THE COMPOSITION OF MOTH IN THE SECONDARY FOREST (SUKAU) AND OIL PALM PLANTATION (MOSTYN ESTATE) IN EASTERN SABAH

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ABSTRACT

This project aims to study the diversity and species richness of macro moth in secondary forest (Sukau) and agriculture area (Mostyn oil palm plantation) in eastern sabah. Sampling was carried out with light trap from January to February 2008. In each sampling night, 11 hour collection time (19:00 to 6:00) was allocated to collect the moths. Although the sampling period of twelve light trapping nights in both locations was relatively short, a reasonably high number of macro moths were collected. These moths comprises of a total number of 407 specimens from 16 families and 170 species. The 16 families were Arctiidae, Cossidae, Cyclosia, Eupterotidae, Geometridae, Lasiocampidae, Limacodidae, Lymantriidae, Metarbelidae, Noctuidae, Nolidae, Notodontidae, Saturniidae, Sphingidae, Thyrididae and Uraniidae. Among the 16 families, the Sphingidae and Geometridae were most abundant. The least number of individuals were of the families Metarbelidae, Thyrididae and Saturniidae, of which each family was represented only 1 individual. Although Lasiocampidae was collected from Mostyn, the family was not found in Sukau. Likewise, Cyclosia, Eupterotidae, Lymantriidae, Metarbelidae, Saturniidae and Thyrididae were collected in Sukau, but not in Mostyn.

CHAPTER 1

INTRODUCTION

1.1 The Important Role Of Moth In Diversity In Southeast Asian

Much interest has focused on the ecological processes responsible for generating and maintaining this diversity. While relatively many studies were carried out for insects in Southeast Asian forests (Chey *et al.*, 1997; Holloway, 1998; Willott, 1999), the neotropical region – even though much richer in species – has received surprisingly little attention (Brehm & Fiedler, 2005). Insects, including the species-rich Lepidoptera, play a central role in all terrestrial ecosystems. Lepidoptera are important herbivores, pollinators and serve as food and hosts for multiple other organisms at higher trophic levels (Summerville & Crist, 2004). So this project wants to study the diversity and species richness of moth in Tropical Zone.

There are at least 5000 species of 'macro' (sizeable) moths in South-East Asia, and many thousands more 'micro' (little) moths, mostly unidentified as yet (Fox, 1986).

In the class Insect, the Lepidoptera fall within the division of Endopterygota (=Holometabola). The adults bear two pairs of membranous wings, usually clothed on both surfaces with overlapping scales (Covell & Charles, 1984). The mouthparts of the adults are frequently modified into a long coiled proboscis, which occurs in no other order. Lepidoptera pass through a complex metamorphosis of egg, larva and pupa to adult (Barlow, 1982).

1.2 Differences Between Moth And Butterfly

Moths and butterflies are, in fact, members of the same group of insects, and the differences between them are slight. Most moths at rest fold their wings into a roof-like shape, with the fore-wings covering the hind-wings. Some spread them out flat, as do the pretty little Emerald Moths of the Geometridae family, so common in the tropics. Very few moths close their wings together over their backs on settling as butterflies do (Fox, 1986).

Another difference is that most moths have the fore and hind-wings linked by a bristle-and-catch arrangement which enables the wings to move in unison, whereas butterflies can in general move their wings independently (Fox, 1986).

1.3 Life Cycle Of Lepidoptera

Butterflies and moths have a complex life-cycle consisting of four phase: egg, caterpillar (larva), pupa and adult. In the egg stage, a caterpillar develops within a protective envelope. The caterpillar stage is the main feeding period. In order to grow, the caterpillar shed its skin several times. During the pupa phase the body components are broken down and reformed moth. This life-cycle is metamorphosis (Carter, 2000).

Egg: the egg darkens and you can see the young caterpillar moving about inside, shortly before emergence time. It first cuts a circular "lid" in the tough egg shell, and wriggling movements. This is one of the most vulnerable stages. Once it has emerged, the caterpillar usually eats its empty egg-shell. This provides the nutrients for it to survive until it can locate its foodplant (Carter, 2000).

Caterpillar: in the case of the citrus swallowtail, the caterpillar selects a suitable stem and spins a silken pad to which it attaches its tail. The caterpillar next spins a loop or "girdle" of silk that passes around the middle of the body and is attached to the plant stem as a support. The caterpillar's skin splits along the back and the pupa begins to emerge. A series of wriggling movements forces the old caterpillar skin towards the tail. The old skin is released and a series of hooks on the tail are engaged into the silken support pad. The pupa now takes on its final shape (Carter, 2000).

Pupa: shortly before emergence, the colour of the butterfly or moth becomes faintly visible. The pupa case splits and the butterfly or moth starts to struggle out.

When completely free, the butterfly or moth releases a fluid called menconium from the tip of its abdomen. This contains the waste materials accumulated during the pupa phase. After emergence, the butterfly or moth rests with its crumpled wings hanging down and expands them by pumping blood into the wing veins. It is important that the wings expand fairly rapidly before they harden, or they will be permanently deformed (Carter, 2000).

Adult: some choose the upper surface of leaves on which to lay their eggs, while others choose the undersides where the eggs may be better protected. Certain species lay their eggs in crevices or inside plant tissues. Females avoid plants that already have eggs laid on them. This ensures that food is there for her eggs only. The female usually glues the eggs to the surface of a leaf, or a similar support, with a viscous secretion from her body. Some butterflies and moths lay their eggs singly, while others lay them in large batches. Butterflies and moths whose caterpillars feed on a wide range of plants often scatter eggs in flight (Carter, 2000).

Many moths avoid birds by flying at night, but they are then in danger from bats. However, many species are able to hear the cries of bats and therefore avoid them. Most night-flying moths have dull coloured wings that provide good camouflage when they rest on tree trunks. Other species have elaborate patterns that break up the wing and body shape so that it is difficult to recognize. Moths, in particular, are good mimics of a wide range of objects from dead twigs and leaves to wasps and spiders (Carter, 2000). Some moths have dull forewing colours that provide good camouflage when the moth is resting. If the moth is threatened, it reveals brightly coloured hind wings in a startling flash. In addition, some species have false eyespots that create a face to startle the attacker.

1.4 Justification

Most tropical rainforests are characterized by their stunning biological diversity. A major proportion of this diversity is formed by insects, the animal group comprising the largest species number on earth (Fullard, 1994). The Malaysia rainforests are acknowledged to be diversity hotspots on the planet for endemic vascular plants and vertebrate species. Insect groups such as butterflies are very species rich in the eastern Malaysia region. However, there are surprisingly few studies on insect diversity within the eastern Malaysia region.

Before we study biological diversity, under the meaning of biodiversity is very important. Biodiversity is the variation of taxonomic life forms within a given ecosystem, biome. Biodiversity is often used as a measure of the health of biological systems. The most straightforward definition is "variation of life at all levels of biological organization". A second definition holds that biodiversity is a measure of the relative diversity among organisms present in different ecosystems. "Diversity" in this definition includes diversity within a species and among species, and comparative diversity among ecosystems. A third definition that is often used by ecologists is the "totality of genes, species, and ecosystems of a region". Biodiversity is also the diversity of durable interactions among species. It not only applies to species, but also to their immediate environment (biotope) and their larger ecoregion. In each ecosystem, living organisms are part of a whole, interacting with not only other organisms, but also with the air, water, and soil that surround them.

1.5 Objectives

The main purpose of this study is to study the composition of moth in Sukau and Mostyn Estate. Objectives that are to be fulfilled are:

a) Analysis of biodiversity of the moth on Sukau and Mostyn Estate.

b) Study the species richness of the moth in Sukau and Mostyn Estate.

c) Study the effect of habitat on moth population and other impacts in Sukau and Mostyn Estate.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction To Bornean Moth

Originally Borneo was almost completely covered by closed forest. In these pristine landscapes river banks and large tree-fall gaps may have played a central role as larval habitats for many moth species. Therefore, it can be assumed that a substantial proportion of Bornean moth species has benefited from clearing of forest areas and the wide variety of recently created secondary habitats, as long as these have not been totally converted into extended monocultural crop stands (e.g., oil palm plantations).

Only a few species like *Daphnusa ocellaris* show a clear preference for the understory of closed forest (Schulze, 2000). Moreover, a comparison of moth ensembles between the canopy of primary diptercocarp forest and anthropogenically opened landscapes nearby revealed a remarkable similarity (Schulze, 2000; Schulze *et al*., 2001), suggesting that a true canopy-specialist fauna is not that well developed among Bornean Sphingidae. Moths are thus an exceptional insect group, with many of their species being well adapted to survive in a changing environment dominated by cultivated areas and secondary forests. Therefore the usefulness of moths for monitoring or inventorying tropical insect faunas (e.g., as biodiversity indicators) is questionable. Even though planted or secondary forests can frequently hold a rather rich moth fauna, losses in diversity and changes in species composition are much more conspicuous for example in Geometridae or Pyraloidea (Chey *et al.*, 1997; Willott, 1999; Schulze, 2000; Beck *et al.*, 2002) than among *Sphingidae*. Hence, for this study, it also point to the limitations in generalizing case studies from one taxon to another, or even in upscaling to entire guilds.

2.2 Moth As Bioindicator For Forest Change

Bioindicators are organisms, such as lichens, birds, and bacteria, which are used to monitor the health of the environment. The organisms are monitored for changes that may indicate a problem within their ecosystem. The changes can be chemical, physiological, or behavioural. Each organism within an ecosystem has the ability to report on the health of its environment. For example, moth is a kind of bioindicators in logging forest. In the short term (i.e., < 5 years of logging), species composition appears to be altered, even when it was not possible to find changes in richness. In the long term, the response varied. For instance, on a 20 year old logged forest in Peninsular Malaysia, *geometroid* moth diversity did not differ significantly between logged and unlogged forests, but there was some reduction in the abundance of individuals in the logged forests and a shift in species in species composition. Moth is important as plant pollinators, second only to the bees. They also are very sensitive to the environment and thus are good indicators in assessing how healthy or unhealthy conditions are. They also have their own important place in the ecosystem like all animals do.

2.3 Effects Of Tourism Activities On Diversity Of Moth

Several protected areas have been established to conserve biodiversity. Many parks, however, also encourage tourist visitation and promote outdoor recreational activities, including wildlife viewing. Unfortunately, wildlife protection and outdoor recreation may be in conflict if human visitation leads to disturbance of wildlife. While ecotourism can produce revenue for protected areas, an excessive number of visitors in a small area may compromise its ability to support wildlife. Several studies have shown that anthropogenic disturbance may reduce the use of some habitats by limiting animal movement or because animal avoid areas with high human activities (Pelletier, 2006).

The heavy flow of tourists is also related to the pollution of the environment. The use of vehicles to transport people to and from the forest, growing number of vehicles contributes to pollution. This is a serious threat to forest of such proportions, the areas available to people are highly sensitive to the wastes produced by the vehicles and sewers which are dumped into the environment of the forest. Pollution ranges from unclean air to contaminated waters (Hadwen *et al.*, 2004).

The current decline a biodiversity of the rainforest is a serious threat. The human activity causing the loss of biodiversity is many sided. The conversion of more and more land to agriculture and resort areas leads to loss of habitats that are crucial to animals and plants; disappearance of tropical forests, pollution and construction works also contribute to loss of habitat. Due to the increasing demand of tourism industry, more land is being converted to resort areas and new roads (Pelletier, 2006).

2.4 Effects Of Human Activities

Many studies were carried out for moth in mainland. The majorities of studies that incorporate the matrix, however, remain focused on the remnants of native habitat and examine how the type of surrounding matrix affects species living in the fragments themselves (Aberget *et al.*, 1995; Moilanen & Hanski, 1998). Especially in the tropics, few studies directly examine biogeographic patterns across the entire countryside by including both forest remnants and human-dominated habitats such as crops, pasture, fallow fields, and gardens (Perfecto & Snelling, 1995; Power, 1996). Such studies can provide insight into (1) the capacities of different countryside habitats to support native biotas, (2) species characteristics that confer a survival advantage in human-dominated areas, and (3) the movement patterns of organisms in complex landscapes. Generally, the diversity of moth in rainforest is higher (Nieminen & Hanski, 1998). Many finding will prove this result, because many of impacts can affect moth. On the other hand, the effect of anthropogenic habitat disturbance at the landscape level on diversity and species composition of moth ensembles sampled at lowland sites (< 600m).

2.5 Effects Of Bats' Activities

The bats feed moth, its population is big effect of moth diversity. Before we research moth diversity, know the bat that living in study site is useful and indispensable. According journal Auditory changes in noctuid moths endemic to a bat-free habitat (Fullard, 1994). The islands of French Polynesia meet these two criteria. A small number of species of endemic moths reside in the less disturbed forests of these islands (Holloway, 1983) and it appears that these islands have never possessed bats. When moth species are exposed to artificial light they have a reduced awareness of echolocation that bats, one of their predators, send out to locate objects. This means moth do not go into a defensive dive, as they would naturally do, when they are in the presence of lights and so are more likely to be eaten by bats.

2.6 Effects Of Biogeography On Diversity Of Moth

A number of different equilibrium theories of biodiversity have been proposed to explain differences in species richness at small and large scales (MacDonald, 2003).

First, areas of high biodiversity could contain large gradients for resources and offer a wide range of habitat for different species to utilize (MacDonald, 2003).

Second, the range of habitat in two regions may be similar and the resource gradient lengths may be equal, but the length of the distribution of individual species along the gradients may be short in one region because they have specialized riches. High levels of interspecific competition in one area might produce a large number of specialist species with small niches, while lack of competition in another area might allow a few species to persist with very large niches (MacDonald, 2003).

Third, key resources may be more abundant in one area than in another. The gradients for the area of high species diversity would be typified by high abundances of resources, while the gradients for the low-diversity area would be typified by low abundances of resources. The greater abundance of resources could allow either a relaxation of competitive pressure, thereby allowing a greater number of generalist species to survive, or it could allow greater numbers of species with highly specialized niches to survive if interspecific competition was an important factor (MacDonald, 2003).

In some regions, species diversity is positively correlated with habitat diversity. Greater habitat diversity correlated positively with greater resource gradient length and greater available niches space. Habitat diversity can be generated by differences in the physical or biological environment (MacDonald, 2003).

Vegetation structure is an important biological contributor to habitat diversity. Vegetation structure can vary both horizontally and vertically. The vertical structure of the vegetation can greatly influence habitat diversity. A highly stratified forest provides differences in plant composition and microclimate in each stratum and presents a wide range of habitats for incests (MacDonald, 2003). Differences in forest strata diversity, even in less complex forests, can have an impact on habitat diversity and species diversity.

2.7 Research Limitation

There is little limitation in this project. In the case of sites in a group, two factors affecting the colonization rate and diversity of moth may be different. First, while the sites 'sample' the immigrants coming from the other sites, their sampling spaces may overlap in the case of closely situated group forest, resulting in fewer immigrants per sites to group forest than to scattered forest. Additionally, some group forest may receive fewer immigrants because they are in the dispersal shadow of other forest in the same group. Second, an unoccupied forest in a group may become colonized from some occupied forest in the same group (Nieminen & Hanski, 1998).

CHAPTER 3

METHOD

3.1 Study Site

The sampling of moth is going to be done at the two locations in the Sukau and Mostyn Estate in Sabah. Every location use light trap to collect moth. The sampling area is oil palm plantation in Mostyn Estate. The oil palms comprise two species of the *Arecaceae*, or palm family. They are used in commercial agriculture in the production of palm oil. Mature trees are single-stemmed, and grow to 20 m tall. The leaves are pinnate, and reach between 3-5 m long. A young tree produces about 30 leaves a year. Established trees over 10 years produce about 20 leaves a year. Biodiversity loss and the potential extinction of charismatic species is one of the most controversial issues in oil palm cultivation. The impact of oil palm plantations on the environment is dependent on multiple factors, including the existence and compliance to environmental legislation, the pre-establishment habitat and corporate responsibility.

The sampling area is secondary forest in Sukau. Secondary, or second-growth, forest is a forest or woodland area which has re-grown after a major disturbance such as fire, insect infestation, timber harvest or wind throw, until a long enough periods has passed so that the effects of the disturbance are no longer evident. It is distinguished from an old growth or primeval forests, which have not undergone such disruptions, as well as third growth forests that result from severe disruptions in second growth forests. My sampling area was beside the Kinabatangan River.

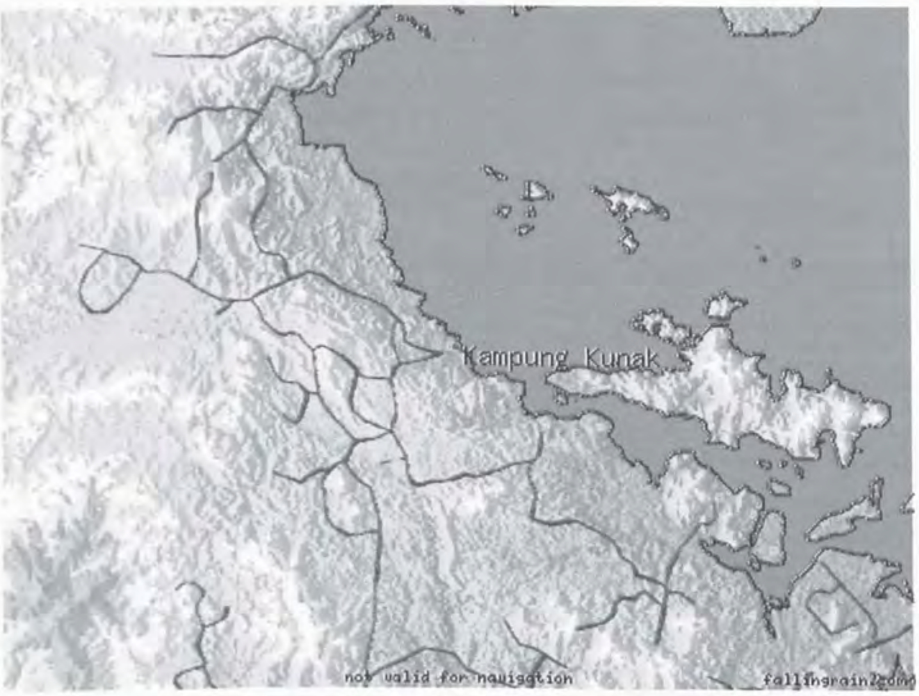

Figure 3.1: location of Kunak in Sabah, Malaysia.

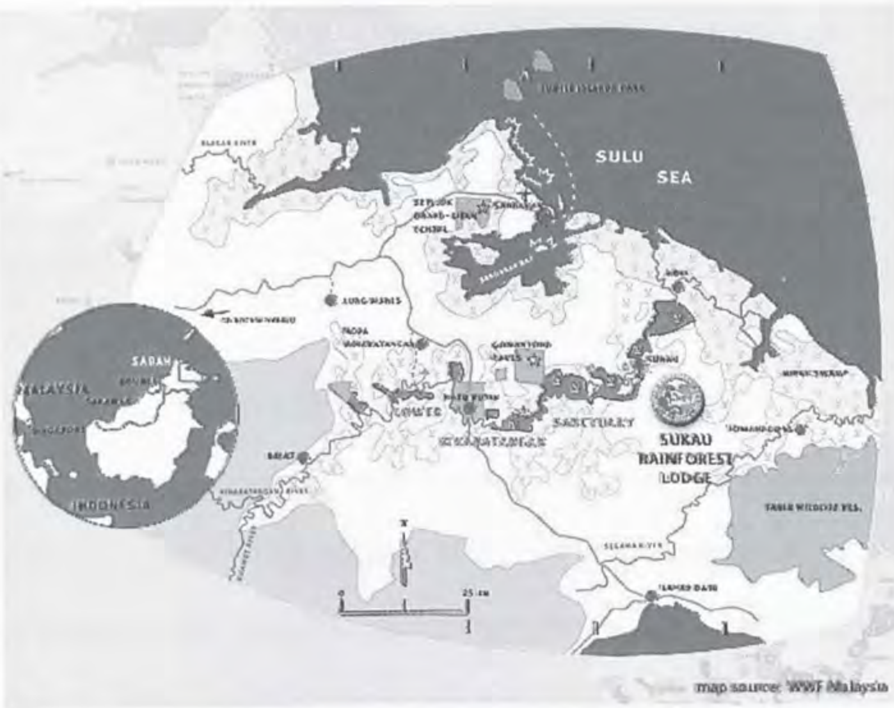

Figure 3.2: location of Sukau in Sabah, Malaysia.

3.2 Sampling

Moths were sampled with light-traps to obtain as comprehensive knowledge of the moth communities as possible. Sampling was carried out from January to February 2008 at irregular interval. The sampling of moth is going to be done at the two locations. One is in Sukau, the other one is Mostyn Estate. Both of location will use light trap to collect moth for few nights.

The light has been demonstrated to catch a wider spectrum of moth species and a higher number of specimens per unit time. Generally it will be found that moths begin to appear in numbers between 7.30-8.00 pm. However, a number of species fly late in the night (Stork, 1988).

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