

PRELIMINARY STUDY ON ACTIVITY BUDGET OF THE RING-TAILED LEMUR (*Lemur catta*) AT HANOI ZOO IN WET WEATHER

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Abstract. The activity budget of ring-tailed lemur (*Lemur catta*) during the wet spring in Northern Vietnam was studied based on 4 lemur individuals at Hanoi Zoo from March to April 2021 with a total of 23 observation days. Generically, the lemurs spent most time resting (48%), moving (19%), feeding (16%), less for vigilance (8%), intra-specific interactions (5%), grooming (2%), and playing (2%). No weird behavior has been found. There was no statistically significant difference between the proportion of time spent on the behaviors of this study and the results of Caselli *et al.* (2022) through the Chi-squared test ($\chi^2 = 30$, $df = 25$, p -value = 0.2243). However, it seems that the animals need more space to move and avoid conflict between individuals because the time spent on resting, vigilance, and intra-specific interactions was slightly high.

Keywords: *Lemur catta*, Ring-tailed lemur, activity budget, primate.

1. Introduction

The Ring-tailed Lemur (*Lemur catta*) is an endemic species of Madagascar Island, Africa. Although it is listed as an endangered species on the IUCN Redlist (2023) [1] due to habitat destruction, ring-tailed lemurs reproduce well in captivity and increase the population in zoos around the world because of their ability to adapt to human appearance (Wilson and Hanlon, 2010) [2]. In the captive environment, they also gradually accept the food given by humans. However, the captive diet predisposes them to a number of metabolic diseases (Wilson and Hanlon, 2010). Ring-tailed lemurs are also able to live well in water-deficient environments by eating succulent plant stems or roots (Jolly, 1972) [3]. However, according to Gould *et al.* (1999) [4], there is still a very strong population decline due to mortality when experiencing drought conditions for a long time. This species has a very strict seasonal reproductive behavior (Jolly, 1966) [5] (Goodman *et al.*, 2006) [6]. Therefore, it is possible that other behaviors are also strongly influenced by seasonal factors, such as diet behavior. Goodman *et al.* (2006) studied the natural distribution of *L. catta* and suggested that the species evolved in arid habitats in southern and southwestern Madagascar and subsequently spread to the seemingly wetter highlands.

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Factors that limits the distribution of this species from South to West are rivers while from North to East of Madagascar are climatic and biological factors, especially the presence of plant species of Didiereaceae. According to Godfrey *et al.* (1999) [7], there were no fossil records of this species outside of its present range, indicating that its geographical range has been relatively stable. Ring-tailed lemurs are classified as prosimians but are active mainly during the day and share some behavioral and ecological features with monkeys and gibbons (Sussman, 1992) [8]. Therefore, by monitoring the behavior of the species during the day from morning to late afternoon, it is possible to provide a schedule of their activity without any significant error. Thus, in free-ranging conditions, ring-tailed lemur usually lives in dry areas but can also live in other climate conditions and captivity. Gabriel (2013) [9] reported that there was a variation in time spent for each activity which led to significant differences in activity budgets of *Lemur catta* groups living at different quality forest fragments in Madagascar. Spring time in Hanoi is a typical wet period and may affect the activities of *L. catta* to some extent. The ring-tailed lemurs at Hanoi Zoo were imported from Europe in December 2016 and have existed so far, but there has been no study focusing on the relationship between their behaviors and ecological factors. Therefore, this study was conducted to examine the effect of wet weather conditions on the behavior of ring-tailed lemurs at Hanoi Zoo, to improve the quality of life for the species in such captive conditions.

2. Content

2.1. Time, place, and research methods

This study focused on 4 adult ring-tailed lemurs that were kept inside a cage, located at Hanoi Zoo, with the coordinates of $21^{\circ}01'52,29''N$ and $105^{\circ}48'21,28''E$). The cage is lakeside, facing the lane and away from the cages of other animals. It is designed in two compartments. The inner compartment is about $7-10\text{ m}^2$ wide and functions as a bedroom with a red-tiled floor. This compartment is a shelter for the lemurs at night or in uncomfortable weather. The outer compartment has an area of about 20 m^2 with red-tiled floor. A half of the cage roof is made of steel mesh. Around the three sides of the cage, there are 2-meter high trellis panels on the top, and the bottom is enclosed by glass to prevent the visitors from teasing the lemurs. In the cage, there are many swing beams for the lemurs to leap and branchiate. Around the cage, several large trees are spreading wide canopy covering it.

This study focuses on a group of 4 adult ring-tailed lemurs kept in a cage at Hanoi Zoo to collect data from March 2021 to April 2021 with a total of 23 observing days, using the focal animal sampling method (Paterson, 2004) [10]. Data were collected by taking notes on all 4 subjects consecutively for about 1 minute each time with 5-minute intervals. Microsoft Excel 2021 software was used to calculate the percentage of behavior types in the total number of observed and recorded behaviors, graph and analyze the correlation between temperature and the lemurs' behaviors. The software R 4.1.2 was used to run Chi-squared test to compare the proportion of several similar behaviors between this study and the results reported by Caselli *et al.* (2022) [11]. The definitions for behaviours of ring-tailed lemurs at Hanoi Zoo are presented in Table 1.

Table 1. Behavioral ethogram of ring-tailed lemurs at Hanoi Zoo

Behaviour	Definition
Feeding	- Taking food or water into the mouth => chewing and swallowing - Licking and swallowing food.
Resting	- Opening eyes aimlessly, staying still, and not engaging in any other activities
Playing	- Jumping, running, swinging, hanging upside down, manipulating things, climbing onto another individual's back, or holding another individual in an excited and non-threatened situation
Moving	Taking the body from one position to another
Grooming	- Self-grooming: Scratching, licking body parts itself. - Grooming for other individuals: Scratching, and licking the hands and feet... of other individuals - Groomed: Being scratched or licked by other individuals.
Vigilance	Opening eyes and looking around while not doing other activities, turning head to facilitate the observation
Intra-specific interaction	- Attacking: physical contact or chase, direct threats towards another individual. - Self-defense, escape: running away, avoiding contact, withdraw,... to react to another individual's attack
Others	Unknown or undefined behaviors

2.2. Results and discussion

2.2.1. Results

With 1194 bouts recorded, the ring-tailed lemurs spend most of their time on 3 behaviours: resting, moving, and feeding (accounting for about total of 83% of their time), in which the time spent resting is the most (accounting for about 48% of their total time), then moving (accounting for about 19%) and feeding (16%). Other behaviors are less time spent by the lemurs. No weird behaviour was found for 4 individuals in the cage.

Because this study took place in 2021, sooner than *Caselli et al.* (2022), a different ethology was used. Therefore, only a few dyadic behaviors, which were similar between *Caselli et al.* (2022) and this study were temporarily used for comparison, including foraging vs. feeding, agonistic vs. intraspecific interaction, Locomotion vs. moving, resting vs. resting, self-management vs. grooming, and vigilance vs. vigilance, respectively. (Figure 2).

According to Figure 2, with a significant level of 0.05, there was no significant difference between the selected behavior proportions of the two studies. Thus, no difference in time budget in captivity was found between ring-tailed lemurs living in dry weather compared to ones living in wet weather.

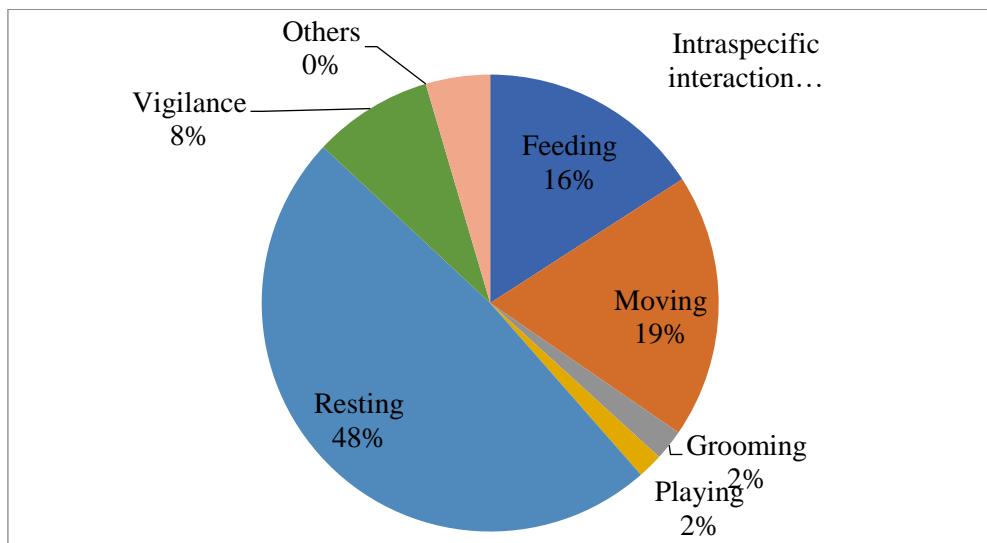


Figure 1. Activity budget of *Lemur catta* at Hanoi Zoo during wet weather

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source Feeding Agonistic Moving Resting Grooming Vigilance
1 ThisStudy 16.0 5.00 19.0 48.00 2.00 8.00
2 Caselli 7.5 0.44 22.4 33.33 2.91 3.88
> chisq.test(ThisStudy, Caselli)
Pearson's Chi-squared test
data: ThisStudy and Caselli
X-squared = 30, df = 25, p-value = 0.2243

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Figure 2. Results of the Chi-squared test between this study and Caselli et al., (2022)

Because of the small number of individuals (2 females and 2 males) and short-term study, there are not enough data to statistically compare the difference in time spent on behaviors, especially vigilance, between alpha-female vs lower-ranking female (116 bouts vs. 106 bouts, respectively), as well as females vs. males (4% vs 5%, respectively) (Figure 3).

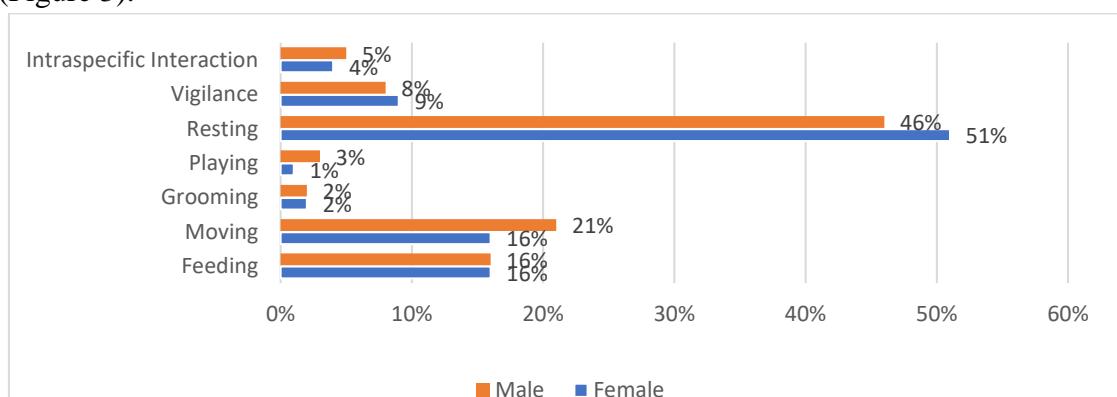


Figure 2. Behavioural proportions of *Lemur catta* males and females at Hanoi Zoo during wet weather

2.2.2. Discussion

According to Figure 1 and Figure 2, the time ring-tailed lemurs at Hanoi Zoo spent time resting seemed to be a lot and this was worrying. There have been studies on *Lemur catta* showing that in captivity they were often less active than in the wild, and this can cause them to become obese (Dishman *et al.*, 2009 [12]; Goodchild & Schwitzer, 2008 [13]).

Figure 2 shows that there were quite large differences between the frequencies of feeding, agonistic (intraspecific interaction), and vigilance, which seem to be inconsistent with the above statistical analysis results. It can be explained by the ethogram of Caselli *et al.* (2022) was built quite complexly with 12 behavior categories (groups), each category has component behaviors, so to reach conclusions about this difference was still quite difficult. The proportion of time spent on vigilance and intraspecific interaction in our study seems high, perhaps because the cage is small, so the lemurs often came into close contact with each other even if they did not want to. On the other hand, maybe they hadn't received enough food or the food wasn't suitable, so they still had to search and compete for their favorite food.

Wet weather in March and April in Northern Vietnam can lead to certain skin disorders or diseases, but the time ring-tailed lemurs spent on grooming appears to be no different from Caselli *et al.* (2022), so it can be assumed that they have adapted, as the ones at many zoos around the world.

Although it is not possible to statistically analyze the difference in time spent on vigilance behavior between lemur females and males, it can be seen that females spend the same amount of time or possibly more time on this behavior than males. This is consistent with the social structure of *Lemur catta*, in which females are dominant, they are also philopatric and more resource defensive of each other as well as another group, based on female-bonding (Norscia and Palagi, 2016) [14]. Therefore, they also have more responsibility for vigilance, and higher-ranking females often exhibit higher levels of vigilance than lower-ranking females (Gould, 1996) [15].

No weird behaviors have yet been discovered, although there have been some studies related to ring-tailed lemurs that have suggested new behaviors (Maloney *et al.*, 2006 [16] with head turn one's head; and Shapiro *et al.* 2018 [17] with stereotypic behavior). This suggests that the short observation time was a limitation of our study.

3. Conclusions

Ring-tailed lemurs at Hanoi Zoo spent most time resting (48%), moving (19%), feeding (16%), vigilance (8%), intraspecific interaction (5%), grooming (2%), playing (2%). No weird behavior has been found, possibly due to it being a short-time study, focusing on wet weather in Hanoi.

They seemed to spend more time on resting, but less time on moving than some other studies. Also, it seemed that the time spent on feeding, vigilance, and intraspecific interaction was higher than in other studies. From the high rate of intraspecific interaction, it can be assumed that they did not have enough space to move, so the level of competition for space and food increased.

Hanoi Zoo should expand the cage space and feed each individual equally so that the individuals have enough space to move around and reduce conflict with each other. Longer-term studies are needed to support our findings in the activity budget.

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