Faculty of Resource Science and Technology

QUANTIFYING SHRINKAGE OF MORPHOMETRIC MEASUREMENTS: MUSEUM SPECIMENS VERSUS LIVETRAPPING SPECIMENS OF LITTLE SPIDERHUNTER (*ARACHNOTHERA LONGIROSTRA*) AND GREY-BREASTED SPIDERHUNTER (*ARACHNOTHERA MODESTA*)

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Bachelor of Science with Honours
(Animal Resource Science and Management)
2015

UNIVERSITI MALAYSIA SARAWAK

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QUANTIFYING SHRINKAGE OF MORPHOMETRIC MEASUREMENTS: MUSEUM SPECIMENS VERSUS LIVETRAPPING SPECIMENS OF LITTLE SPIDERHUNTER (*Arachnothera longirostra*) AND GREY-BREASTED SPIDERHUNTER (*Arachnothera modesta*)

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This project report is submitted in partial fulfilment of the requirements for the Degree of Bachelor of Science with Honours
(Animal Resource Science and Management)

Faculty of Resource Science and Technology
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2015

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I hereby declare that no portion of 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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The project entitled '**Quantifying shrinkage of morphometric measurements: museum specimens versus live trapping specimens of Little spiderhunter (*Arachnothera longirostra*) and Grey-Breasted spiderhunter (*Arachnothera modesta*)**' was prepared by Hairunizam Bin Amiruddin and submitted to the Faculty of Resource Science and Technology in partial fulfillment of the requirements for the Degree of Bachelor of Science (Honours) in Animal Resource Science and Management.

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ACKNOWLEDGEMENTS

ALHAMDULLILLAH, all praises to Allah, for the blessing given to me to finish my final year project.

My first thanks goes to my supervisor, Mr Charlie Laman who always give me his supports, time, comments and correcting my final year project. Besides, thanks a lot to Dr Faisal Ali Anwarali Khan, my co-supervisor, for his guidance, wistful advice and encouragement throughout the proposals and final report writing.

Deepest appreciation goes to the Director of IBEC, UNIMAS, Prof Dr Gabriel Tongga Noweg, Gading National Park staff for granting permission and helping us during the field work and Sarawak Museum for providing me the secondary data to be used in my study. Special thanks to Universiti Malaysia Sarawak (UNIMAS) for the logistic supports.

I also would like to thank my fellow friends, Sofi, Floyd, Afini and Wong and colleagues at Department of Zoology, FRST, UNIMAS for their help and support. Finally, I would like to acknowledge my parents, Amiruddin Kaman and Sumisa Disir, my siblings Amirul Shaiful, Muhammad Hisyam, and Farah Adibah for their love and support. I am very fortunate to have such a wonderful and loving people around me.

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LIST OF ABBREVIATIONS

NHC – Natural History Collection

s.d – standard deviation

$\bar{x}$ – Population mean

d.f – Degree of freedom

mm – millimetre

g – Gram

DNA – Deoxyribonucleic acid

KNP – Kubah National Park

GNP – Gading National Park

TR – Tarsus

BL – Bill length

BW – Bill width

BD – Bill depth

HB – Head to bill length

WS – Wing span length

TA – Tail

WL – wing length

TL – Total length

W – Weight

m – Metres

hrs – Hours

Mt – Mount

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QUANTIFYING SHRINKAGE OF MORPHOMETRIC MEASUREMENTS: MUSEUM SPECIMENS VERSUS LIVETRAPPING SPECIMENS OF LITTLE SPIDERHUNTER (*Arachnothera longirostra*) AND GREY-BREASTED SPIDERHUNTER (*Arachnothera modesta*)

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Frequently, morphometric sexing used museum specimens to derive the morphometric sexing guideline. Over long period of time, these specimens tend to dry, cause shrinkage to the specimens. It is unwise to use directly the morphometric sexing guideline without considering the difference between museums and fresh/live trapping samples that caused by the shrinkage. Morpho-measurement of Little Spiderhunter and Grey Breasted Spiderhunter were used to assess amount of shrinkage occurring in various external body parts. Six of seven morphological characteristics of Little Spiderhunter and two out of seven morphological characteristics of grey-breasted spiderhunter were showed significant different between museum and fresh specimens measurements. The amount of shrinkage was varies, for little spiderhunter, the amount of shrinkage was ranging from 20.34% to 0.16% while for grey-breasted spiderhunter ranging from 11.83% to 0.87%.

Keywords: Grey-breasted spiderhunter, little spiderhunter, morphometric sexing, morpho-measurements, shrinkage.

Lazimnya, pengeseksan morfometrik menggunakan spesimen muzium untuk menghasilkan garis panduan pengeseksan morfometrik. Dalam jangka masa yang panjang, spesimen muzium ini akan mengering, menyebabkan pengecutan berlaku kepada spesimen tersebut. Disebabkan pengecutan yang berlaku, adalah sesuatu yang tidak wajar untuk menggunakan secara langsung panduan pengeseksan morfometrik ini tanpa mengambil kira perbezaan antara sampel muzium dan sampel segar/tangkapan langsung. Ukuran-morfo 'Little spiderhunter' dan 'Grey-breasted spiderhunter' digunakan untuk menilai jumlah pengecutan berlaku di beberapa bahagian anggota luar badan burung ini. Enam daripada tujuh ciri-ciri morfologi Little spiderhunter dan dua daripada tujuh ciri-ciri morfologi Grey-breasted spiderhunter telah menunjukkan perbezaan yang signifikan antara ukuran muzium spesimen dan spesimen segar. Jumlah pengecutan adalah berbeza-beza, untuk Little spiderhunter, julat pengecutan yang berlaku adalah antara 20.34% hingga 0.16% manakala bagi Grey-breasted spiderhunter adalah daripada 11.83% kepada 0.87%.

Kata kunci: *'Grey-breasted spiderhunter', 'little spiderhunter', pengeseksan morfometrik, ukuran-morfo, pengecutan.*

CHAPTER 1

INTRODUCTION

1.1 General introduction

Museums stores millions of valuable specimens. Specimens housed in the museum serve many purposes. There are few importance of natural history collections (NHC) is to document past and present-day patterns of biological diversity, impact of climate change and deforestation to some animals and identify the origin of invasive species (Suarez & Tsutsui, 2004). Recently, museum specimens are widely used by some biologist to answer some biological issues in ornithology. These specimens are vital in understanding the evolution, ecology, behavior and taxonomy of birds (Fairuz, 2007; Moktar, 2008; Ramji & Rahman, 2011; Sazali, 2005; Wandeler, Hoeck, & Keller, 2007).

Little spiderhunter (*Arachnothera longirostra)*, and Grey-Breasted spiderhunter are commonly found birds in lowland areas of Borneo. These birds belong to family Nectariniidae under genus *Arachnothera.* They consumed nectar and some insect (not necessarily spiders) as part of their diets. They have long curved beak makes them unique and easily being identified (Phillipps & MacKinnon, 1993; Smythies, 1999). These birds are monomorphic birds, where males and females possess similar morphological characters and its feather coloration (Sazali, 2005). The gender of this bird is vital to be identified as to understand more about their ecology and behavior of this species. Identification using DNA marker is the best method to be used to identify their gender. However, Sazali (2005) in her study proves that logistic regression analysis can also being used to identify the gender of little spiderhunter using external morphological characteristics. Museum specimens at Sarawak Museum were used to take the external morphological measurements. One research question arises is there any difference between measurements taken from museum specimens and live specimens/live trapping data since the museum

specimens tend to shrink? In this study, live specimens/ live trapping data or later on being known as fresh samples in this study are specimens that are captured and measured directly during field without killed the birds.

Information on differences between morpho-measurements of museum and live specimens (fresh samples) on little spiderhunter and grey-breasted spiderhunter has yet to be investigated. Up to date, no research regarding the difference between museum and live specimens measurements in Sarawak, make the sexing modeling using measurements taken from museum failed to be applied to live specimens. The study is vital as to give an overview on amount of shrinkage happen to external morphological characteristics of Little spiderhunter and Grey-Breasted spiderhunter. Thus, further analysis could be done to make some adjustments to the museum measurements before the morphometric sexing guideline being used directly in field.

1.2 Objectives

The study was done to achieve the following objectives:

1. To assess amount of shrinkage to external morphological characteristics of Little spiderhunter, *Arachnothera longirostra* and Grey-Breasted spiderhunter, *Arachnothera modesta* based on museum and live specimens.
2. To determine the significant different(s) of size on the selected morphometric characteristics.
3. To give future advices on morphometric sexing guideline derive from museum specimens.

1.3 Hypotheses

Hypothesis 1

H_o: There is no different in body measurements between museum and live specimens of little spiderhunter.

H_A: There is a difference in body measurements between museum and live specimens of little spiderhunter.

Hypothesis 2

H_o: There is no different in body measurements between museum and live specimens of grey-breasted spiderhunter.

H_A: There is no different in body measurements between museum and live specimens of grey-breasted spiderhunter.

CHAPTER 2

LITERATURE REVIEW

2.1 Spiderhunter in Borneo

Spiderhunters and sunbird are two closely related groups under family Nectariniidae. These birds have metallic plumage and their behaviour that resembles American hummingbirds makes them be able to hover in front of flowers (MacKinnon & Phillips, 1993). Throughout the Southeast Asia, there are 24 species of spiderhunters and sunbird. In the island of Borneo, there are eight species of spiderhunter that can be found in this island. Eight species of spiderhunter are found in Borneo, namely, little spiderhunter (*Arachnothera longirostra*), thick-billed spiderhunter (*Arachnothera crassirostris*), long-billed spiderhunter (*Arachnothera robusta*), spectacled spiderhunter (*Arachnothera flavigaster*), yellow-eared spiderhunter (*Arachnothera chrysogenys*), grey-breasted spiderhunter (*Arachnothera modesta*), streaky-breasted spiderhunter (*Arachnothera affinis*), and whitehead spiderhunter (*Arachnothera juliae*). Whitehead spiderhunter was found to be endemic to Borneo (Smythies, 1999).

Spiderhunter are well distributed along South East Asia, Sunda Islands and part of Philippines. The spiderhunter are easily identified by having larger body size compared to any other sunbird and possess drab greenish, yellow, or grey plumage on their body (Moyle *et al.*, 2011). Besides, these birds also have long decurved and stout bills. Most of species under this family consumed nectar, insect and pollen (MacKinnon & Phillips, 1993).

Up to date, none from eight species of spiderhunter that can be found within Borneo are classified as totally protected or protected species in any local or international

legislation. Even though none of the species are listed as protected, it does not mean that these species are not important to be studied in details.

2.2 Little spiderhunter *(Arachnothera longirostra)*

Engkerasak, are name given by Iban peoples to little spiderhunter. The Little Spiderhunter (*A. longirostra*) is the commonly found throughout lowlands of Borneo to about 1,400 m above sea level and it occupies primary forests and secondary forests (Phillipps & MacKinnon, 1993; Smythies, 1999). Smythies (1999) claimed that little spiderhunter is well distributed along Greater Sunda region up to Java and Borneo, Nepal, Philippines, Indochina and Peninsular India up to south-west China. This bird tends to produce *chip chip chip* sound when pearched while in flight they produce single and spaced harsh *chip* sound. Same like any other spiderhunters, little spiderhunter consumed soft insect and also nectar from ginger (Family: Zingiberaceae,) and banana (Musa spp.) flowers. Due to this reasons, this bird is important in the ecosystem. It acts as pollinating agent for ginger and banana in tropical forest. The nests of little spiderhunter are pocket-like structure and sewn under the some large leaf. Dead lead become main building materials to build the nest for this bird.

Classification of spiderhunter at higher level is well resolve (Moyle *et al.*, 2011). Little spiderhunter were closely related to *A. crassirostris* and *A. robusta*. The little spiderhunter has been identified to have 13 subspecies which include *A. l. longirostra* (mainland Asia), *A. l. sordida* (southern Yunnan and northeastern Indochina), *A. l. pallida* (southeastern Thailand and southern Indochina), *A. l. cinereicollis* (Malay Peninsula and Sumatra), *A. l. zharina* (Banjak Island), *A. l. niasensis* (Nias Island), *A. l. prillwitzi* (Java), *A. l. rothschildi* (northern Natuna islands), *A. l. atita* (southern Natuna islands), *A. l.*

buettikoferi (Borneo), *A. l. dilutor* (Palawan), *A. l. flammifera* (Mindanao), and *A. l. randi* (Basilan) (Moyle *et al.*, 2011; Rahman Mustafa Abdul, 2000).

Since this species has many subspecies, thus, further analysis on morphometric sexing using live specimens should be evaluated in future to assess amount of shrinkage for every subspecies. By having this study, more information about the biology of this species could be reveals.

2.3 Grey-breasted spiderhunter (*Arachnothera modesta)*

The grey-breasted spiderhunter is one of commonly found spiderhunter in lowland areas in Borneo. Little spiderhunter and grey-breasted spiderhunter are commonly fly fast at lower level of the forest. Similar in diet to little spiderhunter, grey breasted spiderhunter also consume nectar and insect as part of their diet. This bird is usually being found at understorey of undisturbed and disturbed mixed dipterocarp forest. Grey-breasted spiderhunter named after their physical appearance which possess grey colour below its body part with narrowly streaked on its upper breast. Besides, it also has black-tipped tail, brown iris, bill with blackish in colour on its upper part while much lighter on it's under part (Smythies, 1999).

2.4 Shrinkage of museum specimens

Morphometric measurements are usually being used in determining the sex of monomorphic bird such as spiderhunter, babbler and bulbul. Morphometric analysis is one of the easiest and affordable methods to determine the sex of some monomorphic bird. DNA analyses are also used to do sexing in monomorphic bird. Although this method is more accurate, but DNA analyses is expansive than morphometric analysis. Due to this

reason, there are many studies still using morphometric analysis to determine the sex of bird especially monomorphic bird (Fairuz, 2007; Jack, 2011; Sazali, 2005).

Frequently, museum specimens are used to determine the sex of birds. But, due to different processing method during preservation of the specimens and age of specimens itself, the specimens tends to dry and decrease in size (Kuczyński *et al.*, 2002; Stewart, 1963; Winker, 1993). Without making any correction to the museum specimens measurements, it is unwise to apply any equation determine from museum measurement directly to live specimens. Due to this reason, correction should be done to the museum specimen's measurements before it is being applied to live specimens.

The shrinkage of the museum specimens are varies depends on the species. Study done by G. H. Green (1980) and Winker (1993) proved that the amount of shrinkage are varies according to the species. G. H. Green (1980) explained about the amount of shrinkage between ringed plover and dunlin. He found that in average, wing length of ringed plover shrank about 2.7% after 6 month the specimens being skinned while dunlins shrank about 2.2%. But, the study only used one body measurement which is wing length to evaluate the amount of shrinkage in different species. Next, study done by Winker (1993), showed that there were significant different respect to the amount of shrinkage of 2 different species which is Tennessee warblers and Traill's flycatchers. In this study, 3 body measurements were used including wing chord, tail and bill to assess the degree of shrinkage from both species. The study statistically proved that degree of shrinkage are varies to the species.

In addition, degree of shrinkage of specimens also varies to the body part of birds (Bjordal, 1983; Champagnon, Guillemain, Elmberg, Folkesson, & Gauthier Clerc, 2010; Herremans, 1984; Jenni & Winkler, 1989; Knox, 1980; Wilson & McCracken, 2008). Bjordal (1983) and Herremans (1984) found that there was major shrinkage happened to

wing length, tarsus length, and bill length. The shrinkage were varies depends on the body measurements of the specimens. As in Bjordal (1983), the bill length were shrank about 0.11% to 1.58% while wing length shrank about 0.50% to 0.99%. But, both studies found there was increase in size of tail of the specimens. Retraction of skin between retrices was found caused the increment of tail size as explained by Bjordal (1983). The outcome was further supported by Wilson & McCracken (2008) that proved the degree of shrinkage were varies depending on the body parts of the birds. This study was done to investigate the specimen's shrinkage in Cinnamon Teal. They found that tail length were increase after drying while other body parts such as bill height, bill width, and tarsus length facing vary degree of shrinkage after drying.

This present study was conducted to assess amount of shrinkage of little spider hunter and grey-breasted spiderhunter. Does the amount of shrinkage in little spiderhunter and grey-breasted spiderhunter are varies on the body part as proves by previous study as other birds species? Seven measurement including of tarsus length (TR), bill length (BL), bill depth (BD), bill width (BW), and head to bill length (HB) were used to prove the statement. In present study, the sex and age of the live and museum specimens were pooled although some study show there is slight different in term of the amount of shrinkage between male and female and also its ages (Harris, 1980; Stewart, 1963). Thus, further studies should be done specifically to evaluate the impact of sex and age of specimens on the degree shrinkage on little spiderhunter.

2.5 Independent samples *t* test

Independent samples *t* test is widely used in comparing means of two population with unknown population mean and standard deviation or to conduct hypotheses testing on the difference between two population means. There are few assumptions to be fulfilled before

considering this test. The assumptions are two samples must be independent samples, large samples size (usually more than 30 or larger), equal variance of the population and normally distributed data (Peck & Devore, 2007). The samples drawn from the population are said to be independent samples if the selection of the individual does not affect the selection of other individuals (Brase & Brase, 2012). In this test, means between two populations will be compared by looking at the difference of means, μ_1-μ_2. The two population means are said to be identical when μ_1-$\mu_2 = 0$. The following are the formula used in calculating t value:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}, \text{ where d.f. = smaller of } (n_1 - 1) \text{ and } (n_2 - 1) \qquad (1)$$

Where,

$\bar{x}_1$ = population mean group one;

$\bar{x}_2$ = population mean group two;

s_1^2 = sample varience for group 1;

s_2^2 = sample variance for group 2;

n_1 = sample size group 1;

n_2 = sample size group 2;

In context of the current study, external morphological measurements were taken from different samples which were museum samples and fresh/live trapping samples. Different test was used in Winker (1993) and Wilson and McCracken (2008) even though the objective more or less the same which was to find significance different between dried and fresh specimens. In their study, paired t test was used since the measurements taken from the same individuals. The measurements were taken from the same samples before and after the samples were dried.

2.6 Man-Whitney U test

The Man-Whitney U test or Wilcoxon rank-sum test is a non-parametric test used as an alternative to two independent samples t-test (Brase & Brase, 2012). This test is use to compare mean of two independent population. The good thing about this test is that it does not require the population to be normally distributed and it also does not influenced by extreme observations. There are few assumptions that must consider before using this test. First, the 2 group of samples must be taken randomly from the population. But unlike the t test, the Wilcoxon test does not assume that the underlying populations are normally distributed and is less affected by extreme observations. The Wilcoxon evaluates the null hypothesis that the medians of the two populations are identical (for a normally distributed population, the population median is also the population mean). The following are the formula used to calculate U statistic for every group:

$$U_1 = n_1 n_2 + \left(\frac{n_1(n_1+1)}{2}\right) - R_1 \tag{2}$$

$$U_2 = n_1 n_2 + \left(\frac{n_2(n_2+1)}{2}\right) - R_2 \tag{3}$$

Where, n_1 = number of observations in the first group, n_2 = the number of observations in the second group, R_1 is the sum of the ranks assigned to the first group, R_2 is the sum of the ranks assigned to the second group (Nachar, 2008)

CHAPTER 3

METHODOLOGY

3.1 Sample collection

This study was conducted at Gading National Park, Lundu, Sarawak (1°42.00' N, 109° 50.20' E) for over five consecutive days. The study areas were divided into two sites which are Site A and site B (refer to Figure 1). Field sampling for site A was conducted on 19-23 October 2014 while for site B was conducted on 14-19 January 2015. Data collected throughout the field sampling were classified as primary data; while data taken from previously published and unpublished report were classified as secondary data (refer to Table 1). While for museum measurements were taken from Sazali (2005).

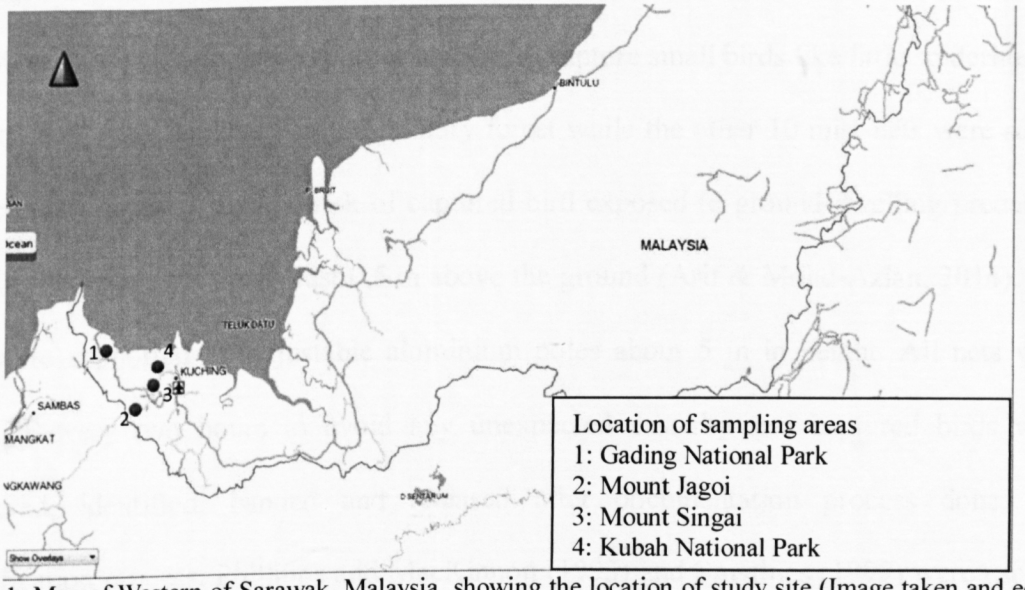

Figure 1: Map of Western of Sarawak, Malaysia, showing the location of study site (Image taken and edited from BaseCamp version 4.2.2, http://garmin.com)

Table 1. List of study site (Retrieved from www.sarawakforestry.com)

Type of data	Locality	Description
Primary	Gunung Gading National Park (GNP)	Located in Lundu district. Provide unforgettable experience to observe Rafflesia blooms to visitor.
Secondary	Kubah National Park (KNP)	This national park was gazetted in May 1989. The park has three mountain peaks including Gunung Serapi, Gunung Selang and Gunung Senduk. Famous with its diversity of palm.
	Mount Singai	Provide diverse species of birds.
	Mount Jagoi	Located near to Kampung Duyoh, close to Serikin border.

3.2 Field methods

Twenty mist nets were set up along the forest trail and also on the forest edge for both site (site A and site B) operated from 0600 hrs. to 1800 hrs. Mist nets with size of 12 m long, 2.5 wide and 3.6mm mesh size with four shelves were used in this study. The mist nets were chose since it is the appropriate size to capture small birds like little spiderhunter. 10 mist nets were deployed on the primary forest while the other 10 mist nets were set up in secondary forest. To avoid risk of captured bird exposed to ground-dwelling predators, the mist nets were set up at least 0.5 m above the ground (Arif & Mohd-Azlan, 2014). The nets were supported by adjustable aluminium poles about 5 m in height. All nets were checked every two hours to avoid any unexpected casualty and captured birds were measured, identified, banded and released after documentation process done. For identification process, Phillipps and MacKinnon (1993) and Smythies (1999) were used to identify the caught birds. The birds were released back to the forest after all documentation works done.