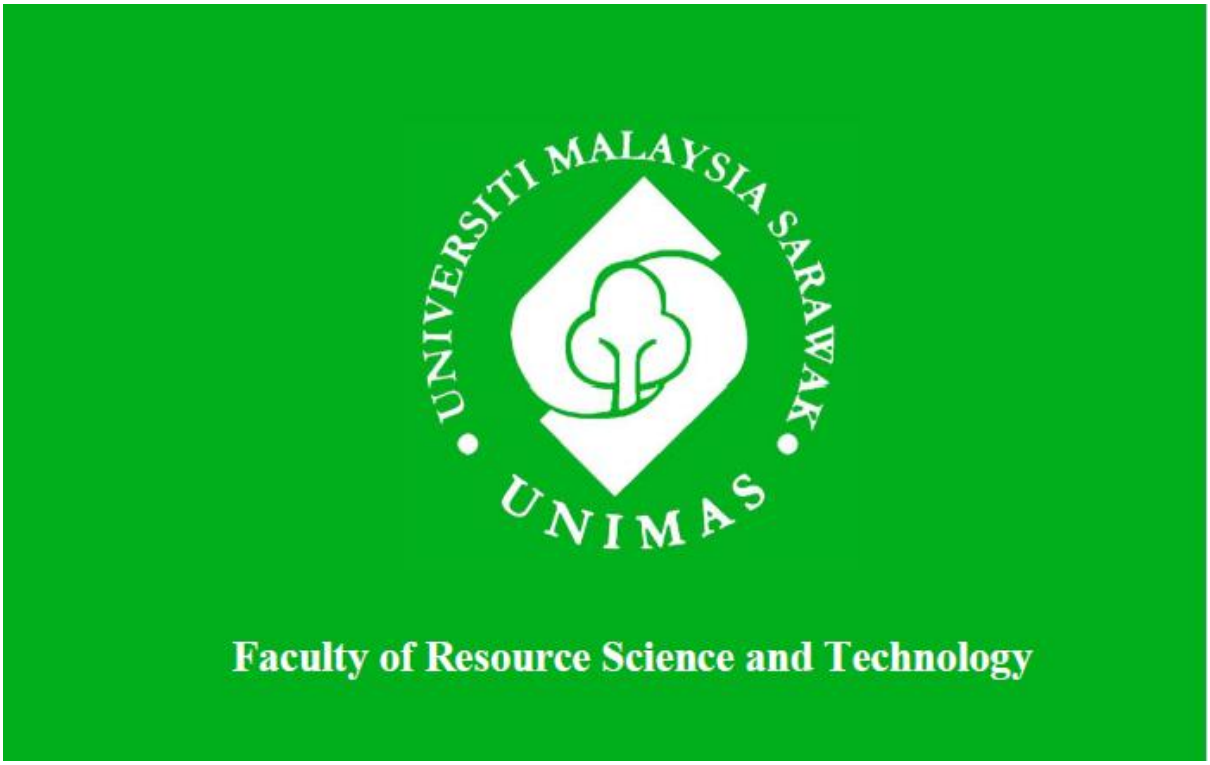

A Morphological Analysis of Spotted-winged Fruit Bat (Pteropodidae: *Balionycteris maculata*) in Malaysia

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27670

Bachelor of Science with Honours

Animal Resource Science and Management

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This project is submitted in fulfilment of the requirements for the degree of

Bachelor of Science with Honours

(Animal Resource Science and Management)

Animal Resource Science and Management
Department of Zoology
Faculty of Resource Science and Technology
Universiti Malaysia Sarawak
2013

Declarations

I declare that no portion of the work referred to this dissertation has been submitted in support of an application for another degree of qualification of this or any other university or institution of higher learning.

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LIST OF ABBREVIATION

BL	Bulla length
CVA	Canonical variate analysis
CW	Cranial width
C1BW	Basal width
C1C1B	Breadth across both canine outside surfaces
C1M3L	Canine molar length
DBC	Distance between cochleae
DFA	Disriminant function analysis
DL	Dentary length
D2MCL	Second digit metacarpal length
D3MCL	Third digit metacarpal length
D3P1L	Third digit first phalanx length
D3P2L	Third digit second phalanx length
D4MCL	Fourth digit metacarpal length
D4P1L	Fourth digit first phalanx length
D4P2L	Fourth digit second phalanx length
D5MCL	Fifth digit metacarpal length
D5P1L	Fifth digit first phalanx length
D5P2L	Fifth digit second phalanx length
E	Ear length
FA	Forearm length
GSL	Greatest skull length
GBPL	Greatest basial pit length
g	gram
HF	Hind foot length
IOW	Interorbital width
mm	Milimiter
MW	Mastoid width
M2L	Second molar tooth crown length
M2W	Second molar tooth crown width
M3M3B	Breadth across both third molar teeth outside surfaces
NP	National Park
PL	Post palatal length
POW	Postorbital width
sq	Square
SPSS	Statistical Package for Social Sciences
TVL	Tail ventral length
TB	Tibia length
UNIMAS	Universiti Malaysia Sarawak
UPGMA	Unweighted pair-group method average
ZW	Zygomatic width
°C	Degree Celcius

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A Morphological Analysis of Spotted-winged Fruit Bat (Pteropodidae: *Balionycteris maculata*) in Malaysia

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ABSTRACT

A morphological analysis of 30 individuals of the spotted-winged fruit bat, *Balionycteris maculata* was performed using 14 external characters and 18 craniodental characters. All the individuals were from three different populations that included Sarawak, Sabah and Pahang population. Discriminant function analysis was done for separated both external and craniodental characters. The D3MCL was suggested as the best predictors for the external characters while DL for the craniodental characters in differentiating the *B. maculata* from different population.

KEY WORDS: *Balionycteris maculata*, Morphological analysis, Discriminant Function Analysis.

ABSTRAK

Analisa morfologi telah dijalankan ke atas 30 individu Balionycteris maculata dengan menggunakan 14 ciri-ciri luar badan dan 18 ciri-ciri tengkorak dan gigi. Semua individu adalah dari tiga populasi yang berbeza iaitu populasi Sarawak, Sabah dan Pahang. Analisa fungsi diskriminasi telah dijalankan secara berasingan bagi ciri-ciri luaran dan tengkorak serta gigi. D3MCL dikenal pasti sebagai karakter terbaik untuk ciri-ciri luaran manakala DL adalah karakter terbaik untuk ciri-ciri tengkorak dan gigi bagi membezakan B.maculata dari populasi yang berbeza.

KATA KUNCI: *Balionycteris maculata, Analisa morfologi, Analisa fungsi diskriminasi.*

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CHAPTER ONE

Introduction

1.0 General Introduction

Bats are classified into a single order, the Chiroptera. Currently, the Chiroptera can be divided into two suborders, which are Megachiroptera and Microchiroptera (Altringham, 1998). Megachiropterans are frugivorous bats, whereas microchiropterans are insectivorous bats. Bats are the only mammal that can fly with the presence of pectoral limb modified as its wing to fly (Payne *et al*., 1985). This is one of the reasons for the wide distribution of bats over the world. The earliest fossil bats are found to come from Eocene which is about 60 million years ago and at that time they were fully developed fliers (Mickleburgh *et al*., 1992). One of the advantages of bats, that they can performed long distance fly searching for foods and shelters. In this study, the selected populations of *B. maculata* in Malaysia were used for morphometric analysis. The significant of this study is to help provide the information on the morphological analysis of *B. maculata.*

This study was conducted using a morphological analysis that includes the external and the craniodental measurements to determine the morphological variation in *B. maculata* populations in Malaysia.

1.1 Study Species

The spotted-winged fruit bat, *B. maculata* is among the smallest fruit bat that inhabiting Southeast Asia (Kofron, 2007). Currently, there are two subspecies of *B. maculata* are known namely *B. maculata maculata* and *B. maculata seimundi. B. maculata maculata* can be found in Borneo while *B. maculata seimundi* in Peninsular Malaysia. The upperpart of *B. maculata* is dark blackish brown, darkest on the head and the underpart is pale grey-brown and there also the pale spots on the edge of the ear and in front of the eye. This species obviously have white to pinkish spots on the wings. The weight is around 10 to 15 g and the tail is absent. Besides, the ear length ranged from 10 to 12 mm which the forearm length ranged from 40 to 45 mm (Payne *et al*., 1985).

In Peninsular Malaysia, this species has been found, roosting in small groups in crowns of palm, clumps in epiphytics ferns and sometimes in caves (Payne *et al*., 1985). This species inhabit primary rain forest up to 1500 m a.s.l and also in coastal area (Hodgkison and Kunz, 2006). In lowland rain forest of Sabah, this species are found roosting in palm trees (Campbell, 2011). This species also forage in the understorey of dense forest (Hodgkison, 2004). It is widely distributed throughout Thailand, Peninsular Malaysia, Borneo, Sumatra, Durian and Galang Isles (Riau Arch, Indonesia) (Wilson and Reeder, 2005).

1.2 Objectives

The objectives of this study are;

1. To determine the morphological variation among the different populations of *B. maculata* in Malaysia.

~~1.~~

2. To determine the best characters to differentiate among the *B. maculata* populations in Malaysia.

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1.3 Hypothesis

This study was ~~hypothesis~~ hypothesise as:

: There is no significant difference in the external, craniodental measurements of *B. maculata* from different populations in Malaysia.

: There is a significant difference in the external and craniodental measurements of *B. maculata* from different populations in Malaysia.

CHAPTER TWO

Literature Review

2.0 Previous Study on *B. maculata*

B. maculata is one of the smallest fruit bats in the world (Campbell, 2011). The *Aethalops* and *Chironax* are similar species to *Balionycteris* due to the small in body size. However, they can be distinguished from each other by their external characters and dentition. *Balionycteris* can be easily recognised by pale spot on their wings. *Chironax* is small tailless bat with two pairs of lower incisors. Meanwhile, *Aethalops* is small grey bat with one pair of lower incisors (Payne *et al.*, 1985). This indicated that the morphometric analysis is very important to differentiate each species of bats. The morphological analysis of *Aethalops aequalis* by direct observation based on its external morphology characteristics is rather inadequate, in as much as it lacks of clear distinctive characteristics. Thus, skull morphometric analysis is probably the best way to explore differences in morphological characteristics among the similar species, in different population (Tingga and Abdullah, 2012).

Few studies on the ecology of this species was conducted, include the reproduction study of *B. maculata* in Brunei (Kofron, 2007). However, this information alone is not enough. Additional data on the characters measurement is crucial to determine the variation among the populations in Malaysia. Thus, this would be the first attempt to understand the variations of *B. maculata* population in Malaysia using the morphometric technique.

According to Faisal (2008), *B. maculata* previously recorded in Sabah (Kota Kinabalu, Madai and Sepilok) and Sarawak (Batang Ai National Park, Bau, Bako National Park, Kuching, Matang Wildlife Centre, Mount Gading, Mount Dulit, Mount Penrissen, Mulu, Niah, Samunsam Wildlife Sanctuary, and Sematan). This species is commonly found in lowland dipterocarp forest and at higher elevation. He found a genetic divergence of 12 % between geographic populations in Borneo and Peninsular Malaysia, suggesting a species level separation, for which the names *B. maculata* and *B. seimundi* respectively, would be available. Morphological variation between Kalimantan (Indonesia Borneo) and Sumatra (Indonesia) populations also supports distinction between the populations (Maryanto, 2003).

2.1 Morphological Study

The use of morphological characters in describing species boundaries has been greatly aided by the implementation of multivariate statistics (Jayaraj, 2008). The statistical data were subjected to disriminant function analysis (DFA) and canonical variate analysis (CVA) using SPSS version 15.0 and unweighted pair-group method average (UPGMA) cluster analysis using Minitab version 14.4 (Sazali *et al*., 2012).

A study of the morphometric analysis of the *Rhinolophous* species was done by Sazali *et al.* (2008). They determined that the *Rhinolophous* species are well grouped in the cluster analysis. They suggested that the morphometric analysis has a potential for species identification within its genus as each species is well separated into each cluster.

A study on morphological variation of the dusky fruit bat, *Penthetor lucasi* from Sarawak populations was done by Rahman and Abdullah (2010). They used DFA to determine the best morphological characteristics to differentiate the individual among the populations. The results suggested that different ecological forces between populations such as breeding, foraging behaviour, crowding effects and resource availability, could have been the moulding factors behind the observed morphological variations in the different *P. lucasi* populations.

The morphological study of Malaysian *Kerivoula* was carried out by Hasan and Abdullah (2011). They found, six groupings of *Kerivoula*. *Kerivoula papillosa* was divided into two distinctive grouping of *K. papillosa* type large and *K. papillosa* type small.

Tingga and Abdullah (2012) found that the montane endemic bat, *Aethalops aequalis* is separated at the geographic level, but not at the population level. Overall 11 craniodental characteristics were examined and analyzed using DFA method. *Aethalops aequalis* from Sabah and Sarawak possessed a single skull morphotype and mountain isolation is, or has not yet been a sufficient barrier.

A study on a predictive model to differentiate the fruit bats *Cynopterus brachyotis* and *C.cf. brachyotis* Forest (Chiroptera; Pteropodidae) from Malaysia using multivariate analysis was done by Jayaraj *et al.* (2012). These cryptic species of bats are successfully grouped in the cluster analysis (CA). They also found five characters that can be used to differentiate among museum vouchers of *C. brachyotis* and *C. cf. brachyotis Forest*.

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CHAPTER THREE

Materials and Method

3.0 Study Area

The study was investigated the three populations of *B. maculata* in Malaysia, namely from Sarawak, Sabah and Peninsular Malaysia (Figure 1). The study site was chosen based on the distribution of *B. maculata* (Payne *et al*., 1985).

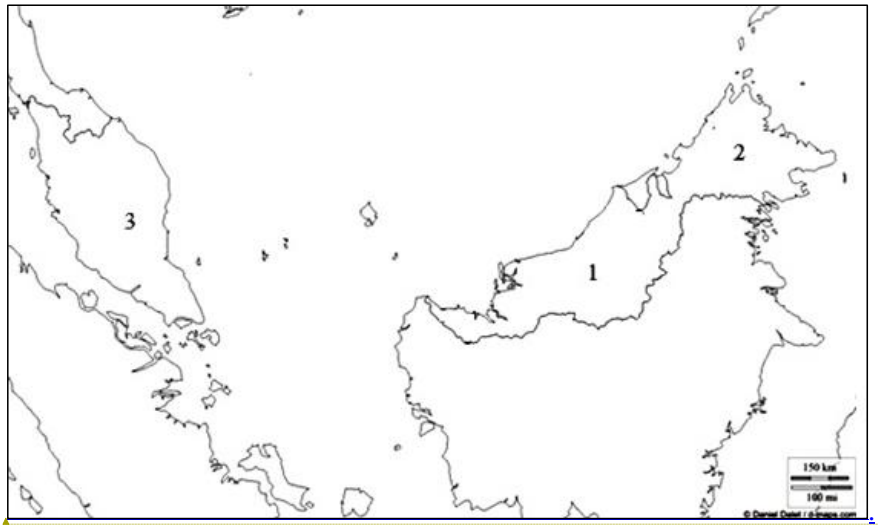

Figure 1. Map show the study sites for morphological analysis of *B. maculata* in Malaysia. 1, Sarawak population; 2, Sabah population; 3, Peninsular Malaysia population.

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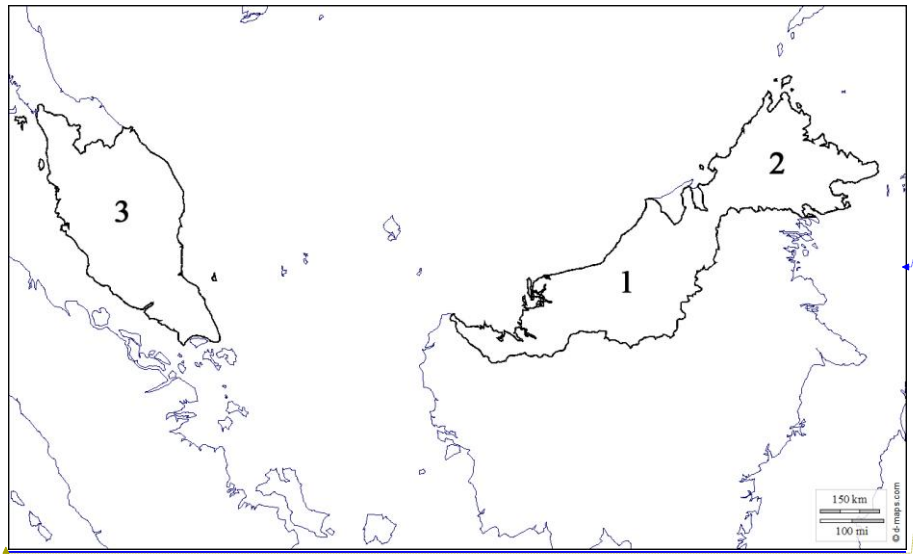

Figure 1. Map show the study sites for morphological analysis of *B. maculata* in Malaysia. 1, Sarawak population; 2, Sabah population; 3, Peninsular Malaysia population.

Sarawak

Five sites have been combined for the Sarawak population that includes Kubah National Park (KNP), Fairy Cave Nature Reserve (FCNR), Sebangkoi Rimba Park (SRP), Niah National Park (NNP) and Mulu National Park (MNP).

a) KNP is situated about 22 km west of Kuching city, near Matang village. It was covered an area of slightly over 22 sq. km (Hazebroek and Abang Morshidi, 2000). The park comprises the slopes and ridges of the Mount Serapi sandstone massif which reaches a height of 911m. KNP is largely covered by mixed dipterocarp

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forest and Kerangas forest. Kerangas forest is developed on slopes formed by sandstones bedding surfaces. Besides, it is also rich in palm flora (Hazebroek and Abang Morshidi, 2000).

b) FCNR is located at Bau district, 48 km away from Kuching. The Fairy Cave is the largest cave entrance in the Kuching area and few minutes away from Wind Cave. Fairy Cave provides the roosting area for various fruit bats and insect bats.

c) SRP is located at the Sarikei district. The type of forest is cultivation forest. This area is characterised by secondary forest and surround by orchard farm. Some fruiting trees that can be found here includes, *Durio zibethinus*, *Artocarpus heterophyllus*, *Lansium domesticum* and *Musa sapientum*.

d) NNP lies 16 km inland from the sea on the north coast of Sarawak. The park protects 31 sq. km of lowland forest and limestone hills (Hazebroek and Abang Morshidi, 2000).

e) MNP is situated at about 100 km east of Miri town. MNP is the largest national park in Sarawak, with an area of 544 sq. km (Hazebroek and Abang Morshidi, 2000). This park cover the lowland mixed dipterocarp forest, lower montane forest, lowland limestone forest, lower montane limestone forest and upper montane limestone forest (Hazebroek and Abang Morshidi, 2000).

Sabah

Three sites have been combined to be the population of Sabah namely, Danum Valley (DV), Tawau Hills (TH) and Imbak Canyon Conservation Area (ICCA).

a) DV is 438 sq. km tract of relatively undisturbed lowland dipterocarp forest. This conservation area is one of the richest conservation areas in the world with over 200 species of tree per hectare thriving on it. The nearest town is Lahad Datu.

b) TH situated on Sabah's east coast. The park covers an area of 280 sq. km. The terrain of the park is hilly jungle and includes two moderate elevation mountains; Magdalena (1,310 m) and Lucia (1,201 m) (Briggs, 1991).

~~c)~~ ICCA is located at Sandakan. The area is 30, 000 ha of pristine tropical dipterocarp forest. It is bordered by the Maliau Basin on its south and the DV on its east.

c)

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Peninsular Malaysia

Pahang population represent Peninsular Malaysia population.

a) The Taman Negara is the largest park in the country, with 4,000 sq km. At higher elevations, the forest is lower, thinner and the trees twisted into weird shapes (Briggs, 1991)

3.1 Field methodology

An average of 10 mist nets were deployed in various locations supposed to be in the flyways of bats such as above streams, narrow pathways in the forest, trails, cleared area in the forest and forest edge. The nets were checked every one to two hours interval until night and closed immediately after the following morning checks. Selected nets were moved to new places depending on the efficiency of the nets. The captured bats were identified based on its morphological measurements and features according to Payne *et al*. (1985). The external body measurements were taken using digital calliper. The measured characters are forearm length (FA), tibia length (TB), ear length (E), hind foot length (HF), second (D2MCL) and third digit metacarpal length (D3MCL), third digit first (D3P1L) and second phalanx length (D3P2L), fourth digit metacarpal length (D4MCL), fourth digit first (D4P1L) and second phalanx length (D4P2L), fifth digit metacarpal length (D5MCL), fifth digit first (D5P1L) and second phalanx length (D5P2L) (Figure 2).

3.2 Skull Extraction and measurement

Table 1. List of the samples of *B. maculata* used in the morphological analysis.

#	Coll	Population	Locality	Sex
1	MZU/M/1076	1	Fairy Cave Nature Reserve, Bau (FCNR)	F
2	MZU/M/1090	1	Kubah National Park(KNP)	F
3	MZU/M/1066	1	Fairy Cave Nature Reserve, Bau(FCNR)	F
4	MZU/M1070	1	Kubah National Park(KNP)	M
5	MZU/M/1515	1	Kubah National Park(KNP)	F
6	MZU/M/1507	1	Sarikei Sebangkoi Rimba Park(SRP)	M
7	MZU/M/1504	1	Sarikei Sebangkoi Rimba Park(SRP)	F
8	MZU/M/1397	1	Sarikei Sebangkoi Rimba Park(SRP)	M
9	MZU/M/1501	1	Sarikei Sebangkoi Rimba Park(SRP)	F
10	MZU/M/1502	1	Sarikei Sebangkoi Rimba Park(SRP)	F
11	MZU/M/1080	1	Niah National Park(NNP)	M
12	MZU/M/1535	1	Niah National Park(NNP)	F
13	MZU/M/1093	1	Niah National Park(NNP)	F