UNIVERSITI PUTRA MALAYSIA

ECOLOGY AND BEHAVIOUR OF LONG-TAILED MACAQUES (MACACA FASCICULARIS RAFFLES) AT KUALA SELANGOR NATURE PARK, MALAYSIA

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By

KAMARUL ARIFFIN BIN KAMBALI @ HAMBALI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Doctor of Philosophy

July 2016

DEDICATION

To my mom and dad who encourage me
AMINAH BINTI ABDUL MAJID
KAMBALI @ HAMBALI BIN PARJAN

Beloved wife
AAINAA SYAZWANI BINTI MOHAMAD AMIR HAMZAH

Beloved son and daughters
MUHAMMAD ARIQ SYAZWAN BIN KAMARUL ARIFFIN
AZZALEA SYAKIRA BINTI KAMARUL ARIFFIN
KHALISH AMMARA BINTI KAMARUL ARIFFIN

Siblings
KHAIRUL ANWAR BIN KAMBALI @ HAMBALI
HAZLINA BINTI KAMBALI @ HAMBALI
ADIBAH BINTI KAMBALI @ HAMBALI

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the Degree of Doctor of Philosophy

ECOLOGY AND BEHAVIOUR OF LONG-TAILED MACAQUES (*Macaca fascicularis* Raffles) AT KUALA SELANGOR NATURE PARK, MALAYSIA

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KAMARUL ARIFFIN BIN KAMBALI @ HAMBALI

July 2016

Chairman : Professor Ahmad bin Ismail, PhD
Faculty : Science

An ecological and behavioural study was carried out on long-tailed macaques (*Macaca fascicularis*) at Kuala Selangor Nature Park (KSNP), Selangor. This study was conducted to obtain a better understanding about social organization, ranging behaviour, food selection, activity budget, pest behaviour and also human-macaque conflict. Nowadays, economic growth and a rapid increase in human population have resulted in a widespread violation on forest habitat, resulting in the burgeoning of human-nonhuman primate conflict due to the crop raiding activity by the macaques and more recently, pest behaviour in urban environments as they exploit garbage and other human food sources. Fieldwork has focused on the activity of following the study groups, which was selected at the preliminary observation, and observing their behaviour using instantaneous scan sampling method. This study was conducted over 11 months from February 2011 to December 2011 for the outside group while for the inside group, it also involved 11 months of timeline from January 2014 to November 2014. At the study area, *M. fascicularis* has indicated significant difference in the size of the group whereby the outside group of KSNP have larger group size (40±0.9 individuals) in comparison with the inside group size of (30±0.9 individuals). Both study groups limit their movements in the core area of their home range and occupy the area repeatedly, which has shown a strong preference for the area and a very familiar path. The factors that can influence the movement patterns of both study groups were the distribution of food and also sleeping sites preference. For the sleeping sites preference, *M. fascicularis* used the limited sleeping sites and tend to sleep at their favourite sleeping sites repetitively. While the use of canopy strata, *M. fascicularis* were mostly found to choose ground level and also lower canopy compared to other levels of trees canopy. The outside group in the study area had a strong priority in choosing other food (anthropogenic food) (27.79%), followed by fruits (22.85%), mature leafs (18.95%), flowers (12.44%), young leafs (11.41%), seeds (4.18%), shoots (1.57%), insects (0.73%) and animals (0.09%) as their food. In contrast, the inside group has more preference in choosing fruits (37.91%), followed by insects (34.42%), mature leafs (8.34%), young leafs (8.26%), seeds (5.61%), shoots (2.96%), flowers (2.5%) and no consumption of animals and others food. The outside group spent a lot of their time to perform moving activities (21.89%) followed

by feeding (19.16%), inactive (15.82%), grooming (10.74%), playing (10.67%), vocal interaction (9.81%), mating (6.54%) and the lowest activity was fighting (4.84%). For the inside group, they spent most of their time in moving (21.66%) followed by feeding (19.65%), vocal interaction (14.12%), grooming (11.97%), mating (11.79%), inactive (9.45%), playing (7.24%) and the lowest was fighting (4.11%). For pest behaviour, it was only recorded to be performed by the outside group. From the observations that have been carried out, the outside group spent a lot of their time to perform littering (27%), followed by damaging facilities (24%), breaking into human areas (18%), messing up garbage cans (18%), disturbing people (11%) and finally stealing (3%). Respondents from residential areas have more experience related to *M. fascicularis* disturbances compared with visitors. Overall, the study of the ecology and behaviour of *M. fascicularis* has run smoothly and has met the required answers according to the desired objectives. This study emphasizes on the ecological and behavioural strategies adopted by *M. fascicularis* to enable them to become the most successful animals as well as in creating conflict with people. Among the ecological and behavioural strategies that have been identified in this study are social organization, ranging behaviour, food selection, activity budget and also pest behaviour. All ecological parameters are the core of behaviour-ecological aspects that is influenced by the habitat that they lived in terms of food diversity, abundance, seasonal variation in productivity and other animal communities that lived in the area. As for the population status, the outside group would cause more problems to visitors and residents compared to the inside group. This is because they are more aggressive and involve in pest behaviour. Increased in human activity such as feeding the macaque, high amount of leftovers that are disposed into dustbins provided outside KSNP leads to more available food for the group. Some of the strategies that can be adopted for management purpose are inventing monkey-proof dustbin and maintaining certain numbers of macaque individuals at around 30 individuals at a time. This can be done through translocation process after understanding the social organization of the groups. Others strategies are also highlighted in the recommendations part. It is hoped that all of the information obtained from this study can be considered in the process of management and conservational effort of this species in the future.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

EKOLOGI DAN TINGKAH LAKU KERA EKOR PANJANG (*Macaca fascicularis* Raffles) DI TAMAN ALAM KUALA SELANGOR, MALAYSIA

Oleh

KAMARUL ARIFFIN BIN KAMBALI @ HAMBALI

Julai 2016

Pengerusi : Profesor Ahmad bin Ismail, PhD
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Satu kajian ekologi dan tingkah laku telah dijalankan ke atas kera ekor panjang (*Macaca fascicularis*) di Taman Alam Kuala Selangor (KSNP), Selangor. Kajian ini dijalankan untuk mendapatkan pemahaman yang lebih baik mengenai organisasi sosial, tingkah laku pembanjaran, pemilihan makanan, bajet aktiviti, tingkah laku perosak dan juga konflik manusia-kera. Pada masa kini, pertumbuhan ekonomi dan peningkatan pesat dalam populasi manusia telah menyebabkan pencerobohan meluas di habitat hutan yang menyebabkan peningkatan konflik primat manusia-bukan manusia kerana terjadinya kemusnahan tanaman oleh spesies kera dan, diburukkan lagi dengan tingkah laku terkini perosak dalam persekitaran bandar dengan mengeksploitasi sampah dan lain-lain sumber makanan manusia. Kerja lapangan telah memberi tumpuan kepada aktiviti mengikuti kumpulan-kumpulan kajian, yang telah dipilih pada pemerhatian awal, dan memerhatikan tingkah laku mereka menggunakan kaedah persampelan imbasan serta-merta. Kajian ini dijalankan selama 11 bulan dari Februari 2011 hingga Disember 2011 untuk kumpulan luar manakala bagi kumpulan dalam, ia juga melibatkan tempoh selama 11 bulan dari Januari 2014 hingga November 2014. Di kawasan kajian, *M. fascicularis* telah menunjukkan perbezaan yang signifikan dalam saiz kumpulan di mana kumpulan luar KSNP mempunyai saiz kumpulan yang lebih besar (40±0.9 individu) berbanding dengan saiz kumpulan dalam (30±0.9 individu). Kedua-dua kumpulan kajian mengehadkan pergerakan mereka di kawasan tempat tinggal tetap mereka dan menduduki kawasan itu berulang kali, yang telah menunjukkan keutamaan yang kuat kepada kawasan yang sudah biasa didiami. Faktor-faktor yang boleh mempengaruhi pola pergerakan kedua-dua kumpulan kajian adalah pengagihan makanan dan juga keutamaan kawasan tidur. Bagi keutamaan kawasan tidur, *M. fascicularis* menggunakan kawasan tidur terhad dan cenderung untuk tidur di kawasan tidur kegemaran mereka secara berulang-ulang. Manakala penggunaan kanopi strata, *M. fascicularis* kebanyakannya didapati untuk memilih paras tanah dan kanopi bawah berbanding paras kanopi yang lain. Kumpulan luar di kawasan kajian mempunyai keutamaan yang kuat dalam memilih makanan lain (makanan antropogenik) (27.79%), diikuti dengan buah-buahan (22.85%), daun matang (18.95%), bunga (12.44%), daun muda (11.41%), biji benih (4.18%), pucuk (1.57%), serangga (0.73%) dan haiwan (0.09%) sebagai makanan mereka. Sebaliknya,

kumpulan dalam mempunyai lebih keutamaan dalam memilih buah-buahan (37.91%), diikuti oleh serangga (34.42%), daun matang (8.34%), daun muda (8.26%), biji benih (5.61%), pucuk (2.96%), bunga (2.5%) dan tiada penggunaan haiwan dan lain-lain makanan. Kumpulan luar menghabiskan banyak masa mereka untuk melakukan aktiviti bergerak (21.89%) diikuti dengan makan (19.16%), tidak aktif (15.82%), dandanan (10.74%), bermain (10.67%), interaksi vokal (9.81%), mengawan (6.54%) dan aktiviti yang paling rendah bergaduh (4.84%). Bagi kumpulan dalam, mereka menghabiskan sebahagian besar masa mereka dengan bergerak (21.66%) diikuti dengan makan (19.65%), interaksi vokal (14.12%), dandanan (11.97%), mengawan (11.79%), tidak aktif (9.45%), bermain (7.24%) dan yang paling rendah bergaduh (4.11%). Bagi tingkah laku perosak, ia hanya direkodkan oleh kumpulan luar. Dari pemerhatian yang telah dijalankan, kumpulan luar menghabiskan banyak masa mereka untuk melakukan pembuangan sampah (27%), diikuti oleh merosakkan kemudahan (24%), pecah masuk kawasan manusia (18%), menyelongkar tong sampah (18%), mengganggu orang (11%) dan akhirnya mencuri (3%). Responden dari kawasan perumahan mempunyai lebih banyak pengalaman yang berkaitan dengan gangguan *M. fascicularis* berbanding dengan pengunjung. Secara keseluruhan, kajian ekologi dan tingkah laku *M. fascicularis* telah berjalan dengan lancar dan telah menemui jawapan mengikut objektif yang dikehendaki. Kajian ini memberi penekanan kepada strategi ekologi dan tingkah laku yang diterima pakai oleh *M. fascicularis* untuk membolehkan mereka menjadi haiwan yang paling berjaya dan pada masa yang sama mewujudkan konflik dengan manusia. Antara strategi ekologi dan tingkah laku yang telah dikenal pasti dalam kajian ini ialah organisasi sosial, tingkah laku pembanjaran, pemilihan makanan, bajet aktiviti dan tingkah laku perosak. Semua parameter ekologi adalah teras kepada aspek tingkah laku ekologi yang dipengaruhi oleh habitat yang didiami dari segi kepelbagaian makanan, kelimpahan, variasi bermusim dalam produktiviti dan komuniti haiwan lain yang tinggal di kawasan itu. Bagi status penduduk, kumpulan luar lebih banyak mendatangkan masalah kepada pengunjung dan penduduk berbanding dengan kumpulan dalam. Ini kerana mereka lebih agresif dan terlibat dalam tingkah laku perosak. Peningkatan dalam aktiviti manusia seperti memberi makan kepada kera,dan pembuangan sisa makanan ke dalam tong sampah di luar KSNP telah membawa kepada lebih banyak makanan tersedia bagi kumpulan tersebut. Beberapa strategi yang boleh diguna pakai bagi tujuan pengurusan ialah seperti membuat tong sampah yang tidak boleh di buka oleh kera dan mengekalkan bilangan tertentu individu kera iaitu kira-kira 30 individu pada satu masa. Ini boleh dilakukan melalui proses translokasi selepas memahami organisasi sosial kumpulan. Strategi lain juga turut dibentangkan di bahagian cadangan. Adalah diharapkan bahawa semua maklumat yang diperolehi daripada kajian ini boleh digunapakai dalam proses pengurusan dan usaha pemuliharaan spesies ini pada masa akan datang.

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I certify that a Thesis Examination Committee has met on 29 July 2016 to conduct the final examination of Kamarul Ariffin bin Kambali @ Hambali on his thesis entitled "Ecology and Behaviour of Long-Tailed Macaques (*Macaca fascicularis* Raffles) at Kuala Selangor Nature Park, Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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

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@	Or
%	Percentage
χ^2	Chi-square
ºC	Degree Celsius
CITES Wild Fauna	Convention of International Trade in Endangered Species of and Flora
cm	Centimeter
df	Degrees of Freedom
DNA	Deoxyribonucleic Acid
DWNP	Department of Wildlife and National Parks
GPS	Global Positioning System
HIV	Human Immunodeficiency Virus
hrs	Hours
IMR	Institute for Medical Research
IUCN Resources	International Union for Conservation of Nature and Natural
km	Kilometer
KSNP	Kuala Selangor Nature Park
m	Meter
MDKS	Kuala Selangor District Council
mm	Millimeter
MNS	Malaysian Nature Society
p	Confident Level
PERHILITAN	Jabatan Perlindungan Hidupan Liar dan Taman Negara
TB	Tuberculosis

CHAPTER 1

INTRODUCTION

1.1 Introduction

Primates are unique animals and most advanced compared to other mammals because it has a complex brain (Jerison, 1973; Napier, 1970). The bigger and more folded the brain, the greater the intelligence of the animal, and the greater its aptitude for receiving, analyzing and synthesizing sensory impulses and converting them into finely adjusted motor responses (Napier and Napier, 1985). This is proven with the name of 'primates' by Linnaeus which is derived from the Latin word, '*primas,'* meaning first (Fried, 1990). In addition, the primates are thought to have a close relationship with humans. It can be seen based on their physical form and behaviour, which are very similar to human. Based on these attributes, many researchers are attracted to study these animals, in terms of anatomy, biology, psychology, anthropology, physiology, ethology, especially involving the medical field (Roonwal and Mohnot, 1977). In addition, the primate species are very important in the global biodiversity. This is because the species of primates are additive factors in the management of tropical forests homeostasis (Bourliere, 1985). Primate species also serves as the pollinator of pollen (Janson, 1983; Janson *et al*., 1981) and seeds (Hladik and Hladik, 1967). In order to understand the process of adaptation and its role in primate evolution it is necessary to study the behaviour of primates in their natural environment (Napier and Napier, 1985).

Studies on primates in the field are not a new thing. According to Carpenter (1934), studies on primates in the field have begun since 40 years ago. The study of the ecology and behaviour of the primate's species in the field focuses on two main aspects (Rodman, 1999). The first aspect of the study involves research that extends from an ecological perspective to interpret the diversity of functions and the relationship between the fossil and living species. This study involves the observation of the type of diet, how to get food as well as how to defend themselves from predation and asylum seekers. This method is also an important factor to understand the function and lifestyle of primates. The second aspect of the study is to understand the behaviour and social systems of a primate from an ecological perspective that allows the adjustment of social relations. Therefore, the accumulation of the early descriptions of the behaviour of primates in the field has resulted in changes in primate studies. Studies are generally carried out to explain the norms of the relationship of social phenomena (Altmann and Altmann, 1970; De Vore and Hall, 1965; Jay, 1965; Southwick *et al*., 1965). Evolution in modern biology, behavioural ecology and socio-biology subsequently stimulate a paradigm shift in analysis and interpretation of primate's behaviour (Wilson, 1975). Initially, only the primate researchers can understand primate studies because it changes so dramatically. Numerical data such as the budget, diet and many more have been obtained (Clutton-Brock, 1977). This paradigm has changed in line with changes in the phenomenon of study that focuses on the social aspects of the group and the social relationship to the study of individual and social behaviour analysis. These changes occur due to natural selection that influences survival and reproductive success. Altman (1974) has resulted

in the observation method for studying the behaviour of animals, which focuses on individual's behaviour as compared to the group.

Many studies have been conducted regarding to primates around the world. Such studies include the one done in Ethiopia (Dunbar and Dunbar, 1974); Campo-Ma'an, Cameroon (Matthews and Matthews, 2002); Bolivia (Yoneda, 1984); Cosa Cashu, Peru (Terbough, 1983); Barro Colorado, Panama (Milton, 1980); Mauritius (Sussman and Tattersall, 1986); Shimla, India (Ross *et al*., 1993); Jodhpur, India (Agoramoorthy, 1994); Polonnarwa, Sri Lanka (Hladik, 1977); Ketambe, Sumatera (Ungar, 1995); Sulawesi, Indonesia (Kawamoto, 1996); Kalimantan, Indonesia (Rodman, 1991; Supriatna *et al*., 1986); Sumatera, Indonesia (Ungar, 1995; van Schaik and van Noordwijk, 1985); Krau Game Reserve, Peninsular Malaysia (Chivers, 1980; Caldecott, 1980; MacKinnon and MacKinnon, 1980; Curtin, 1976); Sabah, Malaysia (Bernard, 1996); and Sarawak, Malaysia (Bennet and Sebastian, 1988). As a whole, the studies on primates in Southeast Asia are still less in number compare to the studies that have been conducted on primates in Africa. According to Brockelman and Srikosamatara (1993), the main problem of the primate's management that inhabits the tropical forests are the species adaptation with the presence of humans. These factors complicate the implementation of the census work and study. Therefore, only a few detailed studies on primate's communities have been carried out (Marsh and Wilson, 1981; Chivers, 1980; Rodman, 1978).

Asia has a high biodiversity in this world because it has the tropical rain forest, which contains complex and diverse vertebrate composition (Harmelin-Vivien and Bourliere, 1989). According to Johns (1992), some species are very sensitive with microhabitat and microclimate and some are not and because disturbance caused will severely affect the specialized species. Many previous studies have shown that large disturbances can cause a reduction in numbers rather than loss of species (Gamer *et al*., 1999; Nordin and Zakaria, 1997, Pimm, 1979). Thus, the animal must be clever to adapt to the changes in order to protect the survival of species (Krebs and Davies, 1993). Disturbance to the natural forest has significantly affected the population of primates. For example, long-tailed macaque showed a significant population increase in disturbed forest (Ibrahim, 1995) and many other species show a significant population decrease after severe habitat disturbance (Johns, 1992). Long-tailed macaques are primate species that has successfully survived along with the development and spread throughout the Southeast Asia (Wheatley, 1980). Even though long-tailed macaques were widely distributed and most successful non-human primates, scientists are also worried if they become like North American passenger pigeon (*Ectopistes migratorius*), which was considered to be the most abundant bird on Earth until it was hunted to extinction in 1900 (Weisman, 2007). Information on primates is very important because they have been recognized as an indicator species that may reflect the condition of the forest as wildlife habitats (Johns, 1992). Besides that, information on primate population is necessary in order to conduct the management action.

1.2 Problem Statement and Research Question

At present, there are many threats to the primate species. This has directly led to a decline in populations (Fashing, 2002; Cowlishaw and Dunbar, 2000; Johns and Skorupa, 1987).

Most of current primate problems are related to habitat depletion through logging, forest conversion, forest fire and uncontrolled hunting (Maklarin, 2008; Molur *et al*., 2003). Increased tourism activity that is closed to the primate habitat also contributes towards the problems of human-macaque conflict. Nowadays, economic growth and a rapid increase in human population have resulted in a widespread violation on forest habitat, resulting in the burgeoning of human-nonhuman primate conflict due to crop raiding by the macaques and, more recently, pest behaviour in urban environments as they exploit garbage and other human food sources (Twigg, 2008). An increase in human population has resulted in the act of opening up of huge forest areas for human settlement. Agricultural activities and sources such as rubber, coconut, oil palm, cocoa, pineapple, rice and others also have been disturbing primate habitats and ecosystems. According to Sia (2005), increased human population and agricultural developed land has caused many serious ecological changes in the countries, which is the habitat of the primates as the native animals. The United Nations Environment Programme (UNEP) reported that, up to 98% of forest habitat in Sumatra and Borneo which part of the long-tailed macaques' core area will be destroyed by 2022 through conversion of land to oil palm plantations, poaching of high-grade timber and clearing land for farming (Nelleman *et al*., 2007). Besides destroying the habitat for economic and also for development, trade in of long-tailed macaques for human consumption as a pet, food and for research institution like pharmaceutical industry are decreasing their populations as well. There is no doubt in these indicators are the requirements for survival continuation of humanity on earth. However, primate also needs habitat and food for their survival. Therefore, there is a conflict between humans and primates, striving for their respective interests. Loss of habitat has become a major cause for primate to feed on human settlements whether in urban or in rural villages. Primates will behave differently when they are in a different environment (Krebs and Davies, 1993). Thus, it will disturb the public serenity that could result in the destruction of crops, deaths of livestock, property damage, injuries and the worst part is they could also cause humans death.

Long-tailed macaques can be found anywhere and now they act as pests to agriculture and also interfere with residential areas (King and Lee, 1987). According to Siex (2005), destruction of habitat and lack of resources cause long-tailed macaques to enter agriculture land for food. This causes farmers to suffer heavy losses. In some cases, the monkeys can also kill small animals, attacking and stealing food from the tourists (Brennan *et al*., 1985; Eley and Else, 1984). There are also sights of long-tailed macaque living on the rooftop of an apartment and stealing food from trashcans on its surrounding. As the long-tailed macaques have become a problem in humans' life, they are considered as pests and should be killed to avoid them from endangering lives. The frequency of aggressive behaviour will increase when animal population density increased in a habitat (Nordin and Don, 1981). According to Strum (1986), long-tailed macaques are known as pests because of their adaptability and their tendency to take advantage. While according to King and Lee (1987), the species that can adapt to these environmental changes would normally be pests. Long-tailed macaque is a primate species that can adapt easily to their environment and still be alive in the group despite having limited food resources (PERHILITAN, 2006). The long-tailed macaques are one of the most successful non-human primates (Fooden, 1976). They can live in various places. Lee and Priston (2005) also stated that the long-tailed macaques are pests in a variety of areas like farms, tourist areas, reserves, streets, temples and towns. Important factors that make

the long-tailed macaques as successful pests are omnivorous, on the earth (terrestrial) and also above the earth (arboreal) animal (Kavanagh, 1980).

The highest complaints received by the Department of PERHILITAN each year are related to disturbances of long-tailed macaques to human compared to other wild animals (PERHILITAN, 2006). The highest interference of long-tailed macaque was reported from rapidly developing state such as Selangor, Kuala Lumpur, Johor, Perak and Penang (PERHILITAN, 2006). Nowadays, interruption and assault of long-tailed macaques towards human being become a hot topic that is often reported by the media. Apart from habitat loss, high reproductive rate, lack of cooperation from the public, abandoned land, the lack of a suitable place of discharge, hygiene issues have also contributed to the increasing interference caused by long-tailed macaque (PERHILITAN, 2006). Estimation of long tailed macaque's population that causes disruption in Peninsular Malaysia is about 116860 to 126470 in numbers, which Johor recorded the highest (32400 individuals), while the state of Perlis recorded the lowest (2550 individuals) (PERHILITAN, 2006).

Matters related to wildlife management in Peninsular Malaysia are under the responsibility of the Department of Wildlife and National Parks (PERHILITAN). Therefore, the Department has made an approach to overcome the interference problem with long-tailed macaque in this country by providing advice, monitoring, translocation, shoot rid and sometimes has to shoot the macaques. However, any action taken by the Department especially the translocation or the shooting of long-tailed macaque will also consider the public opinion in advance. This has shown clearly that the Department role is to ensure the sustainability of human life; yet the wildlife also needs to be conserved. This is to ensure that people can live harmoniously as well as to interact well and enjoy the presence of animals that exist around them. Therefore, sustainable development should be implemented to achieve a win-win situation between humans and wildlife.

1.3 Aims of Study

According to Crockett and Wilson (1980), the flexibility of ecology and behaviour of long-tailed macaque has led to conflict between humans and macaques. Thus, the study of ecology and behaviour of primates should be done to address the conflict between humans and primates, especially the primates that live at the edge of human settlements area (Chivers, 1986). Ecological and behavioural study consists of four aspects namely daily activities patterns, food preferences, ranging behaviour and social organization. All these aspects are central to primate behaviour and ecology of its communities that are affected by the environmental habitat. In addition, aspects of pest behaviour are studied because it is applicable to the behaviour of long-tailed macaque as pests. Therefore, all of these aspects are aimed at gaining baseline data for knowledge, better management and conservation. The aims of the study are as follow:

1. To compare the social organization of long-tailed macaque inside and outside of Kuala Selangor Nature Park;
2. To compare the ranging behaviour of long-tailed macaque inside and outside of KSNP in relation to the usage of space;

3. To compare the food selection of long-tailed macaque inside and outside of KSNP in terms of food-plant species, plant parts and other animal (vertebrates and invertebrates) in the diet;
4. To compare the daily activity budget of long-tailed macaque inside and outside of KSNP to indicate the differences in activity between them;
5. To assess the pest behaviour and the conflict that occurs between human and long-tailed macaque outside of KSNP.

1.4 Organization of this Thesis

The first chapter in this thesis is more on the background, history, problem statement and what need to be achieved in this study in order to address the problem. The next chapter is a review of previous studies of primate, identification of all primates in Malaysia and in depth information of the studied subject which is *Macaca fascicularis* in terms of physical characteristics and morphology, distribution, habitat, ecology, behaviour, role and also conservation status. Chapter 3 describes more about the general method of this study, starting with the preliminary observation, selection of the study group, intensive data collection, selection method of data analysis, background of the study area and climatic conditions. In Chapter 4, there is more information about social organizations for both study groups. Chapter 5 describes the ranging behaviour respect for both study groups in terms of daily movement, distribution of night sleeping sites, home range and the use of different forest canopy strata. Chapter 6 is concerning with food selection by the two study groups in terms of food-plant species preferences, plant parts preferences and also foraging for prey. Chapter 7 is related with the budget activity performed by both study groups while in Chapter 8 is more about pest behaviour and conflict between human and macaque. In the final chapter of this thesis, it tells about the overview of this thesis, primate management and conservation recommendations, future research and conclusions of this study.

1.5 Limitation to the Research

Although the study has achieved the objectives, there are still some limitations that had to be endured by the researcher. First, due to the constraints of time and labour, this research has required the researcher to observe the two study groups in different places. Initially, it should be done separately whereby researcher has to spend some time to follow the outside group first and the inside group was supposed to be followed later in the KSNP area. That is why there is an interval between the observations for the outside group and inside group. Second is the safety factor at the study area. The study area is composed of a secondary forest and close to the mangrove which is a habitat for dangerous wild animals such as vipers and others. Thus, the observation activity towards both study groups was limited in a safe area only. This is to ensure the safety of the researcher. The third limitation was concerned regarding the questionnaire survey which was carried out in residential areas to measure the level of disturbance between human and macaque. The disappointing point of this data collection process was the cooperation given by the residents which was less satisfactory. This happened because there are respondents who do not reside permanently in the residential areas where they only return occasionally during holiday seasons. Other unsatisfactory concern was the attitude of some respondents who did not give their best in cooperating with the researcher.

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LIST OF PUBLICATIONS

Journal article

Kamarul Hambali, Ahmad Ismail and Badrul Munir Md-Zain (2012). Daily Activity Budget of Long-tailed Macaques (*Macaca fascicularis*) in Kuala Selangor Nature Park. *International Journal of Basic & Applied Sciences* 12(4): 47-52.

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