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JUDUL: The Comparison of Rat Apulations Between Different Microhabitats at Gomantong Forest Reserve, Sandakan, Sabah and Mostyn Estate, Kunak, Sabah.

IJAZAH: Sarjana Muda Dengan Kepujian

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THE COMPARISON OF BAT POPULATIONS BETWEEN DIFFERENT MICROHABITATS OF GOMANTONG FOREST RESERVE, SANDAKAN, SABAH AND MOSTYN ESTATE, KUNAK, SABAH.

ONG KAY YORK

DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE DEGREE OF BACHELOR OF SCIENCE WITH HONOURS

CONSERVATION BIOLOGY PROGRAMME
SCHOOL OF SCIENCE AND TECHNOLOGY UNIVERSITY MALAYSIA SABAH

APRIL 2008

DECLARATION

I hereby declare that this report is a result of my own study except for citations quote from referred sources.

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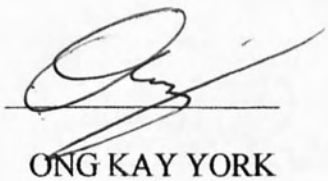

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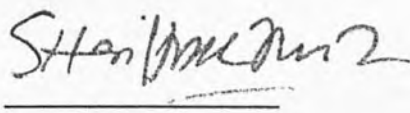

ACKNOWLEDEGMENT

For the completion of this dissertation I truly appreciate all events. The sweat and pain are all taken in as it in either way they helped in the writing.

I would like to take this opportunity to thank my family members for their support. My supervisor, Miss Azniza Mahyudin for the guidance throughout the project.

Also gratitude towards all the staff in Gomantong Forest Reserve, Sandakan and also Mostyn Estate, Kunak. To all friends who lend a helping hand and support.

ABSTRAK

Kajian terhadap perbandingan populasi kelawar antara mikrohabitat telah dijalankan di kawasan Hutan Simpan Gomantong, Sandakan dan Ladang Mostyn, Kunak. Persampelan telah dijalankan antara Januari 2008 hingga Februari 2008 dengan menggunakan jarring kabus dan perangkap 'harp'. Parameter mikrohabitat yang telah diambil adalah liputan kanopi dan jarak perangkap dari sumber air. Data dianalisis untuk: 1) mengetahui kepelbagaian kelawar di kedua-dua lokasi kajian, dan 2) untuk membandingkan populasi kelawar antara mikrohabitat berlainan di kedua-dua lokasi kajian. Hasil menunjukkan terdapat 206 individu daripada 7 spesis telah ditangkap di Gomantong dan hanya 14 individu daripada 4 spesis berjaya ditangkap di Ladang Mostyn. *Hipposideros cervinus* adalah kelawar yang paling dominan di Gomantong manakala *Cynopterus brachyotis* adalah kelawar yang paling dominan di Ladang Mostyn. Indeks kepelbagaian Shannon-Weiner menunjukkan bahawa Gomantong mempunyai kepelbagaian yang lebih tinggi (H'= 0.6423) berbanding Ladang Mostyn (H' = 0.3127). Ini disebabkan oleh vegetasi yang amat berbeza antara kedua-dua lokasi kajian. Pengaruh mikrohabitat didapati mempunyai korelasi yang lebih kuat di kawasan Gomantong berbanding Ladang Mostyn.

ABSTRACT

Research about the comparison of bat populations between different microhabitats had been carried out in Gomantong Forest Reserve, Sandakan and Mostyn Estate, Kunak. Sampling is carried out from January 2008 till February 2008 using mist nets and also harp trap. Microhabitat data taken includes canopy coverage of the trap setting location and the distances of the trap from water system. Collected data were then analysis to : 1) access the diversity of bats of both sites, and 2) to compare the population of bats of different micro-habitat on both sites. A total of 206 individuals from 7 species of bats were caught in Gomantong Forest Reserve while only 14 individuals of 4 species were caught from Mostyn Estate. *Hipposideros cervinus* is the most dominant bat in Gomantong Forest Reserve while *Cynopterus brachyotis* is the most dominant bat in Mostyn Estate. Gomantong Forest Reserve has a higher species diversity (H' = 0.6179) compared to Mostyn Estate (H'= 0.3127). This is mainly caused by the difference in the vegetation of both sites. Between sites, it is found that Gomantong Forest Reserve has a stronger correlation with its microhabitat compared to Mostyn Estate.

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LIST OF SYMBOLS

mm	millimeter
kg	kilograms
m	meter
°C	celcius
%	percentage
H'	Shannon-Weiner Diversity Index
r	rho
t	t value
v	degree of freedom

CHATPER 1

INTRODUCTION

1.1 Order Chiroptera

Order Chiroptera (Chiro= hand, ptera=wings) or generally known as bats are one of the most well adapt mammals on the earth. As the only member in the mammals that is capable of flying, bats proof to be an interesting study subject.

Taking up a large portion of the total of mammal population as much as 1/3 of it (Altringham, 1999), bats are generally divided into 2 large sub-orders, the Microchiroptera and also the Megachiroptera (hereby known as Microbats and Megabats). And both groups of bats are further divided into a total of 18 families and not including of the sub-families. Megabats and the Microbats differs in a lot of ways, one of the most obvious difference is the difference in the body sizes of the Megabats and Microbats where on average, Megabats have a bigger body size compared to Microbats. A research on the life span of bat species is done and it shows that a bat's life span is 3.5 times greater than a non-flying placental mammal of similar size (Wilkinson *et al*, 2002). Where the life span increases significantly with hibernation, body mass and occasional cave use but decreases with reproductive rate and is not influenced by diet, colony size or the source of record.

1.1.1 Megachiroptera

According to Altringham (1996) the Megabats have larger body size compared to Microbats with the average forearm length of 40-220 mm and the weight from 2.0 to 2.5 kg and the wingspan approaching 2m. Megabats generally have large eyes, simple ears and simple muzzles. The second and third fingers of the Megabats are largely independent of each other with a claw on the second finger. As for the tail, Megabats have either a very small tail or non-existent at all. Megabats lack the variation of wing form and flight style as of Microbats, the shoulder anatomy is relatively simple if compared to Microbats. The eating behaviors of both suborders of bats differs that only the Megabats are of herbivores, taking in fruits and nectars. In the recent study, it is showed that one of the nectar consuming bat species has the longest tongue (Muchala, 2006).

1.1.2 Microchiroptera

As for Microbats, the average forearm lengths are from 22 to 110mm. All the Microbats species have the ability to navigate its path by echolocation. The ears of a Microbat are often large and complex and tragus is commonly found among Microbats. Many of the Microbats have nose leaves, which associates with the echolocation ability together with the tragus at the ear. Generally, Microbats have small eyes while the visual capacities are found to be very good. During the hunt, some of the species listen for the prey instead of emitting high frequency ultrasound, some even use its vision for the hunting purpose. The

Microbats are carnivores, consuming insects and some feed on other smaller vertebrates, frogs for example *Trachops cirrhosus*.

1.1.3 Echolocation

Commonly known for their ability to sense in the dark using the echolocation ability, however Megabats do not navigate with echolocation (excluding *Rousettus* genus), their good eyesight instead serve for the navigation purpose. Microbats on the other hand is the true master of echolocation, using it not only for navigation in the dark but also for hunting as well as communication purpose where each echolocation call acts as individual signals (Fenton *et al.*, 2004). The echolocation might even be more advance than what we have known, where the echolocation design is divided into two groups, those signals of low frequencies are used for the navigation for targeting prey's location while the higher frequencies are to distinguish the prey type without having to use the visual or auditory cues (Kingston *et al.*, 1999). It is also a good hunter with a good eyesight, in spite of the ability of echolocation.

1.1.4 Flight

The normal resting position of a bat is by hanging up side down with the feet clinging firmly onto the surface of the roost. However, a few of bat species can be found rest on horizontal surfaces in caves (Walker, 1975). Sometimes when fruit bats get about in the trees they perch on, they also get into a head upward position. The position of the bats

hanging upside down make easy for the bats to take flight. Where the bats only need to let go, drop and then spread the wings and fly. At times bats do fall to the ground either when tackling prey or due to some "unsuccessful" flight, the bats have no difficulty to take flight. It is done by launching themselves up into the air using both arms and legs.

When flying, the bats use both the wings and also their legs. This can be examined through photographs taken when the bats are flying, the combination of the wings and legs movements makes the bats looked as if swimming through air. This wing-leg coordination can also be observed when bats are foraging, especially Microbats which are insectivorous. When catching insects in flight, the insects will be trapped by the wing and tail membrane. And often, when the insect in the mouth is about to struggle loose, the bat will spread its leg out and forward so that the membrane is spread into an excellent lap and then they bend the head forward to consume the prey.

1.2 Anatomy

1.2.1 Body Size and Coloration

The sizes of the bats vary in the head and body length from about 25 to 406 mm. usually the pelage is long, silky with dense underfur. Some have color phases on the fur, for instance *Cynopterus horsefieldi* both female and male have different color tone for the fur.

1.2.2 Wing Structure

The wings that are used for flying are actually membranes that are extended from the back and the belly. The membranes are elastic and thin, with no flesh in between the two layers of skins. Only a small amount of connective tissues are found in the wings with small amount of blood vessels and nerves. The wing membranes are supported by the elongated digits on the forelimbs. Third digit is usually equal to the length of the body and head, including the legs. To support the wing membranes, the knee is directed outward and backward. A cartilaginous spur located on the inner side of the ankle joint helps to spread the tail membrane.

The thumb of the bats usually has a sharp, hooked claw and is often used to cling on to surfaces. In most of Pteropodidae family the second finger also has a claw. The fingers, excluding the thumb help to extend the wing where the fingers are able to spread out with the membranes in between each digit. The toes have sharp, curved claws. The bones of the fingers are slender, light and contain marrow. In order for the support of the arm in functioning as a wing, some joints in the vertebral column are fused together, the ribs flattened, better development in the shoulder girdle compared to the pelvic girdle and is firmly anchored by a well-developed clavicle (collarbone) which reaches to the sternum (breastbone). The sternum is usually centrally keeled or ridged for the enlarged muscles to attach to where the muscles are used in the downward stroke of the wings.

1.2.3 Nose leaf

Some Microbats have nose leaf at the front end of their nose. The purpose of this nose leaf is assumed to aid as a sensory organ which is similar to the function of the tragus, a lobe at the front of the ear orifice functioning as a tool in the echolocation ability, for the emitting of the high frequency wavelength perhaps while the tragus function as a receiver of the wavelength. For those bats which have nose leaf, they lack cones in the retina.

1.2.4 Dental Formula

Maximum number of milk teeth is 22; these teeth are used by the young bats to cling onto the mother's fur when flying with the mother. Maximum number of teeth is 38 and the minimum is 20. The cheek teeth of a bat are usually smooth and have three cusps, while those of Pteropodidae have longitudinal groove.

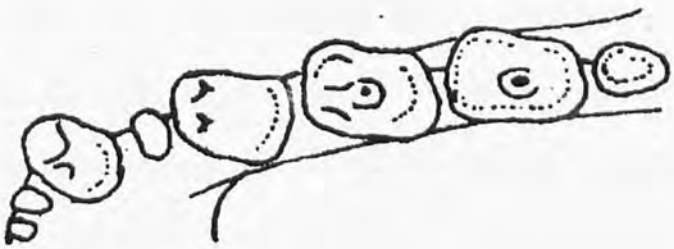

Figure 1.1: Dental Formula of a Pteropodidae Bat

1.3 Habitat Selection (Roosting and Foraging Site)

Bats are especially picky when it comes to the selection of sites for their activity, especially the roosting site. In a recent study, bats have shown the behavior of migrating to different location for roosting according to the seasonal change; either climate (Churchill, 1991; Parry-Jones *et al.*, 1992), or food resource (Penalba *et al.*, 2006). Usually bats can be found in caves roosting in large colonies; roosting in trees; under roof tops and some can be found in tree trunks. The selection of the site may refer to several factors including the humidity of the site (Churchill, 1991), food sources, and also predation (Markus *et al.*, 2004). Bats of different species can be seen occupying the foraging area, where the food resources are shared (Hickey *et al.*, 1996; Aldridge and Rautenbach, 1987). Or in some cases as mentioned by Arlettaz (1999), the bats share the same site but each has distinct preference for the prey.

Bats may also recognize fragmented area as distinct foraging site, which produce a result of capture that shows no significant different in the species diversity but differs significantly in the sense of species composition where higher number of species composition goes to the continuous forest and low species composition in fragmented forest (Bernard and Fenton, 2007).

The flight speed of a bat species also determines the selection of sites for the bats. In Pavey (1998), the study shows that the slow flight of *Rhinolophus megaphyllus* could lead to the increased risk of predation when flying over an open space. This has been a

likely explanation for the avoidance of open areas by bats with slow, maneuverable flight (Ekman and de Jong, 1996). This means that bat species with a slower flight speed will avoid open areas for foraging. Whereas for bat species with swift flight and with the capability of escaping predators are more commonly found foraging in open area.

1.4 Emergence Time

The emergence time for different bats are different due to several factors, according to Russo *et al* (2007), these factors are: a) the canopy coverage, b) the diet of the bat, c) the lactating period and d) flight speed. The canopy coverage effects the emergence time of the bats in a way that the lesser the canopy coverage, the later the emergence time. This is due to the light intensity, as the canopy covered less ground, the higher the light intensity of the forest compared to a forest of continuous canopy. Early emergence in high light intensity forest will make the bats easily fall victim to the predators. There for the late emergence is to reduce the possibility of being prey on.

As for the diet factor, the reason is that different bat species have different food preference; *Barbastella barbastellus* for example, preys on moth, since moth on average has a late emergence time and therefore has a late emergence time. Lactating bats emerge earlier during the reproductive season (Russo *et al,* 2007; Duverge' *et al.*, 2000; Shiel and Fairley, 1999). During this period, bats face strong energy requirements as the female need to gain more food in order to be able to produce enough milk to feed the young. And therefore the earlier emergence in lactating females suggests that this is probably

associated with longer foraging time which increases the amount of food intake per foraging night.

The effect of flight speed on the emergence time is easily understood where the slower the bat's flight speed, the more vulnerable it will be if it comes out early especially when the surrounding is still bright, which provides very little camouflage for it. Therefore, the late emergence time when the light intensity is low, the predation risk is lower. As for those with a faster flight speed, the emergence time is earlier, partly because evasion for predator will be easier compare to bats with slow flight speed. Earlier emergence time also provides a longer foraging time.

1.5 Justification

The world is now facing the crisis of the drastic decrease of biodiversity. In countries like Indonesia, Malaysia and Venezuela the biological diversity is the highest where as Brazil, Zaure and African countries are those with the most critical condition of the loss of tropical rain forests (Brown, 1990). The current rate of extinction is at about 100 species per day and about 50 species are destroyed where tropical rain forest is being logged (Heffa, 1991). And most of these extinctions occur in the tropical rain forests, including Malaysia, especially Sabah and Sarawak where the proportion of the tropical rain forests is still large.

According to the World Conservation Union (IUCN), in South-East Asia, there are 42 species of bats included in the IUCN Red List. And 9 out of the 42 species of bats are either extinct or endangered, while the rest are in need of conservation attention. Making the situation even more difficult is that the study of bats in this region is relatively few. Previous studies are mostly biased towards the distribution, diversity composition, population structure and ecology of the bats. This is because the bats have shown a large diversity of difference from the diet, the distribution according to variations of altitudes and spatial distribution.

Although bats are proven to be ecological and economical beneficial, however the information on bats are still insufficient, either from the aspect of population and status of the bat, the movement, the relative richness and the habitat need (Zubaid, 1994). Therefore, it is crucial for this study to be carried out to study the bats on Pulau Gaya and Pulau Mamutik as the result of this study might be useful for the future study of bats.

1.6 Objective:

In this research, the main objectives are:

1. To assess the diversity of the bats of Gomantong Forest Reserve, Sandakan and Mostyn Estate, Kunak.
2. To compare the population of bats of different micro-habitat on Gomantong Forest Reserve, Sandakan and Mostyn Estate, Kunak.

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