DIVERSITY OF BUTTERFLY (LEPIDOPTERA: PAPILIONOIDEA) AND ITS POTENTIAL ROLE AS ENTOMOTOURISM PRODUCT IN GUNUNG LEDANG, MALAYSIA

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ABSTRACT

Entomotourism is part of nature-based tourism that uses insect as a product. In this study, butterfly was chosen to be proffered as new attraction in Gunung Ledang, Malaysia. The objectives are to i) determine the diversity of butterfly, ii) select ten most charismatic species based on the eight criteria currently used for development of nature tourism product and iii) produce a souvenir prototype. The samplings were done manually using aerial net and baited trapping along 1 km transect in Gunung Ledang Resort trail over six sampling occasions between January to July 2019. This study recorded 40 species comprising of 89 individuals from six families, thus successfully added twelve new records for Gunung Ledang. Butterfly fauna in sampling area considered diverse supported by Shannon diversity index of 3.388 and had even species distribution as species evenness index of 0.906. From the total number of species, ten short-listed of butterfly species had met six criteria of a good nature tourism product: safety, rarity, attractive morphology, behavioural enticement, reliability of sightings, and ecologically important. The species are *Graphium sarpedon luctatius*, *G. agamemnon agamemnon, Papilio polytes romulus, P. memnon agenor, P. nephelus sunatus, Eurema hecabe contubernalis, Idea hypermnestra linteata*, *Zeuxidia doubledayi doubledayi*, *Euploea radamanthus radamanthus,* and *Elymnias casiphone saueri.* Brochure and souvenir prototypes were developed based on the selected species that portrayed local image which could potentially be added to the existing attractions. Overall, much of the research is about to diversify tourism products which is in line with the Malaysia Government's agenda and also, point out the need to conserve Gunung Ledang.

Keywords: Entomotourism, Gunung Ledang, butterfly, souvenir

ABSTRAK

Entomopelancongan merupakan salah satu cabang pelancongan alam semulajadi yang menjadikan serangga sebagai produk pelancongan. Kajian ini mengetengahkan potensi kupu-

kupu sebagai suatu produk pelancongan baru di Gunung Ledang, Malaysia. Objektif kajian ini adalah untuk i) menentukan kepelbagaian spesies kupu-kupu, ii) mengenalpasti sepuluh spesies kupu-kupu yang berpotensi berdasarkan lapan kriteria bagi pembangunan produk pelancongan alam semulajadi dan iii) menghasilkan prototaip cenderamata. Persampelan dijalankan secara manual menggunakan sauk udara dan pemasangan perangkap berumpan sepanjang 1 km transek di denai Gunung Ledang Resort sebanyak enam kali persampelan dari Januari hingga Julai 2019. Kajian ini telah merekodkan sejumlah 40 spesies kupu-kupu yang terdiri daripada 89 individu dan enam famili, dengan tambahan 12 rekod baru untuk Gunung Ledang. Didapati kepelbagaian fauna kupu-kupu di kawasan persampelan adalah tinggi berdasarkan analisis indeks kepelbagaian spesies Shannon yang mencatatkan nilai 3.388 dan juga taburan spesies yang sekata dan mencatatkan indeks kesamarataan spesies sebanyak 0.906. Berdasarkan daripada keseluruhan spesies yang direkodkan, terdapat sepuluh spesies kupu-kupu yang berpotensi yang memenuhi enam kriteria produk pelancongan alam semulajadi yang baik: keselamatan, kelangkaan, daya penarik morfologi, keunikan tingkah laku, keternampakan dan penting bagi aspek ekologi. Antara sepuluh spesies tersebut adalah *Graphium sarpedon luctatius, G. agamemnon agamemnon, Papilio polytes romulus*, *P. memnon agenor, P. nephelus sunatus, Eurema hecabe contubernalis*, *Idea hypermnestra linteata*, *Zeuxidia doubledayi doubledayi*, *Euploea radamanthus radamanthus*, dan *Elymnias casiphone saueri.* Sebuah buku panduan ringkas dan prototaip cenderamata telah dibangunkan berdasarkan sepuluh spesies kupu-kupu yang terpilih untuk diketengahkan sebagai daya tarikan baharu. Secara keseluruhannya, kajian ini dapat menggalakan lagi pendekatan produk pelancongan yang berbeza juga seiring dengan agenda kerajaan Malaysia dalam pembangunan industri pelancongan. Selain itu, kajian ini juga menekankan kepentingan bagi meningkatkan lagi usaha pemuliharaan di Gunung Ledang.

Kata kunci: Entomopelancongan, Gunung Ledang, kupu-kupu, cenderamata

INTRODUCTION

Malaysia is well-known as one of the chosen destinations for nature tourism among tourists due to its rich natural attractions, where is home for large diversity and high endemism of flora and fauna. It also supports countless population of insects, which could be promoted as good nature tourism products. For example, there are 1038 species of butterflies recorded (Eliot & Kirton 2000) and 21 species are considered endemic to Peninsular Malaysia (Corbet & Pendlebury 1992). Meanwhile, a total of 944 butterfly species from Borneo with 90 endemic species were also identified (Otsuka 2001). However, the development of organism-based tourism is still lacking, except one in Sabah that is promoting amphibian group (frogs and toads) as nature tourism products, called as "Anuran Tourism" (Kueh et al. 2006).

Entomotourism is part of nature-based tourism that used insects as product, which theoretically combining Latin word *entomo* (means insects) and *tourism* (refers as leisure activities) (Hamdin et al. 2015). At present, firefly tourism is well-known in Kuala Selangor (Jaafar et al. 2010) and Sabah, resulting in generating incomes and profits to local tour operators (Jaafar et al. 2013). Also, butterfly ranching such as butterfly parks have been successfully developed across Malaysia as part of tourism destinations.

By introducing a new approach to learn about insects in more exciting ways, be it in the wild or natural habitat could develop a new frontier of nature tourism in Malaysia, this will may indirectly educate visitors on the importance of insects and conservation. Butterfly is

considered as one of viable and diverse insect groups that has potential to be promoted as nature tourism product. Most people attracted to insects especially butterfly due to the uniqueness and beautiful colouration (Maryati et al. 2014). In this study, field observation was conducted in Gunung Ledang Resort Trail to determine the diversity of butterfly. In addition to that, ten most charismatic species based on the eight criteria used for development of nature tourism product were selected and finally, souvenir prototypes based on the selected species were produced.

MATERIALS AND METHODS

Study Area

This study was conducted in Gunung Ledang National Park, located at the southern part of Peninsular Malaysia, specifically in district of Ledang, Johor (Figure 1). With the highest peak of 1, 276 meters above sea level, it is well-known as tourist spot for hiking and recreation activities. A 1 km transect was set up at Gunung Ledang Resort Trail (02º 35' N; 102º 63'E), starting from visitor parking lot to Kolam Puteri and divided into 10 checkpoints.

Figure 1. Gunung Ledang in Ledang district at the southern part of Peninsular Malaysia

(Source from mountain-forecast.com 2020)

Data Collection

Butterflies were surveyed along 1km transect within radius of 10m on either side of transect from 0900 to 1700 hrs. The techniques used were manual collection using aerial nets and trapping with bait of over-ripe and fermented banana. There were 10 traps hung on the tree branches and spaced 100m apart along the 1km transect. Each sampling consisted of three days and conducted over six visits in January, March and July 2019. Species identification were based on keys and plates from Corbet and Pendlebury (1992), Otsuka (2001) and Kirton (2014).

Selection of Ten Most Charismatic Species

From the total number of butterflies collected, a short-listed of butterflies' species that fulfilled the Criteria of a Good Nature Tourism Product was produced (Table 1). There are eight criteria currently used including endemism, rarity, attractive morphology, behavioural enticement, reliability of sighting, safety, culturally related and ecologically important (Hamdi et al. 2019). All butterfly species were ranked from highest to lowest scores that fulfilled those criteria, then species with the highest score range would be selected as the ten most charismatic species (Table 1).

Packaging of Butterfly as Nature Tourism Product

An informative butterfly's tourism brochure was developed that could be used for tourist guidelines. The contents explained about the 10 most charismatic butterfly species found in Gunung Ledang, along with information on suggested time and preferred site to experience the butterfly-based nature tourism activity. Also, a prototype of butterfly-based souvenir was designed to portray the locality and memento of Gunung Ledang.

Table 1. The selection of 10 most charismatic butterfly species in Gunung Ledang based on score, which satisfied the eight criteria of good nature tourism product (Hamdi et al. 2019)

Species name	Safety	Reliability of sighting	Attractive morphology	Behaviour	Rarity	Endemic	Culturally link	Ecologically important	Score
 *I. hypermnestra*	√	√	√	√	√			√	6
 *G. agamemnon*	√	√	√	√				√	5
 *G. sarpedon*	√	√	√	√				√	5
 *P. memnon*	√	√	√	√				√	5
 *P. nephelus*	√	√	√	√				√	5
 *P. polytes*	√	√	√	√				√	5
 *E. hecabe*	√	√	√	√				√	5

Data Analysis

All data were analysed to determine the biodiversity values in terms of species composition, diversity, distribution pattern and rarity by using spreadsheet software such as Microsoft Excel 2016 and Paleontological Statistics version 1999-2013 (PAST).

RESULTS AND DISCUSSION

Diversity of Butterflies in Gunung Ledang

A total of 40 butterfly species, comprising of 89 individuals from 27 genera and six families were successfully recorded in Gunung Ledang (Table 2). Out of the 40 species found here, three are considered rare and uncommon, while two species are protected by Wildlife Protected Species Act 2010 [Act 716]. The rare species including *Charaxes durnfordi*, *Zeuxidia doubledayi* and *Amathuxidia amythaon* are rarely seen as they are secretive and well camouflaged (Corbet & Pendlebury 1992; Kirton 2014). Whereas, the protected species were *Idea hypermnestra* and *Charaxes durnfordi*, which are illegal to collect, keep and trade them without a licence (Wildlife Conservation Act 2010).

Table 2. The full checklist of butterflies recorded in Gunung Ledang Resort Trail

FAMILY	NO	SPECIES NAME	COMMON NAME
Papilionidae	1.	*Graphium agamemnon agamemnon* (Linnaeus, 1758)	The Tailed Jay
	2.	*Graphium sarpedon luctatius* (Fruhstorfer, 1907)	The Common Bluebottle
	3.	*Papilio demoleus malayanus* (Wallace, 1865)	The Lime Butterfly
	4.	*Papilio helenus helenus* (Linnaeus, 1758)	The Red Helen
	5.	*Papilio memnon agenor* (Linnaeus, 1758)	The Great Mormon
	6.	*Papilio nephelus sunatus* (Corbet, 1940)	The Black and White Helen
	7.	*Papilio polytes romulus* (Cramer, 1775)	The Common Mormon
Pieridae	8.	*Eurema hecabe contubernalis* (Moore, 1886)	The Common Grass Yellow
Nymphalidae	9.	*Amathusia binghami* (Fruhstorfer, 1904)	The Wingtail butterfly
	10	*Amathusia phidippus phidippus* (Linnaeus, 1763)	The Palm King
	11	*Amathuxidia amythaon dilucida* (Honrath, 1884)	The koh-i-noor
	12	*Bassarona teuta rayana* (Morishita, 1968)	The Banded Marquis
	13	*Charaxes durnfordi durnfordi* (Distant, 1884)	The Chestnut Rajah
	14	*Dophla evelina compta* (Fruhstofer, 1899)	The Red-spot Duke
	15	*Elymnias casiphone saueri* (Distant, 1882)	The Palmflies
	16	*Elymnias hypermnestra tinctoria* (Moore, 1879)	The Common Palmfly
	17	*Elymnias panthera panthera* (Fabricius, 1787)	The Tawny Palmfly
	18	*Elymnias penanga penanga* (Westwood, 1851)	The Pointed Palmfly
	19	*Euploea radamanthus radamanthus* (Fabricius, 1793)	The Magpie Crow
	20	*Euthalia aconthea gurda* (Fruhstorfer, 1906)	The Baron

	21	*Euthalia merta merta* (Moore,1859)	The White-Tipped Baron
	22	*Idea hypermnestra linteata* (Butler, 1879)	The Love Letter
	23	*Lebadea martha parkeri* (Eliot, 1978)	The Knight
	24	*Lethe mekara gopaka* (Fruhstorfer, 1911)	The Common Red Forester
	25	*Mycalesis intermedia distanti* (Moore, 1892)	The Intermediate Bushbrown
	26	*Mycalesis orseis nautilus* (Butler, 1867)	The Purple Bushbrown
	27	*Mycalesis perseoides perseoides* (Moore, 1892)	The Pachmarhi Bushbrown
	28	*Tanaecia clathrata violaria* (Butler, 1869)	-
	29	*Tanaecia iapis puseda* (Moore, 1858)	-
	30	*Terinos terpander robertsia* (Butler, 1867)	The Royal Assyrian
	31	*Zeuxidia doubledayi doubledayi* (Westwood, 1851)	The Leaf
Riodinidae	32	*Abisara savitri savitri* (C. & R. Felder, 1860)	The Malay Tailed Judy
	33	*Taxila haquinus haquinus* (Fabricius, 1793)	-
Lycaenidae	34	*Appias libythea olferna* (Swinhoe, 1890)	The Striped Albatross
	35	*Jamides pura pura* (Moore, 1886)	The White Cerulean
	36	*Nacaduba beroe neon* (Fruhstorfer, 1916)	The Opaque Six-Line Blue
	37	*Simiskina phalia potina* (Hewitson, 1874)	The Blue Brilliant
	38	*Simiskina sibatika* (Eliot, 1969)	-
	39	*Prosotas nora superdates* (Fruhstorfer, 1916)	-
Hesperiidae	40	*Ancistroides nigrita maura* (Snellen, 1880)	-

By using Shannon's Diversity Index (H'), the H' value equals to 3.388, meanwhile, Species Evenness (E') is 0.906. These indicate that the sampling area has high diversity of butterfly and an even species distribution pattern. In terms of species composition, Nymphalidae was the richest family, which recorded 23 species, followed by Papilionidae with seven species, Lycaenidae with six species and Riodinidae with two species. Lastly, both Pieridae and Hesperiidae were the least represented with only one species (Figure 2).

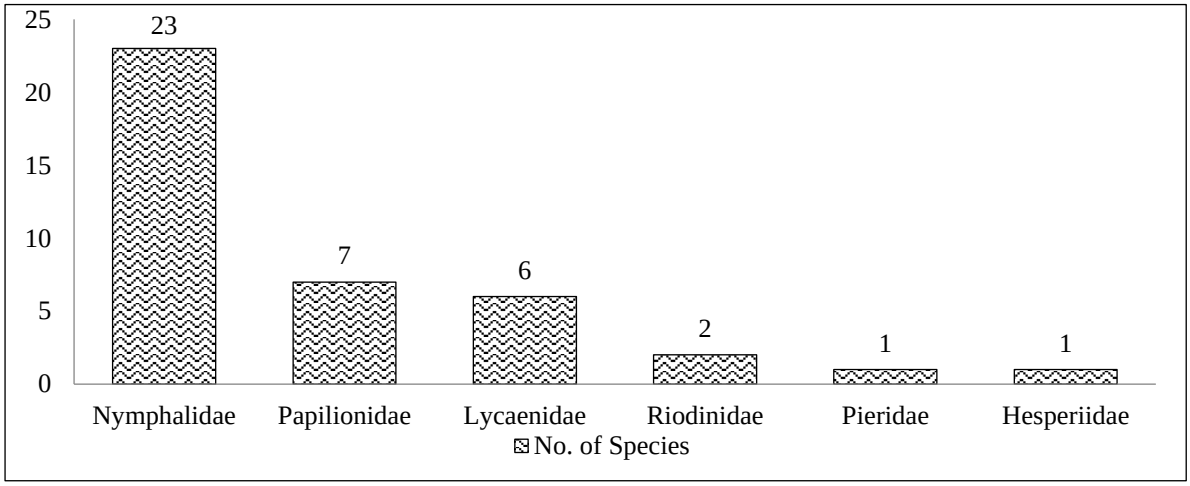

Figure 2. Species composition according to families

In terms of species abundance, Nymphalidae was the most dominant family with 60%, followed by Papilionidae (13%). Both lycaenids and pierids were 10%, respectively, and Riodinidae with 4%. The least dominant family is Hesperiidae with only 1%. Similar patterns were also reported at other study sites such as in Gunung Serambu, Sarawak (Pang et al. 2016), Gunung Ledang National Park, Johor (Ismail et al. 2018) and Fraser Hill, Pahang (Suhaimi et al. 2018).

Rank abundance curve in Figure 3 was plotted to identify the common and rare species (Magurran & Henderson 2011). The species were ranked by the abundance data and clustered into three; the most abundant (>7 individuals), moderate (<5 individuals) and rare or least abundant (1 individual). There are three dominant species found in the sampling area such as *Mycalesis intermedia, Tanaecia clathrata* and *Eurema hecabe* with nine individuals recorded, followed by *Tanaecia iapis* with seven individuals. Species ranked as moderate are *Jamides pura pura, Papilio memnon agenor* and *Elymnias panthera panthera*, which recorded four individuals, respectively. More than half of the species found were rare, recording 25 singletons species such as *Graphium agamemnon, Terinos terpander* and *Charaxes durnfordi.*

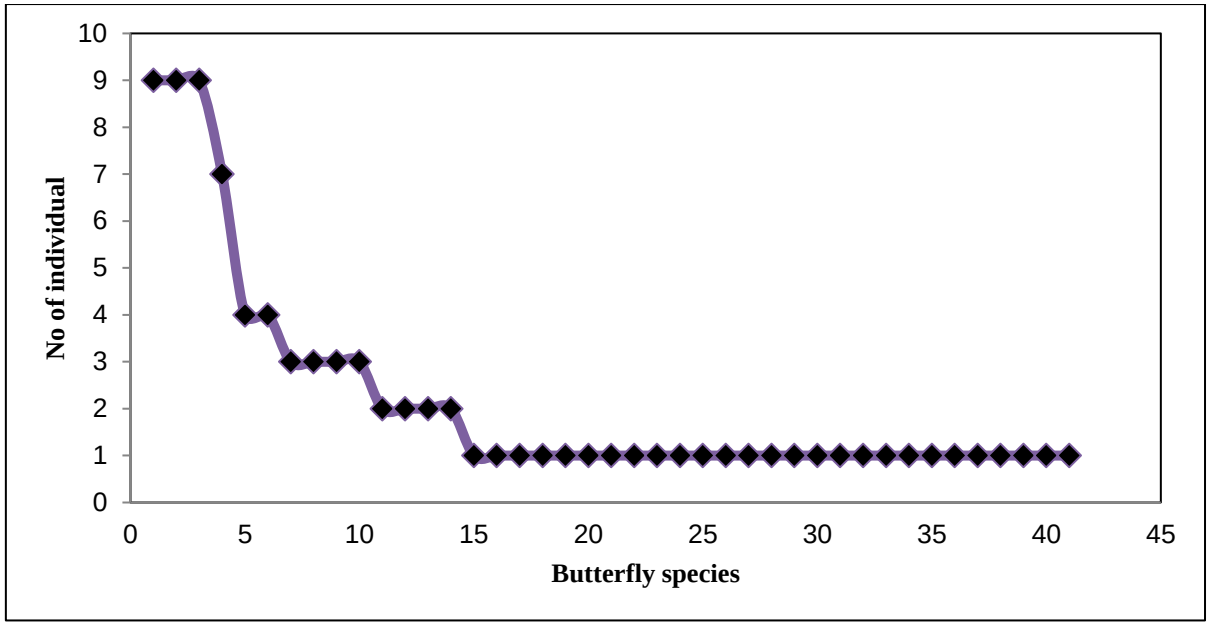

Figure 3. Rank abundance curve of butterfly

Figure 4 compared the distribution of butterfly species between ten checkpoints, where Checkpoint 2 had the highest number of species recorded (19 species), followed by Checkpoint 1 with 7 species recorded. Both checkpoints have various vegetation and habitat heterogeneity which could favour the presence of butterflies (Hamer et al. 2003). During the survey, butterflies such as *Graphium sarpedon* were found mud puddling near the stream bank. At the open areas with more open gaps and garden shrubs, some common and sun loving species such as *Eurema hecabe*, *Papilio polytes*, *Papilio memnon* and *Euploea radamanthus* were commonly seen especially during sunny day (0900 – 1200 hrs). The use of fruit-baited traps could attract the fruit feeding nymphalids species such as *Mycalesis intermedia*, *Tanaecia clathrata* and *Elymnias panthera* and also cryptic and rare species such as *Charaxes durnfordi* and *Zeuxidia doubledayi.*

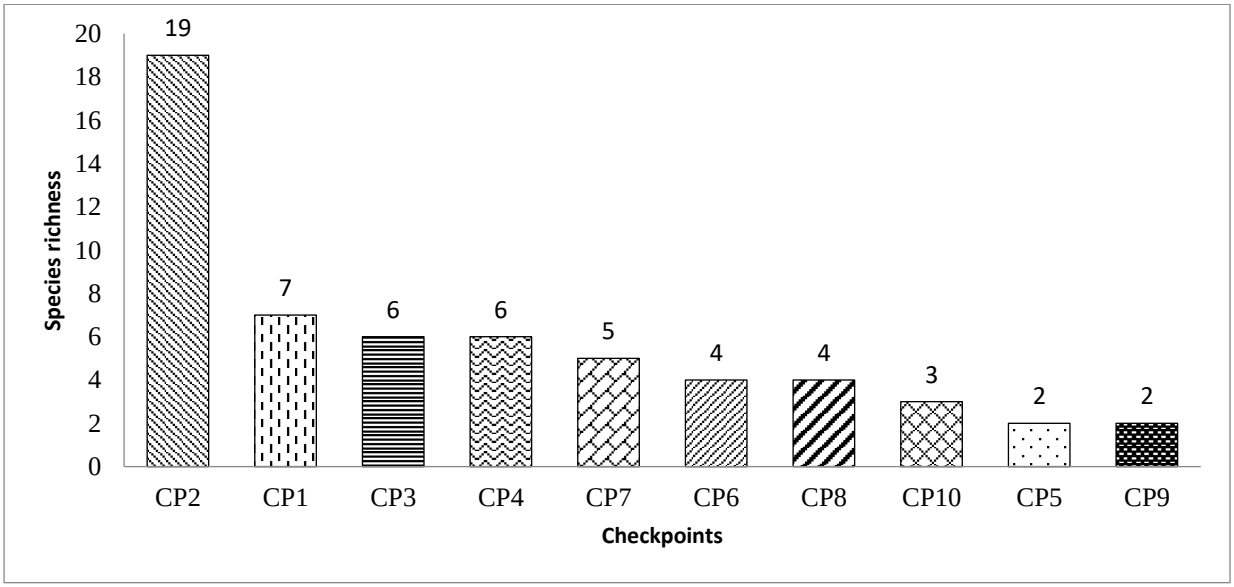

Figure 4. The distribution of butterfly fauna at each checkpoint

Butterfly fauna at different parts of Gunung Ledang were comparatively surveyed since 2012 until the most recent collection was conducted by this study in 2019, which reporting 178 species from 6 families (Aqilah 2019; Ismail et al. 2018; Ismail & Maryati 2017; Maryati et al. 2014; Siddiki 2015). This study has updated the current checklist and successfully added another 12 new butterfly records for Gunung Ledang.

Selection of Ten Charismatic Species Based on Eight Criteria of a Good Nature Tourism Product

The selected charismatic species had satisfied six criteria of good nature tourism product, which are safety, rarity, attractive morphology, behavioural enticement, reliability of sightings and ecologically important (Table 1). The ten species are *Graphium sarpedon luctatius*, *G. agamemnon agamemnon*, *Papilio polytes romulus*, *P. memnon agenor*, *P. nephelus sunatus*, *Eurema hecabe contubernalis*, *Idea hypermnestra linteata*, *Zeuxidia doubledayi doubledayi*, *Euploea radamanthus radamanthus*, and *Elymnias casiphone saueri.*

Packaging of Butterfly as Nature Tourism Product

An informative butterfly's tourism brochure and keychain prototype were developed as tourist guidelines and souvenirs based on the data collection and selection of the charismatic species. By having this brochure (Figure 5), the knowledge transfer between the tour guide and the tourist could be imparted, hence enhance their awareness on biodiversity conservation especially butterflies. The butterfly keychain prototype portrayed the pictures of 10 charismatic species, along with respective scientific name, common name and Gunung Ledang logo to show the representative of Gunung Ledang products (Figure 6). This keychain prototype would not use the real butterfly specimen as to avoid any exploitation activity on the natural resource in Gunung Ledang. Apart from displaying picture of butterfly, information such as scientific and local name were also printed on the keychain as an effort to educate tourists about the diversity and identifying the native butterfly species. Also, to impart their knowledge and understanding on the species would eventually encourage them to protect and conserve the butterfly species (Hey 2009).

Based on the market survey from Johor City and Nature Tourist Guide Association in Johor (JCNTGA), the resource of the souvenirs based on nature tourism product is still limited especially in Johor. This is further emphasised in the report by Maryati et al. (2014), who noted that 53% of visitors in Gunung Ledang were interested to buy souvenir portraying insects if the price is below than RM50.

Figure 5. The brochure of charismatic butterfly species in Gunung Ledang

	**Code:** A001 **Species name:** *Graphium agamemnon* **Common name:** The Tailed Jay **Uniqueness:** A predominantly green and black tropical butterfly that is common and non-threatened.
	**Code:** A002 **Species name:** *Idea hypermnestra* **Common name:** The Malayan Tree-Nymph, Love Letter **Uniqueness:** Listed as a protected species under the Wildlife Conservation Act 2010 (Act 716)

Figure 6. The examples of butterfly keychain prototypes

CONCLUSION

Since that nature tourism nowadays gained a lot of interest especially in Malaysia, a method to enhance more nature tourism-based product are needed. The needs to increase the tourism activity would give raise to research on producing nature tourism product especially using insect as a product. This study shows that butterfly possess high potential to be one of the tourism product and new attraction in the nature tourism area especially in Gunung Ledang.

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