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A Preliminary Study on the Beetle Fauna in Peat Swamp Forest of Kota Samarahan, Sarawak, Malaysia

ISAAC STIA MARCELLINUS*, SITI NURLYDIA SAZALI, RATNAWATI HAZALI, FARAH NABILLAH ABU HASAN AIDIL FITRI & AHMAD IRFAN ABDUL RAZAK

Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

*Corresponding author: marcellinusisaacstia@gmail.com
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ABSTRACT

The largest peatland in Malaysia is in Sarawak with approximately 1.66 million ha (13%) of total area, distributed widely in Sibu division followed by Sri Aman, Miri, Kota Samarahan, Sarikei and Bintulu. Despite being the most diverse animal species, the study of insects in peat swamp forest, particularly beetles, is still in the incipient stage. Therefore, this study aimed to provide recent information on the beetle species composition in a peat swamp forest of Real Living Lab, UNIMAS (RLL) located in Kota Samarahan. Beetles were sampled for five consecutive days and nights within a seven-day sampling trip in August 2020. Three sampling methods were employed in this study, namely handpicking method (HPM), modified Pennsylvanian light trap (MPLT) and pitfall trapping (PFT). A total of 15 families representing 37 species and morphospecies with 185 individuals were successfully collected. The most speciose family from the beetle assemblages in RLL is Scarabaeidae with eight species collected (21.62%), followed by Curculionidae with six species (16.22%) and Staphylinidae with five species (13.51%). The most abundant family was also represented by Scarabaeidae with 64 individuals (34.59%), followed by Scolytidae with 27 individuals (14.59%) and Carabidae with 23 individuals (12.43%), respectively. This suggests that these families are good candidates as biodiversity indicator of peat swamp forests. This study is still in its preliminary stage; hence it is important to conduct further beetle samplings in future to better understand the potential of beetle as a bioindicator in the peat swamp habitat as an effort to conserve and protect the habitat and the biodiversity that came along with it.

Keywords: Beetles, biodiversity, Coleoptera, peat swamp forest, Sarawak

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INTRODUCTION

Insects are being described more than any other life forms, with the greatest portion of this group represented by beetles accounting to two-fifths of all insect species (Chung, 2007). Bouchard *et al.* (2017) mentioned that among all the organisms on earth, beetles have the greatest diversity. However, as most species have yet to be identified specifically thus making it difficult to enumerate the exact number of this species and even more difficult to estimate the population of this species. Nonetheless, due to their ubiquitous nature as well as great diversity of feeding types, it is often fascinating for coleopterists to study beetles across a diverse range of habitat types in tandem with its diversity in terms of numbers as well as their presence in a variety of habitat types and trophic guilds (Chung, 2007). Based on the current records as stated by Chung (2003), by far the number of beetle families in Borneo accounted for 106 known families.

The study of beetles has led the discovery of interesting habitat, particularly the peat swamp forest. As frequently reported with unique biodiversity, the Southeast Asian peat swamp forest represents both rare and endangered animals along with the endemic tree species (Giesen *et al*., 2018). Malaysia has approximately 19.5 million ha of peat swamp forest, covering the 75% of total areas for the wetland areas in the country (Mohd-Azlan & Das, 2016). The largest peatland in Malaysia is located in Sarawak with approximately 1.66 million ha (13%) of total area, distributed widely in Sibu division followed by Sri Aman, Miri, Kota Samarahan, Sarikei and Bintulu. The peat swamp forest is generally characterised as waterlogged due to their high soil absorbency and water-retention ability (Mohd-Azlan & Das,

2016) (Figure 1). Therefore, this forest type serves its purpose as a natural water catchment especially during heavy rainfall events where excess water will be slowly released during drier seasons. Jusoff *et al*. (2007) also stated that peat swamp forest serves as a gene bank as it potentially keeps many useful types of plant species. Due to its condition, the peat swamp forest however, is often regarded as uninhabitable for wildlife and is considered as an extreme habitat as they are nutrient impoverished with highly acidic waters with a pH range of 3.6 - 5.9. Thus, the habitat is often described to have low biodiversity in comparison to other habitat types (Wells & Yule, 2008).

Figure 1. The peat swamp forest environment in Real Living Lab, UNIMAS

Despite these circumstances, peat swamp forests support a unique community of wildlife with high adaptability as well as survivability (Wells & Yule, 2008). Chung (2003) had provided a comprehensive reference to beetle's classification until family levels, of which most samples were derived from Sabah's sampling. Despite its importance and reliability as the baseline data for local reference, it is also equally important to discover the beetle families endemic to Sarawak for the convenience of future studies, especially the studies conducted in Sarawak. Hence, a preliminary study to identify the beetles in Sarawak in order to enhance the information of beetle species and to understand their spatial distributions within the Bornean region is essential. In Sarawak, the study of insects in peat swamp forest, particularly beetles, is still in the incipient stage. Additionally, describing the vast diversity of beetles alone is generally difficult particularly if the given habitat is inhospitable as the peat swamp forest. In other words, the empirical studies of Sarawak's peat swamp forests focusing on beetles is still limited with previous studies being mostly unpublished or, for some, focusing on a specific family instead of the order Coleoptera as a whole (Parsons, 1963; Abang & Das, 2006). Therefore, this study aims to provide preliminary data on the beetle species composition in the peat swamp forest of Real Living Lab, UNIMAS (RLL). It is hoped to provide comprehensive baseline data for beetle community inhabiting the peat swamp forest of Sarawak.

MATERIALS AND METHODS

Study Site

The study was conducted in Real Living Lab, UNIMAS (RLL) (01°27.94350' N, 110°26.90952' E) in the district of Samarahan, Sarawak. The map of location was constructed using QGIS DESKTOP 3.16.8 (Figure 2). Sampling was conducted from 12 to 18 August 2020, whereby the beetles were sampled for five consecutive days and nights within a seven-day sampling trip, with the first and seventh day were used for traps assembling and disassembling, respectively. Real Living Lab was built to exhibit the biodiversity of Sarawak as well as serving as an ecotourism hotspot. According to Abang and Das (2006), peat swamp forest in Samarahan was regarded as secondary and degraded based on the observations of smaller trees and climbers. Hence, this situation initiates the effort to conserve and preserve RLL, which plays an important role in maintaining the current ecosystem. Since its formation, RLL has become a sanctuary for a variety of plants with systematic labelling with the species name for educational purposes.

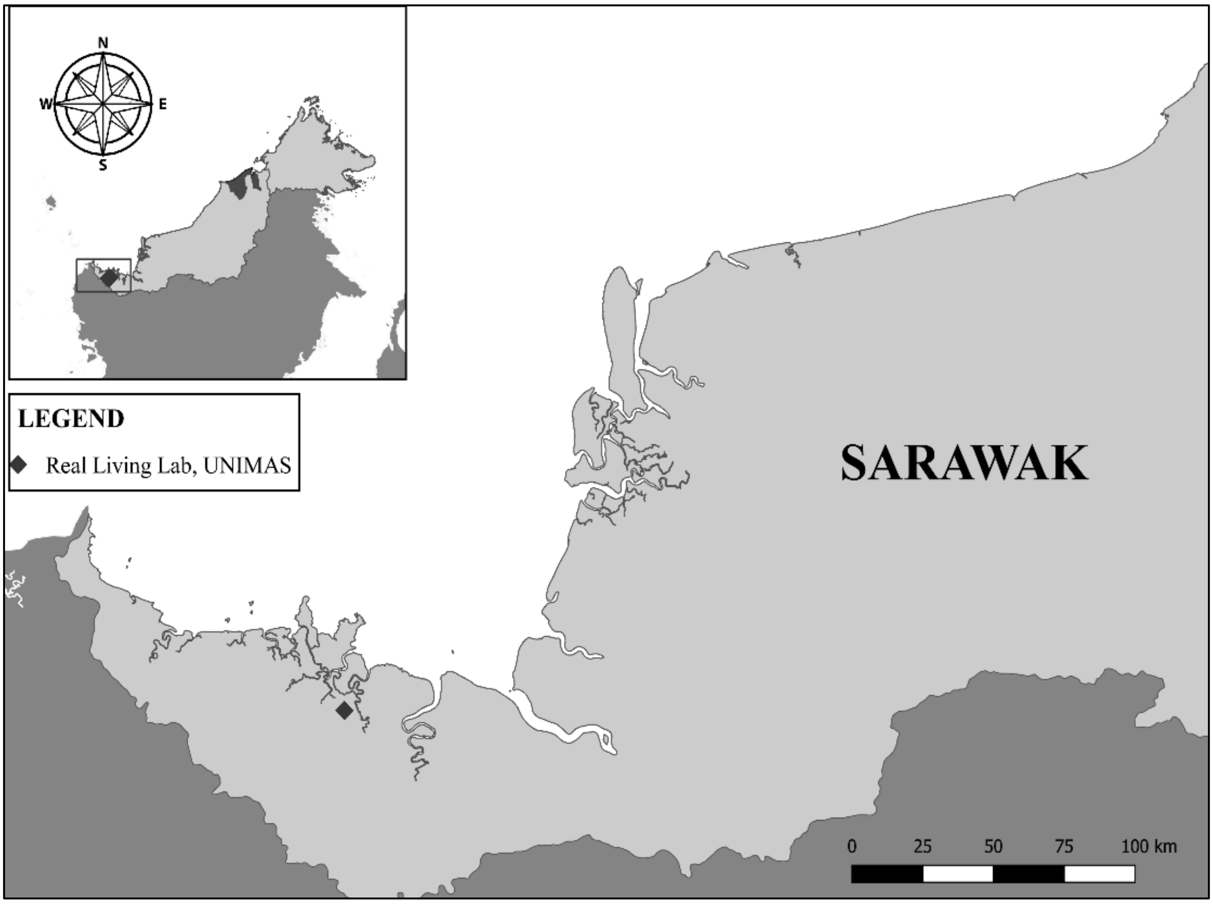

Figure 2. Location of study area in peat swamp forest in Real Living Lab, UNIMAS

Beetle Sampling

The primary method of beetle collection was conducted using active and passive methods. For the active method, collectors were actively searching and capturing the beetle's occurrence along the trail by hand. This method is also known as hand-picking method (HPM). Hand-picking method was done daily for approximately three hours within the study site. The advantage of this method allows collectors to have first-hand experience to see and handle the beetle in their natural environment and provide information regarding life history of insect (Upton & Mantle, 2010). On the other hand, there were two traps used in this study as the passive method namely modified Pennsylvanian light trap (MPLT) and pitfall trap (PFT). In order to target nocturnal species of beetles, light trap is one of the effective traps and widely used among the researchers (Ricklefs, 1975; Thomas, 1996; Holyoak *et al.*, 1997; Axmacher & Fiedler, 2004) since a majority of insects is attracted to light. In this study, two MPLTs were operated for 12 hours working period starting from 1830 hours until 0630 hours by using mercury vapour lamp. The traps were placed on the ground floor approximately 60 m apart. In addition, 15 PFT were installed along a 100 m transect with a 5 m distance between traps and were left open in the field throughout the sampling periods with collection being done daily. Plastic cups (volume: 250 ml; depth: 100 mm; diameter: 55 mm) were planted into the ground with each trap installed and a roof were placed by using plastic board (150 mm × 120 mm) to prevent flooding. The PFT were used to target beetles that living on the ground.

Taxonomic Identification

All the adult beetle specimens were sorted to family level following Chung (2003). Specimens were identified to species level where possible, using available beetle identification resources (Chung, 2003; Hill & Abang 2010; Bosuang *et al*., 2017) as well as voucher specimens from UNIMAS Insect Reference Collection (UIRC), Faculty of Resource Science and Technology, and Research, Development and Innovation Division (RDID) of Forest Department, Sarawak. Specimens that could not be identified to species level were identified as morphospecies with name codes. Therefore, in this study, the term species include both morphospecies and determined species. All beetle specimens in this study were deposited in UIRC, Faculty of Resource Science and Technology of Universiti Malaysia Sarawak.

Data Analysis

Relative abundance of each species collected from the study site was calculated by a percentage of the total number of individuals of each species over the total number of individuals recorded for all species. Relative abundance values for beetle families were also calculated for both number of species (S) and number of individuals (N). Shannon's diversity index (H') were calculated using PAST version 4.03 software (Hammer *et al*., 2001). The same program was used to generate a species accumulation curve, which describes the cumulative species richness with increasing sample size (Hammer *et al*., 2001). It is used to determine sampling quality if the sampling saturation is achieved.

RESULTS AND DISCUSSION

The assemblages of beetles from Real Living Lab, UNIMAS (RLL) are summarised into species and family level in Table 1. A total of 15 families representing 37 species with 185 individuals were successfully collected from the peat swamp forest of RLL.

Figure 3 shows the species accumulation curve for the overall assemblages of beetles from study site. The curve conveyed a continuous increase of species curve coming from the study site and this is broadly observed in tropical forests due to their rich in species (Escobar *et al*., 2005), indicating the need for a more intensive sampling to be conducted to recover more beetle species into the assemblages. In theory, reaching the asymptote conveyed reasons to sample until no more new species were added into the assemblages, but practically, this cannot be achieved even with prolonged biodiversity assessment as the efforts normally only increase the singleton numbers to doubletons with added singletons recovered in the process (Longino *et al*., 2002; Scharff *et al*., 2003). Nevertheless, the incompleteness of species collection resulted from limited field sampling specifically in a very speciose system like in the tropics is considered as a common problem in many biodiversity studies (Beck & Schwanghart, 2010). Thus, the overall sampling efforts from RLL were within the acceptable limits as the data is only preliminary and extensive sampling in RLL in future is really recommended.

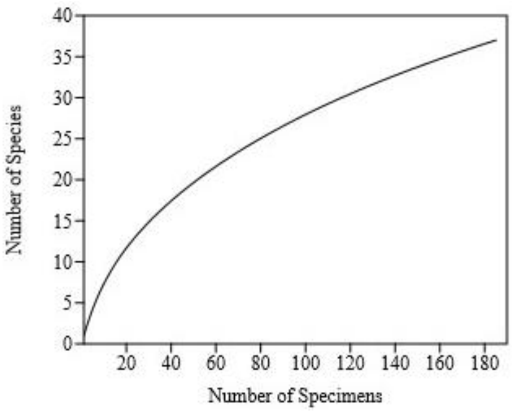

Figure 3. Species accumulation curve for the overall collection at peat swamp forest of Real Living Lab, UNIMAS

The most speciose beetle family from the assemblages in RLL is from the family Scarabaeidae with eight species collected (21.62%), followed by Curculionidae with six species (16.22 %) and Staphylinidae with six species (13.51%). On the other hand, the most abundant family was also represented by Scarabaeidae with 64 individuals (34.59%), followed by Scolytidae with 27 individuals recorded (14.59%) and Carabidae with 23

Table 1. The relative abundance and diversity indices of beetles' species and families from the peat swamp forest in Real Living Lab, Universiti Malaysia, Sarawak

Family	Species	Number of Individuals (Relative Abundance, %)
Cantharidae		1 (0.54)
	Silis sp.	1 (0.54)
Carabidae		23 (12.43)
	CaraSp1	1 (0.54)
	CaraSp2	6 (3.24)
	CaraSp3	1 (0.54)
	Cosmodela aurulenta	15 (8.11)
Chrysomelidae		3 (1.62)
	Coenobius sp.	1 (0.54)
	Monolepta sp. 1	1 (0.54)
	Monolepta sp. 2	1 (0.54)
Coccinelidae		3 (1.62)
	Coccinela transversalis	3 (1.62)
Curculionidae		15 (8.11)
	Niseida sp.	3 (1.62)
	CurcSp1	1 (0.54)
	Rhynchophorus vulneratus	4 (2.16)
	Trochorhopalus strangulatus	2 (1.08)
	Episomus sp.	1 (0.54)
	Nodocnemus sp.	4 (2.16)
Elateridae		2 (1.08)
	Anchastus bicolor	1 (0.54)
	Elater sp.	1 (0.54)
Lampyridae		2 (1.08)
	Pteroptyx malaccae	2 (1.08)
Lycidae		2 (1.08)
	Xylobanellus sp.	2 (1.08)
Lymexylidae		1 (0.54)
	LymeSp1	1 (0.54)
Nitidulidae		3 (1.62)
	Stelidota sp.	3 (1.62)
Platypodidae		5 (2.70)
	Platypus pseudocupulatus	5 (2.70)
Scarabaeidae		64 (34.59)
	Oryctes rhinoceros	1 (0.54)
	Apogonia expeditionis	30 (16.22)
	Apogonia sp. 1	14 (7.57)
	Apogonia sp. 2	4 (2.16)
	Holotrichia serrata	10 (5.41)
	Catharsius sp.	1 (0.54)
	Ontophagus aurifex	2 (1.08)
	Onthophagus semiaureus	2 (1.08)
Scirtidae		21 (11.35)
	Ypsiloncyphon sp.	21 (11.35)
Scolytidae		27 (14.59)
	Xyleborinus sculptilis	27 (14.59)
Staphylinidae		13 (7.03)
	Witteria sp.	8 (4.32)
	StapSp1	1 (0.54)
	StapSp2	2 (1.08)
	StapSp3	1 (0.54)
	StapSp4	1 (0.54)
Number of families		15
Number of morphospecies		37
Number of individuals		185
Shannon's diversity index (H')		2.919

individuals (12.43%). During the present study, *Apogonia expeditionis* Ritsema (1896) (16.22%) was recorded with the highest abundance represented by 30 individuals. This is followed by *Xyleborinus sculptilis* Schedl (1964) (14.59%) and *Ypsiloncyphon* sp. (11.35%) with 27 and 21 individuals, respectively. On top of that, 16 species were represented as singletons while six species were identified as doubletons. A previous study on invertebrate by Abang and Hill (2006) from the peat swamp forest at UNIMAS/Kota Samarahan area was recorded in a form of a list. Although the records focused broadly on invertebrates as a higher taxonomic group, the beetle data is still comparable whereby Scarabaeidae is still the most recorded family, but the values of abundance were not reported (Abang & Hill, 2006). Despite having no numerical data, the species list from the study can still be referred to as baseline data for future studies.

According to Hill and Abang (2010), Scarabaeidae can be regarded as a very large family within the order. Fagundes *et al*. (2011) further elaborated that the larger the group, the more ecological niche the group can occupy and can be regarded as an essential component for the dynamics of any natural ecosystems. Kirmse and Ratcliffe (2019) stated that the family Scarabaeidae has incredibly diverse life histories from which the adults have diverse feeding diets. For instance, it has been recorded that the feeding includes dung, carrion, fungi, leaves, pollen, fruits, compost, and roots, and some species are also attracted to sap flows. Thus, despite being described as an inhospitable habitat, the dominance of the family Scarabaeidae over the habitat suggested that it has a better survivability in the peat swamp forest as compared to other beetle families. This can be observed from the assemblage of *A. expeditionis*, a species of the scarabid family, that are collected in the highest abundance within this assemblage. Bosuang *et al.* (2017) and Martínez *et al.* (2013) highlighted similar finding regarding this species as a common nocturnal defoliators of oil palm plantations. However, *A. expeditionis* is also noted to feed on flowers of other plants as well such as the *Mangifera* sp. (Abdullah & Shamsulaman, 2008). The authors also stated there were no observations of attacks from any natural enemy at any time during the beetle's feeding on the *Mangifera* plant thus, showing better survivability and hence, contributed to their high abundance (Abdullah & Shamsulaman, 2008). In addition to that, Tawan (2006) confirmed the probability of the high abundance of *A. expeditionis* as these *Mangifera* plants were recorded to be found within the habitat of peat swamp forests of Kota Samarahan. Therefore, providing a potential abundance of food source due to presence of *Mangifera* plants to support the occurrences of this species.

UNIMAS Real Living Lab (RLL) is situated in a degraded peat swamp forest and the assemblages of beetles in this study site could only be understood to a certain extend. Posa *et al*. (2011) stated that animal abundance and diversity are lower for this habitat type but also indicated that only highly specialised species can survive within this peat swamp forest. Another notable family that can be highlighted here is Scolytidae, which was represented among the most abundant family with 27 individuals in total. Parsons (1963) regarded this family as a "highly specialised family" to the peat swamp habitat. Likewise, the high numbers of individuals were solely represented by *Xyloborinus sculptilis* that were reported having *Artocarpus* (Moraceae) and *Mangifera* (Anacardiaceae) as host plants (Smith *et al*., 2020). Both host plant genera could be found within the peat swamp forest, specifically the species of *Artocarpus glaucus* Blume (1825), *A. rigidus* Blume (1825), *Mangifera havilandii* Ridley and *M. parvifolia* Boerl. and Koord. (Tawan *et al*., 2006). Moreover, the collection of *Cosmodela aurulenta* Fabricius (1801), or commonly known as the Golden-spotted Tiger Beetle of the subfamily Cicindelinae, within the assemblage should also be highlighted as a potential bioindicator of the habitat as this species is amongst the largest and common tiger beetle species in Borneo (Hill & Abang, 2010; Bosuang *et al*., 2017). This cicindelid beetle serves as a crucial global flagship group for insect conservation, specifically for the role of tiger beetles as the biological indicator of habitat health (Pearson & Cassola, 2001; Jaskula, 2011).

Several families, namely Cantharidae and Lymexylidae, were only represented by singleton species, while Lampyridae and Lycidae were represented by doubleton species, respectively. Despite of these low abundances, it is recommended that the other members of the families might be presented as well, but probably unrecorded during the sampling. However, this low abundance could be due to sampling bias, which can be prevented by establishing more sampling efforts and methods such as by the use of sweep nets, beating sheets and Malaise traps. In addition, there should also be a keener beetle search into specific microhabitats like in dead wood for saproxylic beetles, amongst the canopy for arboreal beetles or along the nearby riverine areas at night for nocturnal riverine beetles like the fireflies, which are underrepresented within the assemblage. While the efforts to maximise sampling capture is various, there should be also a consideration of manpower, accessibility, cost, and safety when conducting biodiversity studies in an extreme habitat such as the peat swamp forests. Hence, sampling efforts can be further improved to maximise the capture probability in future.

As stated by Yule (2010), the Indo-Malayan tropical peat swamp forests are ecosystems with extreme conditions of low pH, unstable, spongy substrates as well as low in nutrients and also are anaerobic. In wet seasons, the forest floor will get flooded meanwhile on dry seasons, the peat stays waterlogged, with water pools observed between trees (Yule, 2010). In this study, the sampling was conducted during wet seasons where most areas were flooded except for some very limited areas that are further away from water bodies like ponds, rivers, and small streams. If the sampling was conducted during drier seasons, there would be more accessibility for traps employment and more areas to venture for hand picking for beetles. This may result in more families within the assemblages. Despite these extremities, however, the peat swamp forest like RLL is home to diverse flora and fauna, which are unique to this forest types. This can be seen from the beetle assemblages in this current study.

The tropical peat swamp forests are more vulnerable to the combined effects of multiple human disturbances compared to any other forest ecosystems because of the balance that persists within the vegetation, peat, and hydrology (Posa *et al*., 2011). Posa *et al*. (2011) highlighted further that the peat swamp forests can be easily degraded by human threats such as fire, drainage, and deforestation once the balance is disrupted. Although these existing threats do not destroy peat forests in the region, further research on biodiversity and ecology of the remaining peat swamp forests as well as the future possibilities of restoration is still somehow needed. Therefore, urgent conservation and policy action to protect these peat swamp forests are also crucial in determining the future of these ecosystems.

CONCLUSION

A total of 185 individuals of beetle specimens from 15 families comprising of 37 species were recorded in this study. Although RLL were regarded as inhospitable due to the extreme conditions of the degraded peat swamp forests, several families of beetles were noted as a specialised family to the habitat, namely Scarabaeidae for their large numbers and Scolytidae for their specialisation in the peat swamp forest, which suggest that these families are good candidates for biodiversity indicator of the peat swamp forests. Future studies should consider to adopt sweep nets during beetle sampling for collecting beetles on the upper part of trees. The knowledge of the beetle diversity in general, is still in its preliminary stage. Hence it is important to conduct further beetle samplings in future to better understand the beetles role and potential as bioindicators in the peat swamp habitat. This may help to conserve and protect the habitat and its biodiversity.

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