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Behavioral Profiling of Timor Deer (*Cervus timorensis*) Across Age and Sex Groups Under Captive Management in East Java, Indonesia

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ABSTRACT
This study analyzed the behavior of Timor deer (Cervus timorensis) across age groups at the Jatilengger Deer Captive Breeding Center, Blitar Regency. Sixteen individuals (8 males and 8 females) aged 1-4 years were observed for 30 days using scan sampling through direct observation and CCTV monitoring. Ten behavior categories were recorded: locomotion, ingestion, resting, grooming, vocalization, defecation, drinking, urination, wallowing, and fighting. Locomotion was the dominant behavior across all groups, with males ranging from 13.24 ± 1,31 to 15.61 ± 1,31 and females from 12.26 ± 1,31 to 16.26 ± 1,31. Ingestion was the second most frequent behavior, with values of 4.53 ± 1,16–7.82 ± 1,16 in males and 4.18 ± 1,16–5.63 ± 1,16 in females. Resting and grooming occurred at moderate levels, increasing with age, particularly in 3-year-old males (resting 5.18 ± 1,17; grooming 5.89 ± 1,71) and 4-year-old females (resting 3.37 ± 1,17). Behaviors such as vocalization, defecation, drinking, urination, and wallowing were infrequent, while fighting was rare, especially in females (0.00 ± 0,05 across all age groups) and minimal in males (0.03 ± 0,05–0.16 ± 0,05). The dominance of locomotion and ingestion reflects active movement and strong feeding motivation, suggesting good physical condition and adaptation to the captive environment. Age related increases in resting and grooming indicate improved comfort and social stability, while the minimal occurrence of fighting demonstrates harmonious social interactions. Overall, Timor deer in captivity allocate most of their time to locomotion and feeding, showing stable behavioral patterns and effective adaptation across age groups.

Keywords: *Timor Deer, Daily Behavior, Age, Ex-Situ Conservation*

INTRODUCTION
The Timor deer (Cervus timorensis) is an endemic cervid species native to Indonesia, distributed across islands such as Java, Bali, and Timor. Its ecological role as a grazer and browser contributes significantly to maintaining vegetation balance within tropical ecosystems. However, overexploitation, habitat fragmentation, and poaching have caused population declines, prompting the establishment of ex-situ conservation programs in several regions (Zulfaeda et al., 2024). Behavioral understanding plays a crucial role in the success of such captive management programs since animal welfare, breeding success, and adaptability to captive conditions are all closely linked to behavior (Lay et al., 2022). Therefore, behavioral studies on Timor deer under captivity are essential to provide empirical bases for improved husbandry, breeding, and welfare management practices.

Despite the recognized importance of behavior for animal welfare, most behavioral studies on Timor deer remain descriptive and limited to general daily activity observations such as feeding, resting, and locomotion (Maretta et al., 2022). These studies provide valuable insight but often lack differentiation among age groups-fawns, juveniles, sub-adults, and adults-that may exhibit distinct behavioral patterns due to developmental, hormonal, and social factors (Hutabarat et al., 2025). However, such comparative understanding is rarely applied to Cervus timorensis, especially under the specific management and environmental conditions of East Java, Indonesia. This limited theoretical foundation constrains the ability of managers to develop age-appropriate enrichment and husbandry strategies.

This study establishes a theoretical foundation by characterizing the behavioral patterns of Timor deer across age groups in captive management, an approach that has not been previously detailed in the English-language scientific literature. By identifying behavioral distinctions among fawns, juveniles, sub-adults, and adults, this research aims to enhance understanding of ontogenetic behavioral variation and its

implications for welfare and breeding success in captivity. The research supports and extends previous findings on general behavioral tendencies in Cervus timorensis while addressing the gap regarding age-specific behavioral patterns. Therefore, the objective of this study is to analyze and compare the activity budgets and behavioral repertoires of Timor deer across age groups under captive conditions in East Java, Indonesia, thereby contributing to improved captive management practices and long-term conservation strategies.

METHOD

This study employed a descriptive observational approach to analyse the daily behavioural patterns of Timor deer (*Cervus timorensis*) in captivity at the Jatilengger Deer Breeding Center, Blitar Regency, East Java, Indonesia. The facility represents a semi-natural captive environment characterised by open paddocks, tree covered areas, and designated feeding and watering points. A total of 16 Timor deer, consisting of 8 males and 8 females distributed evenly across four age groups (1, 2, 3, and 4 years old), were included in the observations. The age of Timor deer was identified using physical features and dental assessment, especially the development and wear of the molar and premolar teeth. Age classes were determined based on tooth eruption patterns. Sex was distinguished through external morphology, where males had antlers and larger bodies, while females lacked antlers and showed visible external reproductive structures. Data collection focused specifically on daily behavioural activities, which were recorded continuously over a 30 day observation period spanning October to November 2025.

Observations were conducted through direct monitoring and CCTV assisted recordings, applying both scan sampling and focal animal sampling techniques. To document variations in daily activity patterns, all behaviours were categorised into four time periods: morning (06:00–12:00), afternoon (12:00–18:00), evening (18:00–24:00), and midnight (00:00–06:00). This methodological design ensured comprehensive and systematic documentation of the daily behaviour of Timor deer under captive conditions at the Jatilengger Deer Breeding Center.

The behavioural variables observed in this study encompassed the full range of daily activities exhibited by Timor deer in captivity. These included locomotion, ingestion, resting, grooming, drinking, defecation, urination, vocalisation, wallowing, and fighting. Each behaviour was defined and categorised based on an ethogram adapted for *Cervus timorensis*, allowing consistent and systematic behavioural recording throughout the study. The inclusion of both high frequency maintenance behaviours and low frequency social or environmental behaviours provided a comprehensive overview of the activity patterns across sex and age groups.

RESULT AND DISCUSSION

The following section presents the behavioural findings obtained from 30 days of continuous observations of male and female Timor deer across four age groups. The results summarise patterns of daily activity, age related differences, and behavioural frequencies recorded under captive management conditions. These findings are then interpreted in the discussion to explain the biological, environmental, and management factors influencing the observed behaviours.

Result

The behavioural observations showed that male Timor deer exhibited a consistent pattern of daily activity, characterised by a dominance of four main behaviours. Throughout the day, the most prominent activities displayed by males were locomotion, ingestion, resting, and grooming, which together formed the core components of their daily behavioural repertoire. Overall, these four behaviours consistently represented the highest proportion of daily activity in male Timor deer, indicating that their daily time budget is strongly shaped by physiological needs and routine maintenance behaviours under captive conditions.

Table 1. Average daily behaviour of male Timor deer

Behavior Categories	Behavior Daily Average			
	Male, 1 year old	Male, 2 year old	Male, 3 year old	Male, 4 year old
Ingesti	5,26 ± 1,16	4,53 ± 1,16	7,82 ± 1,16	6,05 ± 1,16
Locomotion	15,37 ± 1,31	13,24 ± 1,31	15,61 ± 1,31	15,18 ± 1,31
Resting	3,47 ± 1,17	2,11 ± 1,17	5,18 ± 1,17	3,39 ± 1,17
Grooming	2,79 ± 1,71	2,00 ± 1,71	5,89 ± 1,71	2,71 ± 1,71
Vocalization	0,16 ± 0,39	0,00 ± 0,39	0,84 ± 0,39	0,87 ± 0,39

Defecation	0,21 ± 0,14	0,13 ± 0,14	0,45 ± 0,14	0,26 ± 0,14
Wallowing	0,68 ± 0,32	0,29 ± 0,32	0,82 ± 0,32	0,13 ± 0,32
Drinking	0,53 ± 0,44	0,74 ± 0,44	1,71 ± 0,44	0,39 ± 0,44
Fighting	0,03 ± 0,05	0,05 ± 0,05	0,16 ± 0,05	0,03 ± 0,05
Urination	0,05 ± 0,08	0,00 ± 0,08	0,05 ± 0,08	0,05 ± 0,08

Male Timor deer exhibited a daily activity pattern dominated by locomotion, ingestion, resting, and grooming, which formed the core of their time budget. Locomotion varied across age groups, highest in 3 year olds (15.61 ± 1,31) and lowest in 2 year olds (13.24 ± 1,31), without a strict age dependent trend (Table 1). Movement peaked in the morning and increased toward midday, influenced by feeding routines, interactions with keepers and visitors, exploratory behavior, avoidance of aggression, and access to water and resting sites (Figure 1).

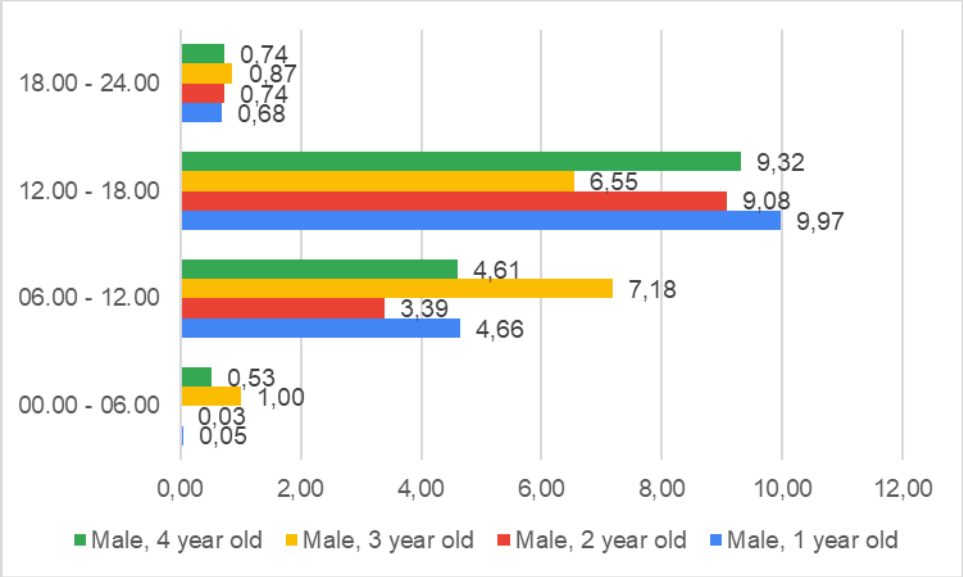

Figure 1. Temporal pattern of locomotion in male Timor deer

Ingestion also varied by age, highest in 3 year olds (7.82 ± 1,16), and occurred mainly during feeding times when provided with elephant grass, cassava, and supplemented by natural vegetation (Table 1). Drinking was concentrated around midday, linked to post feeding hydration and thermoregulation. Resting and grooming were closely associated, with peaks in 3 year olds (resting 5.18 ± 1,17; grooming 5.89 ± 0,32). Grooming primarily occurred during inactive periods, reflecting self maintenance. Defecation and urination were infrequent and usually occurred during locomotion, indicated by brief stops and tail lifting.

Vocalisation was mainly observed during feeding, with 4 year olds vocalising most frequently, while 2 year olds remained silent, reflecting anticipatory feeding behavior (Table 1). Wallowing occurred early in the observation period but declined as rainfall increased, whereas fighting showed the opposite trend, suggesting that environmental changes, particularly wet conditions and reduced dry resting areas, increase social tension and dominance interactions among males.

Table 2 Average daily behaviour of female Timor deer

Behavior Categories	Behavior Daily Average			
	Female, 1 year old	Female, 2 year old	Female, 3 year old	Female, 4 year old
Ingesti	4,71 ± 1,16	4,18 ± 1,16	4,82 ± 1,16	5,63 ± 1,16
Locomotion	14,47 ± 1,31	12,26 ± 1,31	14,53 ± 1,31	16,26 ± 1,31
Resting	1,97 ± 1,17	1,63 ± 1,17	2,24 ± 1,17	3,37 ± 1,17
Grooming	1,24 ± 1,71	0,39 ± 1,71	1,05 ± 1,71	1,42 ± 1,71
Vocalization	0,13 ± 0,39	0,42 ± 0,39	0,29 ± 0,39	1,00 ± 0,39
Defecation	0,08 ± 0,14	0,11 ± 0,14	0,45 ± 0,14	0,24 ± 0,14
Wallowing	0,00 ± 0,32	0,00 ± 0,32	0,05 ± 0,32	0,11 ± 0,32
Drinking	0,42 ± 0,44	0,50 ± 0,44	0,71 ± 0,44	0,45 ± 0,44
Fighting	0,00 ± 0,05	0,00 ± 0,05	0,00 ± 0,05	0,00 ± 0,05
Urination	0,13 ± 0,08	0,03 ± 0,08	0,13 ± 0,08	0,26 ± 0,08

Female Timor deer exhibited a daily activity pattern dominated by locomotion, ingestion, resting, and grooming. Locomotion increased with age, highest in 4 year olds (16,26 ± 1,31) and lowest in 2 year olds (12,26 ± 1,31), reflecting mature females' greater movement for foraging, social interactions, and accessing resources (Figure 2). Ingestion also tended to increase with age, peaking in 4 year olds (5,63 ± 1,16), mainly during feeding periods with provided forage and naturally occurring vegetation. Drinking occurred mostly after feeding and during increased locomotion, with moderate variation across age groups.

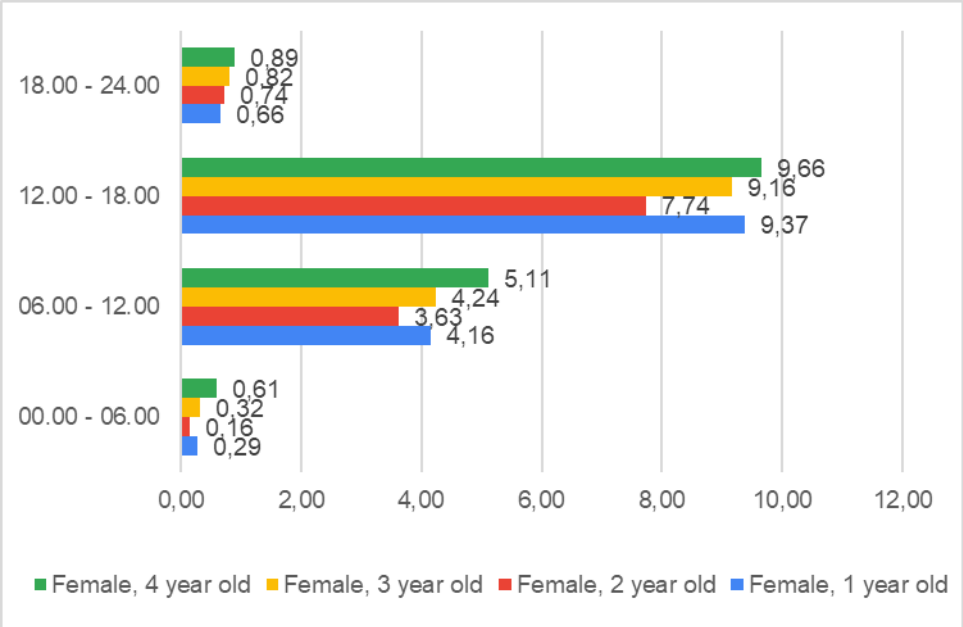

Figure 2. Temporal pattern of locomotion in female Timor deer

Resting and grooming were closely associated, with older females (4 year olds) resting and grooming more than younger individuals (Table 2). Grooming was primarily self directed and observed during resting periods, reflecting body care and maintenance. Defecation and urination were infrequent, generally occurring during locomotion, with slightly higher frequencies in older females. Vocalisation was rare but more pronounced in 4 year olds, usually linked to feeding anticipation or social responses (Table 2).

Wallowing was observed only in older females (3 and 4 year olds), suggesting a role in thermoregulation, comfort, or environmental adaptation (Table 2). No fighting behavior was recorded, indicating stable social dynamics and low aggression in female groups (Table 2). Overall, female Timor deer show age dependent increases in activity and maintenance behaviors, with older individuals exhibiting more locomotion, feeding, resting, grooming, and occasional wallowing.

Discussion

This study revealed pronounced age and sex related variations in the daily behavioural patterns of Timor deer (Cervus timorensis) under captive conditions. Across both sexes, locomotion, ingestion, resting, and grooming dominated the daily time budget, consistent with general cervid behavioural ecology where maintenance activities occupy the largest proportion of activity (Maretta et al., 2022). However, the intensity and distribution of these behaviours varied substantially among age classes.

Male deer showed the highest locomotion, ingestion, resting, and grooming values at 3 years of age, suggesting that this age represents a peak in behavioural expression associated with physical maturity, increased social activity, and high energy demands. The lower activity observed in 2 year old males may reflect transitional developmental stages. Female deer displayed a more consistent age related trend than males, with 4 year old females showing the highest values for locomotion, ingestion, resting, and grooming. This pattern suggests that behavioural stability and energy requirements increase with maturity in female groups. Drinking behaviour peaked in mid age females, while defecation, urination, and vocalisation occurred at low frequencies but tended to rise slightly with age.

Locomotion in Timor deer increased from morning to midday, influenced by feeding routines, interactions with keepers and visitors, and movements related to avoiding aggression. This behavior reflects the deer's adaptation to the captive environment, which is generally busy and filled with human activity. After being transferred to captivity, Timor deer demonstrated the ability to adjust to their surroundings, showing heightened activity from morning to afternoon due to the presence of visitors, vehicle traffic, and

keeper interactions. Conversely, during the quieter nighttime hours, the deer tend to be more passive and rest, displaying a diurnal pattern that aligns with the rhythm of the captive environment (Silalahi et al., 2021).

The ingestion behaviour of Timor deer showed clear variation across age groups in both males and females, with feeding activity strongly influenced by the availability of drop in forage and naturally occurring vegetation inside the enclosure. Feeding typically occurred during scheduled drop in feeding times, when fresh forage consisting of elephant grass (Pennisetum purpureum), cassava tubers (Manihot esculenta), and agricultural waste was provided. In addition to these feed sources, both sexes were frequently observed consuming natural vegetation such as fallen kesambi leaves (Schleichera oleosa) and various wild grasses growing within the enclosure. This pattern is consistent with Apriana et al., 2023, who reported that feeding is the most dominant activity in captive deer due to limited habitat space and easy access to provided feed. Similar to sambar deer in captivity, Timor deer displayed frequent grazing and feeding throughout the day, reflecting the predictable food supply and concentrated forage availability within the enclosure.

Resting in Timor deer involves periods of inactivity to conserve energy and support physiological recovery. In our study, males and females exhibited age and sex specific resting patterns, with older individuals generally spending more time resting, and males resting often interrupted by social interactions or environmental stimuli, while females rested more continuously alongside grooming. This contrasts slightly with Rasyidi et al., 2022, who reported that resting in captive Timor deer occurred randomly throughout the day morning, afternoon, and evening without forming a specific temporal pattern. According to Rasyidi, resting often intersected with feeding and playing activities and occurred in various locations, including under semi permanent shelters (baruga) and in corners of the enclosure.

Grooming in Timor deer often occurs alongside resting behavior and involves licking various areas of the body, with individuals engaging more in self grooming than allogrooming. This observation aligns with Fawzy et al., 2019, who reported that Timor deer also groom while resting and prefer self grooming over grooming others. However, a difference emerges in the sex specific patterns: in our study, grooming was generally more common in males than in females, whereas Fawzy et al., 2019 found that females conducted grooming more frequently than males. Additionally, Fawzy et al., 2019 noted that females groomed between activities from morning to afternoon, while males groomed only in the morning and afternoon, spending midday mostly resting (sitting). These variations may reflect differences in environmental conditions, group composition, or management practices in the respective captive settings.

The findings of this study show that vocalisation patterns in Timor deer partly align with previous reports. Lay et al., 2022 noted that females vocalise when their fawn becomes separated, and this was also observed in the present study, where calls occurred when fawns were too far away or appeared missing. However, in contrast to Silalahi et al., 2021, who reported male vocalisation related to aggression and mating behaviour, male Timor deer in this study vocalised mainly during feeding anticipation or in response to mild social stimuli, not during competitive interactions. Vocalisation frequency remained low overall but increased with age, especially in 3–4 year old males and 4 year old females. In summary, vocalisation represents a small portion of daily activity but plays an important role in mother offspring communication and group coordination.

Wallowing and fighting behaviors responded to environmental changes, with wallowing decreasing and fighting increasing as rainfall intensified, indicating that climatic conditions influence thermoregulation and social tension in males; in contrast, no fighting behaviour was observed in females, reflecting the low aggression levels typical of female cervid groups. Wallowing was observed primarily in older females, although it is generally more common in males, who typically roll in mud, covering all their limbs. This activity serves functions such as regulating body temperature during hot weather and supporting male reproductive behaviors. This finding aligns with Siagian and Putri, 2025, who reported that wallowing is more common in male deer than in females and serves similar thermoregulatory and reproductive functions.

Defecation and urination in Timor deer were recorded at very low frequencies, with defecation ranging from 0.08-0.45 and urination from 0.00-0.26 across age groups, indicating that these behaviours occur far less frequently than primary activities such as locomotion, ingestion, resting, and grooming. In both males and females, these behaviours typically occurred during locomotion, marked by a brief pause and a raised tail. Older deer showed slightly higher values, particularly in defecation. These findings are consistent with the description by Nadya et al., 2023, who reported that when deer defecate or urinate, they momentarily stop activities such as feeding or walking, stand still, bend their hind legs, lift the tail, and then release urine or faeces. Thus, while the posture and behavioural sequence observed in this study aligns

with previous reports, the frequency recorded in Timor deer under captive conditions was notably low, suggesting minimal disruption to other daily activities.

Overall, the behavioural patterns observed in this study demonstrate that age and sex strongly influence activity budgets in captive Timor deer. The dominance of maintenance behaviours, age specific differences in locomotion and feeding, and the influence of environmental conditions on social behaviours highlight the importance of age structured management, predictable feeding schedules, and enclosure design in supporting welfare and natural behaviour in captive populations.

CONCLUSION

This study shows that age and sex play an important role in shaping the daily behavioural patterns of Timor deer (*Cervus timorensis*) in captivity at the Jatilengger Deer Breeding Center. Core maintenance activities locomotion, ingestion, resting, and grooming dominated behaviour across all age groups, while males displayed peak activity at three years of age and females showed a gradual increase that culminated at four years. Low frequency behaviours such as vocalisation, defecation, urination, wallowing, and fighting occurred sporadically and were influenced by both age and environmental conditions, particularly rainfall. The rise in fighting among males and the decline in wallowing during wetter periods highlight the role of climate and social factors in shaping behavioural expression. Overall, these findings demonstrate that Timor deer adapt well to semi-natural captive environments and reveal distinct behavioural differences among age groups, underscoring the need for age-specific management, targeted enrichment, and improved enclosure design to enhance welfare and support conservation focused breeding programs.

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