

CHECKLIST OF BUTTERFLIES IN PULAU PERHENTIAN AND PULAU BIDONG, TERENGGANU

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Abstract: Ninety percent species of butterflies can be found in the tropics. Southeast Asia has one of the highest Lepidopteran biodiversity in the world, while over 1,200 species of butterflies reside in Malaysia. Despite high Lepidopteran diversity, there is still little knowledge on the butterfly distribution in the islands of Southeast Asia. The aim of this study was to generate species data for butterflies at the islands of Pulau Perhentian Besar and Pulau Bidong in Terengganu region, Malaysia. The collected data will be a foundation for long-term monitoring, future research and a species guideline for tourism. The faunistic composition of Rhopalocera was studied by using 20 baited traps in which 10 baited traps were set at the canopy level and another 10 baited traps were set in the understorey for seven days on each island. The baited traps at the understorey and canopy level were set on selected trees at 1 m and 15 m above the ground respectively, and left to function from 0800 hours to 1700 hours. Ripe pineapples were used as bait to attract butterflies. Aerial netting along one kilometre of line transects were also conducted for catching butterflies. A total of 26 species of butterflies from four families were caught during the sampling period. Butterfly population on small islands may be particularly susceptible to environmental and stochastic changes. Thus, development and land clearing should be strictly controlled to prevent further loss of flora and fauna such as endangered tree species and endemic butterflies of the islands.

Keywords: Forested islands, canopy trapping, fruit-bait, stratification, sustainable, ecotourism.

Introduction

Butterflies play an important role in ecosystems. They are useful bioindicators of ecological research (Aoki *et al.*, 1982) as they are sensitive to environmental changes such as light, humidity, wind speed, and temperature; parameters normally affected by habitat disturbance (Wood & Gillman, 1998). Their high specificity to host plants, high reproductive rates (with dependence of the larval stages on a specific host plant) and existence at a low trophic level helps them to react to environmental stress (Tamblyn *et al.*, 2005). These characteristics ensure them to be good indicators of environmental change, diversity and ecosystem health (Beccaloni *et al.*, 1995; Ghazoul, 1997).

Rainforests in Southeast Asia are ranked among the most biologically diverse areas in the world (Myers *et al.*, 2000). Southeast Asia also has over 1,200 species of butterflies

so far, which makes Malaysia one of the most butterfly rich countries in the world relative to its small land mass. Many of these butterflies are endemic (Ministry of Science, Technology and the Environment, Malaysia, 1998). The small islands that are located at the coast of Peninsular Malaysia are heavily forested and probably provide very important ecological roles (Cronk, 2001). Islands offer places for endemic, endangered and migratory species as previously proven on similar forested islands in Southeast Asia (Turner *et al.*, 2002). Although tropical rainforests are known to be rich in biodiversity, they are threatened by the expansion of the global economy and population growth leading to by land use change and resource exploitation (Caughly & Gunn, 1996; Laurance & Peres, 2006; Nepstad *et al.*, 2006). In fact, forest clearance and fragmentation have now become a major determinant of these insect species assemblages (Dennis, 1997; Stork *et al.*, 1997).

In the present study, a survey on the butterflies of Pulau Bidong and Pulau Perhentian Besar was conducted to document the species composition and to update the species checklist on Terengganu's islands with the aim of evaluating the influence of different habitat and vegetation types on the butterfly assemblages.

Materials and Methods

Study Area

The study was conducted in two islands, as in Pulau Perhentian Besar and Pulau Bidong.

The Perhentian Island Archipelago is situated in the state of Terengganu, located 21 km away from the mainland of the Peninsular Malaysia. There are 11 small islands around the archipelago and Perhentian Besar is considered as the largest island with approximately 867 hectares, followed by Perhentian Kecil (approximately 524 hectares) (Tamblyn *et al.*, 2005). These islands and their surrounding waters have been identified and established as Marine Parks (Tamblyn *et al.*, 2005). Marine Parks are managed as Marine Reserves to protect marine ecosystems. Nevertheless, the terrestrial ecosystems that reside nearby the coastal do not receive the same attitudes of protection. It is important to know the linkage between land and sea in order to protect marine ecosystems and its resources. A successful management of islands can be achieved by good interlinking of these two resources and managing them as one complete connecting ecosystem (Tamblyn *et al.*, 2005).

Pulau Bidong (N 05°37.139", E 103°03.494) is mainly lowland mixed dipterocarp forest which covers the sandy rocky site near the coastal area until the hilly rocky area of the islands (Elizabeth, 2016). Pulau Bidong once populated by Vietnamese refugees until the August 2005 when the last refugees departed from Malaysia to Vietnam. In the year 1999, the island was opened for tourism as it has regained much of its pristine beauty and some former refugees came back to revisit their old home (Grismer *et al.*, 2014)

Sampling

Butterflies were sampled by using 20 baited traps placed approximately 10 metres apart and installed at both lower and upper levels (Christharina & Abang, 2014). For the lower level, the traps were positioned 1.5 m above the ground level. While for the upper level, the traps were placed about 15-22 m above the ground level for seven days (Christharina & Abang, 2014). Baited traps are effective on frugivorous butterflies, specifically on large nymphalids (e.g., *Amathuxidia*, *Zeuxidia* sp.). Their secretive habits often make their sighting become difficult (Corbet & Pendlebury, 1992). Rotting pineapples were used as baits, as it is proven that the odour of rotting fruit or any soft fruits are effective to bait butterflies as shown in Figure A1 and A2 (Beck & Schulze, 2000; DeVries & Walla, 2001; Dumbrell & Hill, 2005). Observation along one kilometre of line transect also were done through the forested area, following the sampling protocol of Koh *et al.*, (2002) and Posa and Sodhi (2006). While some larger butterfly species could be distinguished and identified easily, many small-sized nymphalids, hesperiids, and lycaenids could not be reliably identified on sight (Yong *et al.*, 2012). To overcome these difficulties, voucher specimens were collected by using aerial nets and pinned for identification by using identification keys and photographs provided by Corbet and Pendlebury (1992). Specimens were vouchered later at the Kenyir Research Institute, Universiti Malaysia Terengganu, Terengganu (Rosmidi, unpublished report)

Results

A total of 26 species from 117 individuals were collected belonging to families Papilionidae, Pieridae, Nymphalidae, Lycaenidae and Hesperidae from both islands. The species with the highest number of captured individuals was *Tanaecia julli bougainvillea* with 36 specimens recorded.

Table 1: Taxonomic list and comparison of butterflies recorded on Pulau Perhentian Besar and Pulau Bidong

Specific name	Pulau Perhentian Besar ¹		Pulau Bidong ²	
	Understorey	Canopy	Understorey	Canopy
Family Papilionidae				
<i>Papilio memnon agenor</i>	-	-	+	-
<i>Papilio polytes romulus</i>	+	-	+	-
<i>Parides varuna varuna</i>	+	-	-	-
<i>Troides aeacus thomsoni</i>	+	-	-	-
<i>Triodes helena cerberus</i>	+	-	-	-
Family Pieridae				
<i>Eurema lacteola</i>	+	-	-	-
<i>Eurema sari sodalis</i>	-	-	+	-
Family Nymphalidae				
<i>Cyrestis themire</i>	+	-	-	-
<i>Danaus melanippus hegesippus</i>	+	-	-	-
<i>Elymnias hypermnesta agina</i>	+	-	-	-
<i>Elymnias panthera panthera</i>	+	+	+	+
<i>Elymnias penanga</i>	+	-	-	-
<i>Elymnias sp.</i>	+	-	-	-
<i>Euploea core graminifera</i>	-	-	+	-
<i>Euploea tulliolus ledereri</i>	+	-	-	-
<i>Faunis canens arcesilas</i>	+	-	-	-
<i>Hypolimnas bolina</i>	-	-	+	-
<i>Ideopsis juvena sitah</i>	-	-	+	-
<i>Ideopsis similis persimilis</i>	-	-	+	-
<i>Orsotriena medus cinerea</i>	+	-	-	-
<i>Tanaecia julli bougainvillei</i>	+	+	-	-
<i>Ypthima baldus newboldi</i>	+	-	-	-
Family Lycaenidae				
<i>Arhopala aida</i>	+	-	-	-
<i>Arhopala sp.</i>	-	-	+	-
<i>Drupadia theda renonga</i>	+	-	-	-
Family Hesperidae				
<i>Caltoris cahira austeni</i>	+	-	-	-

(+ = Presence, - = Absence)

Table 2: Comparison of butterflies recorded during this study with a previous study

Specific name	Pulau Perhentian ¹	Pulau Perhentian ²	IUCN Status ³
Family Papilionidae			
<i>Papilio polytes romulus</i>	+	+	NE
<i>Parides varuna varuna</i>	+	-	NE
<i>Troides aeacus thomsoni</i>	+	-	NE
<i>Troides helena cerberus</i>	+	-	NE
Family Pieridae			
<i>Eurema lacteola</i>	+	+	NE
Family Nymphalidae			
<i>Cyrestis themire themire</i>	+	+	LC
<i>Danaus melanippus hegesippus</i>	+	-	NE
<i>Elymnias hypermnesta agina</i>	+	-	NE
<i>Elymnias panthera panthera</i>	+	+	NE
<i>Elymnias penanga penanga</i>	+	-	NE
<i>Euploea tulliolus ledereri</i>	+	-	NE
<i>Faunis canens arcesilas</i>	+	+	NE
<i>Ideopsis juvena</i>	+	+	NE
<i>Orsotriena medus</i>	+	+	NE
<i>Tanaecia julli bougainvillei</i>	+	+	NE
<i>Ypthima baldus</i>	+	+	NE
Family Lycaenidae			
<i>Arhopala aida</i>	+	-	NE
<i>Drupadia theda renonga</i>	+	+	NE
Family Hesperidae			
<i>Caltoris cahira austeni</i>	+	-	NE

¹P. Perhentian Besar Island surveys done by us in September 2015

²P. Perhentian Island surveys compiled by Coral Cay Conservation in 2003 and 2004 (Tamblyn *et al.*, 2005)

³IUCN status updated from <http://www.iucnredlist.org> (NE: Not evaluated; LC: Least concern)

Pulau Perhentian Besar had a higher number of species (19 species) compared to Pulau Bidong (10 species). Pulau Perhentian Besar also recorded 10 new species compared with a previous study which are *Parides varuna varuna*, *Troides aeacus thomsoni* and *Troides helena cerberus* from family Papilionidae; *Danaus melanippus hegesippus*, *Elymnias hypermnesta*

agina, *Elymnias penanga penanga*, and *Euploea tulliolus ledereri* from family Nymphalidae; and *Arhopala aida* and *Caltoris cahira austeni* from family Lycaenidae and Hesperidae respectively.

Family Nymphalidae represented the largest number of species, followed by the family Papilionidae. The lowest number of species came from family Hesperidae in both islands.

Discussion

Islands and Forest Phenology

Difference in butterfly diversity between the two islands can be attributed to differences in the environmental conditions on the islands such as the incidence of sunlight, availability of nectar and water (Brown & Hutchings, 1997; Tumuhimbise et al., 2001) and forest characteristics. Pulau Perhentian is categorized as a granite island by its hilly slopes that extend to the sea and granite tors that protrude out forming cliffs and outcrops (Tamblyn et al., 2005). Its vegetation is described as old secondary dipterocarp forest in which species such as *Vatica cinerea* (Dipterocarpaceae) and *Syzygium cerinum* (Myrtaceae) have been found (Elizabeth, 2016; Tamblyn et al., 2005). On the other hand, Pulau Bidong is a regenerated forest as the island's primary forest experienced massive deforestation from 1970s until early 1990s by the hands of Vietnamese refugees

as they harboured as many as 40,000 people at one time and was considered as the most heavily populated place on earth in June 1979 (Grismer et al., 2014). The most common tree species found there are from genus *Syzygium* and *Garcinia* (Elizabeth, 2016).

The data collected showed that the species richness in island can be considered as low if compared to the number of species found in mainland. Low species number in island communities are highly influenced by the absence of closely related species and/or particular species or taxa of organisms which is caused by the interspecific competition (Karr, 1971; MacArthur, 1972; Higuchi, 1979; Kitahara & Fujii, 1997). However, it is already known that there are fewer species variety occurred in oceanic islands than in apparently comparable pieces of mainland (Crowell, 1962; Diamond, 1969; Karr, 1971; MacArthur, 1972; Gorman, 1979; Yukawa, 1984, Begon et al., 1990). Besides that, butterflies are specific in selecting their larval host-plants (Schulze et al., 2001). Thus, the availability, density and quality of exact larval host plants affect their distribution (Christarina & Abang, 2014). In Pulau Perhentian Besar, some tree species were observed to bear fruits and flowers in the forested area. *Vitex pinnata*, *Sindorawallichii* and *Alstonia macrophylla* were observed to bear fruits, while some trees, as such *Vitex pinnata* and *Scaevolataccada* were observed to have flowers (Elizabeth, 2016). These trees offered microhabitats and food sources (e.g. nectar) for butterflies and other entomofauna to feed and live on.

In contrast, no flowering and fruiting trees were observed in forested area of Pulau Bidong during the data collection. Nevertheless, there were trees of species of *Diospyrus* sp. that can bear fruits (Elizabeth, 2016).

The area of the island may also influence the number of butterflies found there (Ricklefs & Lovette, 1999). For example, Devy et al., (1998) stated that more species and higher proportion of less common

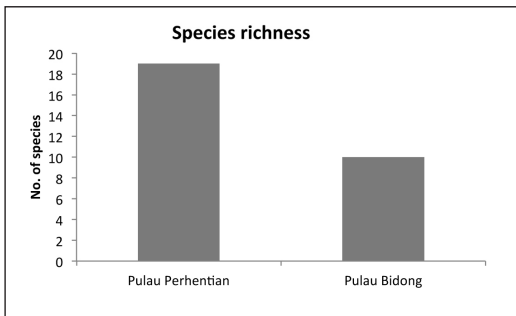


Figure 1: Number of butterfly species recorded at Pulau Perhentian Besar and Pulau Bidong

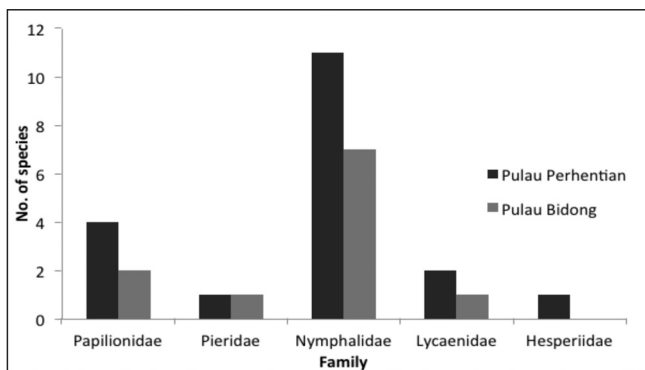


Figure 2: Species composition of butterfly fauna from each family at Pulau Perhentian Besar and Pulau Bidong

species were recorded from larger islands. Pulau Perhentian Besar has a higher number of species as it is bigger than Pulau Bidong which is approximately 867 hectares and 260 hectares respectively. Species richness of Nymphalidae and Lycaenidae were also affected by the size of islands as observed by Yong *et al.* (2012). As the island area decreased, species richness of Nymphalidae and Lycaenidae also steadily declined.

Nymphalidae as Bio-indicators

Butterflies from the family Nymphalidae had the highest frequency of capture compared to the other families in both sampling sites in this study. This may be due to a large number of species in family Nymphalidae as well as their adaptations to feed on a wide range of host plants and a wide variety of feeding habits including feeding on flowers, fruit, honey dew, tree sap, rotting materials and decomposing carcasses (DeVries, 1987; Paseto *et al.*, 2014). Nymphalidae are also sensitive to any changes that occur in the environment, for example, to gaps and edges. Thus, it is easier to access and predict the patterns of diversity in a particular habitat using this butterfly taxa (DeVries *et al.*, 1997; Ramos, 2000; Haber, 2006). The data collected shows a different number of Nymphalids species collected during the sampling period, in which 12 Nymphalidae species were found in Pulau Perhentian Besar, while six species in Pulau Bidong. Lesser species composition found in Pulau Bidong reflects on its forest habitats and vegetation structure.

Threats through Tourism

One of the major contributions towards species decline could be forest degradation due to tourism. It is estimated the Perhentians received up to 69,000 tourists in 8 months of the tourist season (Tamblyn *et al.*, 2005). The increase number of tourists has made the forests relatively vulnerable to disturbance, for example, dumping of rubbish (Tamblyn *et al.*, 2005).

An island is only able to support limited amount of development and infrastructure

(Tamblyn *et al.*, 2005). Uncontrolled development can severely damage the islands as the infrastructure increases, mass demands on water supply and problems of waste disposal are evitable. Shortage of land can initiate conflicts between developers and conservation initiatives such as illegal development on turtle beaches (Tamblyn *et al.*, 2005). However, human habitation may also have some positive effect on species richness in the forest edge and locations near the chalets and hotels (Tamblyn *et al.*, 2005). Butterfly diversity and species richness may increase by the presence of fruit trees and other plantations around the populated area (Spitzer *et al.*, 1993). For example, in Pulau Bidong, vigorously flowering and fruiting tree species of *Terminalia catappa* and *Hibiscus tiliaceus* were recorded around the Universiti Malaysia Terengganu (UMT) research station near the coastal area (Elizabeth, 2016). Most of the species from family Papilionidae were also found around the shrubs and plantations in both islands e.g. *Troides aeacus thomsoni* and *Papilio polytes romulus*. It is known that many species in Papilionidae family are sun-loving butterflies, and attracted to citrus plants and flowers (Tamblyn *et al.*, 2005). In addition, host plants for larvae of many Papilionidae species are citrus species (Baltazar, 1991).

Conclusion

Our work recorded 10 species which have not been recorded from previous study in the studied area. These findings suggest that species were previously collected only in certain environments and seasons and missed due to a short sampling period. Butterflies are important pollinators and as food resources to other animals. Besides that, butterflies can also be the focal point in ecotourism and attract nature lovers. In order to maintain the butterfly populations, a butterfly conservation plan is needed on the islands. The marine park should take responsibility over the marine and terrestrial ecosystem with an integrated protection approach for the betterment of the islands. Development for tourism should be strictly controlled to prevent further loss of

flora and fauna such as endangered tree species and endemic animals of the islands. Finally, if the forests are subjected to uncontrolled timber harvesting, habitat modification and over exploitation of forest products, butterfly species and some of their host plants may face local extinction.

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Appendices



Figure A1: A butterfly (*Tanaecia julli*) feeds on rotten pineapples of baited trap in Pulau Perhentian Besar



Figure A2: Some of the butterflies that were trapped in a baited trap in Pulau Perhentian Besar