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Daily Activity Patterns and Feeding Behavior of Captive Ring-Tailed Lemur *Lemur catta* (Primates: Lemuridae) at the Schmutzer Primate Center, Ragunan Zoo, Indonesia

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Abstract
This study investigates the daily activity patterns and feeding behavior of captive ring-tailed lemurs *Lemur catta* housed at the Schmutzer Primate Center, Ragunan Zoo, Indonesia. Through systematic observation over two months, including Ad Libitum and Focal Animal Sampling methods, data were collected on three adult individuals (one female and two males). Results revealed a predominant time allocation to resting (72.6%), followed by grooming (9.81%), locomotion (8.20%), and feeding (8.15%). Feeding activity peaked in the morning and late afternoon, aligning with thermoregulatory behavior such as sunbathing. The lemurs displayed a preference for provisioned fruits and vegetables, with limited manipulation of food items, reflecting species-specific feeding traits. No occurrences of agonistic, sexual, or play behaviors were recorded during the observation period. These findings highlight the behavioral adaptations of *L. catta* in a semi-natural captive setting and provide essential insights for enhancing animal welfare, enrichment, and management practices in zoological institutions.

Keywords: daily activity pattern, feeding behavior, *Lemur catta*, ring-tailed lemur, Schmutzer Primate.

Introduction

The study of non-human primate behavior in captive environments provides essential insights into species adaptability, social organization, and welfare management. One such setting is the Schmutzer Primate Center (SPC), a 13-hectare facility situated within Ragunan Zoo in Jakarta, Indonesia. As one of Southeast Asia's leading institutions focused on primate conservation, SPC adopts an open-zoo concept, simulating naturalistic habitats that promote species-typical behaviors (Dalimunthe *et al.* 2021). Among its collection are several native and exotic primate species, including Orangutans *Pongo pygmaeus*, Chimpanzees *Pan troglodytes*, Gorillas *Gorilla gorilla* and Ring-tailed lemurs (*Lemur catta*), the latter of which were introduced through a zoo exchange program with Hungary in 2011 (Hernasari 2011).

The ring-tailed lemur *Lemur catta* is a diurnal, highly social primate species endemic to the dry forests and scrublands of southern and southwestern Madagascar (Ramalingam *et al.* 2015; Schwitzer *et al.* 2013)). Its taxonomic classification places it within the family Lemuridae, under the order Primates. It is morphologically distinct, most notably for its long, black-and-white ringed tail, gray to brownish dorsal fur, and white underparts. Males have a specialized scent-marking structure near their wrists known as a horny spur (Schwitzer *et al.* 2013). *Lemur catta* lives in multi-male, multi-female groups ranging from 10 to 20 individuals and exhibits female dominance, a rare characteristic among primates (Kappeler *et al.* 2022; Law *et al.* 2021; Parga *et al.* 2016). These groups are relatively egalitarian among males but are led by a dominant female who often has preferential access to food and space. Behavioral synchrony is a prominent feature of the species' social life, with group members engaging in simultaneous sunbathing, coordinated feeding, and resting behaviors (Caselli *et al.* 2022).

Daily activity patterns in wild *L. catta* populations have been well documented, with the species allocating a large proportion of its time to resting, especially during the warmer parts of the day. Feeding and locomotion occur primarily in the early morning and late afternoon, periods that coincide

with cooler ambient temperatures (Goodenough *et al.* 2019). Morning sunbathing—often conducted in a "lotus posture" facing the sun—is a unique thermoregulatory behavior observed in this species (Kelley *et al.* 2016).

In terms of feeding ecology, *L. catta* is a generalist omnivore that consumes a wide variety of plant and animal matter, including fruits, leaves, flowers, insects, and small vertebrates (Hansell *et al.* 2020; Steffens 2020). In wild settings, fruits and leaves typically comprise the bulk of their diet, while in captivity, diets are influenced by provisioning practices and availability of enrichment. Although an omnivore, *L. catta* demonstrates limited manual dexterity compared to anthropoid primates, often grasping food without intricate manipulation (Dickinson *et al.* 2025; Regaiolli *et al.* 2016). Understanding the behavioral ecology of *L. catta* in captivity is crucial for improving animal welfare, enclosure design, and conservation education. Although many studies have explored this species in the wild, fewer have focused on its activity patterns and feeding behavior in managed care environments. The semi-natural enclosure at SPC offers a valuable opportunity to observe how *L. catta* adapts its behavior under captive conditions that attempt to mimic the wild. Therefore, this study aims to examine the daily activity patterns and feeding behavior of a small captive group of ring-tailed lemurs at the Schmutzer Primate Center. By documenting individual identification, behavioral sequences, and food preferences, this study contributes to a better understanding of the behavioral repertoire of *L. catta* in captivity and offers practical recommendations for improving primate management in zoological institutions.

Methods

This study was conducted over two months, from October to November 2014, at the Schmutzer Primate Center (SPC), situated within Ragunan Zoo, Jakarta, Indonesia (Figure 1). The SPC is one of Southeast Asia's largest and most advanced primate-focused facilities, covering 13 hectares of semi-naturalistic enclosures designed to replicate wild habitats. The center utilizes an open-zoo concept to promote natural behaviors among captive primates, making it an ideal setting for behavioral studies on *Lemur catta* (RZJ 2014).

Figure 1. Map of the Schmutzer Primate Center, Ragunan Zoo, Jakarta, Indonesia.

Before systematic observation, a habituation session was conducted in September 2014 (1 month) to allow the captive lemurs to adjust to the presence of human observers. This step was critical in minimizing observer-induced stress or behavioral changes, as recommended by Gazagne *et al.* (2020). Individual identification was carried out visually, based on observable physical characteristics such as tail banding patterns, body size, and facial markings. Age classification followed the criteria established by (Andrade *et al.* 2004), categorizing individuals as Baby (0–6 months), Infant (7–18 months), Adolescent (19–31 months), Subadult (32–44 months), or Adult (45–192 months).

Behavioral data were collected through two observation sessions per day, from 09:00 to 12:00 and 13:00 to 16:00. The study utilized two complementary observational techniques as outlined by Bateson & Martin (2021): Ad Libitum Sampling and Focal Animal Sampling. Ad Libitum Sampling documents general daily behaviors and infrequent or spontaneous actions such as aggression, play, or social hierarchies. This method allowed for the broad recording of behavioral diversity without constraints, especially useful for capturing social dynamics and unusual events (Bateson & Martin 2021). Observed behaviors were categorized using ethograms adapted from Syafutra (2024) (Table 1), ensuring consistency with primate behavioral literature.

Table 1. Daily behavior ethogram of *Lemur catta*.

Behavior	Description
Feeding	The individual engages in feeding behaviors, including searching for food (foraging), selecting, carrying, eating, and rejecting food.
Drinking	The individual drinks water or other liquids to quench thirst.
Resting	The individual lies down or sits in a stationary position (still), either with eyes open or partially open or eyes closed (sleeping).
Locomotion	The individual moves or changes location, demonstrating all types of movement using its limbs.
Agonistic	The individual engages in conflict, including fighting, escaping, or freezing in place.
Sexual	The individual engages in mating behaviors, including physical contact, courtship, or genital inspection, followed by sexual intercourse.
Grooming	The individual cleans hair or skin (removing dirt or skin flakes) using hands, tongue, lips, or teeth.
Play	The individual engages in chasing, rolling, swinging, or mock fighting that does not escalate into agonistic behavior.
Defecation	The process of expelling feces through the anus as a form of bodily excretion.
Urination	The process of expelling urine through the genital area as a form of bodily excretion; may also serve as territorial marking.
Vocalization	The individual produces sounds (noises) from the mouth, such as calls. These calls may serve as greetings toward others (greeting call), expressions of disturbance (disturbing call), communication between individuals (calling), or courtship signals (courtship call).

Focal Animal Sampling was employed to analyze feeding behavior and dietary preferences in more detail. In each session, one individual was observed continuously for 15 minutes, followed by a 5-minute rest interval before switching to the next focal subject. This approach enabled repeated, systematic tracking of specific individuals' behaviors across multiple time points (Iqbar *et al.* 2024; Bosholn & Anciães 2022; Rose & Riley 2021).

All food items consumed by the lemurs were recorded during observation periods through direct visual assessment. Food types were identified based on appearance, texture, and placement within the enclosure, distinguishing between naturally occurring materials (e.g., leaves and fruit) and provisioned diets supplied by zookeepers. This method provided a practical and ethical means of categorizing diet without invasive sampling, aligning with approaches used in other captive primate dietary studies (Iqbar *et al.* 2024; Matthews *et al.* 2020).

Behavioral data were processed through both descriptive and quantitative analyses. Descriptive statistics summarized general activity trends, including behavior frequencies and durations. Quantitative analysis followed protocols established by Bateson & Martin (2021), involving the calculation of time budgets for each behavior and graphical representation of activity distributions throughout the day. Feeding behavior was further analyzed to determine relative preference for different food types and temporal patterns in consumption. Data visualization was used to support the interpretation and presentation of results.

Results and Discussion

Individual Identification and Habituation

The captive group of *Lemur catta* observed at the Schmutzer Primate Center (SPC), Ragunan Zoo, consisted of three adult individuals—one female and two males (Table 2, Fig. 2). These lemurs were introduced to the zoo through a collaborative exchange program with Hungary in 2011 (Hernasari 2011). Despite sex differences, all three individuals were morphologically similar, which posed a challenge for individual identification. Therefore, distinct visual features such as tail ring patterns, facial markings,

and body size were used to distinguish between them reliably. These identification methods align with prior studies that emphasize the importance of individual recognition in behavioral studies (Vidal *et al.* 2021; Yorzinski 2017).

Table 2. Information on three *Lemur catta* individuals at the Schmutzer Primate Center.

Name	Sex	Year of Arrival	Category
L1	Female	2011	Adult
L2	Male	2011	Adult
L3	Male	2011	Adult

Figure 2. Photo of three *Lemur catta* individuals at the Schmutzer Primate Center: L1 (left), L2 (center), and L3 (right).

Habituation sessions conducted before data collection were crucial in reducing observer-induced stress and allowing natural behaviors to be recorded. This approach is widely recommended in the primatological field methods to ensure that behavioral data reflect undisturbed activity patterns (Hernández Tienda *et al.* 2022; Vicente-Alonso *et al.* 2021; Vidal *et al.* 2021; Gazagne *et al.* 2020; Green & Gabriel 2020). The lemurs displayed signs of successful habituation after repeated exposure to the observer, as evidenced by their continuation of daily activities in the presence of humans.

Daily Activity Budget, Behavioral Dominance, and Sex-Based Patterns

The daily activity of *L. catta* in the SPC enclosure showed a clear dominance of resting behavior, which accounted for the largest proportion of the time budget (Table 3 and Figure 3). This observation is consistent with findings in wild populations, where *L. catta* tends to rest during the hotter parts of the day to avoid thermal stress (Kelley *et al.* 2016). Resting behavior in the captive lemurs included lying in shaded areas, sunbathing during cooler hours, and sitting still while grooming themselves or others.

Table 3. Frequency & percentage of daily behaviors observed in *Lemur catta* group.

Behavior	Morning (09:00–12:00)		Afternoon (13:00–15:00)		Total	Total
	Frequency (times)	Percentage (%)	Frequency (times)	Percentage (%)	Frequency (times)	Percentage (%)
Feeding	1,365	8.38	1,290	7.92	2,655	8.15
Drinking	90	0.55	30	0.18	120	0.37
Resting	12,435	76.3	11,205	68.8	23,640	72.6
Locomotion	1,035	6.35	1,635	10.0	2,670	8.20
Agonistic	0	0	0	0	0	0
Sexual	0	0	0	0	0	0
Grooming	1,080	6.63	2,115	13.0	3,195	9.81
Play	0	0	0	0	0	0
Defecation	0	0	15	0.09	15	0.05
Urination	0	0	0	0	0	0
Vocalization	285	1.75	0	0	285	0.87
Total	16,290	**100**	16,290	**100**	**32,580**	**100**

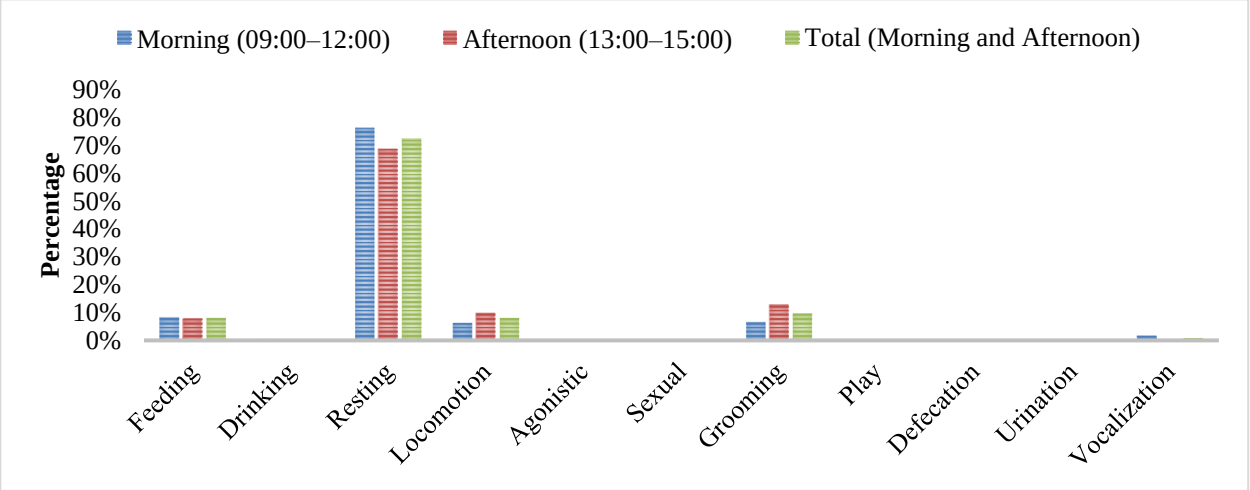

Figure 3. Percentage of daily behaviors observed in *Lemur catta* group.

Feeding, locomotion, and grooming were the next most prominent activities, primarily occurring during the early morning (09:00–10:30) and late afternoon (14:30–16:00). This bimodal activity pattern supports the notion that *L. catta* is adapted to cooler activity windows and aligns with its diurnal nature (Scott 2023; Caselli *et al.* 2022). Locomotion was typically performed as quadrupedal walking or short leaping between perches and climbing structures, while grooming sessions were frequently observed among all individuals, indicating the maintenance of social bonds in captivity (Caselli *et al.* 2022; Law *et al.* 2021).

Female dominance in *L. catta* is a well-documented phenomenon, where females often have priority access to food and central resting areas (Kappeler *et al.* 2022; Grebe *et al.* 2019). This behavior was observed in the SPC enclosure, where the female (L1) was more assertive during provisioning periods and occupied central perches more frequently.

Feeding Behavior

Feeding behavior (Table 4 and Figure 4) was characterized by frequent foraging within the enclosure and consumption of a diverse range of food items, including bananas, sweet potatoes, carrots, leafy vegetables, and occasional enrichment-based feeds such as boiled eggs and corn. Observations revealed that the lemurs demonstrated a preference for soft, sweet fruits, such as bananas and papayas, which were consumed immediately after provisioning. Leafy greens and root vegetables were often consumed later or left partially uneaten, indicating a potential selectivity based on texture and sweetness.

Table 4. Frequency & percentage of feeding activities observed in *Lemur catta* group.

Feeding Behavior	Percentage (%)			Average Percentage (%)
	L1	L2	L3	
Searching for Food (Foraging)	5.00	5.00	5.00	5.00
Selecting Food	11.7	8.33	8.33	9.44
Carrying Food	8.33	5.00	8.33	7.22
Eating Food	75.0	81.7	78.3	78.3
Rejecting Food	0	0	0	0
Total	100	100	100	100

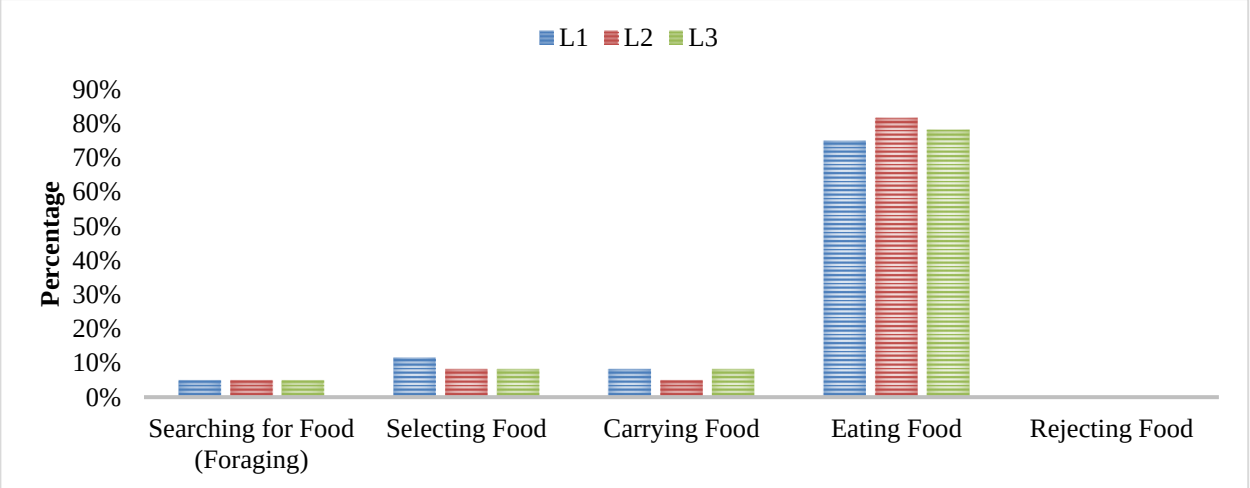

Figure 4. Percentage of feeding activities observed in *Lemur catta* group.

While *L. catta* is known as a generalist omnivore in the wild (Hansell *et al.* 2020; Steffens 2020), the captive diet in this study was more controlled and lacked the seasonal variation observed in their native habitats. Nevertheless, the lemurs displayed clear feeding strategies, including food inspection, manual grasping, and mouth-based manipulation—although the latter lacked the dexterity seen in anthropoid primates (Dickinson *et al.* 2025; Regaiolli *et al.* 2016). Feeding bouts were typically short (1–3 minutes per item), suggesting that satiety was quickly reached or that provisioning exceeded immediate dietary needs.

No significant food aggression was observed during feeding periods, although subtle displacement behavior—particularly by the female—indicated a social hierarchy in food access. These patterns support findings from previous studies suggesting that while *L. catta* maintains social tolerance during feeding, dominance behaviors subtly influence feeding order (Marcus 2020; Fichtel *et al.* 2018).

Implications for Welfare and Management

The results of this study have important implications for the welfare and management of captive *Lemur catta*. The high proportion of time spent resting suggests that the enclosure provides sufficient space, shade, and structural complexity to allow for species-typical behaviors, which is a positive indicator of welfare (Kelly *et al.* 2025; Laméris *et al.* 2021; Spiezio *et al.* 2017). However, to further enhance behavioral diversity and reduce behavioral monotony, enrichment practices should emphasize complexity in feeding (e.g., puzzle feeders, hidden food) and locomotion (e.g., expanded climbing structures).

Moreover, the observed sex-based dominance behaviors underscore the importance of understanding group dynamics when designing social groupings in captivity. The female's dominance in feeding and spatial positioning aligns with the species' natural matriarchal system and should be considered when introducing new individuals or modifying group compositions (Parga & Thurau, 2022; Norscia & Palagi, 2015). Finally, while provisioning was adequate, there is room for improvement in dietary diversity to reflect the natural omnivorous tendencies of the species. Introducing seasonal fruits, insects, or natural browse material may encourage foraging behavior and mimic ecological conditions found in Madagascar (Caselli *et al.* 2022; Laméris *et al.* 2021). Such practices could enhance

psychological well-being and align with global zoo standards for primate care (de Azevedo *et al.* 2023; Caselli *et al.* 2022; Clark *et al.* 2022; Law *et al.* 2021).

Conclusion

This study on the daily activity patterns and feeding behavior of captive ring-tailed lemurs *Lemur catta* at the Schmutzer Primate Center, Ragunan Zoo, reveals that resting behavior dominates their activity budget, mirroring patterns observed in wild populations. Feeding and locomotion occurred primarily during the cooler periods of the day, while sunbathing and social grooming were also regularly observed, indicating the expression of species-typical behaviors in a semi-naturalistic enclosure. The lemurs demonstrated generalist feeding habits, favoring fruits and leaves, with observable preferences for certain provisioned items. These findings highlight the importance of habitat design and feeding management in promoting naturalistic behaviors and overall welfare in captive primates. Moreover, the study underscores the value of systematic behavioral observations for enhancing conservation education programs in zoological settings.

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