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Short Note

Activity Rhythm of the Spinous Country Rat (*Niviventer coxingi*) in Taiwan

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Kurtis Pei (1995) Activity rhythm of the spinous country rat (*Niviventer coxingi*) in Taiwan. *Zoological Studies* **34**(1): 55-58. The activity rhythm for the spinous country rat (*Niviventer coxingi*) was investigated based on 246 photographs taken by automatic camera systems from February 1992 to October 1993. Results show that the rats are a strictly nocturnal species, and probably also exhibit two- to three-hour ultradian cycles within their active period. Initiation of activity at dusk correlates closely with sunset, while the complete cessation of activity at dawn correlates with sunrise. Evidence suggests, however, that certain unidentified internal physiological factors probably also are involved in the decreasing activity level before dawn. The rats stay active longer in autumn and winter than in spring and summer. The higher activity level of the species during autumn and winter, as indicated by the number of photos being taken per unit of time, could have been caused by the need for more food or, also possibly, by higher population size during this period of time.

Key words: Rats, Nocturnal activity pattern, Seasonality, Automatic camera.

The activity rhythm of a prey species is essentially a reflection of the balance between their maintenance requirements and environment risks, both of which should be significant in the evolution and adaptation of the species.

The spinous country rat (*Niviventer coxingi*) is a widely distributed granivorous species found commonly in forest regions from low to middle elevations in Taiwan (Lin 1982, Yu 1983). They were previously described as being active randomly throughout the diel (24 hours) period, i.e., an arrhythmic species (Lee 1988, Yu 1990). This description, however, was found to be incorrect in a recent radio-tracking study which showed that *N. coxingi* are nocturnal animals (Chang 1991). Nevertheless, because this latter study only tracked the animals' movements from 1700 hr to 0700 hr, and there were also occasional captures of rats by traps in daytime during the study period, the establishment of a nocturnal activity pattern for this species is still uncertain.

The present paper reports the activity rhythm of the spinous country rat based on the numbers and time distribution of photographs taken by automatic activity activated cameras. Automatic cameras have previously been used to reveal activity patterns of a number of rodent species (Pearson 1960, Carley et al. 1970). They have also been used successfully in censusing various animals and are further expanding their utilization in wildlife studies (e.g., Gysel and Davis 1956, Dodge and Snyder 1960, Carter and Slater 1991, Jones and Raphael 1993, Kucera and Barrette 1993, Pei 1993a,b).

Materials and Methods—The automatic camera system used in the present study consists of a microwave-infrared transmitter and an autofocus 35-mm camera. The transmitter emits a cone of microwave-infrared pulses. The camera is triggered when a moving object breaks the microwave-infrared beam, and the date and time of the event are displayed on the photograph.

From February 1992 to October 1993, automatic camera systems were used in four study areas in central, southern, and eastern Taiwan. The elevations of these study areas ranged from 200 to 2,500 meters and included bamboo forests, orchards and, mostly, primary or secondary broadleaf forests. The cameras were placed in 39 locations, and the most frequently photographed animal was the spinous country rat.

The number of photos taken per unit hour (Activity Index) was used to represent the hourly activity level of the local rat population. To correlate the rat's activity relative to sunset, the hourly Activity Index was calculated for each hour beginning at sunset (i.e., the 0-h begins at sunset, the 1-h is the first hour after sunset, and so forth). Also, in order to investigate the seasonal changes of their activity pattern, the hourly Activity Indices were grouped into spring-summer and autumn-winter periods. The spring-summer period includes the months of March to September, which represents the short-night season (night length of 9-11 hours). The autumn-winter period includes the months of October to February, and represents the long-night season (night length of 12-13 hours).

Results—The combined total operation time for all 39 locations during the study period was 20,271.5 hours. The operation time for individual hours of the day varied from 818.5 hours for eight o'clock in the morning to 869.2 hours for five o'clock in the afternoon, with an average of 844.6 hours. There were 24 species of mammals, 25 species of birds, one turtle, one frog, and a number of unidentified insects photographed, including species active during both day and night.

A total of 246 pictures of the spinous country rat was gathered. All of these pictures were taken during the period between six o'clock in the afternoon and five o'clock in the morning. All photographs except three contained single rats. These three pictures in which two rats were photographed together were taken on July 23, August 5, and December 13. Only the December photo showed two rats of different sizes, one adult and one immature.

The hourly Activity Index of the spinous country rat for each hour after sunset is shown in Figure 1. During both periods, the spinous country rat initiated activity immediately following sunset, and reached the first and highest activity peak shortly after their emergence during the first and second hours. The activity level decreased and was maintained at a slightly lower level after the first peak. There were also a number of less pronounced ultradian activity peaks, at two- to three-hour intervals, during the night in both periods.

During the short-night season, activity levels decreased significantly after around the ninth hour and had stopped completely by the eleventh hour, when the sun had begun to rise (Fig. 1). During the long-night season, the times when activity levels began to decrease after the last activity peak and when activity stopped completely occurred at the seventh and thirteenth hours, respectively. As a result, the decrease of activity intensity before sunrise was sharper when the nights were short and more gradual during the long-night season. Besides the difference in the length of the activity period, the activity levels were also generally lower in the short-night season than in the long-night season.

Discussion—Results show that the spinous country rat is strictly a nocturnal species, and that probably it also exhibits a number of two- to three-hour ultradian activity cycles during the active period. No activity was detected in the day time, which is in accordance with what has been found for other strictly nocturnal rodents (Madison 1985). The nocturnal activity pattern for this species shown here should be correct since the automatic camera systems used in the study operated both day and night, as mentioned earlier, and showed no variations in operational functions based on time of day (per. obs.). Also, this pattern should be representative of the species as a whole because data were collected from various locations in Taiwan and covered all months.

The evidence also clearly shows that the onset and cessation of the rats' activity are limited by sunset and sunrise, respectively, with sunset being an especially clear determinant for the onset of activity. In other words, the length of the rats' activity period varied according to the length of the night. Nevertheless, the results also show that the rats began to significantly decrease their nocturnal activity level at similar times after sunset in both seasons (i.e., at the seventh and ninth hours for the long and short night seasons, respectively), despite the interseasonal difference in the times of sunrise, suggesting that certain internal physiological factors may also be involved in regulating the length of the active period for this species.

Studies of herbivorous rodents, such as *Microtus*, whose diets consist mostly of items with lower nutritional quality, have shown that the diel activity rhythms for the same species are flexible among populations which live under different conditions (Heidt 1971, Seed and Khalili 1971), among seasons (Lehmann 1976, Baumler 1975), between years (Erkinaro 1970), or even between different individuals within the same population at the same time (Pearson 1960). Furthermore, distinct and clear ultradian rhythms within the active period are also common for species which feed on low-quality diets (Ashby 1972). The necessity for frequent feeding to acquire enough nutrition for maintenance, and frequent defecation as a result of rough forage, were suggested as the reasons for the arrhythmic activity pattern for these animals (Daan and Aschoff 1981 1982, Lehmann 1976).

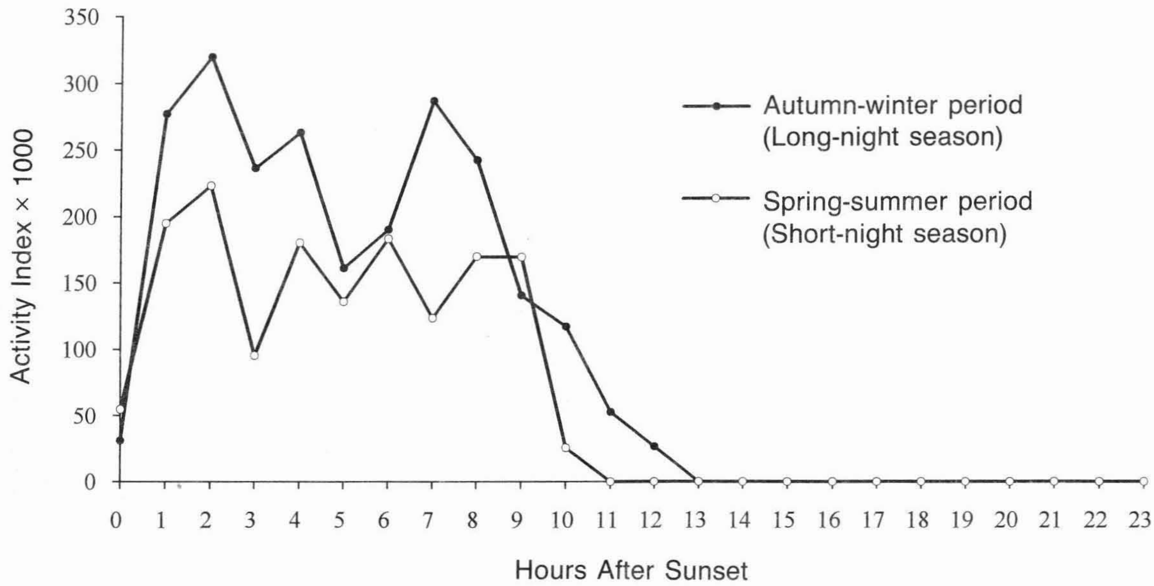

Fig. 1. The hourly distribution of the activity index beginning at sunset for the spinous country rat (*Niviventer coxingi*).

Granivorous rodents, on the other hand, search for food with much higher nutritional value and, therefore, need only be partially active in the diel period (Hansson 1971). They usually do not exhibit as distinctive ultradian rhythms as the herbivorous rodents (Hansson 1971). The need for the spinous country rat being active only at night is also likely to be influenced by the type of the habitat it utilizes. Studies on the habitat preference of the spinous country rat indicate that it prefers to forage and be active on open ground in the forest (Cheng et al. 1986, Liu and Kuo 1990). The nocturnal activity behavior should, therefore, significantly reduce its risk from predation.

Moreover, although the ultradian rhythm for this species needs to be confirmed by further investigations, the almost identical occurrence of the first and second activity peaks for both spring-summer and autumn-winter seasons suggests that certain indigenous factors, such as the need for a short resting period after a long foraging bout, might influence the rats' activity rhythm.

The reason for the difference in seasonal activity levels, as indicated in the present study, is not clear. It is possible that the rats are more active during the autumn-winter period because nights are longer, and presumably darker, or because they need to feed more to fulfill the energy requirements for colder nights. However, this seasonal difference in activity levels may also possible be due to the recruitment of young during autumn and winter, as indicated by the immature individual photographed in December. Recruitment of youngs increased the number of animals as well as the number of photographs taken by the cameras. One early study in central Taiwan showed an even distribution pattern for the reproductive activity for this species (Yu 1983). However, this rat has been trapped during a faunal survey at one of the 4 study areas of the present study, and the results showed that, although there are immature individuals during the summer trapping, the majority of younger specimens were trapped in the winter time (Pei 1993a). Additional study is indicated to clarify this situation.

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刺鼠(*Niviventer coxingi*)之日活動週期

裴家騏[1]

自1992年2月到1993年10月，自動照相機共拍攝到246張在野外活動的刺鼠 (*Niviventer coxingi*) 照片。根據這些照片所拍攝的時間分布來看，刺鼠爲一典型的夜行性動物，且在夜間可能還會出現一些2-3小時較短的活動週期。牠們每夜活動的開始與完全日落的時間有密切的相關，而清晨活動的停止則與日出有關。同時，刺鼠在日出前活動強度逐漸降低的現象，除日出外，可能也受到某種內在生理因素的影響。刺鼠在秋、冬季的夜活動時間較春、夏季要長。單位時間內所拍攝到照片數顯示，刺鼠在秋、冬季較爲活躍，這可能是因爲所需的食物較多，但也可能是因爲此時的族群量較高所造成的。

關鍵字：鼠類, 夜行性活動模式, 季節性, 自動照相機。

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