PROSIDING

SEMINAR KEBANGSAAN

SAINS, TEKNOLOGI & SAINS SOSIAL

27 ~ 28 MEI 2002
HOTEL VISTANA, KUANTAN, PAHANG

Anjuran :

Universiti Teknologi MARA
Cawangan Pahang

Dengan Kerjasama

Kerajaan
Negeri Pahang Darul Makmur

JILID 1

TRACKING BATS IN THE WILD

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ABSTRACT

Bats (Order: Chiroptera) are very mysterious mammals mostly because of their inconspicuous nocturnal behaviour, a major cause in the lack of detailed information of their ecological behaviour in the wild. Today, their very existence is at risk of extinction in many parts of the world, deforestation often being its major contributing factor. Extensive and exhausting studies have been carried out to locate these bats in order to observe and study their needs for survival. Among the more recent and effective methods used is radio telemetry. Although this method of tracking animals has been used before in Malaysia to study the home ranges of turtles, elephants, tigers, birds etc., it is relatively young in bat studies and modifications are needed. Recent research using radio telemetry methods have proved advantageous in tracking bats, particularly in dense Malaysian forests, as presented in this paper.

Keywords: *bats, radio telemetry, animal tracking*

INTRODUCTION

Bats belong to the order Chiroptera. In Peninsula Malaysia, Chiroptera consists of 87 species, the second largest order after Rodentia (Medway 1983[18]). Generally there are two sub-orders of bats; microchiroptera (insect-, and rarely frog- and fish-eating bats) and megachiroptera (fruit-, nectar-, pollen-eating bats) (Nowak 1991[21]). Bats are widely distributed throughout the world in all habitat types except for the Artic and Antarctica extremes (Findley 1993[4], Nowak 1991[21]). However, the Old World fruit bats (Family: Pteropodidae) has a distribution restricted to the tropics and sub-tropics (Marshall 1983[12]) and is among the most abundant of mammals in tropical forests (Fleming 1987[5]).

The short-nosed fruit bat, *Cynopterus brachyotis* (Muller), a megachiropteran, is commonly found throughout Southeast Asia and is the most common fruit bat in Peninsula Malaysia forests (Fletcher & Campbell 2001[7], Francis 1990[8], Lim 1966[15], Medway 1983[18], Payne *et al.* 1985[22], Phua & Corlett 1989[23], Tan *et al.* 1997[24], Zubaid 1993[27]). Studies conducted by Fletcher (2001)[6], Lim (1970)[16], Phua and Corlett (1989)[23], Funakoshi and Zubaid (1997)[11] and Tan *et al.* (1997[24], 1998[25]) have listed a wide variety of fruit species consumed by *C. brachyotis*. Many of the tree species found to be dispersed in these studies have been found to have multiple uses in traditional medicine, forest regeneration, woodwork and food source for human consumption, some of which also have high economic values in the local market amounting to millions of dollars annually (Burkill 1966a[2], 1966b[3], Francis 1994[9], Fujita & Tuttle 1991[10]). Fletcher (2001)[6] also concluded that *C. brachyotis* forages an area of up to 2.5 km radius on a nightly basis. In flight, bats defecate a relatively large amount of seeds. In dispersing fruit seeds over a wide area for an animal of its size, fruit bats are known as important seed dispersers, regenerating open forest areas and cleared lands (Fleming 1987[5], Fujita & Tuttle 1991[10], Phua &Corlett 1989[23]).

Studies by Funakoshi and Zubaid (1997[11]) have shown that *C. brachyotis* are known to roost in foliage individually or in small groups. A unique roosting behaviour of this species observed by Fletcher (2001)[6], Lim (1970)[16], Phua and Corlett (1989)[23] and Tan *et al.* (1997[24], 1998[25]) is their ability to build 'tents' out of palm leaves such as *Johannesteijmannia magnifica, Livistona rotundifolia, L. saribus* and *Corypha utan* Lam. palm species. The main veins are chewed so that the distal end of the leave falls forward creating a shelter. Foliage roosting bats such as the *C. brachyotis* are known to frequently change roosts as when the foliage dries and dies or are eventually unable to provide sufficient protection against weather and predators (Fletcher 2001[6], Gould 1978[12], Kunz 1982[14], Marshall, 1983[17]). Their inconspicuous nocturnal behaviour further contributes to the difficulty of obtaining and lack of detailed information of their ecological behaviour in the wild.

Extensive and exhausting studies have been carried out to locate these bats in the wild in order to observe and study their needs for survival. Attempting to study bats in forests, especially in dense tropical hill forests is not an easy task. Combing the forests in difficult and steep terrain, as well as, the dense forest undergrowth and canopy covering, typical characteristics of tropical rainforests, usually produces very little result. When existing roosts are finally located, most of which are usually by chance, observations have to be done very discreetly and at a safe distance as roosting bats are very aware of approaching animal and humans. Even the slightest disturbance would cause the roosting bats to take off and probably even abandon its roost (Fletcher 2001[6]). Bat call detectors have also been extensively used. However, such techniques limit the researcher to the sound of bat calls to confirm the presence and movements of certain species of bats. This technique will not enable a researcher to make long-term, direct visual observations of bats.

Among the more recent and more effective methods used by far is radio telemetry (Wilkinson & Bradbury 1988[26]). The first publication on radio telemetry was in 1959 by Le Munyan *et al.* and in 1962, Marshall *et al.* published an article on the use of an external transmitter for radio tracking porcupines (Mech 1983 cited by Ng 1999[20]). Radio tracking is ideally used for animals with cryptic behaviour and animals that are easily disturbed by the presence of the observer (Brander & Cochran 1984 cited by Ng 1999[20]). Although this method of tracking animals has been used before in Malaysia to study the home ranges of turtles, elephants, tigers, birds etc., it is relatively young in bat studies (Ng, pers. Comm.) and certain modifications are needed. Recent research using radio telemetry methods have proved advantageous in tracking bats, particularly in dense Malaysian forests (Fletcher 2001[6]).

MATERIALS AND METHODS

This study was carried out at three forest types in the Sungai Lalang Forest Reserve (undisturbed and disturbed forests and village areas) from December 1999-December 2000. Bats were captured with ten mist-nets (12 × 2.6 m, 30 mm mesh) set up randomly at the understorey levels along trails and pathways. Nets were opened from 2000 hours to 0800 hours and checked every half to two hours depending on the distance of nets placed from campsite. All captured bats were identified using field guides by Medway (1983[18]) and Payne *et al.* (1985[22]), weighed and measured and fitted with a number coded aluminium ring band clasped at the forearm bone. Nine recaptured individuals were radio-tagged. Recaptured individuals were chosen to ensure that the radio-tagged bat belong to a local population to simplify the search and future observations. All captured bats are released at the netting site after the identification process.

A radio telemetry system consists of two major parts; the transmitting system and the receiving system. The transmitting system consists of the transmitter, a power source and a transmitting antenna. All these parts are attached unto the animal with various mounting techniques (Mech 1983 cited by Ng 1999[20]). In this study, a medical skin adhesive (surgical cement) was used to attach the transmitting system unto the back of the bat without causing injury to the skin. A collar, consisting of a threaded flexible plastic tube, was also used to ensure that the transmitting system was in place and lasts for a longer period. It is important to ensure that the transmitter is attached to the back between the shoulder blades so as not to restrict the bat's usual movements (Fletcher 2001[6], Hodgkison unpublished[13], Wilkinson & Bradbury 1988[26]).

The single- and double-stage transmitters used (SIRTRACK Wildlife Tracking Equipment, New Zealand and HOLOHIL SYTEMS Ltd.) had frequences between 154.000-154.362 MHz (with a difference of 20kHz between each transmitters). The transmitters were designed to weigh between 0.9 g–2.3 g representing less than 5% of the total body weight. Studies have shown that the weight of the transmitters mounted on a bat should weigh less than 5% of the total body weight, so as to avoid impairing the flight and foraging behaviour of the bats (Aldridge & Brigham 1988[1], Hodgkison, unpublished[13]). Expected transmitter life, ranged from 15 days to 12 weeks depending on the transmitter model used. Pulsating frequency signals are then picked up using a hand-held antenna and receiver.

Two days after mounting the transmitters, the individually radio-tagged bats were tracked on foot with the antenna held in front, starting at the point where the bat was released. A full day is passed before tracking the bats so as to allow the bat to return to its original roost. When disclosing the direction of the roosting bat, the volume of the frequency received will increase and is comparably weaker when the antenna is pointing away from the direction of the roost. Upon locating the roost, further observation studies such as the roosting and feeding behaviour in natural conditions can be carried out without disturbing the roosting bats.

RESULTS AND DISCUSSION

Five *C. brachyotis* individuals were radio-tagged and tracked; three individuals (two females and one male) at the undisturbed forest site and two individuals (one female and one male) at the disturbed forest site as shown in Table 1.

Table 1. Summary of five radio-tagged *Cynopterus brachyotis* individuals at the Sungai Lalang Forest Reserve between December 1999-December 2000.

Roost Code	**Forest type**	**Foliage species**	**No. of individuals at roost**	**Distance of roost from netting site (point of release)**	**Roost fidelity**	**Height of roost from ground level**
01	Undisturbed	*J. magnifica*	1( ) & 1 pup	70 m	2 weeks	3 m
02	Disturbed	*E. metriocheilos /M. acuminata*	1( ) & 3(?)	2500 m	1 day	0.25–40 m
03	Disturbed	*M. gigantea/ E. metriocheilos*	1 ( )	25–150 m	1–3 days	15–25 m
04	Undisturbed	*J. magnifica*	1( ) & 1( )	10 m	2 weeks	5 m
05	Undisturbed	*J. magnifica*	1( ) & 3( )	15 m	> 2 weeks	3 m

Key:

Foliage species:
J. magnifica - *Johannesteijsmannia magnifica* (Palmae)
M. acuminata - *Musa acuminata* subsp. *malacensis* (Musaceae)
M. gigantea – *Macaranga gigantea* (Euphorbiaceae)
E. metriocheilos – *Etheingera metriocheilos* (Zingerberaceae)

From such radio-tracking efforts several important ecological information can be obtained, such as the roost selection of *C. brachyotis*. In this study, for example, using radio telemetry, *C. brachyotis* roosts located were generally close to streams or rivers in cool and shady ravines (< 100 m). The roost chosen were partially surrounded by other foliage but has a clear opening or entrance at the underneath of the roost approximately 0.25-40 m from the ground level. For big-leafed foliage i.e. *Johannesteijmannia magnifica*, the main vein was found to be chewed on causing the collapse of the distal part of the leave forming a 'tent' as described earlier. Distances of the roost from their foraging area (netting site or point of release) ranged from 10 m to 2500 m, being significantly further at the disturbed forest study site.

Three types of roosting behaviour can be classified from this study:

(i) Solitary occupied roost – roost is occupied by a solitary individual, usually by a juvenile male (i.e. roost 03).

(ii) Paired occupied roost – roost is occupied by a pair of individuals. In this study a pair of mother and pup as well as a pair of adult individuals were found roosting under foliage (i.e. roosts 01 and 04).

(iii) Harem occupied roost – roost is occupied by a group of up to three females and protected by a male leader (i.e. roosts 02 and 05).

Roost fidelity depends on the roost material. In this study, the roosts were found to be in use for up to two weeks whereby after this point, the foliage is no longer fit for protection against bad weather and were too exposed to predators. Previous studies by Gould (1978[12]) however, have recorded roost fidelity for up to two years.

More in depth studies can be carried out once a roost is successfully located such as home range, diet information, reproduction cycle, mating system, social organisation and harem behaviour. Most importantly, such studies can be carried out effectively without causing stress or injury to the bat and minimising disturbances, which could cause unnatural behaviour or eviction of roost. Radio telemetry by far is not only effective in locating bats in dense forests but also very reliable if mounted on the bat properly. It saves time and energy rather than to blindly comb the forest area for roosts and risk accidentally causing eviction of roosts. Radio transmitters can be easily obtained from wildlife radio tracking companies that offer custom made radio transmitters to fit a researcher's need such as the weight, shape and battery life of the transmitters intended to use for specific animals.

The downside of radio telemetry would be the cost involved in purchasing a good, reliable and light radio transmitter. Each radio transmitter can cost anywhere between RM 200 – RM 500 (equivalent to US $ 50 – US $ 150). A mounted or attached radio transmitter on a bat cannot be guaranteed to remain attached throughout the battery life span. There is a substantial possibility that due to the frequent grooming and movement of the radio-tagged bats or the moulting of fur, the radio transmitter could be detached even before the battery life span ends. The worst possibility is that the radio transmitter is detached during flight, which would hamper recovery efforts. A researcher should assume that for every five individual bats intended for observation, initially at least eight to ten bats should be radio-tagged. Because of the very small and fragile size of radio transmitters required for bat radio telemetry, at press time, the available battery life span is up to 12 weeks. However, this limitation should not be considered as a major setback because the radio transmitter would not usually stay long enough attached on the bats' back for the battery to wear out. Increasing the battery life span would usually mean increasing the weight of the transmitter. This is however not a simple feat and would usually require higher technology and costs.

Detecting the radio signals in a dense tropical rain forest takes patience and experience. There are many obstacles (i.e. big trees and rock boulders) in the forest that can deflect or block the frequency signals and thus give very misleading directions. The thicker and more dense the forest and the higher percentage of canopy covering, the more difficult it gets as the signals would be quite a task to locate. One would be better advised to begin their search at the point of release (the exact point in which the bat was released after being tagged) or to begin searching for a signal from a clearing, and preferably at a higher elevation to avoid such obstacles.

There is much room for improvement of the currently available radio telemetry system especially in terms of its application in tropical forests. However, even with the downside mentioned, it is still a comparatively effective and reliable method of tracking bats in the wild. The possibilities or further research on radio-tagged bat individuals are endless. So much information can be extracted when observing and understanding bats in the wild.

Today, the very existence of bats is at risk of extinction in many parts of the world, deforestation often being its major contributing factor (Mickleburgh *et al.* 1992[19]). Logging activities encroaching hill forests in Peninsula Malaysia is increasing and possibly threatening unrecorded bat populations in these hilly areas due to accessibility difficulties. Habitat destruction could severely disrupt sensitive existing bat populations and the ecosystem as a whole. Understanding their natural roosting behaviour will enable us to understand their habitat preference as well as requirements. By conserving a healthy population of bats, we will in turn make the effort to maintain a balanced ecosystem, one of which is dynamic and sustainable.

ACKNOWLEDGEMENTS

This study was fully funded by Forest Research Institute Malaysia (FRIM) and Universiti Kebangsaan Malaysia. We would also like to thank the Forestry Department of Selangor for permission to conduct research in the Sungai Lalang Forest Reserve.

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