



Philippine Panay Island Bushy-tailed
Cloud Rat (*Crateromys heaneyi*): A Preliminary Behavioural
Study of Captive Cloud Rats

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Abstract

Panay Island bushy-tailed cloud rats *Crateromys heaneyi* are nocturnal, arboreal, probably herbivorous Philippine rodents. Apart from limited morphological data, there is very little reported information about them. The aim of this study was to gather preliminary data with a view to developing an ethogram for these taxa, based on a captive population housed at ZSL London Zoo. Cloud rats are probably not social rodents and are likely to live in pairs or solitarily in the wild when not raising offspring. They are intolerant of intruders in their territory and will fight to the death when stressed. They spend the majority of their time resting, climbing and feeding. Cloud rats are fastidious in their habits; defecating and urinating away from their nest boxes and food at a particular constant site and cleaning themselves methodically after every meal. There are significant gaps in our knowledge of these mammals, which are listed as endangered on the IUCN Red List.

Keywords: Cloud rats, Ethogram, Behavioural profile, Endangered, Captive population

1. Introduction

Cloud rats, or cloud runners as they are also called, are medium sized, soft-furred, nocturnal, arboreal rodents, found exclusively in the Philippine Islands at 10° north latitude and 125°45' east longitude. The Panay Island bushy-tailed cloud rat (*Crateromys heaneyi*) is the most recent to be identified and London Zoo has the only breeding colony outside of the Philippines. Classified by the IUCN as endangered, the Zoo's protective attitude prevented any invasive or disturbing means of observing behaviour. Almost nothing is known of the genus' behaviour or ecology and the study was intended to function as a preliminary observation on which more intensive studies could be based. Behavioural studies have not been undertaken and at London Zoo the cloud rats are kept according to the principles that govern the captivity of other nocturnal rats. There has been no proper survey of population size or range for any species of cloud rat and the threat of extinction has only been estimated (Heaney et al., 1998, 2005; Musser et al., 1981, 1985; Gonzales and Kennedy, 1996; Nowak and Paradiso, 1983).

All assumptions of behaviour are based on anecdotal evidence gathered by Musser et al. (1985) from Philippine Island hunters. Detailed descriptions of their teeth by Gonzales and Kennedy (1996) indicate herbivory. The cloud rats scurry around the tops of oak and pine trees at altitudes of up to 400m and are seen as glimpses amongst the clouds (Heaney et al, 1998; Oliver et al., 2001). They have yet to have more than one offspring per pregnancy in captivity which is unusual amongst rodents (London Zoo, 2005).

Humans threaten wild cloud rats as they hunt them for meat and pelts, furthermore deforestation has seen a 20% reduction in forest cover between 1950 and 1980. As there is no accurate estimate of population sizes, the probable effect of such habitat loss can only be estimated (Heaney et al., 2005; IUCN, 2006; Heideman et al., 1987; Kummer, 1991).

This behavioural study aimed to build upon existing knowledge to improve captive care. Small mammals are notoriously sensitive to stress and with almost no data about their lives in the wild, it is very difficult to assess the requirements of cloud rats in captivity.

2. Materials and Methods

All methods were designed to minimise stress and disruption to the cloud rats.

2.1 Captive Habitat Conditions and Group Composition

London Zoo houses ten cloud rats in four enclosures (Table 1). The largest enclosure (Enclosure 1) housed a family group; the remaining three enclosures were smaller and housed a breeding pair (Enclosure 2) and single individuals (Enclosures 3 and 4). Each had a layer of woodchips on the base with a number of thick branches acting as climbing poles; this was the only enrichment. The enclosures' building was renovated and their move to new accommodation ended the data collection.

2.2 Observational Data Collection Methods

In October 2005, 60 hours and 8 minutes of observation were undertaken based on the protocol used by London Zoo for all its ethograms. Behavioural categories were added following a brief pilot survey lasting 3 days to include cloud rat specific activities. Instantaneous and one-zero samplings at two-minute intervals were combined to record 20-minute periods of the behaviour of a single focal animal. Data could not be collected by the use of cameras, infra red or changes in photoperiod as the Zoo did not permit any invasive methods. The cloud rats' light sensitivity only allowed observation of activity from 10.45am to 4pm. Table 2 outlines the key behaviours and the definitions were subsequently used as variables for data collection. The duration of time when no cloud rats were visible was recorded as negative data.

Diet sheets were provided by London Zoo and food intake details were recorded over two weeks of London Zoo's normal husbandry routine. Likely calorie intake was estimated from food provided by the keepers and the remains measured the next day. Biographical details (Table 3) were estimated from London Zoo's brief biographical record sheets.

3. Results

Preliminary observations based on the above protocol suggest that the captive cloud rat population at London Zoo spend most of their visible waking time climbing, feeding and resting (Figures 1 - 4). Other activities such as grooming and playing account for significantly less total activity time (Table 4). Their waking time is predominately spent in repose and the only possible activities in the nest boxes are self grooming, allogrooming and resting. This suggests that the cloud rats are either a) generally inactive or b) inactive in captivity. Data for cloud rats in enclosures 2, 3 and 4 were limited and focus here is towards the family group in enclosure 1.

The data suggest that there was little correlation between age and time spent in company outside the nest box with all of the cloud rats spending at least 200 minutes outside of the nest box with another cloud rat. Proximity was usually 0.5-0.75m apart (Table 4). How significant the results are for behaviour is not known as the cloud rats had little choice in proximity due to the enclosure size (Figure 5).

Biographical data is summarised in Table 3. The second youngest specimen at London Zoo, aged some 2 months when the study started, appeared to have a light coloured soft natal coat which was shed at age approximately 10 weeks to be replaced by a darker adult coat. The diet data was analysed and showed distinct food preferences on the part of the cloud rats: Fruit was always favoured while seeds, nuts, rodent pellets and bread were most commonly rejected (Figure 6). The average calorie intake was calculated to be 176.985 calories per day per cloud rat (Calorie King, 2006; Zoo Plus, 2006).

4. Discussion

London Zoo's captive breeding program is part of an international effort to prevent the extinction of threatened species. As far as possible, the effects of enforced time limits were curbed and the resulting data were tested and shown to be statistically significant under Dytham's rule (1999); even rough estimates of likely gestation time and age of sexual maturation are an important advance.

4.1 Negative Data

There were more negative data when no observations of cloud rat activity were recorded than positive data when there were observations (4680 minutes compared to 1600); this was probably because the cloud rats spent most of their time in nest boxes. The family group was the most active and had the largest enclosure so it seems more likely that the cloud rats were idle because of lack of stimulation. The cloud rats were sensitive to light and would not emerge in either artificial or natural light conditions in any of the enclosures.

4.2 Feeding and Play Behaviour

The cloud rats showed a preference for fruit and with the high metabolic demand of a small homeothermic body it is likely that they preferentially feed on the high-energy sugary food. The calorie intake was higher than would normally be predicted (Barnett, 1963), but there was a nursing female who would have an elevated calorie intake. Spatial constrictions did not permit whole group feeding so no conclusions about sociality and food can be made and this is a distinct limit to the research (Montgomery and Gurnell, 1985). As the family only spent 1% of their time allogrooming, close social bonds cemented by altruistic behaviour are unlikely (Figure 3), but the juveniles did follow the adults across branches in play behaviour that could teach agility and territorial boundaries.

4.3 Escape and Reintroduction

In the final week of the study, the juvenile male CRJ1 showed increasingly distinctive behaviour typified by standing on the nest box on the uppermost ledge and clawing / chewing at the ceiling. This formed a hole through which CRJ1, CRJ2 and CRJ3 escaped. Following a temporary separation of approximately 72 hours, they were reintroduced to their family group in the new enclosure. This presented antagonistic behaviour within the group resulting in some physical injury to the two offspring males (CRJ1 and CRJ3) one of which was killed. It may be that cloud rats are territorial and once the males have left the natal group they are not accepted back, which is true in rats (Barnett, 1963). Why the cloud rats had not previously reacted in this way is not known, but juvenile mice produce urine that has a distinctive smell which reduces the aggressiveness shown by elders towards them (Poole, 1985). The cloud rats were often sociable in pairs and were observed feeding or playing in groups of two or three. There was some correlation between age, sex and sociability.

5. Conclusion

This preliminary study has presented novel findings regarding the captive behaviour of the world's only breeding population of cloud rats. Observations made over a longer time period are required. The most important future research would be a simple continuation of the ethogram over a greater range of daily times and also for a longer length of observation, ideally including nest box cameras and infra red. A continuation of the present study was not possible due to concerns expressed by London Zoo regarding within group aggression and stress induced by on-site observers; infra-red cameras and nest box cameras would help alleviate these stresses. Dietary changes, increasing male aggression with age, offspring dispersal, the effect on behaviour of changes in temperature, and daylight length and intensity, would be interesting subjects for further study. Critically, further field studies of *C. heaneyi* and other cloud rats are required to understand their behaviour in the wild. This is particularly important in light of the significant extinction risk facing these enigmatic Philippine rodents.

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Table 1. Captive habitat conditions and group composition

Enclosure	Description of Enclosure	Captive Population
1	2 x 2 x 2m Concrete enclosure with one glass wall exposed to the public Reverse lighting conditions 2 nest boxes	CRA1: Adult male (2 years of age) CRA2: Adult female (2 years of age) CRJ1: Juvenile male (8 months) CRJ2: Juvenile female (5 months) CRJ3: Juvenile male (2 months) CRJ4: Juvenile female (< 5 days old)
2	1 x 1 x 1m Concrete enclosure with one glass wall exposed to the public Reverse lighting conditions 1 nest box	CRA3: Adult male (age unknown) CRA4: Adult female (age unknown)
3	1m depth x 1m width x 2m height Wire cage enclosure, closed to the public Normal lighting conditions 1 nest box	CRA5: Adult male (age unknown)
4	1m depth x 1m width x 2m height Wire cage enclosure, closed to the public Normal lighting conditions 1 nest box	CRA6: Adult female (age unknown)

Table 2. Definitions of the behaviours

Activity	Definition
Feed	Inactive: feeding at rest or if combined with foraging feeding during movement.
Forage	Active: searching for food, not eating it
Rest	Inactive: sitting or lying down without other activity.
Play	Active: usually walk / climb behaviour with another cloud rat as in “follow my leader” game or wrestling.
Walk / climb	Active: movement that was not part of a game with another cloud rat or in search of food.
Groom self	Active: grooming self always done in sitting position and involved a small amount of gymnastic movement.
Groom other	Active: grooming another cloud rat, sometimes moving around or over the other individual to do so. Also known as allogrooming.
Neighbour ID	The identity of the nearest neighbour (if any) to the focal animal.
Distance to nearest neighbour	The estimated distance between the focal animal and its nearest (if any) neighbour.
Hide	Any period when the cloud rat was not visible during the observation time, not definitely at rest but due to the arrangement of the enclosure, usually resting, feeding or grooming were the only activities possible.
Other	Any behaviour that is not covered by the above. Described further in notes; included mating behaviour, creating a hole in the ceiling and other social activities.

Table 3. Life history data for *C. heaneyi* and *P. pallidus*

	<i>C. heaneyi</i>	<i>P. pallidus</i>
Average female sexual maturity	10 months	8 months
Average male sexual maturity	10 months	12-18 months
Gestation time parameters	1-2 months	69-95 days
Birth interval	2-5 months	8 months
Number offspring per pregnancy	1	1
Weight of young at birth	124g	100-150g
Estimated weaning age	2 months	5 months
Oestrus cycle	Unknown	10-15 days
Lifespan	Unknown	13-15 years in captivity

C. heaneyi values calculated from data given by London Zookeepers (2006).

P. pallidus values from Minnesota Zoo website (2006).

Table 4. Total behaviour times for individuals and total behaviour times overall (positive and negative data)
(time in minutes)

ID	Feed	Forage	Rest	Play	Climb	Groom				Distance	Positive	Negative	
						Groom self	Other	Hide	Other		Data	Data	
CRA1	78	96	116	12	174	54	2	170	0	0.707	340	468	
CRA2	154	86	32	42	174	44	2	66	0	0.455	360	468	
CRA3	10	10	4	2	28	0	0	8	60	B	2.75	80	380
CRA4	12	10	58	2	26	0	0	2	10	A	2.75	80	380
CRA5	0	0	40	0	0	0	N/A	0	0	N/A	N/A	40	310
CRA6	0	0	0	0	0	0	N/A	0	0	N/A	N/A	0	310
CRJ1	182	74	202	46	94	50	8	130	0	0.647	480	468	
CRJ2	104	88	50	42	230	52	2	92	4	0.5	340	468	
CRJ3	86	58	60	50	116	16	6	54	0	0.278	240	468	
CRJ4	0	0	0	0	0	0	0	0	0	0	0	468	
TOTAL	532	422	562	209	842	216	20	522	74		1600	4188	

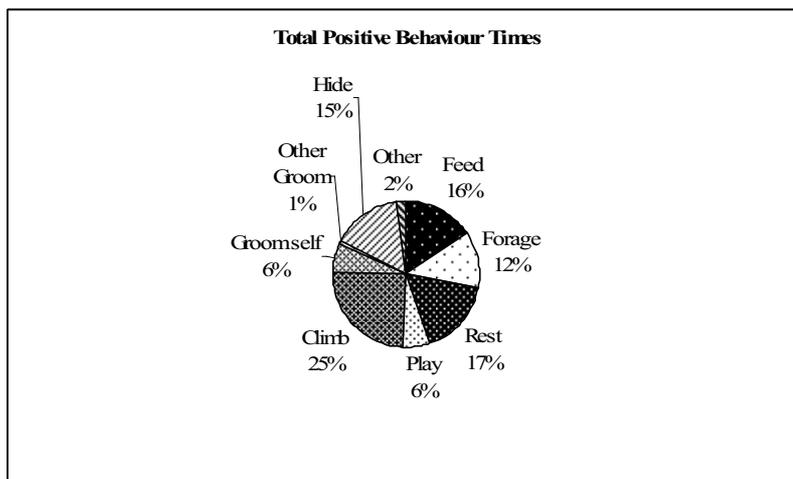


Figure 1. Pie chart showing % behaviour times for all study individuals.

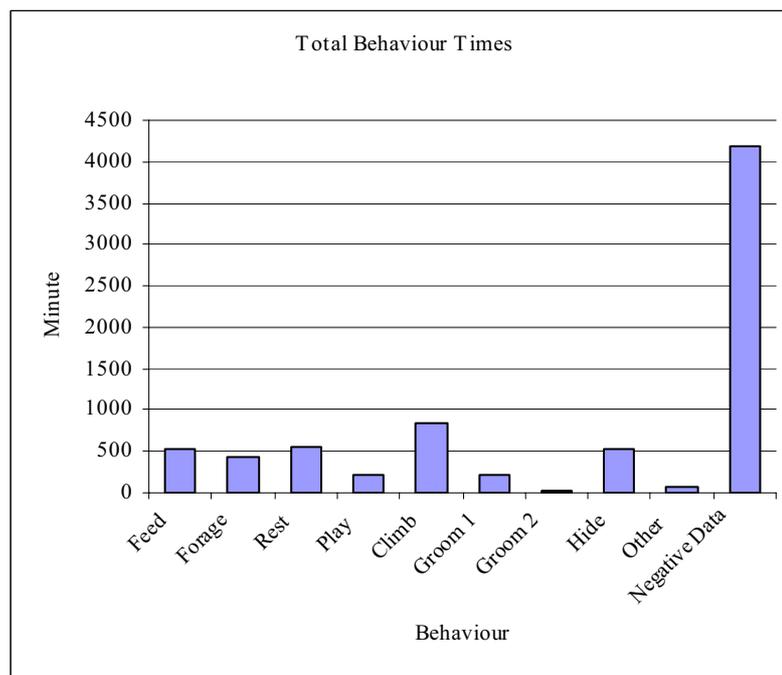


Figure 2. Time spent by individuals in different types of behaviour.

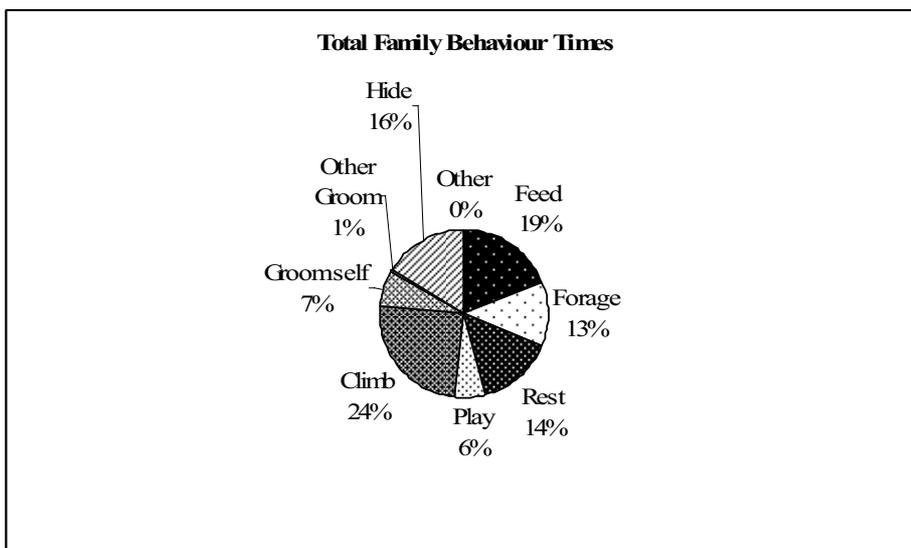


Figure 3. Pie chart showing % behaviour times for the family group.

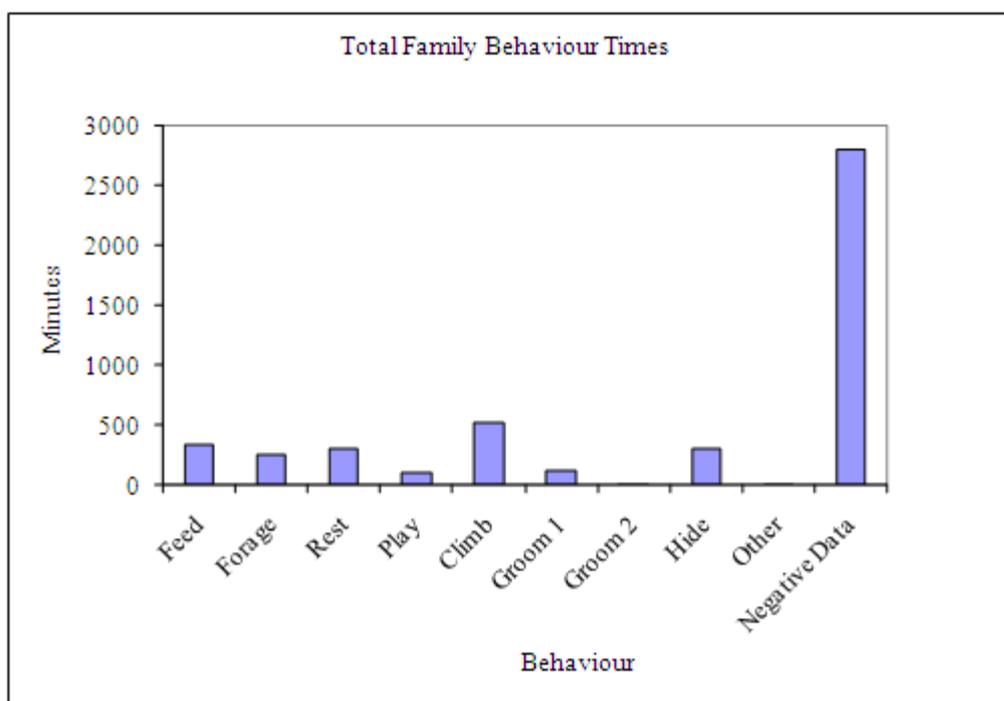


Figure 4. Time spent by the family group in different types of behaviour.

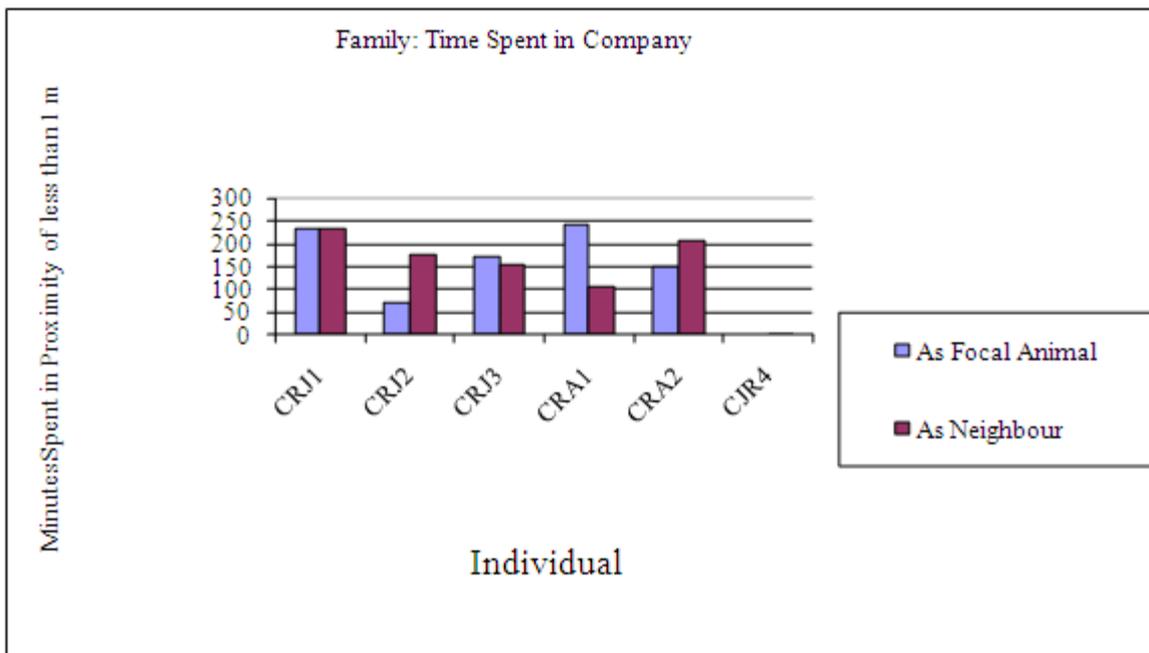


Figure 5. Time spent by the focal animal within <1m to its nearest neighbour.

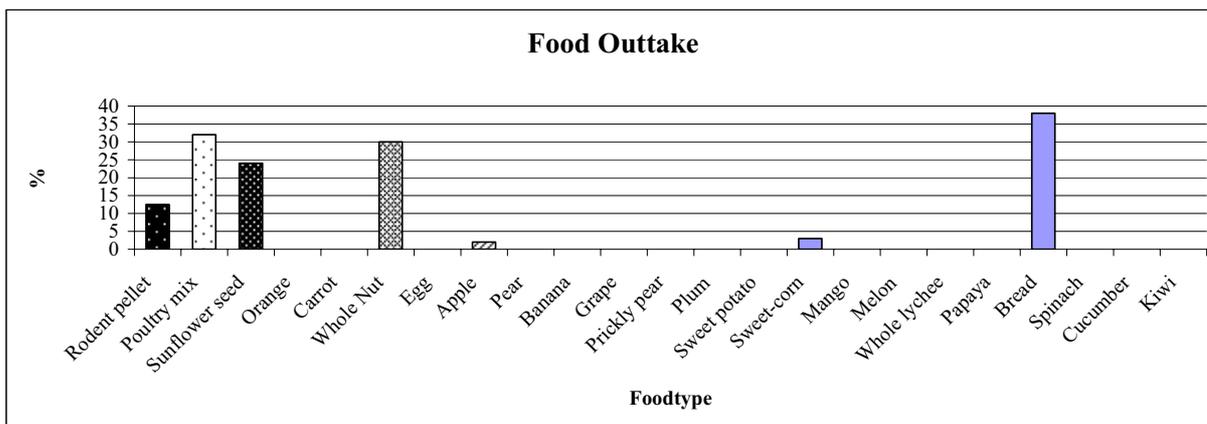


Figure 6. Percentage of uneaten food removed from enclosures. Figures are collated from across the whole study period.