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Published online: 31 Jan 2014.

To cite this article: Letícia de Souza Resende, Glauce Lima e Neto, Patrícia Gonçalves Duarte Carvalho, Gabriella Landau-Remy, Valdir de Almeida Ramos-Júnior, Artur Andriolo & Gelson Genaro (2014) Time Budget and Activity Patterns of Oncilla Cats (Leopardus tigrinus) in Captivity, Journal of Applied Animal Welfare Science, 17:1, 73-81, DOI: 10.1080/10888705.2014.856253

To link to this article: http://dx.doi.org/10.1080/10888705.2014.856253
Time Budget and Activity Patterns of Oncilla Cats (*Leopardus tigrinus*) in Captivity

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Researchers have reported on the diet of *Leopardus tigrinus* and ecological aspects, but studies of behavior are scarce. The aims of this study were to describe the time budget and activity patterns of 10 captive *Leopardus tigrinus* individuals. The group had an activity budget of 66% resting, 20.66% moving, 6.08% vigilant, 3.12% feeding, and 4.14% other activities during 720 hr of observations. The activity budgets of the males and females did not differ significantly; however, males ate more than did females. The nonhuman animals spent more time resting during the day than during the night. Moving, socializing, maintenance, and vigilance showed statistically higher mean values at night. Group analysis of the temporal pattern of behavior showed bimodal peaks. Activity levels were high from 5 a.m. to 6 a.m. and decreased through the day only to peak again at 7 p.m. Stereotypic pacing peaked at dawn and at dusk. Patterns of vigilance, feeding, and maintenance were also determined for the group during a 24-hr period. These results may be useful for the development of management plans and effective conservation strategies for captive cats.

Keywords: behavior, felidae, little spotted cat, activity budget, zoo

With rapid loss of species worldwide, long-term maintenance of captive populations has become a common approach to species conservation. However, scientists have recognized that captivity can drastically alter nonhuman animal behavior, and in particular, concerns have been expressed about the possible effect of captivity in the loss of behaviors essential for survival in the wild.

The *Leopardus tigrinus* (Oncilla; Schreber, 1775) is the smallest Brazilian cat. Males are generally larger than females; body weight varies from 1.75 kg to 3.5 kg and length varies...
from 40 cm to 50 cm (Oliveira & Cassaro, 1999). Although information from the field and captivity indicates that the species is nocturnal (Oliveira, 1994), some food items identified in specimens from Northeastern Brazil indicate a high degree of daytime activity (Olmos, 1993). There are several reports on the diet of the oncilla as well as its ecological aspects (Bitetti, Angelo, Blanco, & Paviolo, 2010; Gardner, 1971; Konecny, 1989; Ximenez, 1982); however, studies of time budget and activity patterns are scarce.

Nevertheless, activity patterns and time budgets are two important aspects of the temporal behavior of animals. In the only study of activity patterns in this species, Moreira, Brown, Moraes, Swanson, and Monteiro-Filho (2007) described a bimodal pattern of activity for oncillas in captivity with peaks occurring at dusk and dawn. During the night, the cats began pacing at 10 p.m. and ceased around 1 a.m. During the day, the animals spent most of the time resting in trees or in boxes. The animals showed a reduction in active behavior during the hottest hours of the day (1 p.m.–4 p.m.).

Probably because of the ease of observation, most studies of activity patterns and time budget were performed in endothermic, diurnal, and terrestrial animals. Studies concerning neotropical cats are difficult because of the solitary behavior of these animals and their preference for nocturnal activities, making reports of field observation sparse (Oliveira & Cassaro, 1999). Thus, studies on captive populations can provide information about the habits of such species, and this information is essential for the development of management plans and effective conservation strategies. Modified activity rhythms have been proposed to explain the high susceptibility of captive animals after their release into the wild. Small cats in captivity often remain inactive or hidden from public view. Furthermore, when they are active, they may frequently engage in stereotypical locomotor patterns (Shepherdson, Carlstead, Mellen, & Seidenslicker, 1993).

Genaro, Moraes, Silva, Adania, and Franci (2007) reported that oncilla reproduction in captivity is poor because of several factors, but stress is probably the most important. These problems suggest a limited understanding of the management conditions and housing requirements of small cats in captivity (Carlstead, Brown, & Seidensticker, 1993; Mellen, 1991). Knowledge about how animals divide up their activities throughout the day is relevant for understanding their lifestyles and for identifying in a general way how animals interact with their environment (Defler, 1995). The aims of this study were to describe the time budget and activity patterns of captive *Leopardus tigrinus* individuals located at the Center for Reproduction of the RIOZOO Foundation (Rio de Janeiro Zoological Park).

**MATERIALS AND METHODS**

The study was developed in the Reproduction Center for Small Felids in the Rio de Janeiro Zoo–RIOZOO Foundation, located at Quinta da Boa Vista Park in the São Cristóvão neighborhood. The center has a total area of 273 m² and is divided into nine enclosures. Enclosures (15 m²) are made of stone masonry walls, with the exception of the front, which consists of wire mesh. The floors of these enclosures are covered with dust and concrete substrate. Plants and trunks are spread randomly, and a wooden box measuring 40 cm³ is located in the upper part, which is used as a shelter. The animals remain in a restricted area and have contact only with their caretakers and technicians.
We studied 10 adult oncillas (*Leopardus tigrinus*) placed in five different enclosures: two enclosures with 2 males, two with a male and a female, and one with 2 females. All the animals were born in free-living environments and had been in captivity for at least 12 years before the start of the study. During this study, the animals were fed regularly between 1 p.m. and 3 p.m. with commercial cat food, morsels of chicken, and lab rats, who had been kept in the laboratory animal housing and killed following the appropriate bioethics protocol.

The behavioral parameters were derived from an ethogram developed by Weller and Bennett (2001). We later modified it to adapt to our own conditions (Table 1). Behavioral data were collected in January and February 2007 by using two microcameras (Sharp CCD, 420TVL, 0.1 l/day/night) installed inside the enclosures. The behavior of each animal was recorded 24 hr per day during 3 consecutive days, totaling 720 hr of observation. Behavioral data were collected from the videotaped records using a scan methodology (Altmann, 1974), with 5-min

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Definition</th>
<th>Mean Percentage/ Day %</th>
<th>Mean Percentage/ Night %</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Resting</strong></td>
<td>Subject is resting on haunches, fully extended on the ground, and may have eyes open or closed</td>
<td>79.51 ± 10.51%</td>
<td>54.33 ± 7.44%</td>
<td>.002</td>
</tr>
<tr>
<td><strong>Lying</strong></td>
<td>Animal inside a wooden box</td>
<td>12.59 ± 1.47%</td>
<td>28.05 ± 1.48%</td>
<td>.002</td>
</tr>
<tr>
<td><strong>Sitting</strong></td>
<td>Subject in bipedal position, with front legs resting against vertical surface</td>
<td>2.34 ± 1.79%</td>
<td>9.67 ± 2.73%</td>
<td>.002</td>
</tr>
<tr>
<td><strong>Moving</strong></td>
<td>Subject leaps from one point to another, either vertically or horizontally</td>
<td>3.42 ± 1.47%</td>
<td>2.83 ± 1.98%</td>
<td>.690</td>
</tr>
<tr>
<td><strong>Jumping</strong></td>
<td>Repetitive walking without apparent aim</td>
<td>1.75 ± 2.34%</td>
<td>2.91 ± 2.47%</td>
<td>.050</td>
</tr>
<tr>
<td><strong>Pacing</strong></td>
<td>Movement toward a specific direction with an aim</td>
<td>0.25 ± 0.03%</td>
<td>1.67 ± 0.56%</td>
<td>.050</td>
</tr>
<tr>
<td><strong>Locomotion</strong></td>
<td>Subject moving attentively, normally sniffing the ground and the walls</td>
<td>0.14 ± 0.02%</td>
<td>0.55 ± 0.61%</td>
<td>.080</td>
</tr>
<tr>
<td><strong>Exploring</strong></td>
<td>Alert, attentive standing or sitting</td>
<td>0.25 ± 0.03%</td>
<td>1.67 ± 0.56%</td>
<td>.050</td>
</tr>
<tr>
<td><strong>Vigilant</strong></td>
<td>All the behavioral acts involved in hunting, lurking, stalking, and killing the prey</td>
<td>0.14 ± 0.02%</td>
<td>0.55 ± 0.61%</td>
<td>.080</td>
</tr>
</tbody>
</table>
intersample intervals totaling 12 scans per hr for each individual. Four 40-kW red lamps aided nocturnal image recording.

To describe the time budget and the activity patterns, the behaviors observed were divided into seven categories: resting, moving, vigilant, feeding, maintenance, socializing, and playing. All behavioral categories were classified as active, with the exception of resting. The number of scans of each animal performing behaviors from each category was reported. Means for each category were calculated for each animal before averaging totals for the group.

Because the behavioral data recorded were not normally distributed, nonparametric statistics were used for data analyses. A Friedman’s test was used to analyze differences in time spent in each behavioral category. The Wilcoxon test was used to verify significant differences in mean percentages of time devoted to behavioral categories during the day (7 a.m.–6:55 p.m.) versus the night hours (7 p.m.–6:55 a.m.). The Mann-Whitney \( U \) Test was used to test the differences between males and females. All tests were performed in BioEstat 2.0 software, and the significance level adopted was 5\% (\( p < .05 \)). The display of behavioral states, as recorded in the instantaneous scans, has been expressed as the percentage of time spent in these particular states of the total time that an individual was observed.

**RESULTS**

*Leopardus tigrinus* individuals spent the largest portion of the time (66\%) resting. Moving (20.66\%) and vigilance (6.08\%) were the second and third most common activities, respectively, followed by feeding (3.12\%). Maintenance, socializing, and playing made up only 4.14\% of their activities. The behavioral categories analyzed yielded values that differed significantly for duration of the behavior (Friedman, \( \chi^2 = 123, 27; p < .001 \); Figure 1).

The animals spent more time resting during the day than during the night (Wilcoxon, \( Z = –3.05, p = .002 \)). Moving, socializing, maintenance, and vigilance showed statistically higher mean values at night. There was no significant difference between time period and the mean percentage of time spent feeding and playing (Table 1).

There also was no significant difference between males and females in time spent in locomotion (Mann-Whitney, \( U = 0.68, p = .490 \)) and maintenance (\( U = 1.21, p = .220 \)), being social (\( U = 1.27, p = .200 \)), resting (\( U = 1.43, p = .150 \)), being vigilant (\( U = 1.50, p = .130 \)), and playing (\( U = 1.85, p = .060 \)). However, the Mann-Whitney Test showed a significant difference between the mean percentage of time devoted to feeding and the sex of the individuals. Males spent more time eating than did females (\( U = 2.34, p = .010 \)).

Group analysis of the temporal pattern of active behavior showed bimodal peaks for this behavior. Activity levels were high from 5 a.m. to 6 a.m. and gradually decreased through the day only to peak again at 7 p.m. Stereotypic pacing peaked at dawn (5 a.m.–6 a.m.) and at dusk (6 p.m.–7 p.m.). Higher proportions of resting behavior were exhibited in the morning at 9 a.m. Patterns of vigilance, feeding, and maintenance were also determined for the group during a 24-hr period. The animals exhibited high percentages of vigilant behavior at dawn (5 a.m.), which decreased during the day and increased again at dusk (7 p.m.). High percentages of vigilant behavior were also reported around 1 a.m. Feeding behavior occurred mainly during the feeding time period (1 p.m.–3 p.m.) and at dusk (6 p.m.–7 p.m.). Maintenance peaked at 1 a.m. (Figure 2).
DISCUSSION

The finding that *Leopardus tigrinus* in captivity spent 66% of their time resting is consistent with Baldwin (1985), who found that captive cats in the National Zoo in the United States rested 75% of the time. Also, Pitsko (2003) observed that tigers in captivity spent a majority (76%) of their time resting. In the natural environment, small cats rested 52.5% of the time (Crawshaw & Quigley, 1989). Ludlow and Sunquist (1987) observed that wild ocelots were inactive from 41% to 50% of the time during a 24-hr period.

The higher percentage of time in which this behavior was observed in captive cats may be an indication of the low stimulus diversity in this environment. According to Carlstead (1996), chronically understimulated animals in captivity depress their needs for stimulation by lowering their expectations of the level of stimulatory input from their surroundings.

Comparing the total amount of time resting during the day and night hours, *Leopardus tigrinus* spent more time resting during the day than during the night. According to Navarro-Lopez (1985) and Crawshaw (1995), free-living neotropical small cats are active 52% to 92% of the hours of the night, and foraging behavior encompasses most of the activities in this period. Our results are consistent with these data obtained for free-living small cats and indicate the maintenance of nocturnal activity even in captivity.

The second most frequent behavioral category observed was moving. In the natural environment, small cats travel long distances searching for food, shelter, and potential mates. Ludlow and Sunquist (1987) recorded the distance traveled by ocelots in the wild, which averaged around 0.45 km per hr. In captivity, the need that animals have to move may be related to the high frequency of stereotypic pacing that is sometimes observed. In this study, the pacing behavior accounted for 64.83% of the behaviors observed in the moving category.
 FIGURE 2  Temporal pattern of behaviors observed in individual *Leopardus tigrinus* housed in the Reproduction Center for Small Felids–RIOZOO Foundation (November 2006 through June 2007). Activity and pacing (a), resting and moving (b), and vigilant, feeding, and maintenance (c).  

(continued)
investigate whether variation in the welfare of different species could arise from a differential impact of captivity on their natural behaviors, Clubb and Mason (2003) calculated the mean frequency of stereotypic pacing by 35 species of captive carnivores and its relationships with a number of variables. Clubb and Mason (2003) showed that the degree of natural foraging and general activity levels did not predict captive stereotypy; in contrast, daily travel distances were positively correlated with pacing.

Many species pace, which is thought to have a variety of causes. For example, pacing may arise when animals are consistently unable to meet a need, such as natural feeding behavior (Carlstead, 1996; Shepherdson et al., 1993). According to Broom and Johnson (1993), animals who spend long portions of time engaged in stereotyped behaviors show a reduction in behavioral diversity, disintegration of the natural behavioral repertoire, and an inability to interact typically with new stimuli. In such cases, the presence of the stereotyped behavior provides direct evidence of poor welfare and suffering.

The oncillas moved significantly more during the night, which is consistent with other results obtained for free-living small cats. For example, Konecny (1989) reported an average distance traveled of 273 m per hr for an individual male *Felis wiedii* in Belize. According to the author, this rate ranged from 197 m per hr during daylight hours to 305 m per hr at night.

The animals spent a mean of 3.12% of the time feeding in the current study. Cats typically eat 10 to 20 small meals throughout the day and night (Macdonald, 1983). In a study conducted in Venezuela, Ludlow and Sunquist (1987) recorded that the ocelot diet consisted of 65% of prey weighing less than 100 g, which corresponds to 1% of the animal’s body weight. Similarly, Emmons, Sherman, Bolster, Goldizen, and Terborgh (1989) noted that at least 60% of the prey of ocelots in Peru weighed less than 300 g. For that reason, repeated cycles of hunting throughout the day and night are required to provide sufficient food for a typical cat. These data explain the absence of a significant difference in the percentage of time spent feeding.
during the day and night and indicate the need for these animals to feed on small amounts of food several times a day.

The activity patterns of *Leopardus tigrinus* identified here are congruent with those of other small felids. In his study on captive carnivores, Baldwin (1985) recorded a strong morning peak and a small late-afternoon peak in the daily activity pattern of felids. Moreira et al. (2007) reported a bimodal pattern of activity for captive *L. tigrinus* and *L. wiedii*, with peaks at dusk and dawn. Small felids in the wild are crepuscular by nature, being active in the early mornings and late evenings and resting through the hotter hours of the day (Bailey, 1993). The peaks in activity and resting behavior observed in the daily activity budget of captive oncillas were likely the result of these crepuscular tendencies.

**CONCLUSION**

Overall, our results indicate that *Leopardus tigrinus* in captivity retain similarities to the activity patterns seen in wild individuals, including nocturnal activity. This information is essential to reintroduction programs. The success of release programs of captive-bred or translocated animals depends to a large extent upon their behavioral skills. However, the captive cats were more sedentary than their wild counterparts and exhibited the stereotypic behavior of pacing. Management plans for these animals in captivity should include the use of environmental enrichment techniques, especially during the dusk and dawn, which are the periods that animals display high rates of pacing behavior. Moreover, the information that these animals feed on small portions of food throughout the day is essential to establish the diet of these animals in captivity. More emphasis on behavioral studies of mammals in captivity is urgently needed to improve the effectiveness of captive conservation efforts.

**ACKNOWLEDGMENT**

We would like to thank the staff and volunteers of the Rio de Janeiro Zoo (Fundação RIOZOO) for their assistance in helping us with data collection.

**FUNDING**

Letícia de Souza Resende received a scholarship from CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior [Coordination for the Improvement of Higher Education Personnel]).

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