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Research Article

Diversity of praying mantises (Insecta: Mantodea) in Bukit Piton Forest Reserve, Lahad Datu, Sabah

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Abstract

This study was the first attempt to investigate the praying mantis diversity and composition on a long term basis in a regenerating forest of Bukit Piton Forest Reserve. The study area was a disturbed forest which had been affected by logging activities and forest fires, and undergone a restoration programme. Twelve sampling sessions were carried out over a period of one year, from August 2016 to July 2017, totalling 144 sampling days and nights. Methods included light traps, baited traps, and manual searching. A total of 187 individuals belonging to 19 species were successfully collected. The species sampled represent approximately 16% of the species that occur in Borneo. Mantidae was the dominant family, accounting for about 53% of total species and 36% of total individuals. The dominant species was *Tropidomantis tenera* which belongs to the family Iridopterygidae and made up 27% of the total individuals. The diversity indices showed that the praying mantis cenosis in the area was moderately diverse. This study highlighted the importance of a regenerating forest for the preservation of a significant portion of the biodiversity. We hope that the information obtained from this study will contribute towards a better understanding of the diversity of this fascinating group of insects, as well as the importance of a regenerating forest as a habitat worthy of conservation efforts.

Keywords: praying mantis, Sabah, composition, diversity, disturbed habitat, regenerating forest

Introduction

Praying mantises (order Mantodea) are a group of invertebrates in the class Insecta and the phylum Arthropoda (Sureshan, 2009). In the arthropod community, mantises are known to be top predators (Balakrishnan 2012) and play important roles in the ecosystem. Approximately 2,400 species have been described worldwide (Rivera & Svenson, 2014). Praying mantises are widely distributed in many ecoregions (Ehrmann 2002; Battiston & Fontana, 2010), but most species inhabit the tropics and subtropics (Rivera & Svenson, 2014). Many species can be found in habitats with high structural complexity (Hill et al.,

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2004). To date, Borneo is recognized as the island with the highest praying mantis diversity, with a total of 118 species having been recorded (Schwarz & Konopik, 2014).

These fascinating insects are well known for their peculiar habits of prey capture, camouflage, and cannibalistic sexual behaviour. Most species camouflage as part of vegetation such as flowers, leaves, twigs, grasses and tree bark (Mukherjee et al., 1995; Ehrmann 2002; Ghate et al., 2012; Rivera & Svenson, 2014; Schwarz & Konopik, 2014). The camouflage enables them to blend remarkably well with their surroundings (Sureshan, 2009), making them less detectable to their preys and tpredators (Gemeno et al., 2005). However, these characteristics also make praying mantises difficult to observe and sample in the field.

Based on the studies conducted in Sabah, the primary forest harbour a higher number of praying mantis species compared to disturbed habitats (Ling, 2011; Musi, 2017). On the other hand, a short term study conducted in Bukit Piton Forest Reserve showed that the area is a potential habitat for praying mantises (Norman, 2015). Therefore, this study aimed to gather more comprehensive information regarding the species diversity and composition of praying mantises in the area. The information would be useful to understand how regenerating forests could help to sustain biodiversity particularly praying mantises, which are highly dependent on their surroundings for their persistence.

Materials and Methods

a. Background of the study site

Bukit Piton Forest Reserve (N 05°09', E 118°00') is located in Lahad Datu, Sabah, and covers an area of 11,612 hectares (Figure 1). It is a lowland mixed dipterocarp rainforest and known to be inhabited by a large population of Orangutans (Simon, 2012; Chung & Majapun, 2013; WWF, 2015). Despite this, the area was severely logged from 1980-2007, and experienced two major fires that completely destroyed the forest in 1983 and 1997-1998 (WWF, 2015). Starting in 2008, a comprehensive restoration programme was introduced to recover the area from the ravages of uncontrolled logging, forest fires and the encroachments of the past.

Previously, this forest reserve was known as Northern Ulu Segama (NUS) before it was renamed Bukit Piton Forest Reserve which forms part of the Ulu Segama-Malua Forest Reserve (Chung & Majapun 2013; WWF, 2015). In 2012, Bukit Piton

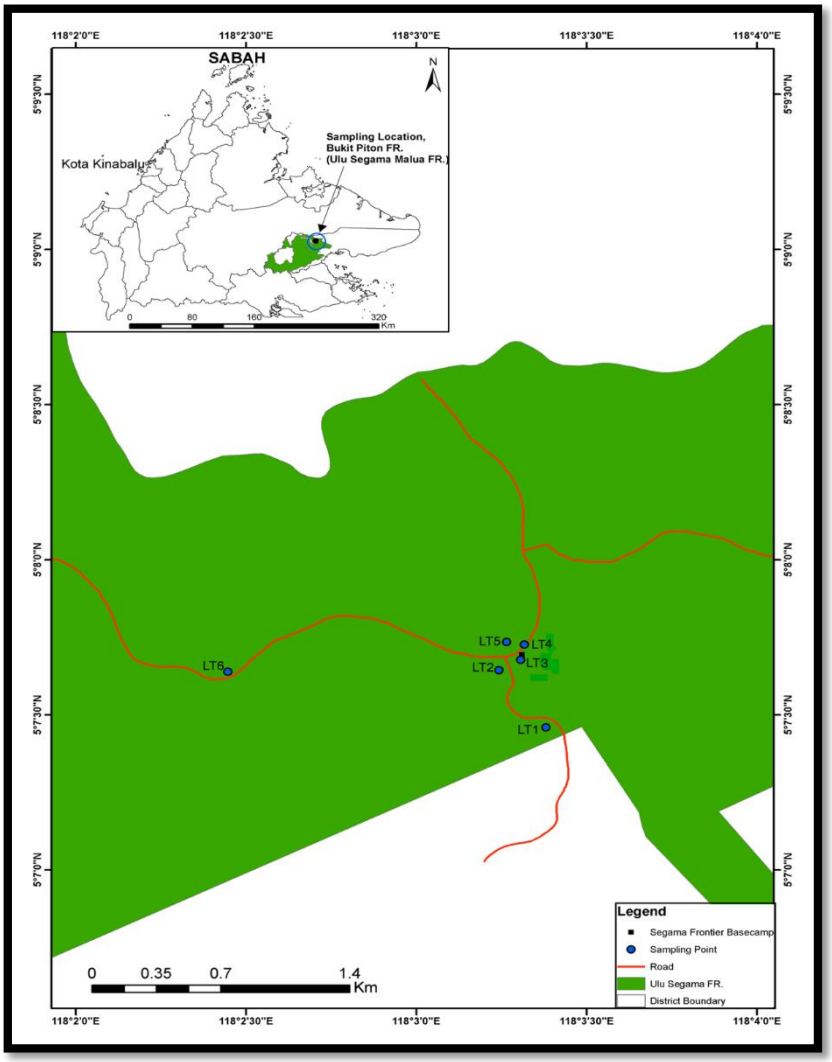

Figure 1. Map of Bukit Piton Forest Reserve (LT=Light trap)

Forest Reserve was upgraded to a Class I Protected Forest from a Class II Commercial Forest Reserve by the State Government of Sabah (Chung & Majapun, 2013).

b. Sampling methods

Praying mantis samplings were conducted over a one year period (August 2016 – July 2017) which included twelve sampling sessions. Three sampling methods were applied, i.e. light traps, baited traps and manual search. The samplings

were conducted at six different sites within the study area (Figure 1). Every site was visited twice to reduce seasonal bias. In each month, sampling was carried out for 12 consecutive days and nights. Overall, there were 144 sampling days and nights.

i. *Light Trap*

This method is widely used for praying mantis sampling and has proven to be the most efficient way to collect praying mantises (e.g. Helmkampf et al., 2007; Ling, 2011; Musi, 2017). The trap was set up by using a vertical white sheet which was illuminated by a light source (in this study a lamp powered by a portable generator) (Figure 2). The trap was placed in a suitable area within the study site and operated from 7.00 p.m. to 00.00 a.m. The trap was checked every half an hour and all mantises that came to the trap were collected. To increase the sample size, the area within a 5 m radius around the light trap was also searched for praying mantises by taking into account that females and nymphs have less ability or unable to fly when compared to males, limiting their mobility to the trap.

ii. *Direct Searching*

Mantises were manually searched for along a line transect of 500 m. Every 50 m was marked as a sampling station and mantises were searched for 20 minutes within a 5 m radius of each station. Intense searching and good observation skills are necessary to locate a praying mantis among the surrounding vegetation.

iii. *Baited trap*

Figure 2. The light trap used in this study

Figure 3. A baited trap used in this study

Ten baited traps were set up at 50 m intervals along a 500 m transect. Five traps were baited with bananas while the remaining five traps were baited with tuna.

Each of the traps was hung on a tree branch at breast height (Figure 3). This method was conducted simultaneously while manually searching for mantises. This method was used as an indirect way to catch mantises while they went after prey lured at the baited traps.

c. Mantis preservation

All the specimens were dry preserved and mounted following standard entomological procedures (Figure 4).

The mantises were identified following the available references including Oliveira (1996) (Key to praying mantids), Bragg (2008), Bragg (2010), Helmkampf et al., (2007), Ling et al., (2013), Schwarz & Konopik (2014), and Musi (2017). The specimens were also examined with the mantis collections in BORNEENSIS (collection centre at Institute for Tropical Biological and Conservation, UMS). Most of the specimens were identified to species level, however, several individuals could only be identified to genus level due to ambiguous characteristics. All specimens were deposited in BORNEENSIS.

Figure 4. A praying mantis specimen (*Hierodula* sp.)

d. Data analyses

i. Diversity indices

The diversity of praying mantises at the study site was analysed using the Shannon-Wiener's Diversity Index (H'), Simpson's Reciprocal Index (1/D) and Margalef's Index (D_{mg}) (Magurran, 2004). The analyses were performed by using

the Software 'Species diversity and richness' version 2 (Henderson & Seaby, 1998).

ii. *Species rank abundance curve*

A species rank abundance curve was used to analyse the diversity pattern in terms of species abundance at the study area. This method ranks the species from the most abundant to the least (McCabe, 2011). The calculations were done using Microsoft Excel 2010.

Results

a. *Praying mantis composition*

A total of 187 praying mantis individuals were sampled, comprising 19 species. They belong to five families and 10 subfamilies (Table 1). The species sampled represent 16% of the species that occur in Borneo. Mantidae was the dominant family with 9 species accounting for 53% of the total species and 36% of the individuals.

Tropidomantis tenera was recorded as the dominant species with 51 individuals, i.e. approximately 27% of the individuals collected (Table 1). This species is a member of the family Iridopterygidae.

All individuals were collected from the light trap and only one individual by manual searching, while the baited traps failed to sample any praying mantis.

Table 1. The list of praying mantis species and number of individuals sampled in BPFR

Family	Subfamily	Species	Individual
Hymenopodidae	Acromantinae	***Acromantis* sp.** Saussure, 1870	12
		Citharomantis falcata Rehn, 1909	1
		Psychomantis borneensis De Haan, 1842	5
	Phyllothelyinae	***Phyllothelys* sp.** Wood-Mason, 1876	1
		Ceratocrania macra Westwood, 1889	6
	Hymenopodinae	***Creobroter granulicollis*** Saussure, 1870	2
Iridopterygidae	Tropidomantinae	***Tropidomantis tenera*** Stål, 1860	51
Liturgusidae	Liturgusinae	***Humbertiella ocularis*** Saussure, 1872	14
Mantidae	Angelinae	***Euchomenella matilei*** Roy, 2001	39
	Amelinae	***Gonypeta punctata*** De Haan, 1842	5

		Myrcinus tuberosus Stål, 1877	3
	Mantinae	***Hierodula dyaka*** Westwood, 1889	1
		***Hierodula* sp.** Burmeister, 1838	1
		Hierodula venosa Olivier, 1792	2
		Tenodera blanchardi Giglio-Tos, 1912	1
		Statilia maculata Thunberg, 1784	11
	Deroplatyinae	***Deroplatys desiccata*** Westwood, 1839	1
		Deroplatys truncata Guérin-Méneville, 1843	3
Tarachodidae	Caliridinae	***Leptomantella* sp.** Uvarov, 1940	27
5	**10**	**19**	**187**

b. Species diversity

The overall findings showed that the praying mantises in the study area were moderately diverse, as indicated by the diversity indices (Shannon-Wiener's Diversity Index (H') - 2.20; Simpson's Reciprocal Index (1/D) - 6.54; Margalef's index (D_{mg}) - 3.44). The result could be influenced by a few abundant species such as *Tropidomantis tenera., Euchomenella matilei* and *Leptomantella* sp. Several species were sampled as singletons.

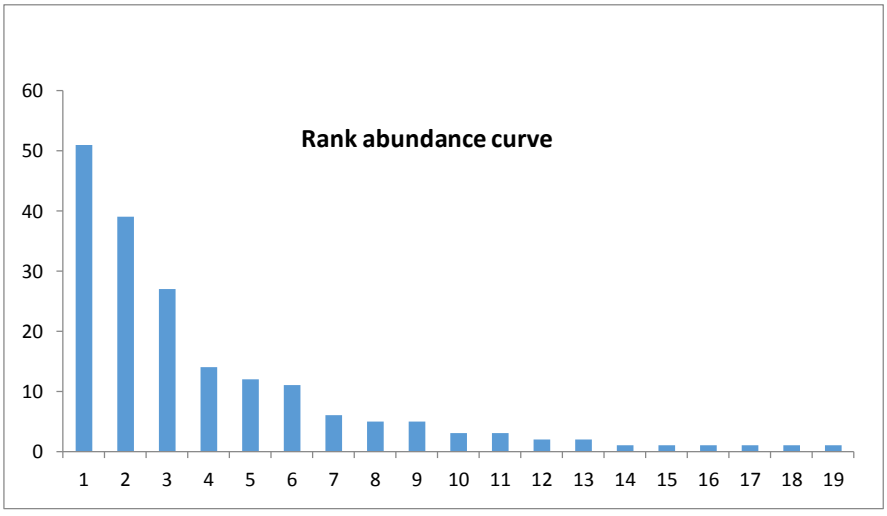

Figure 5. Species rank abundance curve

Discussion

Habitat disturbance is one of the major threats to biodiversity (Montoya, 2008). Forest fires and logging have been recognized as disturbances that commonly occur in forest habitats. However, few studies have been carried out to document species diversity in disturbed forest habitats which have undergone regeneration. Some studies show that habitat structure is important for species survival, mainly for those species that depend on highly cluttered surroundings, such as praying mantises (Hill et al., 2004; Mustaffa et al., 2015). The importance of habitat selection varies across species. For example, heterogenous surrounding vegetation increases camouflaging ability in praying mantises, thus enabling them to hunt for prey or hide from predators efficiently.

This study showed that even a highly disturbed habitat such as Bukit Piton FR can still harbour a moderate diversity of mantis species. Several species that have been recorded in primary forests were also found in the study area, such as *Psychromantis borneensis, Humbertiella ocularis, Euchomenella matilei* and *Deroplatys desiccata* (Musi, 2017). The species richness and abundance of praying mantises in Bukit Piton FR may be related to the regenerating vegetation within the area. Nine species were recorded as singletons. Ulu Segama-Malua FR currently boosts the largest extent of restored and rehabilitated Dipterocarp forest in the world (Sabah Forestry Department, 2017). The forest restoration activities that have been implemented in the area might have improved the forest habitat quality, therefore allowing more species to inhabit and exploit the available resources. Regenerating tropical forest can sustain about 57% of the primary forest biodiversity and has high conservation value (Whitworth et al., 2016). Furthermore, a study by Edwards et al. (2017) suggested that secondary forest can play a vital role in conserving phylogenetic diversity of birds.

In this study, *Tropidomantis tenera* was found to be dominant in the study area. This species was reported to be a generalist species and common in both primary and disturbed habitats, since the females are capable of flying and are attracted to light (Schwarz & Konopik, 2014). This could explain its high abundance in the study area. In comparison, most studies conducted in the primary forests in Sabah have recorded several species of Mantidae as dominant species (e.g Ling, 2011; Musi, 2017; Helmkampf et al., 2007).

In conclusion, a regenerating forest could provide sustainable resources for particular species to occur despite the damage that the forest had experienced in the past. This aspect has been widely neglected and the focus for species

conservation has mostly been on primary forest or an undisturbed habitat. We hope that more initiatives will be put forward to study species persistence and biodiversity in regenerating forest habitats.

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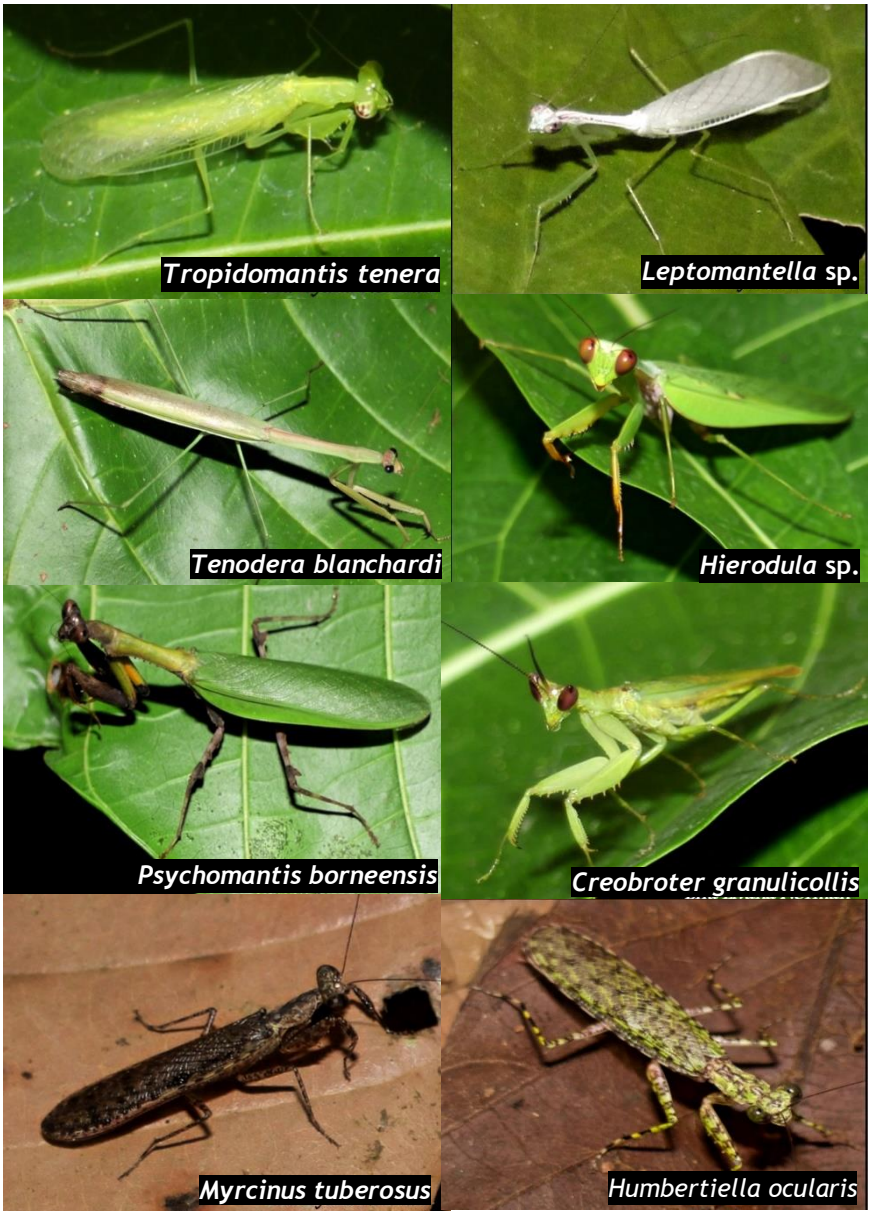
Appendix

Examples of praying mantis species collected in Bukit Piton Forest Reserve, Sabah. Photo by Effa Liyana Norman (2019).




Deroplatys desiccata
Ceratocrania macra
Gonypeta punctata
Statilia maculata
Deroplatys truncata
Euchomenella matilei