

## Plantain Squirrel *Callosciurus notatus* in a Plantation Habitat

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### ABSTRAK

Corak aktiviti harian atau aktogram *Callosciurus notatus* dalam ladang kelapa sawit dan koko di bawah kelapa ditentukan dengan menggunakan radiotelemetri. Hasil menunjukkan *C. notatus* mempamerkan corak aktiviti harian dari jam 0630 hingga 1730 dengan beberapa puncak aktiviti. Dua puncak utama dikenal pasti iaitu pada awal pagi (jam 0730) dan sebelum tengah hari (jam 1130). Ini diikuti dengan fasa rehat yang relatif pada waktu tengah hari (1430 hingga 1630). Puncak yang lebih kecil dicerap pada waktu petang (jam 1730). Kepelbagaian mungkin wujud kerana satu individu menunjukkan empat puncak yang diselang seli dengan beberapa fasa rehat yang singkat. Puncak aktiviti yang kerap mungkin menggambarkan strategi penggelintaran untuk memenuhi keperluan makanan yang tertentu. Kajian isi perut menunjukkan serangga merupakan makanan utama pada awal pagi tetapi menunjukkan makanan yang pelbagai meliputi serangga dan bahan-bahan tumbuhan selepasnya.

### ABSTRACT

The daily activity pattern or actogram of four *Callosciurus notatus* in a mixed plantation crop of oil palm and cacao under coconut in Peninsular Malaysia was determined by using radiotelemetry. Results suggest that *C. notatus* exhibits a daily activity pattern from 0630 to 1730 with several peaks. Two major peaks are identified, one at daybreak (about 0730) and another before midday (about 1130). The two peaks were followed by a relative cessation of activity in the afternoon (1430 - 1630). A third smaller peak was recorded in the evening (1730). Individual variation exists as one individual showed four small peaks interspersed by short periods of rest. The multiple peaks may reflect the foraging strategy in meeting specific dietary needs. A survey of stomach contents suggests that insects constitute the preferred item in the first couple of hours and a mixed diet of insects and plant matter later during the day.

### INTRODUCTION

Rats (*Rattus spp.*) and the plantain squirrel (*Callosciurus notatus*) are important vertebrate pests of many plantation crops in Malaysia (for pests of cacao, see Kamarudin and Lee 1981; Hafidzi 1992). To gain a better understanding of the foraging behaviour of plantain squirrels, the present study investigated their activity pattern. Such a study may contribute to more effective control programmes.

Several techniques have been used in studying the activity pattern of small mammals. Among these are unaided sighting (Shorten

1962), time-scheduled trapping (Kamarudin 1982) and radio telemetry (Tonkin 1983). While unaided sighting causes the least disturbance, it may not be suitable for less conspicuous animals like especially in a habitat characterized by dense foliage. Live-trapping techniques are suitable for studying population dynamics but will reveal little of the ranging behaviour as animals are immobilized at points of capture. Radiotelemetry was employed in this study as one clear advantage of this technique is that it allows continuous monitoring of animals with minimal disruption of their activities in their natural environment.

## MATERIALS AND METHODS

### *Radio-tracking Equipment*

Basic radio-tracking equipment was used; consisting of radio collars, a portable radio receiver (Model M57, Mariner Radio, UK) and a three-element Yagi antenna. Each radio-collar was made up of a SS-1 transmitter (Biotrack UK Ltd.), a 1.5-V battery and an external antenna mounted on a cable tie collar with self-locking ratchet. The transmitter and battery were both coated in epoxy for protection against gnawing and water-proofing. The whole package weighed approximately 10 g. All animals fitted with radios weighed more than 200 g so that the transmitter-animal weight percentage did not exceed 5%. A greater weight probably affects behaviour and movement of animals (Wolton and Trowbridge 1985; Pouliquen *et al.* 1990)

### *Study Site and Radio-tracking Techniques*

The study area was a mixed plantation of mature oil palm and cacao planted under coconut. The squirrels were trapped using ordinary trap cages set in a row on every fourth cacao tree approximately 10 m apart. Trapping was carried out at the edge of the cacao near the cacao-oil palm boundaries. A previous trapping exercise showed most captures were recorded at intercrop boundaries. Squirrels were identified individually by radio transmitters operated at unique frequencies. The sex, weight, breeding condition and capture locations were recorded for each squirrel (Table 1). Radio collars were attached while the animals were lightly anaesthetized for approximately 60 seconds with either diethyl ether or chloroform. The radio-tagged squirrels were kept in a cage overnight, allowed to recover full locomotor activity, and released at their respective site of capture. This measure was necessary to ensure that the radio collars were fully secured and did not physically harm the animal.

A total of six squirrels (three males and three females) were radio-tracked for up to seven days. The tracking period for each animal is shown in Table 1. Location was determined every hour from 0530 to 1730 h either throughout or for part of the period. Tracking was not done on rainy days when animals seemed less active. Radio signals were detectable from at least 100 m away and were pin-pointed by walking along the path of the strongest signal. Apparent animal location was determined to be accurate within 1 – 2 metres as confirmed by actual sighting. The presence of coconut and oil palms grown at 15-m intervals across the study area conveniently served as grid markers to mark animal locations on the map. When radio location was uncertain, triangulation (Kenward 1987) was employed; this involves taking bearings from at least three different points. The point at which the bearings intersect was designated as the animal location. The distance between successive radio locations was taken to represent the level of activity during a 1-hour period. If the animal did not move from its previous location over a period of time, it was assumed for practical reasons that it had remained inactive. To further qualify this assumption, animal location was checked every 10 - 15 minutes. The mean distance moved was used to plot the daily activity pattern for each animal. Palomares and Delibes (1991) showed that distance travelled gave similar results to net activity time in estimating daily activity patterns in the Egyptian mongoose (*Herpestes ichneumon*).

### *Survey of Stomach Contents*

A 1-day shooting exercise was organized in the study area to determine the feeding habits of *C. notatus* based on the stomach contents. Shooting started at daybreak and ended before noon to cover the time of the day when animals were observed to be most active. The exact time of

TABLE 1  
Summary of breeding condition, weight and tracking dates of four *Callosciurus notatus*

	Breeding condition	Wt (S)	Tracking dates
Male A	Breeding	246	June 5 -8, 10 - 12, 1990
Male B	Breeding	232	Jul 6 - 7, 9, 12 - 16, 1990
Female A	Non-breeding	201	July 2 - 5, 7 - 8, 1990
Female B	Breeding	226	July 20 - 28, 1990

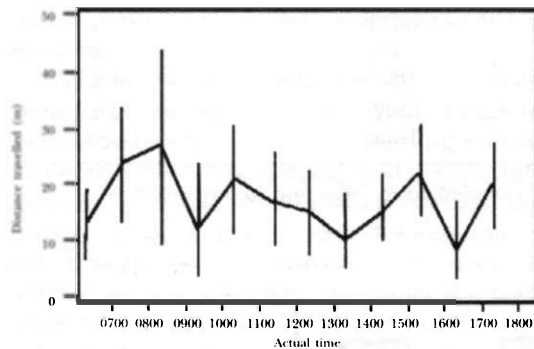
the shooting of each individual was recorded. The gut was opened and contents broadly identified as oil palm fruit, cacao mucilage, unidentified plant matter and insects. The proportion of each item was subjectively quantified.

**RESULTS**

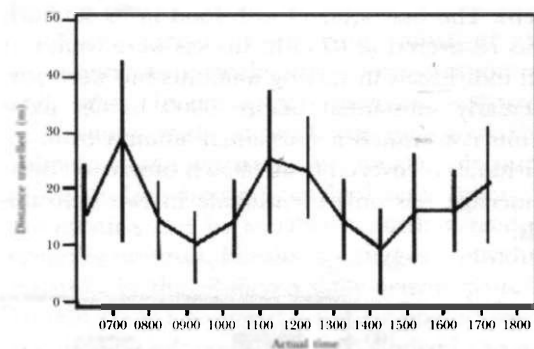
Of the six squirrels, sufficient data for analysis was collected from only four. Signals were not picked up from the other two and their transmitters were assumed to be lost. Daily activity profiles were plotted for each squirrel (*Fig. 1*).

In terms of habitat utilization, Male A was tracked in both cacao and oil palm, Female A in cacao only and Male B and Female B in oil palm only. The small sample size precludes comparison of activity patterns in the two habitats. Individual daily activity patterns (*Fig. 1a-d*) are quite consistent. Differences in the mean distance travelled during the tracking period were not significant between Male A and B ( $Z=1.345$ ,  $P > 0.1$ ) and between Female A and B ( $z=0.275$ ,  $P > 0.1$ ). All squirrels started movement at first

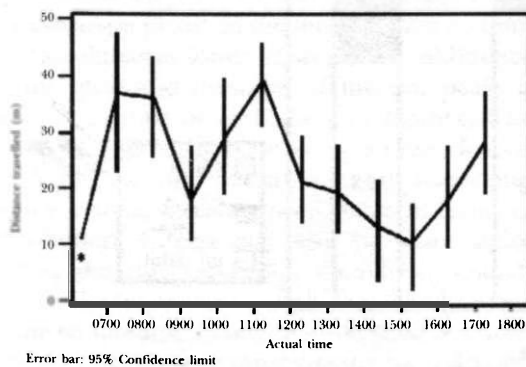
light i.e. around 0600 h and maintained a high level of activity until 0930 h. Since tracking started 30 min earlier i.e. at 0530 h, it is assumed that squirrels stayed at their nest site within that period. In 12 out of 14 instances where tracking was carried out on consecutive days, squirrels were located at their last position (1730 h the previous day), suggesting that they remained inactive throughout the night. Two morning peaks were identified, the first at 0730 h and the second from 1030 - 1130 h. The first peak was higher than the second except for Male A, where the level of activity was similar at both peaks. The afternoon period (1230 - 1630 h) was marked by a period of *ærestæ* except for Female A, which showed a third peak about 1530 h. All squirrels showed increased activity from 1730 h to just before nightfall. In terms of the daily activity profile, they generally showed a progressively decreasing level of peak activity, except for Female A where the four peaks were similar. Female A, the smallest (201 g) was



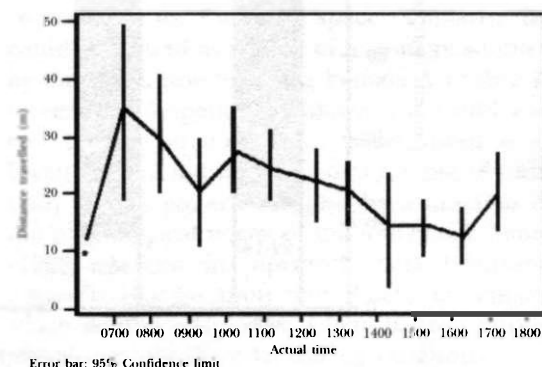
*Fig. 1a. Daily activity pattern of female A (radio-tracked in cacao only)*



*Fig. 1b. Daily activity pattern of female B (radio-tracked in oil palm only)*



*Fig. 1c. Daily activity pattern of male A (radio-tracked in cacao and oil palm)*



*Fig. 1d. Daily activity pattern of male B (radio-tracked in oil palm only)*

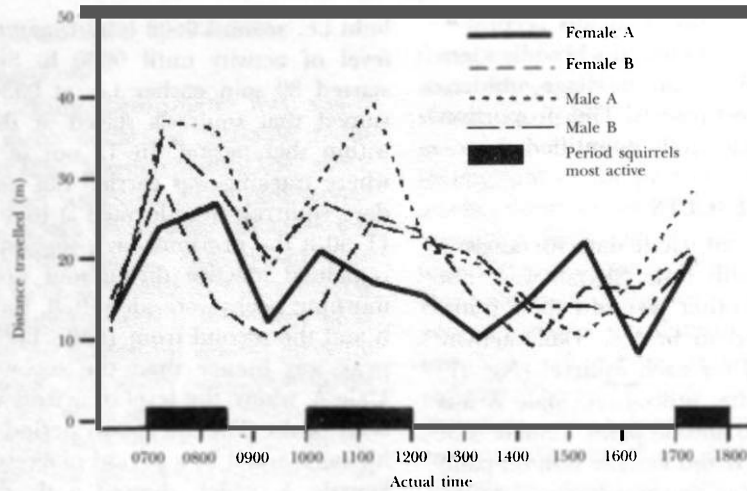


Fig. 2. Comparison of the duration of the active phases of the four radio-tracked *Callosciurus notatus*

therefore active for a relatively longer period. A comparison of the duration of the active phases is shown in Fig. 2.

A total of 18 shot squirrels were recovered for feeding analysis (Fig. 3). The first two squirrels, recovered at 0700 h, both had empty stomachs. The first squirrel with food in its stomach was recovered at 0735 h. Insects were found in all individuals in varying amounts but were particularly substantial before 0900 h. Oil palm fruits constituted a substantial amount from individuals recovered from 0955 h onwards. Cacao mucilage was only identifiable in two individuals.

TABLE 2  
Number of squirrels shot every hour from 0700 - 1200

Time (1-hour period)	No. of squirrels analysed
0800	8
0900	4
1000	3
1200*	3
Total	18

\* pooled from 1000 due to few squirrels

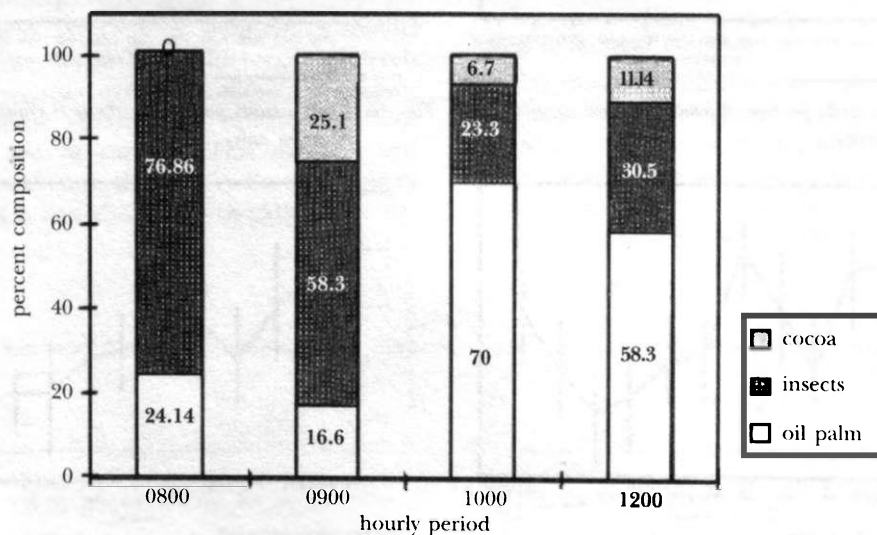


Fig. 3. The percentage composition of oil palm, insects and cacao from stomach contents of *Callosciurus notatus* shot in the study area

Due to the small sample size, squirrels collected within a one hour period beginning from 0700 were grouped together. The respective food items from each stomach were pooled and the mean proportion estimated for each group. The percentage composition of each food item for every 1-hour period is shown in *Fig. 3*.

### DISCUSSION

The present study suggests that *C. notatus* exhibits a daily activity pattern with at least three distinct peaks; two in the morning and one in the late afternoon. However there is individual variation, as exemplified by one individual, which had four peaks. Three or more activity peaks per day constitute a variation of the typical biphasic or bimodal pattern that has been observed in many animals (Aschoff 1966). Tonkin (1983) suggested that this type of behaviour is either a manifestation of the physiological need for rest or that a break following the morning feeding period is needed when animals have eaten their fill. Whereas this might be reflected in the present study, the existence of double morning peaks punctuated by a short break and variability among individuals raised some interesting questions.

The double peaks may also be associated with a particular resource or foraging strategy to optimize food searching effort, hunting success and energy return. The difference in the intensity and duration of the active phases may reflect the nutrient value of the associated food source. This is supported by evidence from stomach contents of squirrels shot in the study area, which showed that insects formed the primary food item during the early morning hours (0730 - 0930 h). Oil palm was only identified in substantial amounts from individuals recovered from about 1000 h onwards. This suggests that the two active phases in the morning may account for two different kinds of food. The difference in the level and duration of the two peaks is again indicative of such food preference. The first peak may account for an insect diet. Insects are highly nutritive but are relatively scarce and highly mobile, thus less predictable in terms of distribution. Insects may also be more active during the early morning. Therefore, animals have to intensify their search to take advantage of the temporarily abundant insect food resource. The short rest before resuming the second active

phase may indicate the point whereby foraging for insects is no longer economic in terms of energetics. Energetic cost is an important factor in the foraging decisions in animals (Krebs *et al.* 1983). Oil palm fruits and cacao pods, on the other hand, are more evenly distributed, highly predictable, conspicuous and immobile, and thus require less effort to secure. The second active phase could be associated with a primarily oil palm diet. A longer phase may suggest a greater volume consumed to meet dietary and energetics requirements. In general, foraging time and intensity are influenced by availability, nutrient value, predictability and handling time of food source (Lewis 1980).

There are other possible explanations for the double morning peak. The first of the two peaks may account for the daily re-establishment of exclusive feeding ranges. *C. notatus* has been suggested to exhibit some form of territorial behaviour (Duckett 1982). Such behaviour was also observed in this study. *C. notatus* is most conspicuous at daybreak, when it can be seen in hot pursuit of other individuals apparently driving away intruders from a dray or a favourite feeding site.

From direct observation, most of the afternoon was normally spent dozing, grooming and other less energy expensive activities. Continuous radio surveillance indicated that animals sometimes stayed in the same location for up to four hours. The final active phase in the evening can be ascribed to a final feeding round or nest run. Results also suggest individual variation in the observed daily activity pattern. Tonkin (1983) observed a similar phenomenon among a population of the red squirrel (*Sciurus niger*). He suggested that newly independent young adults tend to be active during periods when fewer adults were active to avoid direct competition for food and space. Similarly, this could be viewed as a form of a strategy adopted by the small, non-breeding Female A (Table 1) to reduce competition. However, it could also be random variation since observations were based on one individual from a sample of four. Daily activity pattern can also be a function of the physiological needs of the individual. Maier (1992) showed in pipistrelle bats *Pipistrellus pipistrellus* that variation existed between females which exhibit unimodal activity pattern during pregnancy and bimodal during lactation.

**CONCLUSION**

The results of this study show that *C. notatus* is more active during early morning and just before noon. Therefore, shooting exercises to control squirrel infestation in plantations, particularly oil palm, should be carried out during those two periods i.e. when squirrels are more active and thus more conspicuous.

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