



UNIVERSITI PUTRA MALAYSIA

DISTRIBUTION, ECOLOGY AND BEHAVIOR OF *Cephalophacus bancanus borneanus* Horsfield IN SECONDARY AND REHABILITATED FORESTS IN A PUBLIC UNIVERSITY IN MALAYSIA

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By

HANI NABILIA BINTI MUHD SAHIMI

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
Fulfilment of the Requirements for the Degree of Master of Science**

November 2017

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science.

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November 2017

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Cephalophacus bancanus borneanus (previously known as *Tarsius bancanus borneanus*) was first acknowledged by Elliot in 1990. This sub-species can be found in the Borneo Island which consists of Sabah and Sarawak of Malaysia, Brunei Darussalam and Kalimantan, Indonesia. The present study was conducted in secondary and rehabilitated forests of Universiti Putra Malaysia Bintulu Sarawak Campus (UPMKB), from October 2014 until March 2015. Through observations and capture-effort sampling covering an area of 0.37 km² secondary forest patches and 0.0713 km² of rehabilitated forest, a total of 16 tarsiers were captured using mist nets, four tarsiers were spotted through observation and a tarsier were recaptured. The population density of tarsiers captured using mist-nets in the secondary forest was 38 individuals/km² while 28 individuals/km² was recorded for the rehabilitated forest. As for distance sampling, the population density estimation was quite low thus it cannot be calculated. Morphological measurement were taken and described from the captured tarsiers. Morisita's Index for the tarsier in secondary forest was $I_d = 2.42$ ($N = 18$ tarsiers, $n = 37$ plots) and rehabilitated forest was $I_d = 7.00$ ($N = 2$ tarsiers, $n = 7$ plots). Instant behavior of tarsier were described using *ad libitum* sampling method. Neu Habitat Preference index for secondary forest was $w = 1.022$ while in rehabilitated forest $w = 0.884$. The tree species composition and importance value index has been calculated in both plots of secondary and rehabilitated forests. Linear correlation has occur between the number of tarsier captured/ observed and the temperature in secondary forest which the value was greater than the other climatic factors correlation. The present results provided data on the presence of tarsier in both the secondary and rehabilitated forest mainly in UPMKB campus thus highlighting the conservation value of the forested areas. The data also valuable due to the status of species which is Data Deficient in IUCN redlist; and could helped the future management managing the habitat to avoid extinction.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**TABURAN, EKOLOGI DAN PERILAKU *Cephalophacus bancanus borneanus*
HORSFIELD DI HUTAN SEKUNDER DAN HUTAN PEMULIHAN DI
DALAM UNIVERSITI AWAM DI MALAYSIA**

Oleh

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Cephalophacus bancanus borneanus (dahulunya dikenali sebagai *Tarsius bancanus borneanus*) pertama kali diakui oleh Elliot pada tahun 1990. Sub-spesies ini boleh didapati di Pulau Borneo yang terdiri daripada Sabah dan Sarawak (Malaysia), Brunei Darussalam dan Kalimantan, Indonesia. Kajian ini telah dijalankan di Universiti Putra Malaysia Kampus Bintulu Sarawak (UPMKB), dari Oktober 2014 hingga Mac 2015. Melalui pemerhatian dan persampelan menangkap-usaha yang meliputi kawasan seluas 0.37 km² di kelompok hutan sekunder dan 0,0713 km² di hutan pemulihan, sebanyak 16 tarsier ditangkap menggunakan jaring kabut, empat tarsier telah dikesan melalui pemerhatian dan seekor tarsier telah berjaya ditangkap semula. Kepadatan populasi tarsier menggunakan jaring kabut dalam hutan sekunder adalah 38 individu / km² manakala 28 individu / km² dicatatkan bagi hutan pemulihan. Bagi persampelan jarak, anggaran kepadatan populasi agak rendah oleh itu ia tidak boleh dikira. Pengukuran morfologi telah diambil dan diterangkan daripada data tarsier yang ditangkap. Indeks Morisita untuk tarsier dalam hutan sekunder adalah $I_d = 2.42$ ($N = 18$ tarsiers, $n = 37$ plot) dan hutan pemulihan adalah $I_d = 7.00$ ($N = 2$ tarsiers, $n = 7$ plot). Perilaku tarsier telah diterangkan dengan menggunakan kaedah persampelan *ad libitum*. Indeks Keutamaan Neu Habitat untuk hutan sekunder adalah $w = 1.022$ manakala di hutan pemulihan $w = 0.884$. Indeks komposisi pokok dan nilai kepentingan telah dikira dalam kedua-dua plot hutan sekunder dan hutan pemulihan. Hubungan korelasi linear berlaku antara bilangan tarsier yang ditangkap / diperhatikan dengan suhu di hutan sekunder yang nilainya lebih tinggi daripada korelasi faktor cuaca yang lain. Keputusan kajian memberikan data mengenai kehadiran tarsier dalam kedua-dua hutan iaitu hutan sekunder dan hutan pemulihan terutamanya di kampus UPMKB sekali gus menonjolkan nilai pemuliharaan kawasan hutan tersebut. Data ini juga bernilai kerana status spesis yang kekurangan data dalam senarai IUCN; dan boleh membantu pengurusan masa depan bagi menguruskan habitat untuk mengelakkan kepupusan.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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CHAPTER 1

INTRODUCTION

1.1 General Background

Malaysia has been listed as one of the 12 'megadiversity' countries in the world and covers about 70% of the total world's biodiversity (MOSTE, 1998). There are about 170,000 species that have been estimated in Malaysia; both flora and fauna (Conservation & Environmental Management Division, 2006). According to MOSTE (1998), about 12,500 species of flowering plants, 1100 species of ferns, 750 species of birds, 350 species of reptiles, 300 species of mammals, around 300 species of freshwater fish, and 165 species of amphibians have been found. The most diverse areas in Malaysia are Sabah and Sarawak, which are located on the island of Borneo.

According to Meijaard and Nijman (2003), Sabah and Sarawak can be considered to be the richest biodiversity in Borneo rather than Kalimantan. WWF-Malaysia (2015b) reported that out of the total land area of 746,000 km², 620 species of birds, 221 species of mammals, and almost 1000 insect species have been recorded in the past years. Fifteen thousand plant species have also been found recently, including 150 species of dipterocarp trees. Due to the diverse flora and fauna, Borneo has been listed as an area of biodiversity hotspot. Biodiversity is defined as a biogeographical region that is highly occupied by biological diversity which is threatened or endangered (Anon, 2008). Biodiversity hotspots can also be classified as areas that contain a high species rate, rare species, threatened species, and classified as priority for conservation effort (Reid, 1998).

Tropical rain forest is categorised in the tropical wet climate group with temperature between 20°C - 34°C and humidity average around 77 to 88% and more than 100 inches of rainfall per year (Michael, 2001). There are three different stratifications of tree layer in the tropical rainforest; the A, B, and C layer, the shrub/sapling layer, and the ground layer (Woodward, 2012). WWF-Malaysia (2015a) stated that the major forest types of the rainforest are the lowland dipterocarp forest, hill dipterocarp forest, upper hill dipterocarp forest, oak-laurel forest, montane ericaceous forest, peat swamp forest, and mangrove forest. Other minor types of forest in smaller areas are the heath forest, limestone forest, quartz ridge forest, and also freshwater swamp forest (WWF-Malaysia b, 2015). These forest areas can be further categorised into primary and secondary forests. Another category of forest is the manmade regeneration forest or also known as the rehabilitated forest for conservation purposes.

The primary forest can be interpreted as the old growth area with great aged trees that are free from disturbances and can be classified as a climax community (White & Llyod, 1994). The secondary forest is defined as the area that has naturally regenerated after human or natural disturbances and the composition of the forest structure and

species have changed (Chokkalingam & Jong, 2001). Stanturf (2005) defined rehabilitation forest as a restored forest where actions have been taken to rebuild and repair the forest structure and its function. All of these forested areas, either natural or manmade, give huge impacts to the wildlife, especially the mammals for their longevity of life in terms of habitat.

The tropical rainforest in Borneo is a home for various types of fauna such as the primates. According to Myers (2012), the primates consist of 233 species and 13 families in total. The largest primate on Earth is the gorilla with the weight of 175 kg and the smallest primate is the pygmy mouse lemur with a weight of 30 g (Myers, 2012). Primates are usually an arboreal type of animals (Myers, 2012). This order has their own signature of characteristics such as skull, teeth, and limbs which are different from the other orders in mammals (Myers, 2012). The habitat or areas of living for primates are mainly the tropics and sub-tropics and only certain species are found in the temperate regions (Myers, 2012). As for their feeding behaviour, primates are insectivorous, carnivorous, and some are frugivorous (Myers, 2012). According to Klappenbach (2014), primates can be divided into two categories, namely wet-nosed and dry-nosed. Primates live in a complex social unit and most of them are high in socialisation (Klappenbach, 2014).

The order of primates comprises of three suborders i.e; Anthroipoidea (humans, great apes, gibbons), Old World Monkeys and New World Monkeys, Prosimii (lemurs, lorises, and their allies), and Tarsioidea (tarsiers). The sub-order Tarsioidea can be divided into three categories according to the distribution which are the Western Tarsier, Eastern Tarsier, and Philippines Tarsier (Plant, 2011). From past records, no tarsiers have been found in the mainland of Asia, even though there are some fossils that have been found (Plant, 2011). To date, about 10 species of tarsier have been recorded with various red list statuses, from vulnerable to critically endangered (Table 1.1). The population trend of all tarsier species is now decreasing.

Table 1.1: IUCN Red List (2015) Data on Various Tarsier Species

No.	Species	Distribution	Status	Population trend
1.	<i>Cephalopachus bancanus bancanus/ Cephalopachus bancanus bancanus</i>	Sumatera and Bangka Islands	Endangered	Decreasing
	<i>Cephalopachus bancanus borneanus/ Cephalopachus bancanus borneanus</i>	Borneo Island	Vulnerable	Decreasing
	<i>Cephalopachus bancanus natunensis/ Cephalopachus bancanus natunensis</i>	Serasan Island	Critically Endangered	Decreasing
	<i>Cephalopachus bancanus saltator/ Cephalopachus bancanus saltator</i>	Belitung Island	Endangered	Decreasing

2.	<i>Tarsius diana</i> / <i>Tarsius dentatus</i>	Sulawesi Island	Vulnerable	Decreasing
	<i>Tarsius fuscus dentatus</i>	Sulawesi Island	Vulnerable	Decreasing
	<i>Tarsius fuscus pelengensis</i>	Peleng Island	Endangered	Decreasing
4.	<i>Tarsius larian</i>	Sulawesi Island	Data Deficient	Decreasing
5.	<i>Tarsius pumilus</i>	Sulawesi Island	Data Deficient	Decreasing
6.	<i>Tarsius sangirensis</i>	Sangihe Island	Endangered	Decreasing
7.	<i>Tarsius spectrum/Tarsius tarsier</i>	Sulawesi Island	Vulnerable	Decreasing
8.	<i>Tarsius syrichta</i>	Southeastern Philippines	Threatened	Decreasing
9.	<i>Tarsius tumpara</i>	Siau Island	Critically Endangered	Decreasing
10.	<i>Tarsius wallacei</i>	Sulawesi Island	Data Deficient	Decreasing

Cephalopachus bancanus borneanus which previously known as *Tarsius bancanus borneanus* (hereafter will be mentioned as *Cephalopachus bancanus borneanus* for this research) is endemic to Borneo and is listed in the totally protected animal under the Wild Life Ordinance 1998 of Sarawak. *Cephalopachus bancanus borneanus* has also been listed in the IUCN list as a vulnerable species (IUCN, 2015). A previous study by Norfahiah, Azema, Marina, and Zakaria (2012) in Universiti Putra Malaysia Bintulu Sarawak Campus between 2006 and 2009 investigated whether the secondary forests and rehabilitated forest can act as adequate habitat for tarsiers as the primary forest, thereby, comprising the conservation value of those forest areas. Data on the ecology of *Cephalopachus bancanus borneanus* in their natural habitat will be valuable in managing such animals in the wild, besides providing a guideline in the efforts of conserving the genus *Cephalopachus*, especially in Sarawak.

1.2 Problem Statement

In general, conservation on tarsiers is poorly known (Gursky, Shekelle & Nietsch, 2008). Twenty taxa and population of tarsier have been recorded in Indonesia, including the island of Borneo, where *Cephalopachus bancanus borneanus* is distributed (Brandon-Jones et al., 2004). The estimated occurrence for *Cephalopachus bancanus borneanus* as recorded by Brandon-Jones et al. (2004) was more than 100,000 km². Gursky et al. (2008) reported that population data on specific tarsier species is lacking. Therefore, more research on specific regions should be implemented to obtain accurate data on every sub-species so that estimation on population density and other parameters can be recorded scientifically. Another problem related to the *Cephalopachus bancanus borneanus* is that the population density estimation is not well-obtained, especially in Bintulu, Sarawak (Ahmad, 2010). Studies on *Cephalopachus bancanus borneanus* have been very slow compared to the Philippines Tarsier (Brandon-Jones et al., 2004), as the species cannot be bred well in captivity and the specimen for the capture is low in number (Hellingman, 2004). In Malaysia,

specifically in Sarawak, this animal falls under the category of totally protected animals, thus, the study of its habitat is crucial.

In Borneo, most of the studies on *Cephalopachus bancanus borneanus* were done in Sabah. Crompton and Andau (1986) have done the research about free-ranging *Cephalopachus bancanus borneanus* in Sepilok Forest Reserve, Sabah, while Roberts and Cunningham (1986) did a research on space and substrate used in captive. Jablonski and Crompton (1994) conducted a research on feeding behaviour, mastication, and tooth wear in the Western Tarsier (*Cephalopachus bancanus*). As can be seen, most of the researches were conducted in Sabah rather than Sarawak. Therefore, secondary and rehabilitated forests in Universiti Putra Malaysia, Bintulu Campus, Sarawak has a great potential to provide data on *Cephalopachus bancanus borneanus*, specifically in Sarawak as different regions may give different results, especially on population density, even if it comes from the same sub-species.

According to the IUCN (2015), 30% of the *Cephalopachus bancanus borneanus* habitat has been lost over the last 20 years. Universiti Putra Malaysia, Bintulu Campus, Sarawak (UPMKB) is one of the few green lungs still left in the Bintulu Division (Norfahiah et al., 2012). Nowadays, the development in Bintulu is rapid and more forested areas are being cleared for residential and industrial purposes. When the total area of primary and secondary forests is decreased, it may harm the population of wildlife in terms of habitat loss. Deforestation may cause wildlife to find other places for living and the Bukit Nyabau Forest Reserve (secondary forest) and Mitsubishi Rehabilitation Forest (rehabilitated forest) of UPMKB are the only green places for them. *Cephalopachus bancanus borneanus* may receive a huge habitat loss impact and the population may decrease from day to day. As scientific data for *Cephalopachus bancanus borneanus* is still lacking in Sarawak, thus, it is high time to collect such data so that the existence of the species can be documented for future references.

Regarding the conservation status of *Cephalopachus bancanus borneanus*, which is vulnerable according to the IUCN (2015), further research must be conducted to protect the species. The IUCN also stated in the year 2000 that the lack of data on this sub-species means the lack of information to understand the population trend in certain areas. This animal is totally protected by law under the Wildlife Ordinance 1998 in Sarawak. Tarsier is very sensitive and its population can simply be affected by climate change. It can also be affected by the changes in habitat (Sinaga, Wirdateti, Iskandar, & Pamungkas, 2009). Deforestation due to forest conversion and large-scale logging operations may cause an impact of habitat loss for tarsier (Curran et al., 1999). Hunting activities of this unique and endemic creature have caused the disappearance of their habitat and could probably direct to the species' extinction (Gursky, 2005). Moreover, Wright, Toyama, and Simons (2003) highlighted that the population pattern of tarsier is more to patchy distribution and not uniformly distributed, which means tarsiers live in specific forest patches and not distributed all over the forest.

Because of the problems that have occurred, the study on *Cephalopachus bancanus borneanus* in the secondary forest and rehabilitated forest of in Universiti Putra

Malaysia Bintulu, Sarawak Campus should be conducted to determine specific information, especially on the distribution, population density, and habitat characteristic of the tarsier sub-species. More information can be obtained and used in determining the most suitable management for conservation of the species. The conservation value of the secondary and rehabilitated forests in Universiti Putra Malaysia Bintulu, Sarawak Campus can be highlighted when the presence of *Cephalopachus bancanus borneanus* can be confirmed.

1.3 Research Objectives

The general objectives of this study are:

- to investigate the habitat characteristics and microclimatic factors suitable for *Cephalopachus bancanus borneanus* in the secondary and rehabilitated forests of UPMKB.

The specific objectives of this study are:

- to determine the population density and distribution;
- to determine the morphometrics description and measurements; and
- to determine the instant behaviour of *Cephalopachus bancanus borneanus* in the secondary and rehabilitated forests of UPMKB.

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