

## **Behavioral Responses of Timor Deer (*Rusa timorensis*) Fawns to the Presence of Visitors at the Semarang Zoo**

*(RESPONS PERILAKU ANAK RUSA TIMOR  
(RUSA TIMORENSIS) TERHADAP KEHADIRAN  
PENGUNJUNG DI KEBUN BINATANG SEMARANG)*

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### **ABSTRACT**

Animal behavior is a directed activity resulting from environmental stimuli involving the coordination of the nervous, endocrine and muscular systems. The presence of visitors at the zoo, whether on weekdays or weekends, can significantly impact animal behavior. Deer avoid contact with humans, but conditions at the zoo, which differ from the wild, require deer to be able to interact with humans. The purpose of this study was to evaluate the behavioral responses of Timor deer (*Rusa timorensis*) fawns to the presence of visitors on weekdays and weekends in the *ex-situ* conservation area of Semarang Zoo of Central Java, Indonesia. The behavioral responses observed included aggressive, locomotor, eliminative, self-grooming, resting, feeding and social behaviors. This study was conducted over 21 days by observing the behavior of nine Timor deer fawns, consisting of six females and three males, that were still suckling their does. The observation method used was scan-sampling, which was conducted in the morning, noon and afternoon, with a two-hour observation interval. The data obtained were analyzed using a t-test. The presence of visitors on weekdays and weekends had no effect ( $p>0.05$ ) on all observed behavioral parameters of Timor deer fawns. However, the percentage of locomotion, eating, self-care, social and elimination behaviors was higher in the morning with a longer duration, while the percentage of rest was longer in the afternoon. This study concluded that the behavioral responses of Timor deer fawns at the *ex-situ* conservation area to visitors were consistent on both weekdays and weekends. The Timor deer were accustomed to the presence of visitors, allowing them to exhibit their natural behavior still.

**Keywords:** eliminative behavior; grooming; natural behavior; Timor deer

## ABSTRAK

Respons perilaku hewan adalah aktivitas terarah yang dihasilkan dari rangsangan lingkungan dengan melibatkan koordinasi sistem saraf, endokrin dan otot. Kehadiran pengunjung di kebun binatang pada hari kerja atau hari libur dapat memberikan dampak pada perilaku hewan. Secara alamiah, rusa menghindari kontak dengan manusia, namun kondisi di kebun binatang yang berbeda dengan alam liar menuntut rusa untuk dapat berinteraksi dengan manusia. Tujuan dari penelitian ini adalah mengevaluasi respons perilaku anak rusa timor terhadap kehadiran pengunjung pada hari kerja dan akhir pekan di kawasan konservasi *ex-situ* Kebun Binatang Semarang, Jawa Tengah, Indonesia. Respons perilaku yang diamati meliputi perilaku agresif, bergerak, eliminatif, perawatan diri, istirahat, makan dan sosial. Penelitian ini dilakukan selama 21 hari dengan mengamati perilaku pada sembilan anak rusa timor, terdiri atas enam betina dan tiga jantan yang masih menyusui ke induknya. Metode observasi perilaku yang digunakan adalah *scan-sampling* yang dilakukan pada pagi, siang dan sore hari, dengan interval waktu pengamatan dua jam. Data yang diperoleh dianalisis menggunakan uji-t. Hasil penelitian menunjukkan bahwa kehadiran pengunjung pada hari kerja dan akhir pekan tidak berpengaruh ( $p>0,05$ ) pada semua parameter perilaku anak rusa timor yang diamati. Namun, persentase perilaku lokomosi, makan, merawat diri, sosial dan eliminasi lebih tinggi pada pagi hari dengan durasi yang lebih panjang, sedangkan persentase istirahat lebih lama dilakukan pada siang hari. Simpulan dari penelitian ini bahwa respons perilaku anak rusa timor di area konservasi *ex-situ* memperlihatkan kesamaan pada hari kerja dan akhir pekan, anak rusa timor terbiasa dengan kehadiran pengunjung sehingga masih dapat mengekspresikan perilaku alaminya.

Kata-kata kunci: *grooming*; perilaku alamiah; perilaku eliminatif; rusa timor

## INTRODUCTION

Indonesia is one of the countries with high biodiversity, including endangered species such as the Timor deer (*Rusa timorensis*) (Semiadi and Meijaard, 2019), which is threatened with vulnerability (IUCN 2015). There are three types of deer native to Indonesia, namely the Timor deer (*R. timorensis*), sambar deer (*Cervus unicolor*) and Bawean deer (*Axis kuhlii*). The Timor deer is distributed across the islands of Java, Timor, Lombok, Maluku and Sulawesi. The Sambar deer can be found on the islands of Sumatra and Kalimantan (Tamam 2018), while the Bawean deer is endemic to Bawean Island in Gresik Regency of East Java Province (Rahman *et al.*, 2023). The Timor deer can adapt outside its native habitat; therefore, its preservation is important both *in situ* and *ex situ* (Timmins *et al.*, 2019).

The daily behavior of animals provides an understanding of their needs and

welfare, especially in captivity or conservation environments (Siswanto *et al.*, 2016). Timor deer fawns exhibit daily behaviors that can be observed, such as aggression, movement, elimination, grooming, resting, feeding and social behavior (Putra and Prayitno, 2019). Research on the daily behavior of Timor deer fawns has been conducted in various conservation areas, with varying results (Purnomo and Haryono, 2020). The presence of visitors at the zoo, as *ex-situ* conservation, stimulates interaction between deer fawns and visitors. An increase in visitors on weekdays or weekends can also increase or even disrupt the daily activities of deer fawns in *ex-situ* conservation. Understanding the daily behavior of Timor deer fawns can help in the management of rearing deer fawns in zoos for *ex-situ* conservation (Wahyuni *et al.*, 2018). Research reports on the daily behavioral responses of Timor deer fawns in zoos as *ex-situ* conservation areas are still limited and not widely published;

therefore, this research was aimed to evaluate the daily behavior of Timor deer fawns. In the long term, this can improve the management and welfare of Timor deer fawns and contribute to conservation efforts.

Animal behavioral responses are directed activities resulting from environmental stimulation that involve coordination between the nervous, endocrine and muscular systems (Coria-Avila *et al.*, 2022). Various physiological processes underlie the emergence of behavior in animals, including sensory processes, integration in the central nervous system, and motor responses (Wahyuni *et al.*, 2018). The sensory process occurs at the receptors in the senses that detect internal and external stimulation. Sensory information is transmitted to the central nervous system through afferent nerve pathways, integrated in various brain areas and produces behavioral responses through the activation of efferent nerve pathways in the muscles and endocrine glands (Ramono *et al.*, 2019). Neurons in the sensory cortex encode sensory information, whereas neurons in the limbic system are involved in emotional processing. The hypothalamus and brainstem play roles in motivation and movement coordination. Neurotransmitters, such as dopamine, serotonin and oxytocin, are used in interneuronal communication and play important roles in the modulation of behavior (Coria-Avila *et al.*, 2022). This study aimed to evaluate the behavioral responses of Timor deer fawns to zoo visitors on weekdays and weekends within the *ex-situ* conservation area at Semarang Zoo. The observed behavioral responses included aggression, movement, elimination, grooming, resting, eating, and social behavior. The results of this study are expected to significantly contribute to the long-term improvement of the management, welfare and conservation of Timor deer fawns.

## RESEARCH METHODS

This research was carried out in an *ex-situ* conservation area at Semarang Zoo of

Semarang City, Central Java, Indonesia, for 21 days. The research began with habituation for five days, followed by data collection for 16 days. The objects observed were nine Timor deer fawns (six months to one year old, six females and three male fawns). The Timor deer in the Semarang Zoo came from the Natural Resources Conservation Agency of Central Java. The research implementation used the scan sampling method (Dewi and Wulandari, 2011) with the behavior definitions shown in Table 1. The daily behavior of the Timor deer fawns was documented using a camera video (Poco X3 Pro 8/256, MIUI 13 version, Xiaomi, Guangdong, China) three times each day, i.e., morning (08:00-10:00 a.m.), noon (10:00 a.m.-12:00 p.m.), and afternoon (12:00 p.m.-04:00 p.m.). Observations and data recording for all deer fawns were carried out by frequency and duration behavior for 10-minute intervals. This study did not require ethical approval.

Table 1. Behavioral definition of Timor deer (*Rusa timorensis*) fawns

Behavior	Definition
Aggressive	The activity of rubbing between the male deer fawns, fighting, or grabbing for food
Locomotion	Movement of deer fawns from one location to another
Feeding	The activity of foraging, putting it in the mouth, chewing, swallowing, and ruminating
Grooming	The activity of licking the body, performed independently or between deer fawns
Resting	Silent activity, not doing physical activity, sitting quietly under trees or shelters, sleeping
Social	Interaction between deer fawns in a group, interaction with visitors, playing, or suckling behavior
Eliminative (defecation and urination)	An activity that removes digestive or metabolic residue form stools/feces, or urine

## Statistical Analysis

All behavioral response data obtained

were tested for normality and homogeneity, and data analysis was performed using a paired sample t-test for weekday and weekend behavior. All results that were significantly different are expressed as  $p < 0.05$ . The mean of each behavior in the morning, noon and afternoon was tabulated, and the percentage of each behavioral occurrence, both duration and frequency, was presented as a histogram. All data analyses were performed using SPSS software version 26.

## RESULTS AND DISCUSSION

The results of the behavioral response research from nine Timor deer fawns (three males and six females), consisting of aggressive, locomotion or moving, feeding, grooming, resting, social and elimination behavior on weekdays and weekends, are presented in Table 2. The types of feed provided to the Timor deer fawns at the Semarang Zoo are presented in Table 3. All behavioral variables were analyzed with no significant differences ( $p > 0.05$ ). The deer fawns at Semarang Zoo seem to have adapted to the presence of humans, so all the daily behaviors observed in this study showed no significant difference between weekdays and weekends. The presence of visitors on weekdays (fewer than 150 visitors) and weekends (more than 150 visitors) had no significant effect on the aggressive behavior of Timor deer fawns; they are already accustomed to the presence of visitors. Contrary to the Bawean deer, which Rahman *et al.* (2023) reported to be greatly disturbed by the presence of humans. The results of this study differ from the behavior of adult deer reported by Husna *et al.* (2024), who found that the presence of visitors on weekends increased deer aggressiveness. Visitors who approached the deer enclosure brought feed provided by the zoo management. Visitors are allowed to feed the deer, an activity that encourages adult deer to compete to approach visitors to obtain additional feed. Meanwhile, for fawns, approaching visitors did not have a significant impact on their aggressiveness, pos-

sibly because they were unable to compete with adult deer.

The aggressive behavior response of Timor deer fawns with a higher duration in the morning was associated with a longer interval of feeding time. The aggressiveness of Timor deer fawns observed in this study included competing for feed and milk from their does. The duration of aggressive behavior was the highest in the morning (Figure 1), whereas the frequency of aggression was higher in the afternoon (Figure 2). Timor deer fawns received their last feeding at 3:00 p.m. and would eat at 10:00 a.m., so all the digested feed had been absorbed and metabolized to produce energy and provide essential nutrients for body cells to support the growth and daily activities of the deer fawns. We assumed that the increased duration of aggression, especially competition for feed in the morning, was related to decreased blood glucose levels. Sapolsky (2021) stated that blood glucose is an easily mobilized energy source, and its levels will increase in the absorptive phase. Aggressive behavior in animals often arises when their blood glucose levels are low. Browne *et al.* (2021) and McEwen (2020) reported that low blood glucose levels impair brain function and decrease neurotransmitters such as serotonin, which plays a role in suppressing aggression. This energy deficit reduces cognitive function and triggers the release of stress hormones, including cortisol and adrenaline. The frequency of aggressive behavior was found to be higher in the afternoon, which is related to the higher level of crowding in the afternoon compared to noon due to the competition for feed and the presence of more visitors at those times. Crowds of visitors trigger aggressive behavior. Ceacero *et al.* (2019) reported that deer interactions with humans or competition between deer can trigger stress and aggressive behavior. Interactions with unfamiliar visitors can be perceived as a threat through the activation of the limbic system in the brain. The limbic system sends danger signals to the hypothalamus, triggering the release of *corticotropin-releasing hormone* (CRH) and stimulating the anterior pituitary

gland to release *adrenocorticotropic hormone* (ACTH).

Table 2. Duration and frequency of daily behaviors of Timor deer fawns on weekdays and weekends.

Variables	Duration (minutes)		Frequency (times)	
	Weekday	Weekend	Weekday	Weekend
Aggressive	5.84 ± 1.03	5.76 ± 1.05	2.20 ± 0.99	2.80 ± 1.02
Locomotion	0.01 ± 0.00	0.04 ± 0.01	3.38 ± 0.02	2.72 ± 0.02
Feeding	52.90 ± 0.02	67.18 ± 0.02	0.81 ± 0.02	0.81 ± 0.02
Grooming	0.52 ± 0.07	0.71 ± 0.07	24.80 ± 1.08	23.20 ± 1.07
Resting	29.14 ± 0.02	41.07 ± 0.02	0.68 ± 0.02	0.50 ± 0.02
Social	0.67 ± 0.12	0.44 ± 0.11	4.20 ± 1.03	5.80 ± 1.06
Eliminative	0.15 ± 0.05	0.14 ± 0.05	4.00 ± 1.02	4.20 ± 1.02

Note: The data are shown as the average ± standard deviation. All the daily behavior of Timor deer fawns on weekdays and weekends showed no significant difference (p>0.05).

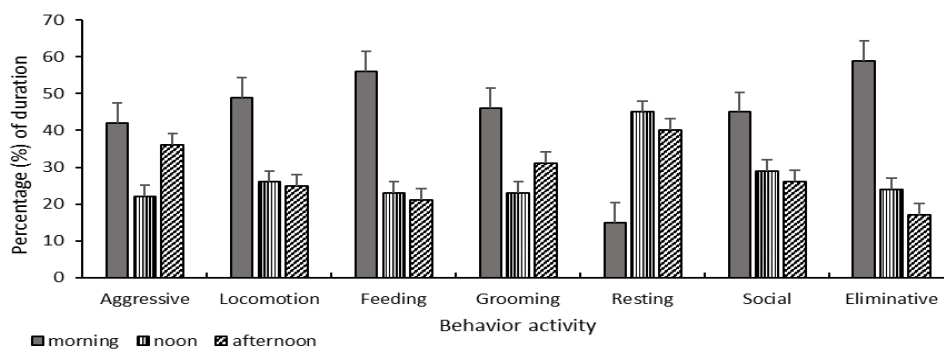


Figure 1. Percentage of Timor deer fawn behavior duration in the morning, noon, and afternoon.

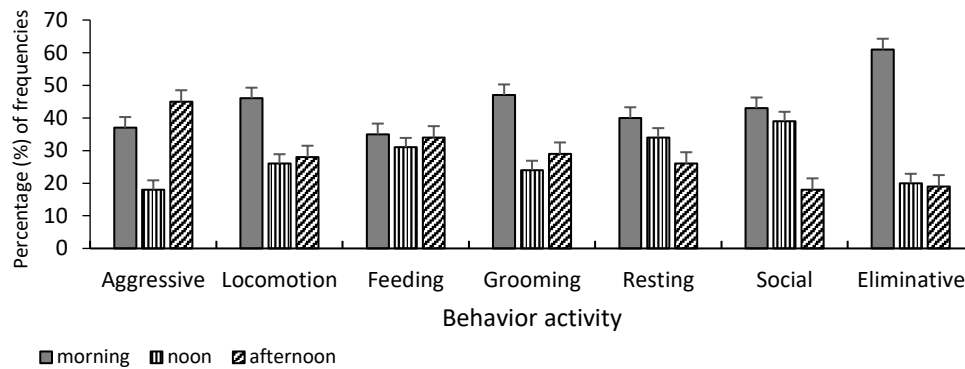


Figure 2. Percentage of Timor deer fawn behavior frequencies in the morning, noon, and afternoon

Table 3. Types of feed for Timor deer fawns were provided by Semarang Zoo.

Feed Type	Processing	Consumed Part
Kolonjono grass ( <i>Brachiaria mutica</i> )	Whole	Stem and leaves
Sweet potatoes ( <i>Ipomoea batatas</i> )	Chopped into small pieces	Tuber
Long beans ( <i>Vigna unguiculata</i> )	Cut into long pieces	Pod skin and pod
Carrots ( <i>Daucus carota</i> )	Cut into long pieces	Tuber
Pollard	Milled	Bran (in powder form)



Figure 3. Social behavior of Timor deer fawn. A) Deer fawn suckling their doe; B) Interaction with a visitor

which stimulates the adrenal cortex to produce cortisol as an indicator of stress.

The percentages of locomotion behavior duration and frequency are presented in Figures 1 and 2, respectively. The locomotion behaviors observed in this study included walking, running and other movements (e.g., approaching feed, visitors or other deer). The presence of visitors on weekdays and weekends does not seem to affect the locomotor activity of fawns. Meanwhile, Olazábal *et al.* (2013) found that male Pampas deer fawns performed 22% walking and 0.3% running activities daily, while female Pampas deer walked 18% and males 0.9%. In their study, Meng *et al.* (2011) also found that captive female and male Alpine musk deer performed locomotion, 27.4 s and 19.23 s, respectively. Husna *et al.* (2024) reported that adult Timor deer engage in more locomotion activity on weekends, with longer periods of movement.

The percentage data for duration and frequency indicated that locomotion was higher in the morning than at noon and in the afternoon. We hypothesized that this increased morning locomotion activity reflected the increased need for access to feed and water, social and play between fawns. The locomotion of Timor deer fawns in this study was lower than that observed in juvenile deer by Marettta *et al.* (2022) and also differed from the findings of Tajchman *et al.* (2022), who reported that Fallow deer fawns run and jump more in the evening. Bartos and Kotrba

(2013) stated that locomotion is triggered by the urge to explore in the form of seeking feed and approaching visitors. The high duration and frequency of movement in the morning may also be related to temperature and humidity differences. Morning temperatures ranged from 28-29 °C, whereas noon and afternoon temperatures ranged from 29–30 °C. Morning humidity was 76-78%, compared to 66-73% at noon and in the afternoon. The increased morning activity and decreased activity at noon in Timor deer fawns may represent a thermoregulatory strategy to regulate body temperature (Atmadja *et al.*, 2014) and reduce heat production (van Beest *et al.*, 2019). Lower air humidity at noon increases evaporative water loss, potentially increasing the risk of dehydration, thus prompting deer to reduce their activity to maintain body temperature homeostasis (Jiang *et al.*, 2021).

The feeding behavior of the Timor deer fawns, including feeding activity on various feed components provided by Semarang Zoo (Tables 2 and 3), is described here. The presence of visitors did not affect the feeding behavior of fawns. The feeding behavior of fawns observed in this study was a combination of browsing, grazing and rumination. The Semarang Zoo allows visitors to supplement the fawn's diet with long beans (*Vigna unguiculata ssp. sesquipedalis*) and carrots (*Daucus carota subsp. sativus*). The fawns exhibited a preference for carrots over Kolonjono or Buffalo grass (*Brachiaria*

*mutica*), likely because their developing molar structure was better suited to the high water content of carrots. Although not a staple feed, carrots and long beans were highly preferred, possibly because of their softer texture than grass. The percentage of feeding behavior (Figures 1 and 2) observed in this study was higher than that reported for juvenile and adult deer by Maretta *et al.* (2022) and Rasyidi *et al.* (2022). Husna *et al.* (2024) showed that adult Timor deer feed more frequently on weekends and for shorter durations than on weekdays. Villagrán *et al.* (2012) revealed that Pampas deer fawns spent 25% of their time ruminating, 2.8% browsing and 57.9% grazing. One factor involved in eating behavior is hunger. The hunger center in the hypothalamus is activated, triggering foraging, grazing and ruminating behaviors.

The grooming behaviors observed in Timor deer fawns included self-licking and mutual grooming (i.e., licking and cleaning each other). Visitor presence did not significantly affect the grooming behavior ( $p > 0.05$ ; Table 2). However, the duration and frequency of grooming (licking and rubbing) were highest in the morning (Figure 1), potentially due to cooler temperatures, which, according to Mooring (2024), increase skin oil and dirt accumulation, prompting increased grooming. Husna *et al.* (2024) showed that grooming in adult Timor deer took 2.38 s with a frequency of 8.6 times/minute on weekends, which was related to high feeding activity with increased visitor presence. Wang (2021) suggests that grooming is initiated by sensory stimulation from skin irritation (dirt or insects). This sensory input travels via sensory fibers to the spinal cord and then to the hypothalamus (the grooming center), which, as proposed by Fukuzawa (2017) and Aldridge (2020), signals the motor cortex to initiate limb movements for cleaning. The grooming frequency observed in the fawns in this study exceeded that reported for adult deer by Jastroch (2021).

The presence of visitors, both on weekdays and weekends, did not affect the duration and frequency of the resting beha-

avior of Timor deer fawns (Table 2). However, the percentage of resting duration for Timor deer fawns was higher at noon (Figure 1), coinciding with an increase in environmental temperature and the ongoing rumination process. The increased resting response at noon was related to efforts to reduce dehydration and conserve the energy reserves needed for daily activities and homeostasis. Jastroch (2021) stated that high environmental temperatures cause the thermoregulation center in the anterior hypothalamus to detect an increase in core body temperature. Herget (2022) and Fuller (2022) suggest that the hypothalamus sends signals to the posterior pituitary to release the *antidiuretic hormone* (ADH), which causes peripheral vasoconstriction of blood vessels, reduces evaporation, reduces skeletal muscle contraction, and reduces heart rate, thus reducing body heat production

The highest frequency of resting behavior (Figure 2) was observed in the morning, followed by that at noon. Visitor arrivals in the morning were still few, so feeding, social, grooming and locomotion activities were followed by more frequent resting activities in the morning. Meanwhile, at noon, the increased frequency of resting was thought to be related to higher temperatures. van Beest *et al.* (2019) reported that deer fawns rest a lot when temperatures are high to prevent hyperthermia. This present study differs from the findings of Tajchman *et al.* (2022) that the resting behavior of Pampas deer did not differ between morning and afternoon. Meanwhile, Husna *et al.* (2024) added that adult Timor deer spend less time resting on weekends because the increase in visitors attracts the deer to approach the fence of the enclosure near the visitors. Maretta *et al.* (2022) showed that the resting frequency of deer fawns of juvenile and adult ranging from 43 to 48%.

The social behaviors of Timor deer fawns observed in this study included suckling (Figure 3A), playing with other fawns or deer and interacting with visitors (Figure 3B). The presence of visitors on weekdays and weekends did not affect the social behavior of the Timor deer fawns

(Table 2). The suckling response of Timor deer fawns occurs because the increased secretion of prolactin is triggered by the body's circadian rhythm and the suckling stimulus on the doe's nipples. The suckling stimulus from deer fawns is transmitted to the anterior hypothalamus, which stimulates the release of prolactin from the anterior pituitary gland (Litherland *et al.*, 2020). Prolactin stimulates the mammary glands to produce and release milk. Tactile stimulation from the doe's nipples when suckling stimulates the release of oxytocin from the posterior pituitary. Oxytocin triggers the contraction of myoepithelial cells in the udder, leading to milk release. Villagrán *et al.* (2012) found that 6 to 12-month-old Pampas deer calves require suckling time amounting to 3% of their daily activity, with suckling positions including antiparallel, perpendicular, lying and caudal positions. Furthermore, Tajchman *et al.* (2022) stated that suckling by Fallow deer calves occurs more frequently in the evening. In addition, deer fawns exhibit play behavior with other fawns. The Timor deer fawns in this study were more active in playing in the morning and afternoon (Figure 2), coinciding with the cool environmental temperatures. The observation of Timor deer fawn play activity in this study was similar to that of Fallow deer reported by Tajchman *et al.* (2022). Social behavior and interaction with visitors begin with sensory stimulation from the environment perceived by the sight, smell and touch of deer fawns.

This study observed urination and defecation as eliminative behaviors in fawns. These behaviors were not influenced by visitor presence on weekdays or weekends (Table 2) but rather reflected a circadian rhythm, with the highest duration and frequency occurring in the morning (Figures 1 and 2). Morning eliminative events represent the culmination of overnight digestive and metabolic processes from the previous day's feed intake. The eliminative behavior of fawns is similar to that of adult deer, according to observations by Husna *et al.* (2024), with urination and defecation not being affected by crowds of visitors. Meng *et al.* (2008)

added that longer urination/ defecation durations were found in adult female Alpine musk deer than in males.

## CONCLUSION

In conclusion, the behavioral responses of Timor deer fawns at the Semarang Zoo to the visitors were consistent on both weekdays and weekends, indicating that visitor presence did not negatively impact their daily activities. The fawns still exhibited their natural behavior.

## SUGGESTION

Semarang Zoo management should add to the concentrate feed provided for lactating deer and provide a permanent shelter to store feed for the fawns, also serving as shade.

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