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Parental Care Behavior of Sumatran Elephants (*Elephas maximus sumatranus*) During Nocturnal Activities in Gunung Leuser National Park, Tangkahan Resort, Langkat, North Sumatra, Indonesia

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ABSTRACT

The Sumatran elephant, active both day and night, is more active two hours before sunset and after dawn. In a matriarchal system, a dominant female leads the herd, with mothers and allomothers (non-nursing females) caring for the calves. This study, conducted at Gunung Leuser National Park, Tangkahan Resort, used CCTV to observe behavior like grooming, feeding, playing, and resting for 12 hours each night. Over 84 hours of observation, 5639 data points were recorded for adults and 5117 for calves, totaling 5040 minutes. Key nighttime activities included grooming (adults: 36.5%, calves: 22.07%), feeding (adults: 33.71%, calves: 24.5%), and playing (calves: 11.8%, adults: 5.24%). The study showed strong mother-calf bonds, with mothers actively protecting and teaching their young. These findings emphasize the mother's role in the calf's development during nighttime.
Keyword: behavior, CRU, nocturnal activity, parenting pattern, sumatran elephants.

ABSTRAK

Gajah Sumatra, yang aktif baik siang maupun malam, lebih aktif dua jam sebelum matahari terbenam dan setelah fajar. Dalam sistem matriarkal, seekor betina dominan memimpin kawanan, dengan ibu dan allomother (betina yang tidak menyusui) merawat anak-anak gajah. Penelitian ini, yang dilakukan di Taman Nasional Gunung Leuser, Resort Tangkahan, menggunakan CCTV untuk mengamati perilaku seperti grooming, makan, bermain, dan istirahat selama 12 jam setiap malam. Selama 84 jam pengamatan, tercatat 5639 data untuk gajah dewasa dan 5117 untuk anak gajah, dengan total 5040 menit. Aktivitas malam hari yang utama termasuk grooming (gajah dewasa: 36,5%, anak gajah: 22,07%), makan (gajah dewasa: 33,71%, anak gajah: 24,5%), dan bermain (anak gajah: 11,8%, gajah dewasa: 5,24%). Penelitian ini menunjukkan ikatan kuat antara ibu dan anak, di mana ibu aktif melindungi dan mengajari anaknya. Temuan ini menekankan peran penting ibu dalam perkembangan anak selama aktivitas malam hari.
Keyword: *aktivitas nokturnal, CRU, perilaku, pola pengasuhan, gajah Sumatera.*

1. Introduction

The elephant herd is led by a dominant female elephant, both in body morphology and character, known as a matriarchal system [1-3]. The elephant herd consists of adult female elephants, adolescents of both sexes and calves. When a female elephant gives birth within the herd, she immediately takes on the role of intensively caring for her offspring [4-6] The care of elephant calves is also assisted by other adult female elephants (allomothers) within the group. Thus, both the mother elephant and allomothers play similar roles in nurturing elephant calves within their group, the only difference being that allomothers do not nurse the elephant calves [7]. The mother nurtures, accompanies, and assists in the daily activities of the elephant calf

such as playing, communicating, and nursing. The mother elephant also teaches her offspring to forage and select food, provides assistance when they fall or get stuck in mud, and protects them from predators. Furthermore, mother elephants bathe their offspring with their long trunks and will retrieve them if they become lost [7].

The Sumatran elephant is a terrestrial mammal that is active both during the day and night, but it is more active from two hours before sunset until two hours after dawn. During this time, elephants naturally engage in various activities such as foraging, mating, caring for offspring, eating, drinking, sleeping, and others. This animal is categorized as having keen hearing and a strong sense of smell, and it has special adaptations to perform activities in low-light conditions[8]. The Conservation Response Unit (CRU) and Gunung Leuser National Park (GLNP) involve elephants in conservation programs. Elephants serve as a means for patrols to safeguard forests from illegal logging and monitor areas of human-wildlife conflict, including in the Tangkahan Resort, which directly borders the Gunung Leuser National Park (GLNP).

2. Methods

2.1 Study Sites

This research was conducted from June to July 2023. The research location was in Gunung Leuser National Park (GLNP), Tangkahan Resort, Langkat, North Sumatra. The research location can be seen in the figure below.

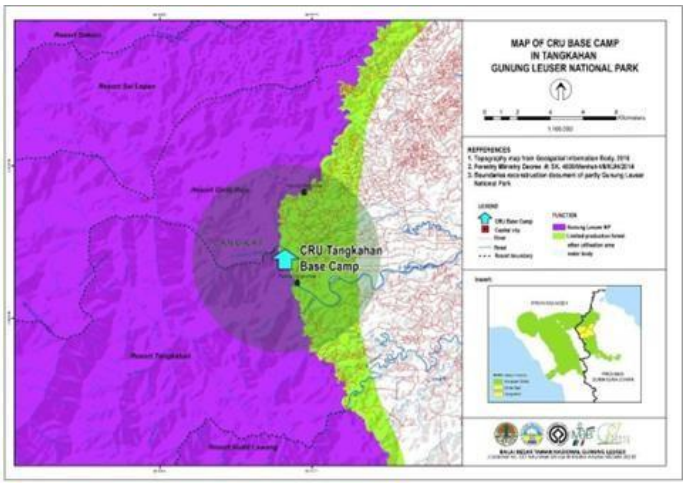

Figure 1. Map of the Research Location in GLNP, Tangkahan Resort

The subjects of this research were two Sumatran elephants (Elephas maximus sumatranus). The first, Sari, is a 47-year-old female elephant originally from the Forest Block in the Gampong Keude Ulee Gle area, Bandar Dua District, Pidie Jaya Regency, Aceh. Sari was relocated to Tangkahan at the age of 12. She weighs 2400 kg, stands 223 cm tall, and has a chest circumference of 320 cm. The second elephant, Boni, is the second offspring of a female elephant and is 2 years old. Boni weighs 349 kg, stands 148 cm tall, and has a chest circumference of 107 cm.

Figure 2. Adult female elephant (Sari) and elephant calf (Boni)

2.2 Data Collection

The research method focused on the parenting patterns of adult elephants towards Sumatran elephant calves during nocturnal activities using sampling rules with focal animal sampling method and observation rules with continuous recording method. The observational tool used was the Closed Circuit Television (CCTV) Ezviz C3N, equipped with IP 67 outdoor waterproofing, 2.4 GHz dual antenna WiFi, push notifications, and a flashlight. It features 2Mp 1080P resolution, a wide angle of 130 degrees, one-way audio with clear audio quality, and dimensions of 75.5 x 75.5 x 155 mm, weighing 422 g. The CCTV was activated at 18:00 WIB for 12 hours, and data collection on the behavior of both the adult and calf elephants was conducted without restricting their activities. Observed behaviors included multiple categories such as grooming, feeding, playing, movement, interactions, nursing, approaching/being approached, following/being followed, vocalizations, sniffing, resting, defecation, and urination. The CCTV was deactivated at 06:00 WIB, and behavioral observations of the elephants continued through video recordings, followed by the documentation of observed behaviors including their duration and frequency over a week.

2.3 Data Analysis

The data on parental care patterns of adult elephants towards elephant calves during nocturnal activities were processed using descriptive analysis to provide an overview of the parental care patterns of adult elephants towards Sumatran elephant calves, utilizing the formulas from [9] :

$$\% \text{ Frequency of Activity} = \frac{\text{Frequency of activity}}{Total\ frequency\ of\ activity}\ x\ 100\%$$

3. Result and Discussion

The observation of nocturnal activities of Sumatran elephants at the CRU Tangkahan for 84 hours yielded 5639 observation points for adult elephants and 5117 observation points for juvenile elephants, with a total duration of 5040 minutes. The research findings are presented in **Table 1** below. The highest observed nocturnal activities of adult and juvenile Sumatran elephants, in sequence, are grooming, resting, feeding, and playing.

Elephants often exhibit grooming behavior when numerous Tabanidae insects are flying around their eyes and other areas of their skin **(Figure 3A)**. Results in itching due to insect bites in those areas. Grooming behavior involves scratching different parts of their bodies with their trunk or using tree branches. This behavior includes scratching with their feet, flapping their ears, and tail. Its purpose is to avoid bites from ectoparasitic insects. Grooming behavior in Sari elephant lasted for 1874 minutes, while in Boni elephant, it lasted for 1078 minutes, with frequencies of 36.5% and 22.07% respectively. Based on observations, it is apparent that Sari elephant often scratches Boni's body. This is presumed to be a maternal care behavior of adult elephants towards their offspring.

Table 1. Behavior during Nocturnal Activities of Sumatran Elephants

No.	Behavior	Sari		Boni	
		Duration (Minute)	Frequency (%)	Duration (Minute)	Frequency (%)
1	*Grooming (*GG*)*	1874	36.5	1078	22.07
2	Feeding (MK)	1502	33.71	1125	24.5
3	Playing (BN)	230	5.24		
4	Movement (MV)	154	4.5	908	10
5	Interaction (IK)	119	2.3	182	3.9
6	Nursing (MU)	39	0.9		
7	Approaching (MT)	41	1.01	30	0.9
8	Following (MI)	31	0.76	29	0.72
9	Vocalisation *(*VI*)*	25	0.51	20	1
10	Sniffing (MM)	19	0.4	14	0.41
11	Resting (IS)	925	12.51	1023	22.3
12	Defecation (BA)	53	1.06	42	1.04
13	Urination (UI)	28	0.60	18	0.43
	Total	**5040**	**100%**	**5040**	**100%**

During the night time, both elephant individuals engaged in feeding activities. Sari, the adult elephant, demonstrated behavior resembling teaching its offspring to select available forage in the vicinity

and then offering it to the young one **(Figure 3B)**. This aligns with the findings of [10], indicating that elephant calves consume forage found around their mothers or remnants of their mothers' forage. This behavior exemplifies the maternal care exhibited by elephant mothers in teaching their offspring to feed. The duration spent by elephants engaging in feeding activities amounted to 1502 minutes, with a frequency of 33.71% for the adult elephant (Sari) and 1125 minutes, with a frequency of 24.5%, for the juvenile elephant (Boni), as depicted in **Table 1**. These durations and frequencies indicate a substantial allocation of time towards feeding behavior and movement compared to other behaviors. This is attributed to the elephants' need for sufficient forage intake to meet their daily dietary requirements, which are adjusted according to their body size and simple digestive system. According to [11], elephants exhibit a high feeding rate to fulfil their energy needs based on body size, age, and gender. Hence, feeding activities occupy the longest duration, both during the night and daytime. The prolonged duration of nighttime behavior is attributed to elephants being large herbivorous animals, thus requiring ample availability of green forage. Consistent with [10], elephants require a substantial amount of forage, approximately 200-300 kg per day for each adult elephant, which accounts for 5% - 10% of their body weight

Figure 3. Behavior A. Grooming, B. Feeding, C. Playing, D. Movement, E. Interaction, F. Nursing, G. Approaching, H. Following, I. Sniffing, J. Resting

The duration of playing behavior during the nighttime for the elephant Sari reached 230 minutes with a frequency of approximately 5.24%, while the juvenile elephant Boni engaged in playing behavior for 532 minutes with a frequency of 11.80%. Playing behavior occurred either with other elephants or using play objects. When Boni played with other juvenile elephants inside the enclosure, it was observed engaging in head-butting and pushing each other's heads **(Figure 3C)**. Sari, the adult elephant, was also seen suddenly running, followed by Boni, and then they took turns chasing each other. This represents a form of play between the adult and the offspring to enhance the juvenile elephant's agility during nighttime. Additionally, Boni was observed playing with other adult elephants within its group, consistent with the findings of [12], indicating that juvenile elephants also engage in play with allomothers within their groups. Hence, juvenile elephants do not exclusively play with other juveniles. According to [13], play behavior is an attractive behavior among animals. Some species exhibit consequences during play. Play behavior serves three main functions: object recognition, motor skill development, and fostering social bonds within the group [14]. Therefore, the playing behavior exhibited by the adult elephant (Sari) towards its offspring (Boni) is presumed to be a form of caregiving and training provided to the offspring.

The move behavior of the elephant Sari showed a duration of 154 minutes and a frequency of 4.5%, while for the elephant Boni, it was 908 minutes with a frequency of 10% during the nighttime. Elephants exhibit move behavior prior to engaging in other behaviors. Move behavior involves an individual slowly stepping to transition from one location to another. This behavior is influenced by the natural inclination of elephants to engage in exploration activities, hence, elephants are accustomed to spending extended durations on move behavior. Sari and Boni are often observed engaging in move behavior within the enclosure during the nighttime **(Figure 3D)**. This behavior involves stepping towards a specific destination, such as a pile of grass or coconut leaves. Elephants can move two to five steps from their initial location within a brief duration, typically lasting 2 - 5 minutes. However, elephants can also engage in moves that exceed five steps with durations longer than 5 minutes. Sari, the adult elephant, is observed stepping while touching the hindquarters of the juvenile elephant Boni, seemingly nudging it with its trunk. This suggests that Sari is encouraging Boni to move towards the forage pile. Subsequently, Sari teaches Boni to consume the forage. However, elephants only engage in move behavior within close proximity to the enclosure. This is because during the nighttime, elephants are confined within the enclosure by barriers, preventing them from moving long distances as they would in their natural habitat. The area of exploration differs from that in their natural habitat. Elephant groups move from one area to another, with their home range determined by the availability of forage, shelter, and breeding grounds. According to [15], the presence of forage determines the size of an elephant's home range. The diversity of a habitat also influences the size of the home range. The more diverse an area, the smaller the home range, as elephants can meet their needs within a relatively small area [16-19]. Additionally, [20] suggest that as vegetation density decreases, the availability of forage diminishes, making it harder to find water, resulting in a decrease in the carrying capacity of the elephant habitat. Consequently, the influx of elephants to such areas also decreases.

Interaction behavior can occur in both positive and negative relationships. However, in this study, the adult elephant (Sari) exhibited a positive relationship beneficial to the caregiving of its offspring (Boni). The interaction behavior between the two elephants had a duration of 119 minutes with a frequency of 2.3% for Sari, while Boni spent 182 minutes with a frequency of 3.9%. These data indicate that Boni spent more time and had a higher frequency of interaction with its mother, indicating the dependence of the juvenile elephant on its mother. Meanwhile, Sari displayed caregiving towards its offspring by touching and sniffing Boni using its trunk. Sari also taught Boni to select forage for consumption **(Figure 3E)**. Interaction behavior performed by the adult elephant serves to nurture and care for its offspring, displaying affection. When interacting between the adult and juvenile elephants, it serves as a means of communication to convey information or current conditions to other individuals, often through touch using the trunk. According to [21], the elephant trunk is a unique organ functioning as a nose, hand, mouth/tongue, and vibration chamber, known as synesthesia, used to convey and receive messages in all sensory modalities. Sari demonstrated interaction by reaching out to each other, intertwining trunks, inserting the trunk tip into the mouth of the other elephant, placing the trunk on the back, or simply touching the juvenile elephant Boni with the tip of its trunk.

The observation results of nursing behavior indicate a duration of 39 minutes with a frequency of 0.9% for both Sari and Boni. Juvenile elephants will nurse when feeling hungry, thirsty, or stressed. Boni, being an active and aggressive juvenile elephant during various activities, expends energy quickly, leading to feelings of hunger and thirst. Lactation efficiency refers to the energy from the milk provided by the mother elephant to her offspring [22]. Therefore, Boni requires intake of its mother's milk. Furthermore, the mother

elephant Sari is always ready to nurse her offspring. Sari allows and remains calm as Boni wraps its trunk around and pulls the mother's nipple to suckle her milk while standing **(Figure 3F)**. According to [7], maternal nursing behavior towards juvenile elephants can occur at any time when the juvenile feels hungry. The juvenile elephant will use its trunk to wrap around and pull the mother's nipple to release milk. Subsequently, the juvenile elephant will tilt its head and suckle from the mother's nipple with its mouth. Based on observations, the two-year-old juvenile elephant (Boni) is still frequently nursing during both nighttime and daytime. This aligns with [16] statement that elephant mothers will nurse their offspring until they are 3 years old or older.

The approach behavior exhibited by both the adult elephant (Sari) and the juvenile elephant (Boni) had a duration of 41 minutes with a frequency of 1.01% for Sari and a duration of 30 minutes with a frequency of 0.9% for Boni. These data indicate that the adult elephant approached its offspring more frequently and for a longer duration, likely to protect its offspring. Approach behavior is often initiated by the juvenile elephant towards the adult elephant ahead of it. Additionally, approaching behavior towards chasing other elephants is observed when there are other elephants in front of them, prompting them to follow or approach. The adult elephant is seen approaching its offspring when the offspring is perceived to be far from its sight, causing the adult to feel anxious and immediately approach its offspring to protect it. Meanwhile, if Boni wanders far away, it sometimes returns to approach its mother **(Figure 3G).**

The behavior of following exhibited by both elephants had a duration of 31 minutes with a frequency of 0.76% for Sari and a duration of 29 minutes with a frequency of 0.72% for Boni. Following behavior is one of the ways in which elephant mothers care for their offspring. Based on observations, the adult elephant (Sari) always follows its offspring (Boni). This behavior is presumed to be the adult elephant's way of providing protection to its offspring. Similarly, the juvenile elephant always follows its mother wherever she goes, allowing the juvenile to feel safe being close to its mother. Meanwhile, the adult elephant (Sari) also appears to wait for the juvenile elephant Boni to approach. This behavior is evident from Sari's slow-paced steps. Subsequently, Boni always follows from behind its mother and mimics the activities of the adult elephant **(Figure 3H).**

Vocalization behavior involves elephants opening their mouths to produce sounds originating from the oral cavity. Additionally, elephants occasionally exhibit vocalization behaviors such as raising their trunk above their head and slightly lifting their head. This behavior serves as a means of communication with other elephants. The duration of vocalization behavior was 25 minutes with a frequency of 0.51% for the adult elephant (Sari) and 20 minutes with a frequency of 1% for the juvenile elephant (Boni). The adult elephant (Sari) vocalizes to call its offspring and then moves towards it when the offspring is playing at a distance. This is a way for the adult elephant to protect its offspring from danger. Meanwhile, Boni also approaches its mother, feeling comfortable and secure. Additionally, the juvenile elephant Boni is often observed exhibiting vocalization behavior during play. This suggests that Boni enjoys playing, resulting in a higher frequency of vocalization compared to its mother. Research on vocalization has been conducted by various researchers [23-25]. Elephants communicate through several means, including vocalization behavior to identify other individuals [26-28]. They possess sensitive hearing abilities, capable of detecting higher frequencies than humans, and can emit ultrasonic sounds audible over several kilometers [26,29,30,31]. Additionally, elephants communicate through sensitivity to seismic movements [32-34].

The duration of sniffing behavior amounted to 19 minutes with a frequency of 0.4% for Sari and 14 minutes with a frequency of 0.41% for Boni. Sniffing behavior is one of the ways in which elephant mothers care for and protect their offspring. During the nighttime, Sari is also observed sniffing her offspring by gently probing with her trunk to ensure Boni's condition and presence nearby **(Figure 3I)**. Some elephant mothers commonly express their affection by hugging, stroking, and sniffing their offspring using their trunks. This is done by elephant mothers to ensure their offspring feel comfortable.

Rest behavior refers to a state of inactivity (quiet). According to [35], rest behavior is an integral part of mammalian life and is defined as an inactive state associated with reduced responsiveness. Elephants are polyphasic animals characterized by multiple sleep and wake intervals throughout the 24-hour day. Polyphasic sleep patterns are not uncommon in the animal kingdom [36]. Based on observations, elephant rest behavior occurs both during the day and night, with elephants lying down or standing. According to [36- 39], elephants sleep by standing or lying down sideways at night, both in the wild and in captivity. Elephants often wake up to eat and then lie back down to sleep. The adult elephant (Sari) rests in a lying position, closing her eyes and sometimes using a pile of branches or twigs as a cushion. Meanwhile, rest behavior in a standing position involves closing the eyes while still protecting her sleeping offspring under her. Typically,

elephants sleep standing under the shade of a leafy tree. This position is one way elephants stay alert and protect themselves and their offspring from predators. Rest behavior in elephant Sari lasts for 925 minutes with a frequency of 12.51% and lasts for 1023 minutes with a frequency of 22.3% for Boni **(Figure 3J)**. The high duration of rest behavior in Boni indicates comfort, safety during rest, and good health. Thus, rest behavior is considered fundamental for good health status and physical recovery through relaxation of the musculoskeletal system (i.e., rest while awake) or the central nervous system (i.e., sleep rest) throughout the animal kingdom [35]. Additionally, the comfort and safety experienced by Boni are due to the continuous protection provided by the adult elephant Sari at night, even within the elephant enclosure. The high activity of Boni during the daytime also necessitates a longer resting period at night.

Defecation behavior involves the expulsion of undigested food residues from the body through the excretory passage (anus) in the form of faeces. Elephant faeces are characterized by a high fibre content compared to cattle faeces. Elephant faeces typically have a solid and fibrous texture, but when elephants experience digestive issues, the texture of their faeces may become more liquid. Elephants have a monogastric, non-ruminant digestive system with a hindgut fermentor [40]. Therefore, elephants can only absorb 40% of the nutrients from the digested food, with the remainder being excreted as faeces. Defecation behavior involves the expulsion of faeces by elephants, followed by the excretion of urine. Observational results indicate that defecation behavior lasts for 53 minutes with a frequency of 1.06% for Sari and 42 minutes with a frequency of 1.04% for Boni. The duration and frequency of defecation in the adult elephant (Sari) are higher compared to the juvenile elephant (Boni) **(Figure 4A)**. This occurs because the adult elephant consumes more food compared to the juvenile elephant.

Figure 4. Behavior A. Grooming, B. Feeding, C. Playing, D. Movement, E. Interaction, F. Nursing, G. Approaching, H. Following, I. Sniffing, J. Resting

Urination behavior is typically exhibited before or after defecation. Elephants display urination behavior for approximately 28 minutes with a frequency of 0.6% in the adult elephant (Sari) and 18 minutes with a frequency of 0.43% in the juvenile elephant (Boni). The type of vegetation consumed by elephants influences the frequency of urination. Furthermore, the more frequently elephants drink, the higher the frequency of urination. This aligns with [7], indicating that high feeding activity and high moisture content in the diet affect the frequency of urination. Therefore, the frequency of defecation and urination activities depends on digestibility, body metabolism, and food consumption. Additionally, the frequency is considered low due to the average nighttime temperature of approximately 30.58°C and humidity of 69.58%. These factors contribute to elephants exhibiting urination behavior less frequently.

4. Conclusions

Parental care behavior towards elephant calves during nocturnal activities in TNGL Resort Tangkahan, Langkat, North Sumatra, exhibits several behaviors, including grooming, feeding, playing, moving, interacting, nursing, approaching, following, vocalizing, sniffing, and resting, while behaviors such as defecation and urination are not considered parental care behaviors. In the case of the elephant mother (Sari), the highest observed behavior is grooming (1874 minutes; 36.5%), whereas the lowest observed behavior is sniffing (19 minutes; 0.4%). Conversely, in the case of the elephant calf (Boni), the highest observed behavior is feeding (1125 minutes; 24.5%), while the lowest observed behavior is sniffing (14 minutes; 0.41%).

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