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Recording different behaviours of Ring-tailed Lemur, *Lemur catta* (Primate: Lemuridae) under captive conditions at Sri Chamarajendra Zoological Gardens, Mysuru, Karnataka, India

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Abstract: Investigation was conducted at Sri Chamarajendra Zoological Gardens, Mysuru (Latitude: 12.3028° N, Longitude: 76.6552° E) after obtaining the permission from the higher authority to record different behaviours and behavioural changes if any with ring-tailed lemur, *Lemur catta* (Primate: Lemuridae) during different hours of the day under captive conditions during 2025. *L. catta* was periodically observed by distance without creating any disturbance for its activity by consulting with Zoological Garden Authority, Animal Caretaker, Education Officer and Biological Scientist. Total 17 parameters were observed and the results revealed quite interesting facts as follows. Except sleeping during morning and negative interaction during afternoon, all the 17 behaviors such as locomotion, drinking, eating, sleeping, resting, vigilance, vocalisation, positive and negative interaction abnormal behaviour, approach, depart, jumping, hanging, grooming, scratching, jumping, chest beating, chasing and sun bathing were shown by *L. catta*. Analysis of variance of different behaviors of *L. catta* didn't show significant variation ($F=0.599$; $P>0.05$) under captive conditions and demonstrated that *L. catta* exhibited similar type of behavior during most of the periods in a day under captive conditions. Interestingly, no abnormal behaviour was observed during the present investigation and indicated that *L. catta* adapted well to captive conditions of Sri Chamarajendra Zoological Gardens, Mysuru.

Key words: Captive primate, *Lemur catta*, Zoo, Mysore

I. INTRODUCTION

Understanding how captivity impacts the natural behaviour of wild animals is a challenging task. In the wild, animals engage in diverse activities such as feeding, foraging, socializing, territorial behaviour, avoiding predators and enemies. However, animals held in captivity may exhibit significant alterations in their natural behaviour due to restricted space, repetitive routine activities and human interventions. Such behavioural modifications can range from reduced activity levels to the development of stereotypic behaviour repetitive, purposeless movements such as pacing or head bobbing (Mason *et al*., 2007). Under human captivity emphasis is given to ensure safety, food security and medical care for animals. Despite, the captive environment create stress that is due to various man-made activities which could affect feeding behaviour, sleep cycles, social interaction and reproductive success (Mason, 2006). Understanding these behavioural shifts is vital for improving the welfare of animals in zoos and refining conservation practices.

In Zoological Gardens, wild animals are kept for public display, education, conservation, research and scientific study (WAZA, 2020), which served as entertainment centres, but modern Zoological Gardens have evolved into conservation hubs, which focus on ex-situ conservation, species rehabilitation, and public awareness programs (IUCN, 2014). Hence, Zoological Gardens play a pivotal role in the survival of endangered or threatened species along with least concerned and other exotic and indigenous species so as to contribute to biological research and environmental education. Further, Zoological Gardens act as rescue centres for trafficked or injured animals (Reade and Waram, 1996; Hosey, 2008 and 2013) and they function under the guidelines of the Central Zoo Authority (CZA), India which ensures scientific management of wild animals for their better survival.

Various researchers (Brent and Eichberg, 1991; Carlstead *et al.,* 1991; Visalberghi and Anderson, 1993; Ludes and Anderson, 1996; Boinski *et al.,* 1999; Blaney and Wells, 2004; Fragaszy *et al.,* 2004; Stoinski *et al.,* 2004; Sellinger and Ha, 2005; Ross *et al.,* 2008; Wells and Irwin, 2008; Leonardi *et al.,* 2010; Polizzi-di-Sorrentino *et al.,* 2014; Albuquerque *et al*., 2020; Young and Robbins, 2022; Carrasco *et al*., 2023) have reported on different captive animals (e.g. Bears, Capuchins, Gorillas, Chimpanzees, Orang-utans, Squirrel Monkeys and Jaguars) and their social behaviour,

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learning behaviour, visitors influence and enclosure enrichment to bring down stress in captive animals. Enrichment and appropriate social grouping are essential in reducing the stress in captive animals (Carlstead and Shepherdson, 2000). Young (2003) has emphasized the need of enrichment, which is crucial in preventing behavioural abnormalities and ensure captive animals' mental stimulation. Hosey (2005) has observed that *Lemur catta* is sensitive to environmental and social stressors, it require well-designed enclosure for better survival. Mason *et al.* (2007) have observed the stereotypic behaviours in captive Zoo animals. Davey (2007) has reviewed the visitor's effect on captive Zoo animals. Captive animals show stress-related behaviours when they are exposed to dense or noisy crowds and often display increased vigilance (Davey, 2007). Hosey (2008) has demonstrated a model of human–animal relationships in Zoological Gardens, advocating for structured, predictable human interactions to improve captive animals welfare. Saito *et al.* (2011) have reported higher cortisol levels and increased stress behaviours in captive Lemurs when exposed to human proximity and enclosure limitations. Racevska *et al.* (2018) have emphasized that regular, calm zookeeper-animal interactions reduce stress and promote natural behaviours particularly in primates and carnivores. All these published reports clearly suggested that in Indian Zoological Gardens, research on *L. catta* is diffused. Although, India possess good number of Zoological Gardens, established and managed in the name of *ex-situ* conservation of many species of wild animals. Surprisingly, published reports on the behaviour and status of captive animal like *L. catta* in the Zoological Gardens of India are sparse and fragmentary. Sri Chamarajendra Zoological Gardens in Mysore is one of the major Zoological Gardens in India, in terms of its gate collection and different exotic and indigenous species housing. It is maintained well with utmost care, but captive animal's behaviour and their status are not available in public domain. Hence, there is a necessity to generate scientific data on captive animals and their behaviour as they are kept in cages for public display. And, opportunities to record the behaviours of primates which are placed in a captive conditions is poor. Because, it is very difficult to get such an opportunity, however, we were fortunate enough to obtain permission to do such a task during the present investigation. Hence, the present investigation was undertaken and results of such study are presented in this communication.

II. MATERIALS AND METHODS

Study area: Present investigation was conducted at Sri Chamarajendra Zoological Gardens (Latitude: 12.3028° N, Longitude: 76.6552° E) commonly/popularly known as 'Mysuru Zoo' in Mysuru, Karnataka. It is established in 1892 and it is considered as one of India's oldest and most well managed Zoological Gardens and spread over 157 acres amidst Mysuru city. The Sri Chamarajendra Zoological Gardens is housed with more than 150 species of mammals, reptiles and birds, and is recognized for its naturalistic enclosures, scientific animal care and conservation breeding programs. After obtaining the permission from the higher authority, Sri Chamarajendra Zoological Gardens, Mysuru vide Official Order No. MZA/Edu-internship/084/2024-2025, dated 28.03.2025. Present study was conducted to record different behaviours and behavioural changes if any during different hours of the day in a captive conditions to display to visitors.

Methodology: During the present investigation, the non-human primate Ring-tailed Lemur, *Lemur catta* was selected. The animal was periodically observed by distance for its daily behavioural patterns in its respective enclosures without creating any disturbance for its activity. In this Zoological Gardens, regular feeding schedules, enrichment practices and public visitation hours are start from 0830 AM to 0530 PM. Proper planning was made by consulting with Zoological Garden Authority, Animal Caretaker, Education Officer and Biological Scientist to conduct observation timings so as to record the potential influence of human presence on *L. catta* natural behaviour. *L. catta* was maintained enriched with ropes in a separate enclosure platforms, vegetation and climbing structures to promote natural behaviours. Observations were made two days in a week from morning (10.00 AM), afternoon (01.00PM) and evening (04.00 PM) period for a period of 56 days i.e., from 4th April to 31st May, 2025. Observation were made using the focal animal sampling method with each session lasting for a period of 20 minutes. A standardized ethogram was used to categorize observed behaviours as follows. Informal interview was conducted with animal caretakers and Zoological Garden Staff to gather additional information like feeding schedules, enrichment practices, animal responses to public interaction, medical history or known behavioural concerns to use this information to interpret the behavioural observations. Moreover, a digital stopwatch was used to record each behaviour and data was recorded manually in a field notebook. Observations were made from a distance sufficient to avoid influencing the animal behaviour, typically from designated visitor viewpoints or behind enclosure barriers. To assess the influence of human presence, visitor density near each enclosure was estimated during every observation session by counting the number of visitors within a 10 meters radius at the start, middle and end of each session. These values were averaged to represent crowd levels as low (0 to10 people), moderate (11 to 30 people) or high (>30 people). A well-designed, self-administrated questionnaire was prepared to record 17 parameters. They are: animal name, no. of individuals in the cage, age, diet, stratum, weight, habitat, type of enclosure, area of the enclosure, activity of the animal, time and date of observation, no. of visitors in front of animal cage, weather condition (e.g. Temperature, RH), opinion of visitors about the activity of the animal in the cage/enclosure, name of visitor, age of visitor, native place of visitor, purpose of visit, opinion of the animal caretaker, name of animal caretaker, relationship

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with captive animal, feeding habits of captive animal, medical history of captive animal were recorded in the questionnaire. Further, behaviour of the captive animals includes: locomotion, drinking, eating, sleeping, resting, vigilance, vocalisation, positive and negative interaction abnormal behaviour, approach, depart, jumping, hanging, grooming, scratching, jumping, chest beating, chasing and sun bathing were critically observed and recorded periodically by following standard methods. All these observations were non-invasive and no interaction or interference with the captive animals occurred. The study was conducted under the awareness of Zoological Gardens Authorities and aligned with the ethical standards for observational studies in Zoological Gardens. Collected data was systematically compiled and analysed using standard methods as per Saha (2009).

III. RESULTS

Table 1 show the different behavior of ring tailed lemur, *Lemur catta* during morning, afternoon and evening periods of the day under human captive conditions. Total 17 different behaviors were recorded, of which 16 behaviors (except sleeping) were recorded during morning period and 16 behaviors (except negative interaction) were recorded during afternoon period. However, during evening, all the 17 behaviors shown by *L. catta* (Table 1). *L. catta* revealed distinct temporal patterns in its activity throughout the day. During morning period it showed very high energy expenditure with more locomotion (20.6%), jumping (16.8%), hanging (16.8%) and vigorous social behaviours like chasing (5.6%) and wrestling (5.6%). The early morning activities represents territorial patrols, play and hierarchy establishment upon waking. The afternoon shows a dramatic behavioural shift toward sustenance and rest, featuring the highest eating (3.9%) and drinking (6.2%) frequencies, alongside dominant resting (8.9%) and sleeping (3.5%) behaviours - a probable adaptation to avoid midday heat stress (Table 1). However, during evening periods, the activity presents an interesting compromise: while locomotion remains high (24.8%) and hanging peaks dramatically (18.8%), possibly for sleeping site selection, positive social interactions (1.4%) increase slightly, suggesting social bonding before nightfall. Maintenance behaviours show time-specific patterns: grooming is most frequent in mornings (6.1%), potentially for social bonding after waking, while scratching peaks (14%) in afternoon, possibly due to heat-related stress or parasite avoidance during rest periods. Alertness (vigilance at 4.3%) and negative interactions (0.5%) are morning-loaded, possibly reflecting territorial checks after nocturnal inactivity. The absence of abnormal behaviours across all time periods suggests good welfare conditions during the present study (Table 1). These patterns collectively paint a picture of a species following a biphasic activity rhythm - high energy output in morning and evening with a restful, sustenance-focused afternoon. The behavioural shifts likely represent evolutionary adaptations to balance energy expenditure, thermoregulation and social needs. For caretakers, these findings suggest the importance of timing feeding (afternoon), enrichment (morning), and social monitoring (evening bonding, morning aggression checks) to align with natural lemur rhythms. Further research pairing this data with environmental variables like temperature could yield even more precise management recommendations. The different behaviour of *L. catta* recorded during the present study in Sri Chamarajendra Zoological Garden, Mysuru. Although, analysis of variance of different behaviors of *L. catta* didn't show significant variation ($F=0.599$; $P>0.05$) under captive conditions, clearly indicates that *L. catta* exhibited similar type of behavior during most of the periods in a day (Table 1). Figure 1 shows the per cent occurrence of different behaviors of *L. catta* during different periods of the day under captive conditions in Sri Chamarajendra Zoological Gardens, Mysuru.

IV. DISCUSSION

The ring-tailed lemur, *L. catta* (Primates: Lemuridae) is one of the most recognizable primate species, possess distinct black-and-white striped non-prehensile tail used for balance and social signalling. It is a native species of Southern Madagascar, inhabit dry deciduous forests, scrublands and spiny bushy areas. It is a diurnal, terrestrial and arboreal animal, live in social groups called 'troops'. Each troop usually consisting of 6 to 30 individuals with females dominate males in social hierarchy. Troops are matrilineal and highly territorial. *L. catta* feeds on fruits, leaves, flowers, bark and occasionally insects and making it as an opportunistic omnivore (Jolly and Pride, 1999; Manna *et al*., 2007). *L. catta* exhibit various behaviours in their natural environment. The commonly occurring behaviours are sunbathing in a 'sitting yoga posture' to absorb warmth, scent-marking for territory using wrist and shoulder glands, vocal communication using grunts, wails, alarm calls and grooming rituals for social bonding. These natural behaviours are vital for *L. catta* to live with social cohesion and survival in the wild. While, zoological gardens aim to replicate natural habitats, *L. catta* exhibited captive stress symptoms such as pacing or circling, over grooming or tail-chasing, aggression or withdrawal during high visitor's density and reduced play or social interaction. Similar type of observations were made by Mason *et al*. (2007) and Hosey (2005). During the present investigation, various behaviours were recorded which are almost on par with the observations of earlier workers. Therefore, enrichment tools (e.g. Puzzle feeders and climbing structures) have been shown to reduce abnormal behaviour and increased naturalistic activity (Carlstead and Shepherdson, 2000). *L. catta* are housed in a well-vegetated enclosures with climbing platforms and shaded areas at Sri Chamarajendra Zoological Gardens, Mysuru. Zoo garden animal care takers/staff report that individuals become more alert in early

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morning and late afternoon and sometimes retreat to higher spots during peak visitor hours. Human presence in Zoological Gardens particularly visitors effect through visitors interactions have both positive and negative effects on captive animals (Hosey, 2008). For social species like *L. catta*, visitors could act as a source of novelty or enrichment (Hosey 2008 and 2013). Captive primates (e.g. *L. catta*) show increased activity, becoming more alert, playful or interactive when people are present in moderate numbers. Moreover, many captive animals may develop stress or aggression due to large noisy crowds that cause animals to hide, pace, over groom, or avoid feeding.

Lemurs showed early day bursts of locomotion and social interaction, suggesting territorial or hierarchy based behaviours after waking. Afternoon feeding and resting patterns align with energy conservation strategies. *L. catta* exhibited a clear biphasic activity pattern, with heightened the physical and social activity during morning and evening periods, and a considerable drop-in activity during afternoon period. The afternoon mid-day lull is likely a behavioural adaptation to avoid heat stress and conserve energy consistent with findings in other studies of primates and lemurs in both wild and captive settings. *L. catta* are highly responsive to environmental cues and exhibited structured daily routine activity (Table 1), which are important for welfare monitoring. However, according to the IUCN Red List (IUCN, 2014), the *L. catta* is classified as endangered species and estimated that its populations have declined by over 95% in recent decades (IUCN, 2020) due to its rapid habitat loss (e.g. Deforestation, slash-and-burn agriculture), hunting for bush meat and pet trade, fragmentation of forest habitats. Therefore, its protection is very essential to restore its presence in the ecosystem. The present study throw a light on the behavioural rhythms of *L. catta* at Sri Chamarajendra Zoological Gardens, Mysuru. These observations help understand that how during different periods of a day, activity of captive wild animal like L. catta behave under controlled human captive conditions.

V. SUMMARY AND CONCLUSION

During the present study, behavioural pattern of non-human primate, ring-tailed lemur, *L. catta* across different periods of the day was recorded at Sri Chamarajendra Zoological Gardens. *L. catta* displayed a biphasic activity pattern, with increased locomotion, jumping, hanging and social behaviours during morning and evening periods and a clear mid-day rest period marked by eating, drinking and resting. The locomotion (e.g. Walking, climbing, jumping), feeding and drinking, resting (e.g. Sitting or lying inactive), sleeping, vigilance (e.g. Alert posture, scanning surroundings), vocalization, positive social interaction (e.g. Grooming, playing) and negative interaction or aggression (e.g. Threats, chasing, hitting) were recorded during the present study. The grooming was notably high during morning, likely serving for social purposes, while scratching was highest during afternoon possibly due to heat stress. Interestingly, no abnormal behaviour was observed and indicated that *L. catta* adapted well to captive conditions at Sri Chamarajendra Zoological Gardens, Mysuru.

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Table 1. Analysis of variance of different behaviours of Ring tailed Lemur, *Lemur catta*

Sl. No.	Name of behaviour	No. of observation (n) of different behaviours during			Total
		Morning	Afternoon	Evening	
1.	Locomotion	81	64	91	236
2.	Drinking	8	16	11	35
3.	Eating	9	10	8	27
4.	Resting	9	23	15	47
5.	Sleeping	-	9	2	11
6.	Vigilance	17	8	13	48
7.	Vocalization	4	9	1	14
8.	Positive interaction	3	2	5	10
9.	Negative interaction	2	-	1	3
10.	Depart	5	3	4	12
11.	Approach	15	5	7	27
12.	Jumping	66	24	57	147
13.	Hanging	66	22	69	157
14.	Grooming	24	14	19	57
15.	Scratching	40	36	38	114
16.	Wrestling	22	4	14	40
17.	Chasing	22	8	12	42
Total		393	257	367	1027
'F' value		0.559*			-

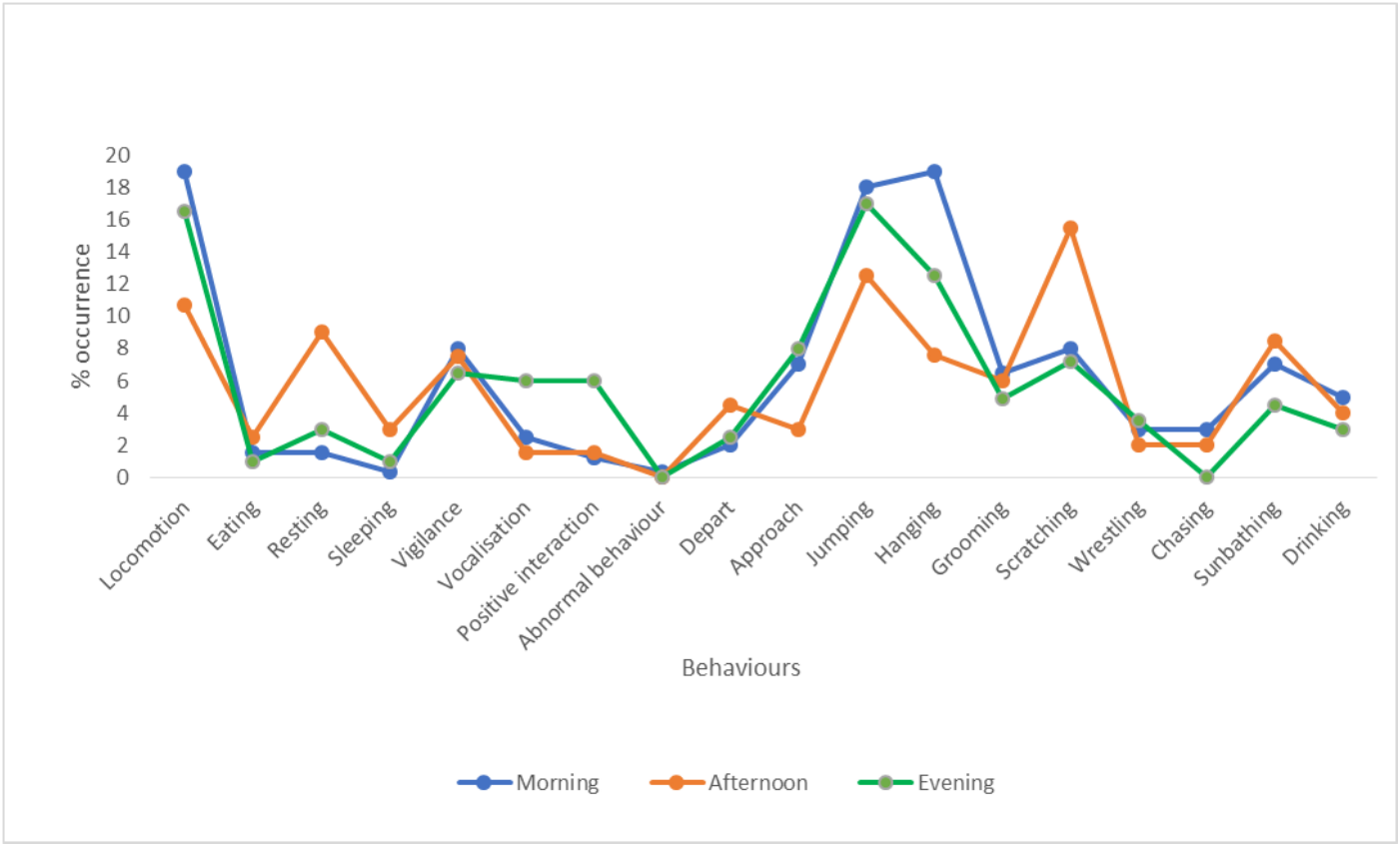

Figure 1. Per cent occurrence of different behaviours of Ring tailed Lemur, *Lemur catta*

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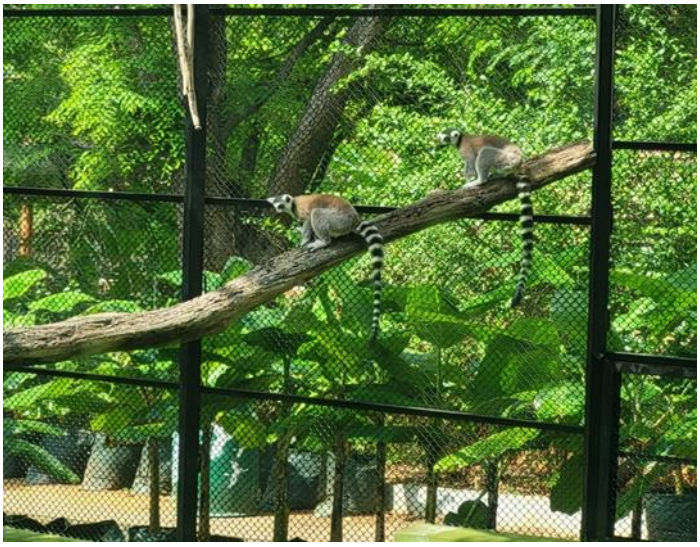
Photo 1. Ring tailed Lemur, *Lemur catta* taking rest in the hut



Phote 2. Ring tailed Lemur, *Lemur catta* playing and watching visitors