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DOCUMENTATION OF THE BUTTERFLY (LEPIDOPTERA:RHOPALOCERA) FAUNA BASED ON VOUCHER SPECIMENS OF MAJOR REPOSITORIES IN SARAWAK

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ABSTRACT

Voucher specimens in biological reference collections constitute the material basis for biodiversity assessments. They serve as proof for the identity of a particular organism, and for the existence of that entity at a certain location at a particular point in time. They also include an immense wealth of information pertinent to inventory production and distributional studies. The butterfly fauna of Sarawak, Malaysian Borneo was documented based on existing voucher specimens from three major repositories in Sarawak, namely the Sarawak Museum - Natural History Section, The Sarawak Forest Corporation Research Centre Insect Collections and the Universiti Malaysia Sarawak Insect Collections. The collections hold five families of butterflies, namely Papilionidae, Pieridae, Nymphalidae, Lycaenidae and Hesperiidae comprising 730 species from Sarawak. This represents 77.7% of the known number of butterfly species occurring on Borneo. Of the five families, Lycaenidae was the most speciose with 287 species found in Sarawak or representing 72.7% of the

total number of lycaenids reported for Borneo. The second most diverse family was Nymphalidae with 197 species in the collections, representing 81.4% of the total known Bornean nymphalid fauna. The third diverse family in the collections was Hesperiidae, followed by Papilionidae and Pieridae with a total of 171, 38, and 37 species respectively. Each represents 79.5 %, 84.4% and 86 % of the total Hesperiid, Papilionid, and Pierid fauna of Borneo respectively. Three species are new records for Sarawak, as well as Borneo. These are *Troides aeacus* (Papilionidae), *Appias olferna olferna* (Pieridae) and *Udaspes folus* (Hesperiidae). With the addition of these three new records, the number of Bornean butterflies increases from 937 species to 940 species. Results from this study also denote that the tropical rainforest in Sarawak is characterized by the predominance of Lycaenidae over other families of butterflies in Borneo. The high diversity of host plants associated with the butterflies, and the wide range of habitat types in Sarawak are perhaps among the factors that contribute to the overall diversity and distribution of the butterfly species in Sarawak.

Key words: butterfly, Sarawak, Borneo, voucher specimens

ABSTRAK

Specimen baucer dari koleksi rujukan biologi merupakan bahan asas dalam penilaian kepelbagaian biologi. Spesimen ini merupakan bukti identiti dan kewujudan organisma atau entiti tersebut di lokasi tertentu pada skala masa tertentu. Spesimen baucer ini juga mengandungi maklumat mengenai takson dan ini adalah penting dalam penghasilan inventori takson tersebut dan taburannya. Fauna rama-rama Sarawak telah didokumen berasaskan spesimen baucer daripada tiga repositori utama di Sarawak, iaitu Muzium Sarawak – Bahagian Sejarah Semulajadi, Koleksi Serangga Pusat Penyelidikan Korporasi Perhutanan Sarawak dan Koleksi Rujukan Serangga, Universiti Malaysia Sarawak. Koleksi ini mengandungi sejumlah 730 spesies yang mewakili lima famili rama-rama, iaitu daripada famili Papilionidae, Pieridae, Nymphalidae, Lycaenidae and Hesperiidae.

Dari kajian ini, spesies rama-rama yang terdapat di Sarawak mewakili 77.7% daripada jumlah spesies rama-rama yang terdapat di Borneo. Famili Lycaenidae didapati paling tinggi bilangan spesiesnya dengan jumlah 287 spesies di Sarawak. Ini juga mewakili 72.7% daripada jumlah spesies Lycaenidae di Borneo. Famili kedua paling tinggi kepelbagaian spesiesnya ialah Nymphalidae dengan jumlah 197 spesies dalam koleksi. Ia mewakili 81.4% daripada jumlah fauna Nymphalidae Borneo. Ini diikuti oleh Hesperiidae, dan seterusnya, Papilionidae and Pieridae, masing-masing dengan jumlah 171, 38, and 37 spesies. Tiap-tiap satu daripadanya mewakili 79.5 %, 84.4% and 86 % daripada jumlah fauna Hesperiidae, Papilionidae, and Pieridae Borneo. Tiga spesies merupakan rekod baru bagi Sarawak dan juga Borneo, iaitu *Troides aeacus* (Papilionidae), *Appias olferna olferna* (Pieridae) and *Udaspes folus* (Hesperiidae). Dengan penambahan tiga rekod baru ini, jumlah spesies rama-rama Borneo bertambah dari 937 spesies menjadi 940 spesies. Hasil kajian ini juga mendapati hutan hujan tropika Sarawak dicirikan oleh kedominanan famili Lycaenidae berbanding dengan famili rama-rama lain di Borneo.

Kepelbagaian tumbuhan perumah yang tinggi bagi rama-rama di tambah pula dengan kepelbagaian jenis habitat di Sarawak berkemungkinan merupakan antara faktor-faktor yang menyumbang kepada wujudnya kepelbagaian rama-rama yang tinggi di Sarawak.

Kata kunci: *rama-rama, Sarawak, Borneo, spesimen baucer*

INTRODUCTION

Butterflies and moths belong to the insect order, Lepidoptera. This is a very large group, of tremendous diversity, completely worldwide but more abundant in warmer countries. Butterflies are not really so distinct from moths and share with them many aspects of appearance and behavior, and generally recognized by their bright colors and clubbed antennae. They are day-flying insects (diurnal) and are frequently associated with sunshine, flowers and gardens.

Among the insect fauna of Sarawak, the beetles (Coleoptera), moths and butterflies (Lepidoptera) attracted early entomologists and were obviously the taxa much sought after (Abang *et al.* 1996). However, there has been no real attempt to compile knowledge on these fauna, particularly, the butterfly fauna of Sarawak. Best (1969) gave a list of butterflies caught around Kuching in December 1968. Although Best (1969) does not give a comprehensive list of butterflies found in the area, it gives a snapshot of what species were present at that particular time. Nevertheless, there are a few publications dealing with the butterflies of Borneo and Malaysia: Otsuka (1988; 2001) and Corbet & Pendlebury (1992). Corbet & Pendlebury (1992) is a detailed text, dealing with the respective groups while Otsuka (1988; 2001) are illustrated guides covering most of the butterflies occurring on Borneo. Other relevant publications include Maruyama & Otsuka (1992), Seki *et al*. (1991), Aoki *et al*. (1982); Tsukada (1991); Tsukada & Nishiyama (1982) Tsukada *et al*. (1985) and Yata & Morishita (1985). The latest work of particular relevance are the host plant book by Robinson *et al*. (2001) and the pocket guide to butterflies of Malaysian Borneo by Abang (2006)

Being among the best-known insects, butterflies are perhaps the best group of insects for examining patterns of terrestrial biotic diversity and distribution. They also have a favourable image with the general public. Hence, they are an excellent group for communicating information on science and conservation issues such as biodiversity, as well as a potential bioindicator of ecosystem health.

The major aims of this study were to establish baseline data of the Bornean butterflies, particularly that of Sarawak. Results from this study provide indispensable information for further taxonomic and ecological study on the butterflies of Sarawak, and further contribute to our knowledge on the butterflies of Borneo.

MATERIALS AND METHODS

Vouchers are collections of organisms that are maintained to provide the permanent, physical documentation of species, and as

proofs of their occurrence at a particular point in time. The present study of butterflies in Sarawak was based on voucher specimens available in the Sarawak Museum Natural History Collections from 1894 to 1914, the Sarawak Forest Corporation Research Centre, from 1978 to 2001, and the Unimas Insect reference Collections, from 1994 to 2004. To facilitate the process of recording, the scientific name, collecting locality, and date of collection for each species from the specimen label were documented. These data serve as the basis of information for the existence of that entity at a certain locality at a particular point in time.

Distribution mappings were done based on locality data labels of the studied voucher specimen studied. The patterns of distribution of a species, either widely distributed or endemic to certain habitat can be illustrated by analyzing the map itself.

Species classification and identification were based on Corbet and Pendlebury (1992), and Otsuka (1988) while information of host plants was based on Robinson *et al.* (2001).

RESULTS AND DISCUSSION

The word diversity is not given the same meaning by those belonging to different ecological schools of thought. In general, it simply means the number of species in different communities that is, the species richness of fauna at different study sites. Others consider that the term diversity should be restricted to measures of indices and include the relative abundance of each species. However, since species number is certainly an indicator of diversity in the common usage of the words and since it is always correlated with indices, taking into account relative abundance, the number of species can be used as a measure of diversity (Connell 1978). In this study, species richness of the butterfly species was simply interpreted based on the number of existing species in the collections that had been collected over a century.

The collections consist of 730 species of butterflies out of the 940 species documented on Borneo (Otsuka 1988; Maruyama & Otsuka 1991 and Seki *et al*., 1991; Holloway 1984). It is now

known that the butterfly fauna of Sarawak represents 77.7% of the known number of butterfly species occurring on Borneo. They comprise five families, namely Papilionidae, Pieridae, Nymphalidae, Lycaenidae and Hesperiidae. A breakdown of the number of species occurring in Sarawak according to families in relation to the number of species on Borneo is shown in Table 1.

Species diversity across families within the butterfly fauna coincides with that noted for Borneo, with a predominance of Lycaenidae over the other families. Lycaenidae was followed by Nymphalidae, Hesperiidae, Papilionidae and Pieridae. It is well noted that the butterfly fauna of Borneo is very similar to that of Peninsular Malaysia, Sumatra and Java. Borneo has strong zoogeographical links with rainforest areas in mainland Asia but much weaker ones with the Philippines, Sulawesi and the Lesser Sunda chain (Lombok to Timor) (Holloway 1996). Accordingly, in general, the species composition in Sarawak is also similar to that of other parts of Borneo and Peninsular Malaysia.

Table 1 also shows the percentage of species representation of the butterfly fauna of Sarawak, in relation to the number of recorded species of each family and subfamily of butterflies on Borneo. Based on the existing voucher collections in all the three repositories studied, the family Lycaenidae was found to be the most speciose family with a total of 287 species represented in Sarawak. This represents 72.7% of the total number of lycaenids reported for Borneo.

The Lycaenidae are undoubtedly the most diverse family of the superfamily Papilionoidea (New 1993). They comprise approximately 4500 described species worldwide (Bridges 1988), with life history data available for more than 1200 of these (Fiedler 1991). The lycaenids account for 30-40% of all butterfly species, and it has repeatedly been argued that myrmecophily has played a major role in the genesis of the present day species richness of the family (Cottrell 1984; Pierce 1984). Apart from that, their wide distribution in many major biomes and their vegetation association could contribute to the establishment of early seres in terrestrial successions (New 1993).

Lycaenids are most diverse in the tropics and in accordance, they form the most diverse family in the tropical rainforest of

Sarawak. This family is represented by seven subfamilies (Table 1). The two predominantsubfamilies in Sarawak were Theclinae and Polyommatinae. Most tropical Polyommatinae recorded in Sarawak belong to the *Nacaduba, Prosotas, Jamides* and *Lycaenopsis* groups and these species predominantly utilize woody host plants.

Nymphalidae was the second most diverse family with 197 (81.4 %) species of the Bornean nymphalid butterflies represented in the collections. Within the Nymphalidae, the subfamily Nymphalinae represents the most speciose subfamily in Sarawak. About 42.6 % of the total Bornean Nymphaline species are represented in Sarawak. Species from the genus *Neptis* are by far the most abundant member of Nymphalinae and occur widely in Sarawak. They are highly polyphagous and are widely distributed. The various food plants known are mostly in the family Leguminosae and Tileaceae (Corbet & Pendlebury 1992).

The third diverse family in terms of the number of species in the collections was Hesperiidae, followed by Papilionidae and Pieridae with a total of 171, 38, and 37 species respectively. Each represents 79.5 %, 84.4% and 86 % of the total Hesperiid, Papilionid, and Pierid fauna of Borneo, respectively.

Hesperiidae is a large family of generally small to medium sized, moth-like butterflies and is worldwide in distribution. It differs so much from all the other butterflies that some authors consider that it should have the status of sub-order equal to the butterflies and to the moths. The butterflies are mostly rather dull in color and they fly extremely fast. Some genera are sun lovers whilst others fly only at dusk and dawn. The Hesperiidae of Sarawak is represented by three subfamilies, namely Coeliadinae, Pyrginae and Hesperiinae (Table 1). Hesperiinae forms the most diverse subfamily, representing 78.1 % of the total hesperiine fauna of Borneo.

In Borneo, Papilionidae and Pieridae are represented by a considerable number of species (Otsuka 1988). Similarly, these families were also considerably well represented in Sarawak (Table 1). Thirty-seven species out of the 43 species of Bornean pierids was recorded. The pierid fauna of Sarawak is characterized by the domination of species from the subfamilies Pierinae and

Table 1: Percentage of species representation of the butterfly fauna of Sarawak, in relation to the number of recorded species of butterflies on Borneo.

Family	Subfamily	No. of Species		Species representation within family in relation to Borneo
		Sarawak	Borneo	
Papilionidae		**38**	**45**	**84.4**
	Troidinae	7	9	77.8
	Papilioninae	14	15	93.3
	Teinopalpinae	1	1	100
	Leptocircinae	16	20	80
Pieridae		**37**	**43**	**86**
	Pierinae	21	27	77.8
	Coliadinae	16	16	100
Nymphalidae		**197**	**242**	**81.4**
	Danainae	27	28	96
	Satyrinae	39	50	78
	Morphinae	17	24	70.8
	Acraeninae	0	0	0
	Nymphalinae	103	127	81.1
	Charaxinae	11	12	91.7
	Libytheinae	0	1	0
Lycaenidae		**287**	**395**	**72.7**
	Poritiinae	19	24	79.2
	Liphyrinae	1	1	100
	Miletinae	31	41	75.6
	Curetinae	4	8	50
	Polyommatinae	61	87	70.1
	Lycaeninae	1	1	100
	Theclinae	158	217	72.8
	Hamaerinae	12	16	75
Hesperiidae		**171**	**215**	**79.5**
	Coeliadinae	21	24	87.5
	Pyrginae	29	36	80.6
	Hesperiinae	121	155	78.1
TOTAL		**730**	**940**	

Coliadinae. Most Pieridae are monophagous at the family level and feed on Capparidaceae.

Papilionidae or the swallowtail family contains about 570 described species worldwide (Shields 1989; Heppner 1991; Scriber 1995). As indicated by the papilionid voucher specimens in the collections studied, there are at least 38 species of swallowtails in Sarawak, representing 84 % of the Bornean swallowtail species. The most diverse subfamily was Leptocircinae followed by Papilioninae (Table 1). Most swallowtail species are monophagous. Eight plant families are known to be host plants of this family. Aristolochiacea is the most important host plant family followed by Rutaceae and Lauraceae (Fiedler 1991). These plants can also be found in Borneo.

Interesting findings from this study include three species that had not been reported on Borneo (Otsuka 1988) prior to the present study. These are *Troides aeacus* (Papilionidae), *Appias olferna olferna* (Pieridae) and *Udaspes folus* (Hesperiidae). With the addition of these three species, the number of Bornean butterfly species increases from 937 to 940 species.

Troides aeacus, represented by a single specimen in the Insect Collections of The Sarawak Forest Research Corporation was collected in Niah, Miri in 1980. It is a common species in Peninsular Malaysia and has a distribution range from the Himalaya south to Peninsular Malaysia and Indo-China. It is now reported on Borneo for the first time.

Appias olferna olferna was first reported from Kuching in August 1996 by Takashima (Osamu Yata, personal communication). It is believed to have been introduced to Borneo from Peninsular Malaysia. This species was represented in the Unimas collections as early as 1995 but not documented. Like *Appias olferna*, *Udaspes folus* is also believed to have been introduced from Peninsular Malaysia. It was not included in the Hesperiidae of Borneo by Maruyama & Otsuka (1991). This species is found where turmeric plants (*Cucurma* sp.) are grown. Its larvae feed on turmeric leaves.

Documentation of the butterfly fauna of Sarawak is now made possible through the availability of good voucher specimens and representations of the butterfly fauna of Borneo. Much of the

insect fauna of Sarawak still awaits discovery. This is partly due to the size and diversity of the insect fauna that makes it impracticable for an entomologist to collect and study all groups of insects adequately. Perhaps, the greatest problem in the study of insects is that of actually identifying the insects concerned. Knowledge of species diversity of the butterfly fauna is fundamental in providing the basis for scientific research. It also contributes to the understanding of ecosystem processes, so that ecological services essential for human survival can be maintained. Certain species flag changes in biotic or abiotic conditions, and they should reflect the quality and changes in environmental conditions as well as aspects of community composition. The systematics and distribution of the butterflies in Sarawak were also studied but not discussed in this paper.

CONCLUSIONS

Results from this study indicate that 730 species of butterflies out of the 940 species documented from Borneo (Otsuka 1988; Maruyama & Otsuka 1991 and Seki *et al*., 1991; Holloway 1984) are represented in the three major insect collections in Sarawak. The collections comprise five families, namely Papilionidae (38 species), Pieridae (37 species), Nymphalidae (197 species), Lycaenidae (287 species) and Hesperiidae (171 species). The tropical rainforest in Sarawak is characterized by the predomination of the Lycaenidae and Hesperiidae, which are among the most diverse families of butterflies in Borneo. Interesting findings from this study include three species that had not been reported on Borneo (Otsuka 1988) prior to the present study. These are *Troides aeacus* (Papilionidae), *Appias olferna olferna* (Pieridae) and *Udaspes folus* (Hesperiidae). The high diversity of host plant associated with the butterflies, and the wide range of habitat types in Sarawak are perhaps among the factors that contribute to the diversity and distribution of the butterfly species in Sarawak.

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