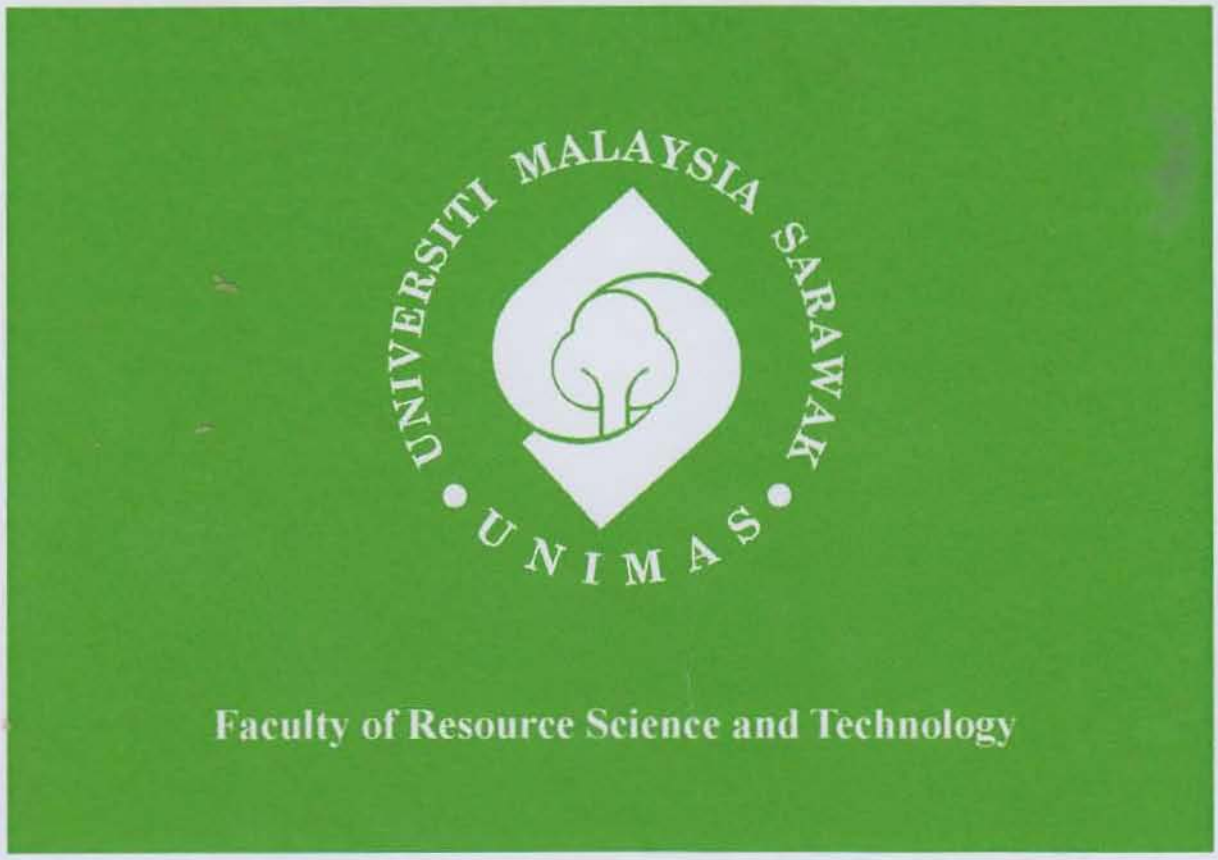

The Stag Beetle (Coleoptera: Lucanidae) Assemblages of Sarawak Based on Museum Collections

Nur Nabihah Binti Shaharudin (45890)

Bachelors of Science with Honours
(Animal Resource Science and Management Programme)
2017

THE STAG BEETLE (COLEOPTERA: LUCANIDAE) ASSEMBLAGES OF SARAWAK BASED ON MUSEUM COLLECTIONS

Nur Nabihah Bt Shaharudin (45890)

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

Supervisor: Prof. Dr. Fatimah Bt Abang

Animal Resource Science and Management Programme

Faculty of Resource Science and Technology
Universiti Malaysia Sarawak
15th of May 2017

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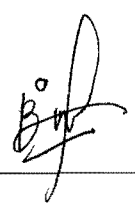

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I dedicate this dissertation to my beloved parents, Mr. Shaharudin Miswan and Mdm. Siti Ruhayah Sibadar, and to all my siblings. They are the greatest gifts in my life, whose love has always been my strength in pursuing this wonderful journey.

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ABSTRACT

Fundamental knowledge on most insect taxa of Borneo are still very much lacking despite challenges faced because of the degradation of their natural habitats, the rainforest. Compiling data on the assemblages of stag beetles in Sarawak is important for conservation efforts, as collecting information on the biodiversity of a region must be carried out to initiate an effective conservation plan. This study examined the stag beetle (Coleoptera: Lucanidae) assemblages of Sarawak as well as providing an annotated checklist based on specimens deposited at the Universiti Malaysia Sarawak (UNIMAS) Insect Reference Collections and Forest Research Centre, Kuching. Each specimen was examined based on morphological characteristics. A total of 658 specimens representing one subfamily, five tribes, 15 genera and 38 species were studied. The most common species of stag beetle in Sarawak is *Prosopocoilus occipitalis* with a wide range of localities and the three extremely rare species are *Neolucanus muntjac* Gestro, 1881, *Aegus krieschei* Nagel, 1928 and *Aegus rungusiorum* Ikeda, 2000. An annotated checklist for each species is presented. This study shows that base-line information on insects such as the stag beetle species assemblages could be retrieval from museum systematics collections.

Key words: stag beetle, assemblages, Lucanidae, Sarawak, annotated checklist.

ABSTRAK

Pengetahuan asas mengenai kebanyakan taxa serangga di Borneo masih banyak yang belum diketahui di samping cabaran yang dihadapi disebabkan oleh kemusnahan tempat tinggal semulajadi mereka, iaitu hutan hujan. Pengumpulan data mengenai kumbang sepit di Sarawak adalah penting sebagai usaha pemuliharaan, kerana pengumpulan maklumat ini akan membantu ke arah pelan pemuliharaan yang efektif. Kajian ini memfokuskan himpunan kumbang sepit (Coleoptera: Lucanidae) di Sarawak dan menyediakan senarai semak berilustrasi berdasarkan sampel yang disimpan di Universiti Malaysia Sarawak (UNIMAS) Insect Reference Collections dan Forest Research Centre, Kuching. Setiap spesimen dinilai berdasarkan ciri morfologi. Sebanyak 658 spesimen yang mewakili satu subfamili, lima tribus, 15 genera dan 38 spesies telah dinilai. Spesis kumbang sepit yang paling banyak ditemui di Sarawak ialah Prosopocoilus occipitalis dengan kadar taburan yang luas dan tiga spesis yang paling jarang ditemui ialah Neolucanus muntjac Gestro, 1881, Aegus krieschei Nagel, 1928 dan Aegus rungusiorum Ikeda, 2000. Senarai semak berilustrasi telahpun disediakan. Kajian ini menunjukkan informasi garis asas bagi serangga seperti himpunan spesis kumbang sepit boleh didapati daripada koleksi sistematik muzium.

***Kata kunci**: kumbang sepit, komposisi, Lucanidae, Sarawak, senarai semak berilustrasi.*

Table of Contents

List of Tables

List of Figures

List of Abbreviations

UNIMAS	Universiti Malaysia Sarawak
IUCN	International Union for Conservaton of Nature
km^2	kilometre square
ICZN	International Code of Zoological Nomenclature
SFD	Sarawak Forestry Department
cm	centimetre
mm	millimetre
%	percent
♂	male
♀	female
LDF	Lower Dipterocarp Forest
HDF	Hill Dipterocarp Forest
MF	Montane Forest

1.0 Introduction

Vast amount of biological and ecological information could be acquired from museum collections preserved over the years. Nevertheless, the importance of museum materials are often belittled and ignored as they are sometimes considered as of low scientific values, likened to stamp collections. Indeed these materials are of great importance and contribute to the retrieval of fundamental biological and ecological information of local and regional fauna as stored on these collections, specimen and labels.

Fundamental knowledge on most insect taxa of Borneo are still very much lacking despite challenges faced because of the degradation of their natural habitats, the rainforest. The task to document local insect faunas will be such an enormous effort which possibly renders as an unfinished business. Despite that, fundamental studies in gathering base-line information are still possible. Base-line biological and ecological information on these species could be retrieved from museum systematic collections. These could subsequently be employed in a rapid assessment of their species assemblages and diversity. Results from such studies should not belittled as they contribute to our knowledge on the species assemblages of the studied fauna. This information could eventually contribute to our knowledge on the status of our biodiversity data as exploitation of natural resources and disturbance of their natural habitats continues.

One of the groups of insects which are of interest to many researchers worldwide is the stag beetles of the family Lucanidae. The world fauna of this beetle is well studied. Nevertheless, the stag beetle fauna of Borneo still awaits much study. Besides Tung (2016), not much is known of the stag beetles of Sarawak.

In Europe, the stag beetles are classified as endangered or protected and has been included in Annex II of the EC Habitats Directive and is classed as a 'European Protected Species'. Their status under IUCN is 'near threatened' in 2010 across Europe. This analysis can only be done with the presence of complete taxonomic checklist for the area of study. Hence, local faunistic studies of this group are necessary and very much needed.

The objectives of this study were as follows:

1. To study the assemblages of the stag beetle fauna in Sarawak.
2. To present an annotated checklist of the stag beetles of Sarawak.

2.0 Literature Review

2.1 Classification and Distribution

The beetles from the order Coleoptera is the largest group of insects comprising over 350,000 species worldwide. The stag beetles from the family Lucanidae is relatively a small family with about 1,500 described species throughout the world (Didier & Seguy, 1953; Benesh 1955; Bartolozzi 1989; Holloway 2007 and Paulsen 2013). They are easily adaptable in most environmental conditions and hence, they form a rich component of biodiversity, particularly in the tropics.

Members of this family have distinguishable characteristics such as large mandibles, robust body, clubbed and often geniculate antennae. Males are often hornless but bear a large mandible that make them easily recognised. Male stag beetles use their large mandible to attract female and excavate home in rotting logs.

There are 228 described species from two subfamilies (i.e. Aesalinae and Lucaninae) in Malaysia, Singapore and Borneo (Tung, 2016). However, documentation on the stag beetle species in Malaysia and Sarawak are still lacking and not widely reviewed (Lawrence & Newton, 1995).

The stag beetles can be found globally (Lawrence & Newton, 1995; Holloway, 2007; Araya, 2011). However, like any other insect fauna, their species assemblages are different in different geographical regions. Globally, the Lucanidae is represented by seven subfamilies, namely Aesalinae, Nicaginae, Syndesinae, Lampriminae, Penichrolucaninae and Lucaninae (Lawrence & Newton, 1995 and Holloway, 1960). Aesalinae consists of the tribe Aesalini while the subfamily Lucaninae consists of seven tribes, namely Figulini,

Nigidiini, Odontolabini, Allotopini, Cyclommatini, Lucanini and Aegini. In Malaysia, two subfamilies are known, namely Aesalinae and Lucaninae (Smith, 2006).

The family Lucanidae is currently known to consist of 43 genera throughout Peninsular Malaysia and Borneo (Tung, 2016). In Peninsular Malaysia, there are 113 species recorded while Borneo is represented by 182 species. Both Peninsular Malaysia and Borneo are known to share 67 species out of the total of 228 known to occur in both Peninsular Malaysia and Borneo (Tung, 2016).

There are several similar species between Peninsular Malaysia, Borneo and Singapore because in the past, the Malay Archipelago (Malay Peninsula, Borneo, Sumatra and their satellite island including Palawan and Balabac) were united in a continent named Sundaland (Huang and Lin, 2010). Before the land separation occurred, local beetle fauna used to distribute evenly during scavenging or feeding on food plants. (Tung, 2016) Similarity in most of forest type (secondary forest and peat-swamp forest) and climate (hot and wet all-year-season) are also known as another contributing factors (Jensen and Das, 2008).

Borneo is made up of 73% Indonesia, 26% Malaysia and 1% Brunei (Tung, 2016). Malaysia is known as home to the oldest rainforest and listed as one of mega-diversity countries in the world. In South-east Asia, Sarawak stores a huge area of primary dipterocarp forest (near 1 billion km^2) and the "Heart of Borneo" is also located in Sarawak. This type of forest is not only the habitat for more than 2,000 species of trees and plants; it also has a diverse range of animal and insects (WWF, 2009). Continuous

human disturbance, deforestation, glaciation and deformation of Sundaland should have effect on the population dynamics (Holloway, 1972 and Kim and Farewell, 2015). Thus, better understanding on the effect of forest disturbance and mitigation plan to conserve should be achieved through conducting more studies.

2.2 Previous Studies

There are several local and international studies and articles published on Lucanidae as early as 1980's until today. Hill and Abang (2010) discussed on distinctive features of Lucanidae in Borneo. Some highlighted local species are *Cladognathus giraffa, Cyclommatus tarandus* (today is known as *Cyclommatus (C.) rangifer*), *Eurytrachelus titanus* which was recognised as the largest species living in Sarawak (7 cm), *Odontolabis* spp., *Prosopocoilus biplagiasus* and others. They also agree on the facts that habitat preference of Lucanidae is in rotting trees or roots and they feed on nectar, tree sap and fruit flowers.

The "Stag Beetles (Coleoptera: Lucanidae) of Peninsular Malaysia, Singapore and Borneo (with a complete taxonomic checklist)" by Tung (2016) is another informative reference to the stag beetle of Borneo. Most of the content in this book is primarily based on his own yearly observation. In this book, the author is discussing on history and taxonomic work, geography and climate, identification, biology, collecting and studying, nomenclature, rearing and breeding in captivity, localised distribution and species checklist from Peninsular Malaysia and Borneo with illustrations of all the species found there.

Harvey *et* al. (2011) published a paper on "Bionomics and distribution of the stag beetle *Lucanus cervus (L.)* across Europe". Method of study is by contacting 41 researchers from

all countries and compiling data on various life history and body length of the chosen species. They conclude that population of stag beetle has been decline in all over Europe mostly due to habitat loss.

Lawrence and Newton (1995) in their published paper entitled "Families and Subfamilies of Coleoptera (with selected genera, notes, reference and data on family-group names)" states that there has been no attempt to review and document the names of all beetle families and subfamilies since the introduction of formal rules governing such names into the International Code of Zoological Nomenclature (ICZN 1961). This fact then supported by Kim and Farrell in 2015 through their paper; "Phylogeny of world stag beetle (Coleoptera: Lucanidae) reveals a Gondwanan origin of Darwin's stag beetles". This paper emphasised that there has been almost no study of lucanid relationship and evolution, even though stag beetle is one of earliest branching lineages of scarab beetles.

2.3 General Biology

As mentioned in Tung (2016), adult of stag beetle is slow moving and nocturnal. Sometimes, they can also be found during the day in wet and humid environment. They prefer cool, damp habitat and not only found in thick primary jungle but also at montane forests (500-2000 m) (Holloway, 2007; Abang, 2010; Tung, 2016). Adults consume overripe fruits such as banana, starfruits, guava and soursop. Most species can be collected all year round, while some species such as *Allotopus mollenkampi*, *Rhaetulus didieri* and *Echinoaesalus* sp. are seasonal and can be found in very specific condition (Tung, 2016).

2.4 External Structure

Obviously, stag beetle can be distinguished by their characteristic mandibles. Males usually have larger mandibles for scavenging food, suitable for in-wood habitat and mating. The most upper part of the body is called mentum. There lies eye (ocelli), antenna, flagellum, head and mouthparts (Benisch, 2007). Besides their characteristic mandibles, Lucanidae can also be differentiated by having antennal club with 3-8 segments and a large pronotum (Figure 1). The larvae are usually scarabaeiform (C-shaped).

Figure 1: *Odontolabis dalmani* (Hope & Westwood, 1845)

2.5 Life Cycle

Lucanidae starts their life as egg or ova which usually can be found at rotten logs, fallen trees or rotten roots and tree stumps (Hill & Abang, 2010; Tung, 2016; Holloway, 2007). After that the egg will hatch into larvae and consume soft core of trees until they reach

adult. However, before they turn into third and last instar (hardened elytra) the larva will moults twice. After that the insect will not grow anymore as they have accomplish a complete growth. These life phase is called complete metamorphosis. Studies on the life cycle of the stag beetles is still lacking in Malaysia. Generally, stag beetle are economically known as agricultural pest as they cause damage to plant, especially flower and flower stalks (Schenk, 2006).

3.0 Materials and Method

This study was based on voucher specimen deposited at two repositories in Kuching, Sarawak that are Sarawak Forest Department (SFD) and the Insect Reference Collection of the Faculty Resource Science and Technology Museum, UNIMAS.

SFD is a government organization which is located at Jalan Datuk Amar Kalong Ningkan, Kuching, Sarawak. Insect Reference Collection of the Faculty of Resource Science and Technology was established in 1995. It is located at the first floor of Faculty of Resource Science and Technology, UNIMAS. There are various entomological collection were collected there.

From these voucher specimens, data such as locality, collecting date and collector's name were recorded. The total number of each stag beetles also has been counted. The morphological characteristics of each species were described based on the observation. Thus, observation through compound microscope or using magnifier also has been applied in order to get detailed information of their characteristics. All individual of the stag beetles were examined to measure their total length using 15 cm ruler.

Description were based on the morphological characteristics such as its general appearance (size, shape and colour) and the form of various body part (antennae, mandibles, legs, wings, bristles, mentum and pronotum) were then described and recorded. Information on diagnostic characteristics used for identification of specimens were based on Tung (2016) and Hill & Abang (2010). Then, annotated checklist of all the species were constructed based on the morphological characteristics of voucher specimens. Representative for each

species were photographed using Nikon D3100 lens kid 18-55 mm 1:3.5-5.6 G. Eventually, data for all the specimens were recorded according to sex, locality, date collected (day/month/year) and collector in a database.

4.0 Results and Discussion

4.1 Species Composition

Overall, both repositories studied hold a total of 658 specimens of stag beetles collected over the last 34 years in Sarawak from 1982-2015. All of the specimens are well preserved and represent the stag beetles species assemblages occurring in various forest types in Sarawak. As revealed by this study, the Lucanidae of Sarawak comprised of one subfamily, five tribes, sixteen genera and thirty eight species (Table 1). The tribe Lucanini is the most speciose tribe comprising of 60.47% (398 individuals) of the total representation of these beetles in Sarawak followed by the tribe Odontolabini (33.73%) and Aegini (17.35%). Tribe Lucanini is the most speciose tribe because it covers wide number of genera and species. So, the probability to be the most speciose tribe is high.

The tribe Lucanini is represented by eight genera, namely *Hexarthrius, Prosopocoilus (Metopodontus), Prosopocoilus (Hoplitocranum), Prosopocoilus (Cyclotropus), Prosopocoilus (Prosopocoilus), Prosopocoilus (Macrodorcinus), Serrognathus (Serrognathus), Serrognathus (Eurythracelus)* and *Dynodorcus*. Among all, the most dominant genus is *Prosopocoilus* with three species and thirty individuals represented.

Table 1: The number of stag beetle species recorded in Sarawak based on museum collections from 1982-2015

Subfamily	Tribes	No. of Genus	No. of Species	No. of Individuals	Percentage (%)
Lucaninae	Nigidiini	1	1	1	0.15
	Odontolabini	2	10	222	33.73
	Cyclommatini	1	5	23	3.5
	Lucanini	8	13	398	60.47
	Aegini	3	9	114	17.35
Total	**5**	**15**	**38**	**658**	**100**

The tribe Odontolabini is represented by two genera, namely *Odontolabis* and *Neolucanus*. Among all, the most dominant genus is *Odontolabis* with eight species and one hundred and thirty-three individuals represented.

Aegini is represented by three genera, namely *Aegus (Gnaphaegus)*, *Aegus (Aegus)* and *Aegus (Tumidaegus)*. Among all, the most dominant genus is *Aegus (Aegus)* with five species and eight individuals represented.

Nigidiini is the tribe with the least species. It represented by only one individual of *Calcodes aeratus* from the genus *Calcodes*. There is also no data on locality and date collected on the specimen. According to Tung (2016), Nigidiini tribe especially *Calcodes aeratus* can be easily found in lowland dipterocarp forest to upper hill dipterocarp forest. Although the status of occurrence for this tribe is common, the rare number of specimens from this study may indicate that they are not as common as previously reported.

Most of the specimens are found in the FRC compared to the UNIMAS Insect Collections as the UNIMAS collections are more recent in establishment compared to FRC (Table 2). The FRC Collection has a much larger insect holdings compared to that of UNIMAS Insect Collections because of the ongoing Lambir Canopy Biology Program in Sarawak by the Center of Ecological Research, Kyoto University since July 1992 until now. All their collections are deposited at the Forest Research Centre.

Table 2: Total number of Lucanidae specimens examined from each repository: UNIMAS Insect Repository and Forest Research Department in 2017

Species	Total no. of Specimens		
	UNIMAS	FRC	Total
Genus *Calcodes* Westwood, 1834			
C. aeratus Hope, 1834	0	1	1
Genus *Odontolabis* Hope, 1842			
O. alces Fabricius, 1775	0	9	9
O. brookeana Snellen von Vollenhoven, 1861	0	12	12
O. chewi Schenk, 2003	0	1	1
O. dalmani Hope & Westwood, 1845	1	93	94
O. femoralis Waterhouse, 1887	2	0	2
O. gazella Fabricius, 1787	1	0	1
O. latipennis Hope & Westwood, 1845	0	1	1
O. leuthneri Boileau, 1897	0	14	14
Genus *Neolucanus* Thomson, 1862			
N. muntjac Gestro, 1881	0	6	6
Genus *Cyclommatus (Cyclommatus)* Parry, 1864			
C. (C.) titanus Nagel, 1936	0	1	1
C. (C.) canaliculatus Ritsema,1891	3	5	8
C. (C.) chewi Mizunuma, 1994	0	1	1
C. (C.) lunifer Boileau, 1985	0	1	1
C. (C.) rangifer Schonherr, 1817	6	6	12
Genus *Hexarthrius* Hope, 1843			
H. mandibularis Deyrolle, 1881	0	17	17
Genus *Prosopocoilus (Metopodontus)* Westwood in Hope, 1845			
P. M. astacoides Hope, 1840	0	10	10
Genus *Prosopocoilus (Hoplitocranum)* Jokowlew, 1896			
P. H. attenuates Parry, 1864	0	2	2
P. H. flavidus Parry, 1862	0	1	1
Genus *Prosopocoilus (Cyclotropus)* Oberthur & Houlbert, 1913			
P. C. occipitalis Hope & Westwood, 1845	31	158	189
P. C. sericeus Westwood, 1844	0	11	11
Genus *Prosopocoilus (Prosopocoilus)* Westwood, 1845			
P. P. buddha Hope, 1842	0	2	2
P. P. forceps Snellen von Vollenhoven, 1861	0	15	15
P. P. zebra Olivier, 1789	1	12	13
Genus *Prosopocoilus (Macrodorcinus)* Maes, 1990			
P. M. tigrinus Didier, 1928	0	133	133
P. M. passaloides Hope & Westwood, 1845	0	1	1
Genus *Serrognathus (Serrognathus)* Motchulsky, 1861			
S. S. titanus Boisduval, 1835	0	1	1
Genus *Serrognathus (Eurythracelus)* Thomson, 1862			
S. E. reichei Hope, 1842	0	2	2