Daily Activity Budgets of the Taiwan Ferret Badger (*Melogale moschata subaurantiaca*) in Captivity

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Abstract

Daily activities of the Taiwan ferret badger (*Melogale moschata subaurantiaca*) were studied by using a time-lapse recorder to record the individual behaviors of five animals in captivity from January to March 1993 in southern Taiwan. The activity level was low during emergence at dusk, increased gradually to the highest level right before sunrise, and then decreased sharply. Sunrise is the most obvious determinant for the cessation of the daily activity, while, hunger is also likely to be an important factor in entraining the activity in this species. Traveling was the most frequent behavior that comprised 60.2% of the total active time. Other major behaviors included playing (14.9%), remaining alert (13.8%), feeding (7.1%) and drinking (4.0%). Both feeding and drinking activities took place in very short bouts and occurred intermittently throughout the night, but only the drinking intensity was significantly correlated with the activity level. Continual searching for small and scattered food items and the requirement for reducing heat stress from the search were possible explanations for the feeding and drinking patterns. Therefore, besides for avoiding predation, the nocturnal active pattern is in favor for avoiding hyperthermal condition.

Key words: behavior, Mustelidae, nocturnal active pattern, small omnivore
Received: April 18, 2000 Accepted: February 9, 2001

Introduction

Taiwan ferret badger (*Melogale moschata subaurantiaca*) is a small (about one kg) nocturnal species of the family Mustelidae, and commonly found throughout forestlands at elevations below 2,000m in Taiwan. It has an extended breeding season from February to September, with each adult female producing only one litter in any one year (Pei and Wang 1995).

Due to a combination of poor visual perception, small teeth and weak biting force, ferret badger is not a strong hunter, but an omnivorous animal feeding mainly on small animals, such as earthworm, insect, snail, frog, lizard, and occasionally eggs, fruit, roots and carcasses of small birds and mammals (Chian and Sheng 1976; Long and Killingley 1983; Ewer 1985; Neal 1986; Chuang and Lee 1997). It lacks any obvious defense apparatus to protect itself except for the anal scent gland, which is used to deter attacks by other animals. Another possible protection to the ferret badger is the conspicuous black-and-white facial patches, which has been suggested as a warning or aposematic coloration (Belt 1888; Pocock 1908; Young 1957; Walker *et al*. 1975; Andersson 1976; Guilford 1990; Ortolani and Caro 1996). Moreover, only recent observations indicated that this species lives solitarily in the wild. Being active only at nighttime, therefore, could be a strategy for the ferret badger to avoid predation.

Despite of the ferret badger's abundance in forests of Taiwan, little is known about its biology and ecology, since to make continued direct observation in the forests with dense undergrowth is almost impossible. This paper reports and discusses the time budget and behavior pattern of major activities of the Taiwan ferret badger in captivity.

Materials and Methods

Three females and two males of adult Taiwan ferret badger were live-trapped in the wild from Shih-tzu Hsiang, Pingtung County. They were housed in a rooftop enclosure located on the campus of National Pingtung University of Science and Technology, Neipu, Pingtung, about 48 km north to where they were trapped. The roof of the enclosure was constructed of semitransparent plastic boards, which made the daily illumination rhythm inside the enclosure parallel to that in the natural condition.

Each animal was kept individually in a 1.5X1.5X1.3 m^3 metal cage. In each cage, there were two metal bowls one for food and the other for water, one nest box consisting of a black plastic pot (15 cm in diameter, 30 cm in height), and a piece of the trunk of the Taiwan acacia (*Acacia confusa*; about 25 cm in diameter and 70 cm in length). The trunk was intended to enrich the environment and was frequently scratched, bitten and moved by the animal. Except for regular visits by keepers and researchers, the enclosure was nearly free from other disturbances, particularly during the night. Cleaning and feeding were conducted every afternoon between 13:00 and 16:00. Researchers' visits were confined to these hours to avoid disturbance. Water and food were provided *al libitum*. Food consisted of a moist mixture of commercial dry and canned dog food, and occasionally live frogs and snails.

All the experimental animals were kept in the cages for 12 to 15 months before the study was conducted. Their body weights were all within the normal range of 800 - 1,000g during the study period. From January to March 1993, the daily activities of each animal were recorded in separate sequential sections. The recording device was constituted by a PANASONIC Time Lapse Video Cassette Recorder (Model AG-6750-P) and a TOSHIBA Color Camera (CCD Model IK-632) with COSMICAR TV Zoom Lens (12.5 mm - 75 mm). The iris of the camera adjusted automatically according to the ambient light intensity. The camera was situated 3.5m above the cage to cover the whole view of the cage.

For each recording section, one of the animals was recorded continuously at least for either 12 hours (nighttime only) or 24 hours. The recording interval was set on 0.6 sec, which is 1/36 of the normal recording speed. Because the intention of this study was to record the activity pattern of the solitary-living individual, the animal to be recorded was isolated from the others to minimize social behavior caused by physical or visual contacts, or other social stimuli (Crowcroft and Rowe 1963; Kavanau 1963; Bovet 1972; Kenagy 1973; Dubost 1975; Roper and Ryon 1977). Also, for better video resolution, one or two 40-watt fluorescent lamps were kept on throughout the night. Preliminary observation suggested that these additional lights did not influence the behavioral expression of the animals.

A total of ten 24-hour sections (two sections for each individual) and six 12-hour sections were recorded. They were later played back at normal speed. The day of each of the experimental animals was categorized into "resting phase" when the animal was in its nest box, and "active phase" when it was outside of the box. Since the animal could not be seen inside of the nest box, and some actions, such as cleaning, autogrooming, and stretching, were expected to occur, the "resting phase" should not be interpreted as a complete motionless period. On the other hand, using "active phase" to represent the time outside the nest box is valid, because the animal did not exhibit any form of resting, except very short pauses for alert behavior (see below). Moreover, because major behaviors (traveling and playing) and events (alerting, feeding and drinking) likely occurred in the active phase, the percent time spent outside the nest box was used to represent its activity level or percentage of activity of each of the experimental animals.

In order to understand the detail time budget for each of the above-mentioned major behaviors or events during the active phase, duration of each behavior was recorded to the nearest second. The category of "traveling" included both horizontal and vertical movements of the animal in the cage. "Playing" included activities such as chasing its own tail, and biting, scratching and moving the metal bowls, plastic pot or trunk. "Alert behavior" meant the animal stopped its action abruptly and smelled the air or turned its head around, or pointed its head toward a certain direction for a while. "Feeding" and "drinking" represented the behaviors to pertaining use of the food or water bowl, respectively.

To minimize the occurrence of unusual behaviors caused by the disturbance of keepers and researchers, activity data for 30 minutes prior to and after their visits were deleted. No test was conducted for sexual differences in activity pattern due to the small sample size. Data of all individuals were pooled.

Results

The results of this study showed that the ferret badger started their nocturnal activity about two hours after sunset and stopped about two hours after sunrise (Fig. 1). The level of activity increased gradually with a rather consistent stepwise pattern from its emergence in the early evening to the moment of sunrise, when it reached the highest activity level of the day. The activity level then dropped sharply and faded out almost completely two hours later. When the animal was active outside of its nest box in the night, it frequently went back to the nest box for the periods of a couple of minutes to about 30 minutes. There were a few activities during the daytime hours (Fig. 1), but since they

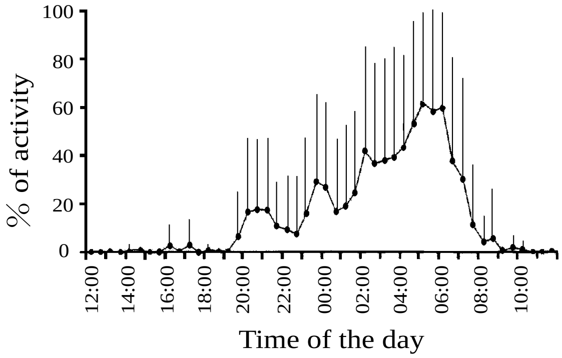

Fig. 1. The circadian distribution of the average percentages (circles) of the activity with standard deviations (thin lines) for successive half-hour periods for the captive Taiwan ferret badger, January to March 1993.

were so rare and scattered, and most likely were caused by human disturbances, the significance of the daytime activities to the species is questionable. The average period of the "active phase" for the experimental animals was 4.22 hours (= 17.6%) per day.

During the "active phase" traveling was the most common behavior exhibited by the animal, comprising 60.2% of the total time spent for activity (Table 1). Over 95% of the traveling consisted of horizontal movement, while less than 5% were vertical movement (climbing). Play was the second most common behavior exhibited by the animal, of which moving objects, and biting and scratching on objects were the predominant behaviors (> 98%). Chasing its tail like a dog only occurred on one individual. Alert behavior occurred throughout the night, and constituted 13.8% of the total active time.

Ferret badgers spent approximately 18 and 10 minutes every day on feeding and drinking, respectively (Table 1). Despite food and water being provided together in abundance, both feeding and drinking occurred as short, separate bouts. Each bout consisted of a number of feeding or drinking activities. Each feeding and drinking activity was about 2 - 3 sec, and the ferret badger usually left the bowls for other activities for a long period until its next feeding or drinking bout. The average number of feeding or drinking bouts per hour were both less than three, even in the most active period (Fig. 2) .

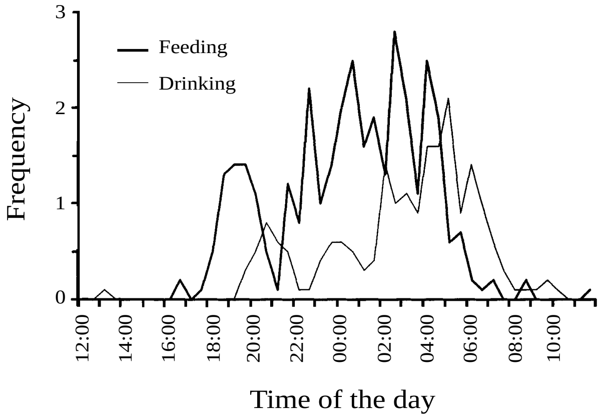

Fig. 2. The circadian distribution of the average frequency of feedings and drinkings for successive half-hour periods for the captive Taiwan ferret badger, January to March 1993.

Table 1. Daily time budgets for major behaviors and events performed by captive Taiwan ferret badgers (*Melogale moschata subaurantiaca*) during their active phase, January to March 1993

Behavior or event	Time spent (hour)	Percentage
Traveling	2.54	60.2
Playing	0.63	14.9
Alerting	0.58	13.8
Feeding	0.30	7.1
Drinking	0.17	4.0
Total	4.22	100.0

The frequency distribution of both feeding and drinking of the ferret badger (Fig. 2) were generally parallel to the activity level throughout the night (Fig. 1). However, only the drinking frequency was significantly correlated with the activity level ($r = 0.93$, $df = 32$, $p < 0.01$), whereas the feeding frequency and activity level were insignificantly correlated ($r = 0.24$, $df = 32$, $p > 0.1$). Also, despite the low activity level right after emergence, feeding behavior was intensive between 18:00 and 20:00 (Fig. 2).

Discussion

For mammalian species it has been shown that small cage size and ambient weather conditions, such as temperature and precipitation, significantly affect the activity pattern and behavioral expression of the experimental animals (Pearson 1960; DeCoursey and DeCoursey 1964; Clutton-Brock 1974; Kavanau and Peters 1976; Stewart and Bider 1977). However, the shape of the nocturnal activity pattern of the ferret badgers in captivity described in this paper is similar to that observed, based on the circadian distribution of the number of pictures taken by auto-trigger cameras, in natural forests with almost no human disturbance (Pei 1998). Therefore, the activity pattern derived from this study may be fairly representative to the species.

Nevertheless, the daily time budget of activity (= 4.22 h) estimated in this study was for the non-breeding animals in the winter. Therefore, it should not be considered as a standard year-round time budget for the species. Breeding individuals are expected to have higher time budget for activity, as in the case of the stoat *Mustela erminea* (Erlinge 1981; Robitaille and Baron 1987). Because enough food was provided in this study, the time spent in foraging was also very likely lower than that would be performed in the field (Zielinski 1988). Furthermore, the explanation for the interesting pattern of a gradual increase in the activity level after emergence and throughout the evening is not clear yet. Because the feeding frequency (3 bouts per hour) did not change, it is unlikely that the activity level increase was due to an increase in the intensity of food searching. Other factors, such as searching for mates, communicating between conspecifics, and exploring new habitat, might also involve. A further study is required.

The activity pattern derived from this study (Fig. 1) and the previous study of Pei (1998) showed that the onset and cessation of the ferret badger's activity are most likely determined by sunset and sunrise, respectively. The necessary of a sudden drop in the activity level right after sunrise is expected, since the predation pressure must be high in the daytime for such a small and relatively vulnerable species (Rasa 1986; Rood 1986, 1990). The relatively high intensity of feeding soon after emergence at dusk suggested that, besides sunset, hunger might also be a significant zeitgeber to entrain the activity in the ferret badger. The same mechanism has also been suggested for rats (Edmonds and Adler 1977a, b; Krieger *et al*. 1977; Krieger and Hauser 1978) and the squirrel monkey *Saimiri sciureus* (Sulzman *et al*. 1977a, b).

The discontinued and extensive quick feedings exhibited by captive individuals of the ferret badger in this study should correspond to the situation in the wild. Since the ferret badger feed primarily on small and rapidly digestable invertebrates in the wild, frequent traveling, searching, scraping and digging are necessary in order to find enough food. This kind of short and frequent feeding is typical for small mammals (Erlinge 1980; Daan 1981). Consequently, the feeding pattern expressed by captive animals appears to reflect the normal performance under natural conditions. It is considered as an endogenous rhythm or a persistent freerunning rhythm (Aschoff 1984). Feeding mainly on invertebrates apparently is time consuming in food searching. Nevertheless, when compares with species preying on larger animals, such as rodent-eating weasels (King and Moors 1979; Erlinge 1980; King 1983a, b), such a food habit should be advantageous for the ferret badger with a more stable food supply, since invertebrates are abundant, evenly distributed and rapidly renewable in the environment (Waser 1981; Waser and Waser 1985).

In addition to avoiding predation, the results of this study suggested another factor which is favor the nocturnal activity pattern for the ferret badger. The frequent water-drinking pattern observed in this study indicated that the ferret badger must consistently experience heat stress or hyperthermal condition during the active phase. Consumption of enough water is crucial when a homeothermic animal increases evaporative loss of its body heat under the hot or hyperthermal condition (Moen 1973). Being active in the daytime obviously will increase heat stress and, thus, active nocturnally can be favored to avoid the heat stress as in the case of many herbivorous species (Taylor 1968; Sinclair 1983; Merrill 1991). The extensive and active food searching movement performed by the ferret badger may be partially responsible for the frequent hyperthermal condition, though carnivores that prey mainly on invertebrates or small animals also consist of diurnal species, such as dwarf mongooses *Helogale parvula* (Rasa 1987). In additional, if the close association between the activity level and drinking demand showed by the captive individuals (Fig. 3) also exist under natural condition, it might be necessary for the species to confine their activity range within a certain distance from water sources.

Finally, despite being a nocturnal species, the ferret badger still spent considerable time being alert (13.8% of the total active phase) in this study. As mentioned previously, the noxious anal secretion is the most apparent weapon of the ferret badger. However, the anal secretion is believed to be more effective to discourage mammalian predator, but not to prevent attack by swooping raptor (King 1989). Therefore, being vigilant and cautious remains important or even necessary in order to avoid any possible attacks (Rood 1978; Rasa 1986) for a small solitary-living animal such as the Taiwan ferret badger.

Acknowledgements

The author is particularly grateful to Mr. Cheng-Kwang Dung for his help in collecting study animals. Special thanks to Mr. Chin-Shan Tsu and Miss Chyi-Ying Wang for their assistance in taking care of the animal and collecting video data. Dr. Richard D. Taber and Ms. Kristin Nowell kindly reviewed the early draft of this manuscript and one anonymous reviewer provided valuable suggestions improved this paper significantly. Funding was provided by the National Science Council (Project number: NSC82-0409-B-020-010) and the Council of Agriculture (Project number: 82 NCP-02-13).

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圈養環境下台灣鼬獾(*Melogale moschata subaurantiaca*)的全日活動時間分配

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摘要

由1993年1月到3月間，在臺灣南部以長時間錄影的方式對5隻圈養的台灣鼬獾 (*Melogale moschata subaurantiaca*) 進行夜行性活動的分析。結果顯示本種在日落剛開始活動時的活動程度較低，然後逐漸的增加直到日出前達到其最高的活動程度，之後，活動程度就快速地下降並停止活動。日出是最明顯使鼬獾結束夜間活動的決定因子；而除了日落外，飢餓也可能是另一個決定進入夜間活動的因子。在所有的行爲當中，以位移出現的頻率最高，約占總活動時間的60.2%。其他主要的行爲還包括：玩耍 (14.9%)、警戒 (13.8%)、進食 (7.1%)和飲水 (4.0%)。鼬獾每次進食或飲水約持續2-3秒就結束，而且這兩種行爲整夜均會斷續的出現；不過，只有飲水的次數與活動程度有顯著的正相關。如此的行爲模式應與此種動物在野外尋覓小型且分散出現的食物，以及以頻繁飲水來降低體熱有關。因此，除了可以減少被天敵獵捕的機會外，鼬獾的夜行性活動模式也可能可以避免熱緊迫的發生。

關鍵詞：行爲、貂科、夜行性活動模式、小型雜食性動物

收件日期： 2000年4月18日　　　　接受日期： 2001 年 2月 9日