UNIVERSITI PUTRA MALAYSIA

ACTIVITY PATTERN OF TWO PORCUPINE SPECIES IN AN AGRICULTURAL AREA AND DISTURBED FOREST

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ACTIVITY PATTERN OF TWO PORCUPINE SPECIES IN AN AGRICULTURAL AREA AND DISTURBED FOREST

By

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ABSTRACT

This study is to describe the activity pattern of two species porcupine in two different areas, which is an agricultural area and disturbed forest. For an agricultural area, Kampung Wawasan Jaya Bintulu and Kampung Sepaduk Bintulu have been chosen while Nirwana Forest UPMKB and Kampung Ulu Kelulit Bekenu selected for the disturbed forest. Camera trap were used in this study. Camera trap were set up in front of the porcupine's den, trail and its paths. All the photographs that have been captured will be recorded and analyzed. The study confirmed that one of the species, which is the Thick-spined porcupine have two peak time. Agricultural area recorded the highest data with 12 photograph captured compare to the disturbed forest which only recorded two photographs. Thick-spined porcupines were found active during the times 0200 hour until 0600 hour and also between the times 0400 hour until 0600 hour. This proof Thick-spined porcupine is a nocturnal animal. In the study, 28.57 % of the activity pattern was recorded during the peak hour which is the highest meanwhile 7.14% is the lowest that have been recorded during that time.

ABSTRAK

Kajian mengenai corak aktiviti dua spesies landak dijalankan di dua jenis kawasan iaitu kawasan pertanian dan hutan terganggu. Dalam kawasan pertanian, dua tempat telah dipilih iaitu Kampung Wawasan Jaya dan Kampung Sepaduk Bintulu dan Kampung Ulu Kelulit, Bekenu Miri. Untuk mengetahui corak aktiviti spesies landak, perangkap kamera (camera trap) telah digunakan. Perangkap kamera (camera trap) dipasang di laluan dan hadapan lubang busut landak. Setelah gambar direkodkan, ia akan dianalisis bagi mengetahui corak aktiviti spesies landak dan jumlah spesies tersebut. Terdapat satu spesies yang telah ditentukan mempunyai dua waktu kemuncak iaitu landak borneo. Landak borneo mempunyai dua waktu kemuncak iaitu pada 0400 dan 0600 jam dan 0200 hingga 0600 jam. Kawasan pertanian merekodkan data tertinggi di mana 12 gambar berjaya direkodkan berbanding dengan kawasan hutan terganggu yang hanya merekodkan 2 gambar. Dalam kajian yang dijalankan, data tertinggi yang berjaya dikumpul sewaktu masa kemuncak landak borneo adalah sebanyak 28.57% manakala yang terendah dikumpulkan adalah 7.14%.

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APPROVAL SHEET

I certify that this research project report entitled "Activity pattern of two porcupine species in an agricultural area and disturbed forest" has been examined and approved as a partial fulfillment of the requirement for the degree of Bachelor of Bio-industry Science in the Faculty of Agriculture and Food Sciences, Universiti Putra Malaysia Bintulu Campus.

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CHAPTER 1

INTRODUCTION

1.1 Background of Porcupine

According to Junaidi and Charles, 1998, in Malaysia there are 4 species of porcupine which are Common porcupine (*Hystrix brachyura*), Thick-spined porcupine (*Thecurus crassispinis*), Brush-tailed porcupine (*Athecurus macrourus*) and Long-tailed porcupine (*Trichys fasciculata)*. Porcupine behavior live in family clans of up to four to eight members, who share common runs, trails, excrement depositories, feeding places, refuges, and territories. Dwellings are, as a rule, not inhabited by one animal, but rather by a group. Typical groups consist of an adult couple and a varying number of young and growing animals. Porcupines provide extensive care of the young. These animals forage nocturnally and alone, but shelter in groups during the day (Grzimek *et al.*, 2003).

Porcupines prefer to live by plantations or cultivated areas, river forests, forest islands, as well as primary and secondary forests and make shelters in burrows, caves, trees, and other natural cavities. They are nocturnal animals, spending most of the day in underground shelters. They rest during the day in burrows, crevices, termitaries, under and in fallen trees, in holes among tree roots, caves, or cavities along stream banks. The burrow is usually self-constructed, with a long entrance tunnel, multiple exits and a large inner chamber (Gurung and Singh, 1996).

Porcupines are mainly herbivorous, eating fruits, seeds, bamboo shoots, and the cambium layer of trees, although their diet can also include invertebrates main food source for the porcupine is vegetable material of all kinds, including fruits, grains, and

roots (Prater 1965). They have also been known to chew on bones, in search of minerals (such as calcium) that help their spines grow (Gurung and Singh, 1996; Prater, 1965). The species utilizes both natural plants and agricultural crops as food sources. These animals strictly forage during the night. They are herbivorous and usually feed on vegetation. They enjoy tree bark, roots, tubers, leaves, bulbs, and fallen fruits. However, they sometimes also feed on cultivated crops, insects, and carrion. (Gould, McKay, and Kirshner, 1998; Grzimek, Schlager, and Olendorf, 2003).

For Common and Thick-spined porcupine, they have different active period. Active period for Common porcupine is around 7 to 10 pm while for Thick-spined porcupine it has two peak time of active period which are 5-7 am and 6-7.45 pm. (Nihayah *et al.*, 1995).

1.2 Background of Camera Trap

Through the camera trap has been around since the start of the 1900's it is only in the late 1960's scientist started to use it as a research tool (Lynam, Draft). Its first use was to document species whose presence was unsure in the forest Barro Colorado Island, after the flooding of the canal zone of the Panama Canal (Chapman, 1927). Camera trap are used for inventory as well as ecological research (Lynam, Draft). Camera trap can be used to ascertain species presence-absence, species richness, relative and absolute abundance, monitoring and activity pattern (Lynam, Draft).

Recent improvements in technology provide us with various ready-made camera traps with tiny infrared-motion sensors, built-in flash, and data packs at a reasonable price.

Potential application of the method in wildlife studies are in creasing. Although demands for monitoring wildlife diversity and abundance in a particular area have been increasing recently, few attempts at methodological standardization have been made so far.

1.3 Objective

A detailed study is needed to determine activity pattern of porcupine species by camera trapping. This study is important to carry out one objective, which is to determine the activity pattern of two porcupine species namely the Common porcupine and the Thick-spined porcupine.

CHAPTER 2

LITERATURE REVIEW

2.1 Background Study area

For an agricultural area study in Kampung Wawasan Jaya, Bintulu. This area situated beside a private oil palm plantation. The den here was surrounded with ferns. This area is quite far from the streams. Among the oil palm tree, there were some local fruit being plant. For this area, four den's hole was found. Only two den's hole that being occupied by the porcupine. Kampung Sepaduk Bintulu is an agricultural area. In this area, there was 10 den's hole being found. Illegal hunting takes place in the area. A hunting tower were found about 5 meter from one of the den. The villagers also use the area as a source for jungle delicacy.

For disturbed forest study, the area involved two different places. One of selected area is Kampung Ulu Kelulit, Bekenu, Miri. In this area, two porcupine dens have been located. These dens were located quite for from the stream. The dens were quite rocky and clayish in structure. The area surrounding the dens was covered by tall trees and scrubs. According to the villagers, these dens were long occupied by the porcupines. This area was quite dangerous because a lot of illegal hunting takes place in this area. For Nirwana Forest UPMKB, two holes den were found. By looking to den's hole, it is believed that the dens were occupied by small sized porcupine. These dens is situated nearby a small river and surrounded with tall trees and scrub. Nirwana Forest UPMKB formerly is a logging area and now is being used by the students of UPMKB as their project site.

2.2 Description of world's porcupine

The porcupine is classified under order of Rodentia, which consists of two families with 7 living genera and 21 species distributed all over the world (Nowak, 1999, Medway, 1978; Legakul, 1977). There are only two families of porcupine such as hystricidae (Old World porcupine) and Erethizontidae (New Old porcupine). The family of Hystricide consists of three genera and eleven species occurs in parts of Southern Europe, all across Southern Asia, India and Africa. Meanwhile, the family of Erethizontidae includes four genera with ten species. These species are found at the North America to Northern Mexico and the Appalachian Mountains and from Southern Mexico to Ecuador and Argentina (Nowak, 1999). The systematic list of world's porcupine is shown in (Table.1).

2.2.1 Hystricidae (Old World Porcupine)

Those porcupines are highly adaptable, being found in all type of forest, plantations, rocky areas, mountain steppes and hill deserts. They also can live at the elevation range see level to 3,500 meter (Medway, 1978). They usually used cave, rock crevices, dead tree burrow and borrow they dig by themselves (Nowak, 1999). For their safety, the burrows usually have several entrances and some time used for several years.

The female may establish a separate tunnel to bear its young. Breeding has been reported through out the year. Study by Van Aarde and Skinner (1986) of Cape porcupine (*H. africaeaustralis*), the male porcupine are reproductively active through out the year and sexual maturity at an age of 8 to 18 month. It will produce a single new born and estrous cycle of about 35 days and gestation period of about 112 days. Meanwhile, (Nowak,

1999) was reported the *H. africaeaustralis* have average gestation period is 93.5 days. He also mentions the number of offspring of this genus varies from one to four, but commonly found with only one or two offspring. The female reach sexual maturity at six to nine months, male is between nine to sixteen months.

2.2.2 Erethizontidae (New World Porcupine).

This family consists of four genera (*Erethizon, Coedou, Echinoprocta* and *Chaetomys*) and ten species found from Arctic Coast of North America to Northern Mexico to Appalachian Mountains and from Southern Ecuador and Northern Argentina (Nowak, 1999; Lekagul and Nc Neely, 1977; Honacki *et al.*, 1982). This family is the biggest and heaviest rodent in that region.

The foot is modifying from arboreal life: the sole is widened, and in some forms the first digits have strong and curved claws. The lambs are fairly short. The tail is relative short in *Echinoprocta* and *Erethizon* but long in *Coendou*. The dental formula is (I1/1, c0/0, pm 1/1, m 3/3) x 2 = 20 (Nowak, 1999). The families of New Old porcupine in Europe some time remain in their holes through the winter season (Honacki *et al.*, 1982).

Some of the hairs on body and tail are modified into short, sharp spine with overlapping barbs. The weight of adult average about 7 kilograms, with some individual from the genus *Erethizon* weighing until 18 kg. Female porcupine has three pairs of mammary (Wakler, 1964).

2.3 Description of Porcupine in Borneo

Wildlife diversity is high on the island, with 221 species of terrestial mammals (Payne *et al.*, 1985), and about 19% of the mammalian fauna are endemic (Bennet *et al.*, 1996). In Sarawak there are only 3 species of porcupine occur in all types of forest. There are *Hystrix brachyura* (Common porcupine) have long spine,white with black band towards the tip and front part of the body is mostly blackish (Medway, 1977; Payne *et al.*, 1985), while *Thecurus crassispinis* (Bornean porcupine) are generally dark brown and smaller in size (Payne *et al.*, 1985; Yasuma and Andau, 2000) and *Trichys fasciculata* (Long - tailed porcupine) is smaller compare to *Thecurus crassispinis*, which also has a brush of hollow bristle at the end (Payne *et al.*, 1985). Porcupine are characterized by having the body cover with hairs modified into shape, rigid spines or quills.

The porcupine are larger and more heavily built than squirrels or rats. All of them are protected by a coat of hard sharp spine which grow among the fur and are themselves modified hairs (Tweedie, 1978). The Asian porcupine are ground–living animals and dig burrows in which they rest by day and have their young. In the species whose breeding has been observed one young is born, rarely two (Grzimek, 1975). There is no record or study on population status of porcupine in this country, but in term of conservation effort those porcupine species were protected under Wildlife Act 76/1972, Sabah Wilelife Enactment and Forest Enactment in sarawak. Borneo porcupine is endemic at Borneo Island (Medway, 1965; Freye, 1975; Payne *et al.*, 1985).

The Borneo porcupine is also protected under both states wildlife and forestry laws. Common porcupine is the popular hunting animals compared the other species because

the large size and consumed most races in Malaysia like other meat. Locals also believe that porcupine meat has medicinal values. The study on porcupine in this study country is lacking. (Zainal, 1999) did some asssesment on the Common porcupine at Malacca Zoo and propose that this species is potentially to be commercializing for food. First study was done on behavior of Common and Borneo porcupine in captivity at University Putra Malaysia and University Kebangsaan Sabah conducted by (Nihayah *et al.*, 1995).

2.3.1 Common porcupine (*Hystrix brachyura*) or Landak Raya

The Common porcupine as *Hystrix brachyura.* The physical characteristics head and body length between 60 and 93 cm, tail is 8-17 cm and weight is 10-30 kg (Nowak, 1999). Lekagul and McNeely (1977) decribed that the head, neck, shoulders, limb and underside of the body arer cover with coarse, dark brown or black bristles. According to Zainal (1999) the average male body weight was 12.5 kg and female with range between 9 -10 kg. In captivity at malacca zoo, porcupine is fed with mustard,honeydew,long nes and sweet potato (Zainal, 1999). Common porcupine is an omnivorous animal, in the wild feeding mainly on bark, roots, tubers, rhizomes bulbs, fallen fruit and cultivated crops (Walker, 1995).

The Common porcupine (*Hystrix brachyura*) has been categorized by International Union for Conservation of Nation (IUCN) in red list of endangered as a "vulnerable" and in Sarawak it has been classified as protected wildlife within Schedule 2 (II) as hunting animals under Wildlife Protection Act No 76 (1972). This species is a popular as

game animal and The Department of Wildlife and National Parks (DWNP) issuing permit for hunting with the rate of RM 50.00 per five animals per year per license.

2.3.2 Thick spined porcupine (*Thecurus crassispinis*) or Landak Borneo

The Borneo porcupine (*Thecurus crassispinis*) is physical characteristics with body length is 1.4 –3.0 ft (42–93 cm), tail length is 1.0–7.5 in (2.5–19 cm), and weight is 8.4–11.9 lb (3.8 –5.4 kg). Short, rounded head; no head or neck mane; upper side is dark brown to black and partly speckled in light color; underside is brown to gray-white. Body is covered with flattened spines; each grooved longitudinally with increased rigidity near tip. Quills are smaller along tail and more flexible on underside.

Coarse, bristle-like hairs cover feet. Nasal bones are small. Subgenus *Thecurus* resembles subgenus *Hystrix* in having shorter tail and longer quills. Resembles subgenus *Acanthion* in that it lacks well-developed crest and its quills have only one black band (Table. 1). The Borneo porcupine habitat is living in forests and cultivated areas, from sea level to 3,900 ft (1,200 m). The Borneo porcupine behavior is nocturnal; terrestrial.

Spine arrangement and structure resemble sub-genus *Thecurus*. Front half of porcupines body covered with short, dark brown spines, while hindquarters have long, pointed, whitish spines, usually with one blackish ring. short, whitish crest found on neck and upper back. Short tail has long, pointed spines and rattle quills. Females and males possess hollow quills on tail, which are shaken to scare predators. Habitat in forests, lowlands, hills, cultivated areas. Behavior of porcupine is nocturnal; terrestrial. Feeding ecology and diet of porcupine are fallen fruits including oil palm, roots, and stems.

Table. 1 : The world porcupine (Nowak 1999)

Order : Rodentia

Family : Hystricidae

Genus	Sub-genus	Species	Distribution
Hystrix	*Tthecurus*	*H. pumila*	Pahlawan, busuanga and Bababac Island
		H. sumatrae	Sumatrae
		H. carassispinis	Borneo
	Acanthion	*H. brachyura*	Nepal to malay Peninsular, Hainan,Sumatrae and Borneo
		H. javanica	Island from java to Flores
	hystrix	*H. indica*	Asia Minor and Arab Peninsular to Central Asia and india, Sri lanka
Atherurus		*A. macrourus*	South China, Assam, Burma,Thailand, Indochina, Malay Peninsular and Hainan.
		A. africanus	Gambia to Kenya and Southern Zaire.
Trichys		*T. fasciculata*	Malay Peninsular, Sumatra and Borneo
Echinoprocta		*E. rufescens*	Colombia
Coendou		*C. bicolor*	Panama to Bolivia
		C. prehensilis	Venzuela, Guianas, Brazil, Bolivia and Trinided.
Sphiggurus		*S. mexicanus*	Mexico to Panama
		S. pallidus	From West Iddies
		S. insidious	Surinam, Brazil
		S. spinosus	Brazil
		S. vestitus	Colombia, Venezuela.
		S. vilosus	Brazil
Erethizon		*E. dorsatum*	North American

2.4 Camera trap

Mammals are a significant group often considered for monitoring because of their vulnerability to poaching and their sensitivity to human activity (Robinson and Bodmer, 1999). There are at least 221 species of mammals in Borneo (Payne *et al.*,1985), but only 48 are large mammals (>2 kg), which mammals > 75% of these species relatively small and difficult to detect. Prior to the use of automatic cameras and sensor

technology, mammals had to be surveyed either by walking through the habitat or searching for animal signs such as tracks or droppings (Wemmer *et al.*, 1996).

Since the 1990s various camera trapping schemes have been used in tropical forest of Asia and Africa (Griffiths and Van Schaik, 1993; Karanth and Nichols, 1998; Franklin *et al.*, 1999). Camera traps, which have increasingly been used in wildlife studies (Wemmeret *et al.*, 1996), are ideal for indetifiying the species inhabiting a particular area, monitoring relative and absolute abundence of species, and studying activity pattern (Karanth, 1995; Van Schaik and Griffths, 1996; Miura, 1997; Karanth and Nichols, 1998; Kawanishi *et al.*, 1999; Koerth and Kroll, 2000; McCullough *et al.*, 2000; Martorello *et al.*, 2001; O'Brien *et al.*, 2003). Camera also can help to answer a varitey of ecological and conservation-related question such as nest predation, frugivory and seed dispersal, etc. (Liemgruber *et al.*, 1994; Miura, 1997; Yasuda and Azman, 2000; Otani, 2001, 2002).

The method has wide application in species inventories, presence-absence studies, and population surveys of individually recognizable species, such as Sambar Deer (Giman *et al.*, 2007). Camera trap information will provide in sight to the species diversity in the study area and contribute to the collection of distributional in Sarawak. Camera trapping is potentially, therefore, a powerful, practical method of monitoring wildlife diversity. Camera trap method is superior to other encounter-based method that have been commonly used to estimate abundance, for example, counting animals or animal signs and provide detailed information for conservation. Camera trap also can census is utilized to study the relative abundance of porcupine and mark-recapture framework.

Photograph taken with camera trap can be monitoring the porcupine species population and measured activity level of porcupine. Camera trap can provide other biologically relevant information such as temporal variations, distance of travel, activity pattern wildlife and other wildlife in the study area. Camera trap can used categorized the nocturnal and diurnal mammal's peak time study monitoring wildlife in the study area. Time and date is very important to do the photos analysis activity pattern of porcupine.

2.5 Activity pattern

The activity of Common porcupine in the while show slightly different compared to captive individuals reporting by Nihayah *et al.*, (1995). They recorded that captive porcupine was highly active between 19-22 hours and in early morning (9-11 hours) when food served. They also concluded that porcupine can easily adapting to the captive or endorsed environment but in general, patterns still like others nocturnal animals which is more active at night.

The activity pattern of Common porcupine in the study also slightly different from African Brush-tailed porcupine studied by Emmons (1983). She found that, generally African brush-tailed porcupine toward trimodel pattern, with two rest periods during the night. The behaviors of female were quite regular, with rest period around 20-21 hour and 02-04 hour. Male spend more time immobile and had a more irregular pattern; they often rested in the middle of the night when females were active, and were active during the rest periods of female. Common porcupine is generally known as social or group animals Kawanishi and Melvin E (2003) in her study on tiger ecology in Taman Negara using camera trap, reported more than 90% of porcupine picture indicated that the

animals moving in group or family group. Normally it lives in small group or colonies of 6-8 individual (Lekagul and Mc Neely, 1977).

According to (Haim *et al.*, 2003), *Hystrix africaeaustralis* also spend more time in the burrow during day to conserve energy and hiding from predator and the new born always in the burrow until first 9 weeks. Many animals drink with their meals, feeding behaviors being a direct stimulus for drinking. Thus, an animals living on an established eating and drinking daily routine may never become dehydrated (Robins, 1993). Species porcupine activity pattern was investigated from the camera-trap data. When the camera tripped, the time is imprinted on the photograph. The percent activity pattern was calculated based on pooled camera-trapping data from the four study sites, exclusive of photographs of same species taken within twenty second at the same trap location.

CHAPTER 3

MATERIALS AND METHODOLGY

3.1 Description of study area

Four sites have been selected for the study. The first area is located at a private oil palm plantation in Kampung Wawasan Jaya, Bintulu. Among the oil palm plantation, the area also being planted by some local fruits such as 'Rambutan' and 'Pisang'. In this study area, the oil palm tree was planted since 2004. Second area is an area of rubber tree orchard at Kampung Sepaduk, Bintulu. This area is located about half an hour journey using a four-wheeled vehicle from Bintulu-Miri road. In this area also many local fruit can be found. For example, 'Cempedak', 'Jering' and 'Bambangan' fruits.

Kampung Ulu Kelulit Bekenu Miri the third location is a disturbed forest area. This area is a victim of agriculture shifting cultivation system whereby the areas were being planted with hill paddy. Because of that, due to the negative soil condition, there were no agriculture activities being done in this area. What left is a disturbed forest which consist some old tree that grew tall. The fourth area is, Nirwana Forest UPMKB Bintulu with situated line base sixteen. In this site Meranti (*Shorea* sp), Keruing (*Dipterocarpus* sp.) and Kapur (*Dryobalanops* sp) can be found here. In this study, two camera traps were used for recording activities but only one camera trap used in one site for one time. The camera trap has been set up at animal trail or track, porcupine footprint and in front of burrow (Figure 1).

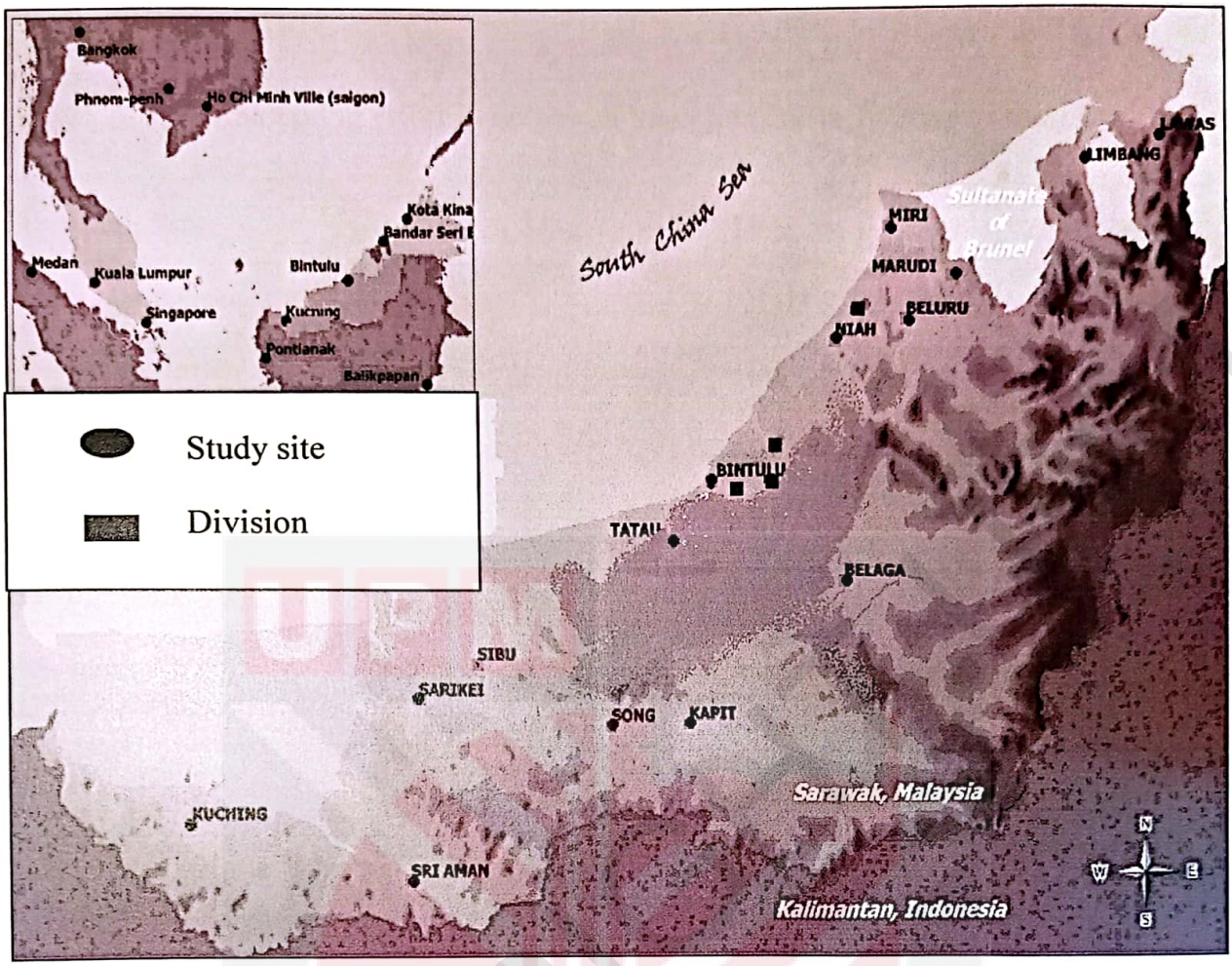

Figure 1: Location Of study site within Bintulu division and Miri division in Sarawak, Malaysia

Table 2. Sampling effort (numbers of trap night) from January to March 2007.

Trapping Site	Type Camera Trap	Date	No. Of Day
Simpang Bakun Kampung Wawasan Jaya, (Bintulu)	Cam Trakker	12/ 01 / 2007-27 / 01 / 2007	15
Kampung Sepaduk (Bintulu)	Cam Trakker	19 / 02 / 2007-24 / 02 / 2007	4
Kampung Ulu Kelulit (Bekenu)	Cam Trakker	24 / 02 / 2007-20 / 03 /2007	26
Nirwana Forest UPMKB Bintulu	Cam Trakker	19 / 01 / 2007-10 / 02 / 2007	23
Total of Days			68

For this study, 68 days of camera trap set in the agricultural area and disturbed forest. Kampung Wawasan Jaya, Bintulu the camera trap set just 15 days. Camera traps in study site set in trail and in front of burrow porcupine. In this study site, it is very successful because 12 photos of porcupine species were recorded. The photos also include a Thick-spined porcupine in this area. The camera trap set for 4 days in Kampung Sepaduk. In this study site, no photograph was recorded because the porcupine didn't come out from its burrows. Kampung Ulu Kelulit Bekenu is disturbed forest area. The camera trap set for 26 days. Camera trap set in front of burrow. During this period, 2 photographs were recorded. The Thick-spined porcupine was recorded. For Nirwana Forest UPMKB Bintulu, the camera trap set for 23 days. No photograph was recorded in this site. Maybe it was disturbed by student who did practical in this site.

3.2 Camera trap setting up

Camera trapping was conducted from January to March 2007. The two cameras trap commercially brand Digital Ranger S600 CB made Cam Trakker units (manufactured by Cam Trak South, inc., 1050 Industry Drive, Watkinsville, GA 30677, US) were deployed during the study. Each unit consists of plastic casing, camera with built flash, sensors with selectors and viewing window.

Each unit was fully enclosed within a weatherproof casing to reduce moisture getting inside. Each cam Trakker unit consists of a Cyber-shot 6.0 mega pixels Sony digital camera, power by Lithium AA battery size, attached to an inbuilt infrared sensor. Four 'C' sized alkaline batteries power the infrared sensor. Exposure delay was set at an interval of 20 second. Silica gel was placed inside camera units to further reduce the moisture in the casing due to condensation (Plate 1).

Plate 1: Component of camera trap. Four batteries size "C" for the sensor and two batteries size "AA" for camera.

Date and hour reading was imprinted on each photograph taken for both models to provide information needed for estimation of activity patterns (Laidlaw, 1999; Wong *et al.*, 2003).Camera units were secured to tree or stick and hide from human. Cam Trakker combines Cyber-shot 6.0 mega pixels Sony digital camera, with a passive infrared heat-in-motion detector. The heat-in-motion sensor operates on a horizontal plane, thus it is important that it is aimed parallel to ground. When something that moves and gives off heat, a silent electronic switch engages the camera, which takes photograph. These units are equipped with a delay selector mechanism that precludes the camera from taking a photograph for set period of time. All cameras were operational 24 hours a day (Plate 2).

Plate 2: Camera trap was set up at suitable location.

Camera trapping can also provide other biologically relevant information such as temporal variation (Laidlaw and Shaharudin, 1999), distance of travel, relative abundance of prey species (Kawanishi, 2002) and other wildlife in the study area. Beside that, individual identification or population estimation (Karanth, 1995). However,

undercount can be dealt with if the camera traps are utilized in a mark-recapture framework. (Azlan and Sharma, 2003).

3.3 Photo analysis

Animal identification was determined based on illustration and description by Payne *et al.*, (1985) and Medway (1977). Identification of the species was made using the photographs obtained. Beside that, the cameras recorded the time which is used to determine the activity pattern. The total number individuals were also determined. Exposures without an image were categorized as ghost shot, which may occur due to sudden shift in ambient temperature. Some animals could not be identified due to poor angle of wildlife shot, the animals were too far away or they moved during the exposure. The overall sex ratio of the entire sample could not be determined, as the visibility of external genitalia in the remote camera photographs was poor (Azlan and Sharma, 2003) (Plate 3).

Plate 3: The Thick-spined porcupine (*Thecurus crassispinis)* was recorded.

3.4 Activity pattern

The activity levels were calculated from the date and time imprinted on the photograph (Wong *et al.*, 2003). Photo without a time imprint were discarded from the analysis. Photo recorded of animals species with less than 10 photographs were not included (Azlan and Engkamat, 2004). The percentage of activity level was used to indicate whether the mammal species are nocturnal or diurnal. Activity recorded between 1800-0600 hours was classified as nocturnal. Activity pattern was only calculated for two species.

3.5 Secondary data from Grand Perfect Sdn Bhd

In this study, secondary data on the same species porcupine obtained from Grand Perfect were used as comparison. This data was recorded in a remnant forest and *Acacia mangium* plantation in tubau. The data Grand Perfect using forty two cameras trap and scented lures. This data collected only 14 days in Grand Perfect conservation area.

CHAPTER 4

RESULTS

4.1 Photo analysis

From the study, total 14 photographs Thick-spined porcupines were recorded. There were no photographs were recorded in study sites for Common porcupine (*Hystrix brachyura)*. In agricultural area is highest recorded frequency of 12 exposures by Thick-spined porcupine in study.

Plate 4: Thick-spined porcupine *(Thecurus crassispinis)* was recorded by camera trap in front den hole.

Table 3: Number of observations recorded by the current study and Grand Perfect for both porcupines species.

Common Name	Current study	Grand Perfect
Common porcupine	none	11
Thick-spined porcupine	14	12
Total	14	23
Number of species	1	2

A total 14 of porcupine photographs was achieved from 12 January 2007 until 20 March 2007. The Thick-spined porcupine (*Thecurus crassispinis)* had the highest frequency of recorded with 14 exposures and Common porcupine no photos was recorded (Table 3). Photographs were confidently utilized for identification of individual animals. The overall sex ratio of the entire sample could not be determined, as the visibility of external genitalia in the camera trap photographs was poor.

From this table, no photograph of Common porcupine was recorded during the duration of the study. However, 14 photographs of Thick-spined porcupine were obtained. For the study, only one species porcupine was found. In the study by Grand Perfect 11 and 12 observations were recorded for these porcupines accordingly. A total 23 of porcupine photographs consisting of two species were recorded. The Thick-spined porcupine (*Thecurus crassispinis)* had the highest frequency of recorded with 12 exposures and Common porcupine is recorded 11 exposures (Table 3).

Several types of lure were used to make the camera site more attractive to mammals. A small amount of lure was placed on a small stick that has been cut near the center of the detection range for the camera. The difficulty for these plantations is to maintain both timber harvest and wildlife diversity (Bennett, 2000; Meijaard *et al.*, 2005). This is a distinct need to monitor wildlife population within these planted forests (Forest Stewardship Council, 2005). For this case, Grand Perfect used forty one camera traps in one time to record the porcupine photographs.

4.2 Activity pattern

For this study, the Thick-spined porcupine (*Thecurus crassispinis)* was an active animal during early morning from 0200 hour to search feeding or water and come back to dens until 0600 hour. As for Thick-spined porcupine has 2 peak time of activity pattern namely at 0400 and 0600 hours. The result is a approximately 28.57 % of the Thick-spined porcupine (*Thecurus crassispinis)* highly recorded at 0400 and 0600 hour, 21.42 % at 0500 hour,14.28 % in 0200 hour and 7.14 % at 0300 hour, (Figure. 1). It was from that time, Thick-spined porcupines (*Thecurus crassispinis*) were detected by camera trap. The *Thick*-spined porcupine (*Thecurus crassispinis)* is an inactive animal during the time 0700 until 0100 hour. It maybe resting and sleeping in the burrow because the porcupine is nocturnal mammal.

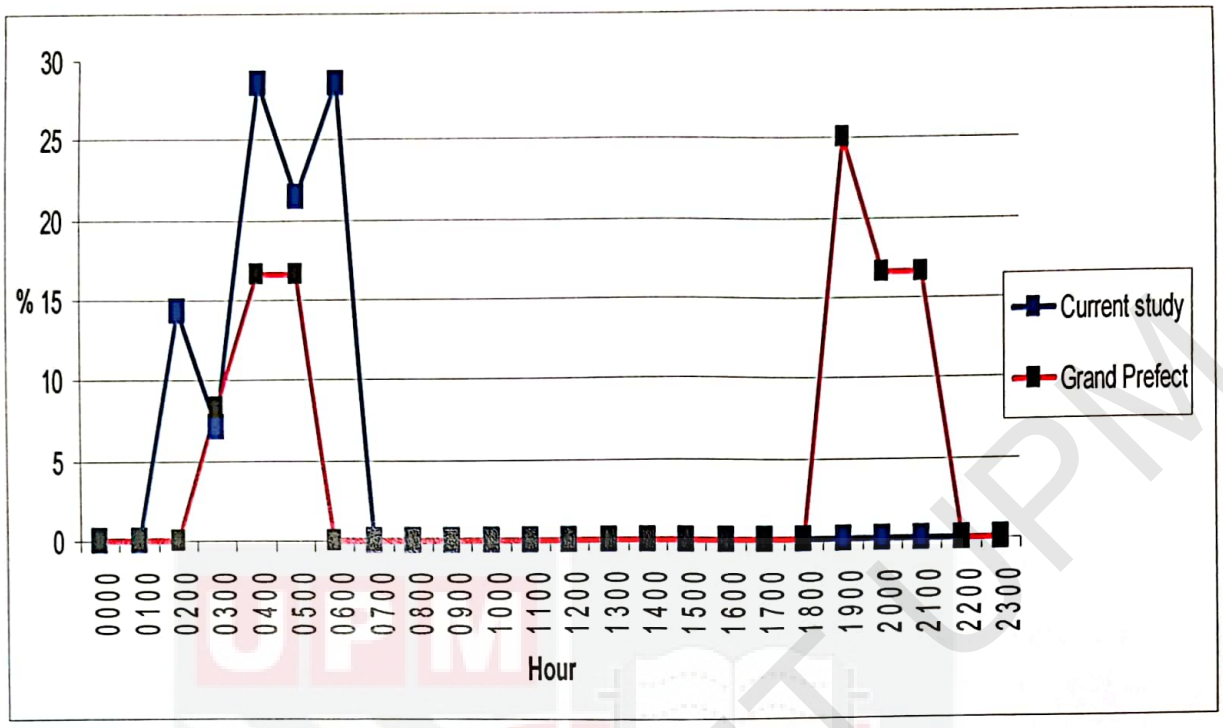

Figure 2: Percentage of Activity Pattern of the Thick-spined porcupine (*Thecurus crassispinis*) Current study (n = 14 photos) Grand Prefect Conservation Sdn. Bhd. (n = 12 photos)

This information will provide insight to the species diversity and contribute to the collection of distributional records of large mammals (Azlan and Engkamat Lading *et al*., 2006). Thus, it is difficult to estimate population size, relative abundance or activity pattern of these species (Silveira *et al*., 2003).

From the Grand Prefect Conservation Sdn. Bhd data on the other hand observed only a single peak at 1900 hour. An approximately 25% of the Thick-spined porcupine (*Thecurus crassispinis*) high recorded in 1900 hour. In time 2000, 2100, 0400 and 0500 hour the 16.66% were photographs recorded. The lowest 0300 hour the Thick-spined porcupine (*Thecurus crassispinis)* photographs were recorded an 8.33 % (Figure 3). For these results, the Thick-spined porcupine (*Thecurus crassispinis)* was nocturnal an

active early morning at 0300 hour to go out for search feeding or drink water and come back to dens 0600 hour. From data base Thick-spined porcupine (*Thecurus crassispinis)* no photographs detect in day from 0700 until 1800 hour.

From this graph, generally say that the Thick-spined porcupine is active during the night and is considered as a nocturnal animal. During the day, the Thick-spined porcupine spends most of its time in the den. Difference in the peak time obtained in this study which is early morning as compared to that obtained by Grand Perfect mostly evening might be related to the current study sites consisted mostly of disturbed areas where as Grand Perfect areas were mainly conserved area.

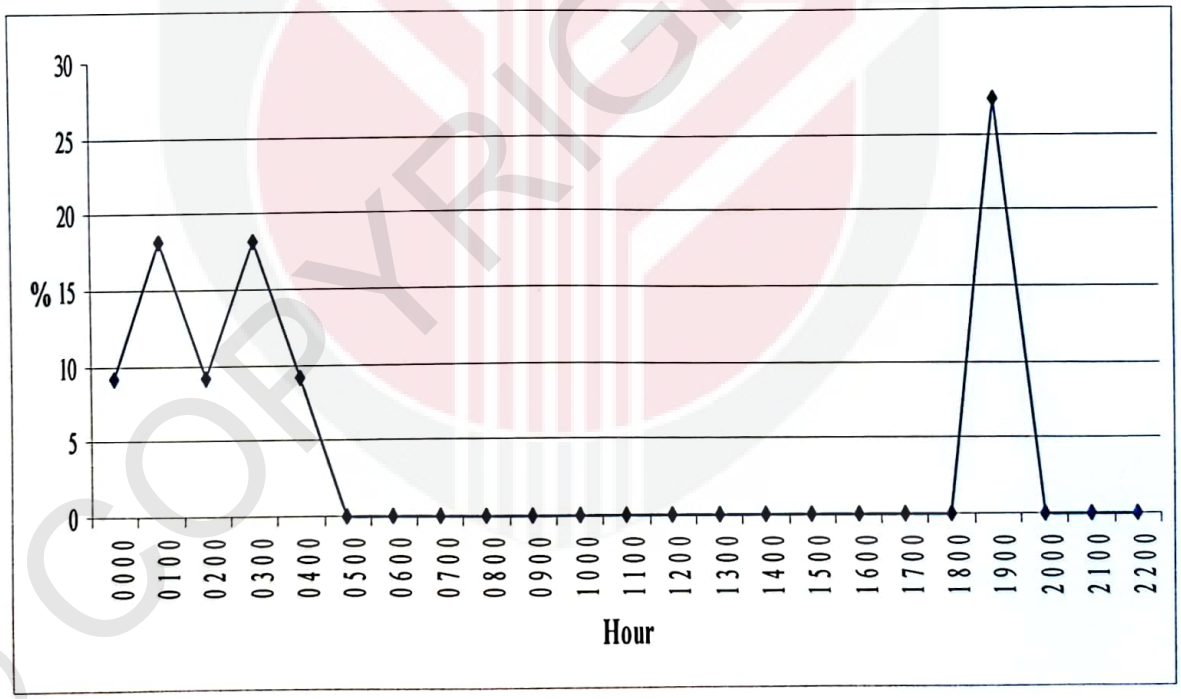

Figure 3: Percentage of Activity Pattern of Common porcupine (*Hystrix brachyura)* from Grand Prefect Conservation Area (n = 11)

As no data was obtained for Common porcupine species in study area. From Grand Perfect data Common porcupine (*Hystrix brachyura)* was observed that the species was active nocturnally. Common porcupine (*Hystrix brachyura)* has one peak times been observed at 1900 hour. In 1900 hour after dusk and 0000 hour until 0500 hours early morning. From Grand Perfect data the Common porcupine (*Hystrix brachyura)* photographs, in 1900 hour activity pattern of Common porcupine (*Hystrix brachyura)* 27.27 %.

The 0100 and 0300 hour 18.18 % activity pattern recorded. In 0000 hour, 0200 hour and 0400 hour, the Common porcupine (*Hystrix brachyura)* activity pattern is low where 9.09 % only recorded. The Common porcupine (*Hystrix brachyura)* is inactive in hour 0700 hour until 1800 hour and 2100 hour until 2300 hour.

CHAPTER 5

DISCUSSION

The time limitation to this study was the ability to sample the porcupine comprehensively. The study case only one species were recorded. Camera traps will allow us to make comparison between sites for any single species or group of similar species. This will greatly enhance our ability to monitor porcupine. However, it provides baseline data on the diversity and relative abundance of these species in a habitat. For the study, comparison data study with data from Grand Perfect Conservation Sdn. Bhd.

5.1 Photo analysis

The species Thick-spined porcupine *(Thecurus crassispinis)*, were frequently photographed at study site throughout the study period. Two sites successfully detect Thick-spined porcupine (*Thecurus crassispinis*) presence in this sites. The agricultural area highest recorded the Thick-spined porcupine and two photographs were recorded in disturbed area. Date and time imprinted with photographs was exposures. It would also be possible to look into their activity patterns by analyzing photos the time and date recorded at each photographs, if adequate data representing each species were available. (Medway, 1983; Payne, 1985).

From the Grand Perfect Conservation Sdn. Bhd data, Common porcupine (*Hystrix brachyura*) and Thick-spined porcupine *(Thecurus crassispinis)* presence have been recorded in Tubau Planted Forest. Forty one set commercially sold Deer Cam branded cameras (Non-Typical Inc. Park Falls, Wisconsin, USA) used to collecting data

photographs. Camera traps are being set up at Tubau Planted Forest for 14 days to record the photographs. The data shown that the Common porcupine (*Hystrix brachyura*) and Thick-spined porcupine *(Thecurus crassispinis)* has two peak times. The peak time for both species is different from each other. This can be supported by the date and the time imprinted in the captured photograph showing that Thick-spined porcupine (*Thecurus crassispinis)* came out early from their dens compare to Common porcupine (*Hystrix brachyura*).

5.2 Activity pattern

From the study, all photographs recorded a single porcupine exposures photos. The camera traps can detect and records when the porcupine used the trail and go out from the dens. Using camera trap to study these secretive and nocturnal animals, suggest that it could be an ideal tool for further study to determine their activity patterns of porcupine (Medway, 1983; Payne, 1985). The Thick-spined porcupine (*Thecurus crassispinis)* has one peak time for this study, 0200 until 0600 hour. Thick-spined porcupine (*Thecurus crassispinis)* is inactive animals at 0700 until 0100 hour.

Thick-spined porcupine (*Thecurus crassispinis)* spends a substantial amount of time on the ground, even though activities have been recorded as arboreal (Medway, 1983; Payne, 1985). These porcupine that were photographed occasionally are considered to be individual that possess home ranges either adjacent or primarily outside of the study site itself. This suggests that they may have little territorial stake within the study site and are referred as non-resident individuals (Franklin *et al.*, 1999).

Grand Perfect Conservation Sdn. Bhd collecting their data by each camera was positioned adjacent to game trails, pathways, natural salt licks and random places. Grand Perfect Conservation Sdn. Bhd data also recorded two peak times for each porcupine species. Thick-spined porcupine *(Thecurus crassispinis)* was recorded by camera trap between 1900 until 2100 hour and Common porcupine (*Hystrix brachyura*) recorded by camera traps at 2000 hour and during midnight time that is between 0037 until 0500 hour. The Common porcupine (*Hystrix brachyura*) is inactive between 0600 until 1900 hour. Meanwhile, the inactive time for Thick-spined porcupine *(Thecurus crassispinis)* is between 0600 until 1800 hour.

A comprehensive study will be required to understand the population dynamics habitat. Such information will provide input to the conservation strategies for these species in this region (Azlan *et al.*, 2003). The difference in the Hystricidae diversity may be due to various factors including variation in sampling methods, duration of study and the suitability of this mixed habitat to support a great diversity of Hystricidae. (Carbone *et al.*, 2000) suggested a minimum of 1000 trap-night were required to obtain comprehensive information on diversity and population estimation of certain cryptic mammalian species.

These porcupine that were photographed occasionally are considered to be individual that possess home ranges either adjacent or primarily outside of the study site itself. This suggests that they may have little territorial stake within the study site and are referred as non-resident individuals (Franklin *et al.*, 1999).

CHAPTER 6

CONCLUSION

In this study, a total of 14 photographs of the Thick-spined porcupine have been recorded. From that total, 12 photographs were recorded from the agricultural area and two from the disturbed forest area. Compared to the Grand Perfect data, they manage to record 23 photographs where 12 of the photographs recorded the Thick-spined porcupine and 11 photographs of the common porcupine. From current study, Thick-spined porcupine was found out active from 0200 to 0600 hours with 2 peak times that is during 0400 and 0600 hours. Meanwhile, Grand Perfect data found out Thick-spined porcupine start active from 0300 until 0500 hours and actives again from 1900 until 2100 hours with peak time on 1900 hour. Common porcupine showed two active times that is during 0000 until 1900 hours. The peak hour was on 1900 hour. Both results from current study and Grand Perfect indicate that porcupine was a nocturnal animal which usually start too active at early dusk time from 1800 until 0600 hours. For an efficient data, it's recommended that a longer time for observation should be included with more camera traps fixed. Besides that, the usage of baits and scented lures can also be an advantage to attract the porcupine presence in study area.

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APPENDICES

Appendix A: Thick-spined porcupine *(Thecurus crassispinis)* was recorded by camera trap during camera set up in an agricultural area.

Appendix B: Common porcupine (*Hystrix brachyura*) was recorded by camera digital during survey area in an agricultural area.

Appendix C: Thick-spined porcupine *(Thecurus crassispinis)* was recorded by camera trap in an agricultural area.

Appendix D: Thick-spined porcupine *(Thecurus crassispinis)* was recorded by camera trap detects in trail.

Appendix E: Number of photographs recorded for Common porcupine (*Hystrix brachyura*) from Grand Perfect Conservation Sdn Bhd.

Species	Number of Photographs	Photo Recorded
Hystrix brachyura	11	0037
		0151
		0253
		0254
		0325
		0421
		0434
		0530
		2007
		2012
		2027

Appendix F: Number of photographs recorded for Thick-spined porcupine (*Thecurus crassispinis*) from Grand Perfect Conservation Sdn Bhd.

Species	Number of Photographs	Photo Recorded
Thecurus crassispinis	12	0359
		0422
		0450
		0529
		0536
		1930
		1934
		1959
		2107
		2117
		2024
		2027

Appendix G: Number of photographs recorded for Thick-spined porcupine (*Thecurus crassispinis*).

Species	Number of Photographs	Photo Recorded
Thecurus crasspinis	14	0208
		0209
		0358
		0408
		0408
		0430
		0447
		0559
		0518
		0519
		0600
		0600
		0601
		0601

PUBLICATION OF THE PROJECT UNDERTAKING

This is to certify that I have no objection to publish the project entitled "Activity pattern of two porcupine species in an agricultural area and disturbed forest" by the supervisor in a joint authorship. However, it has to be evaluated by the Faculty of Agriculture and Food Sciences, Universiti Putra Malaysia Bintulu Campus and published in the form approved by the Faculty

Mensan Anak Belayong

Date: 23 March 2007