCN Red List	No. of individuals
1.	Chiroptera	*Balionycteris maculata*	LC	2
2.		*Macroglossus minimus*	LC	2
3.		*Hipposideros cervinus*	LC	34
4.		*Hipposideros galeritus*	LC	3
5.		*Hipposideros dyacorum*	LC	1
6.		*Hipposideros sabanus*	NT	1
7.		*Rhinolopus trifoliatus*	LC	1
8.		*Emballonura alecto*	LC	4
9.		*Kerivoula intermedia*	NT	2
10.	Rodentia	*Sundamys muelleri*	LC	1
11.	Scandentia	*Rheithrociurus macrotis*	VU	1
12.	Primates	*Hylobates funereus*	EN	1
			Total no. of individuals	53

**LC=Least Concern; NT=Near Threatened; VU=Vulnerable; EN=Endangered*

Conclusion

A total of 12 small mammals and primate species were recorded in Tama Abu PF. Order Chiroptera appears to be the most common Order in Tama Abu PF with a total of nine species of 50 individuals. This was followed by the order Rodentia, Scandentia and primate with one species for each order. Interestingly, there are species that are rarely found and was recorded in this survey. This suggests that there are possibilities that more species of small mammals and primates could be found in future surveys with longer sampling period and more trapping efforts covering different parts of the forest.

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