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Short Communication: Behavioural Adaptations in Mating Patterns of Timor Deer (*Cervus timorensis*) in Captive Conditions in Kediri Facilities, East Java

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ABSTRACT

The Timor deer (*Cervus timorensis*), an endemic species of Indonesia, faces a severe population decline caused by habitat degradation, illegal hunting, and limited conservation initiatives. Captive breeding represents a strategic measure to enhance reproductive performance and ensure species persistence. This study examined the mating behaviour of Timor deer at the Brigif-16/Wira Yudha facility, Kediri, emphasising the effects of environmental conditions, social dynamics, and enclosure management. A total of 15 adult males and 40 adult females were monitored over two months using scan sampling across four daily periods (06:00–12:00, 12:00–15:00, 15:00–18:00, and 18:00–24:00). Results indicated that mating-related behaviors accounted for 18.7% of total activities, with the highest occurrence in the morning (06:00–12:00; 42.5% of mating events). Male-to-male competition represented 11.3% of all observations, also peaking in the morning, while female affiliative behaviours reached 15.8% during the same period. Activity levels declined sharply during midday heat (12:00–15:00; 8.6% of mating events) and in the evening (18:00–24:00; 6.2%), indicating strong environmental influence. Compared with wild populations, captive deer exhibited more clustered behavioural patterns, likely due to controlled feeding schedules, enclosure design, and the absence of predators. These findings suggest that reproductive monitoring and interventions should prioritise morning sessions when mating and social interactions are most frequent. Management practices that consider natural rhythms, minimise midday heat stress, and optimise social grouping can significantly improve welfare and reproductive output. Beyond practical applications, this study contributes to the understanding of polygynous cervid reproductive ecology under captive conditions. The insights gained provide a framework for refining conservation breeding strategies not only for Timor deer but also for other threatened ungulates facing similar challenges.

Keywords: behaviour, captivity, environment, Timor deer, mating

INTRODUCTION

The Timor deer (*Cervus timorensis*), an endemic species of Indonesia, plays a significant ecological role as a herbivore, influencing vegetation dynamics and serves as an economically valuable resource for local communities. However, the species has experienced a sharp population decline, primarily due to habitat destruction, poaching, and the absence of long-term sustainable conservation strategies (Boucher et al., 2024). According to the IUCN Red List, several deer species across Southeast Asia, including Timor deer, face similar pressures due to human disturbance, with captive breeding widely recognised as a complementary tool for mitigating population loss (Ilham et al., 2024). Previous studies on deer conservation have highlighted that successful captive programs depend heavily on understanding behavioural ecology, particularly reproductive strategies, under controlled conditions. Despite these advances, gaps remain in the documentation of species-specific mating behaviour in captivity, especially in localised Indonesian facilities.

Research on captive cervid populations elsewhere has demonstrated that environmental and social factors strongly influence reproductive success. Farquharson et al. (2021) showed that managed enclosure conditions and structured social grouping correlated with increased breeding outcomes in captive deer. Similarly, Binsasi et al. (2024) documented that seasonal variations and enclosure design significantly affect mating performance among Timor deer in other Indonesian breeding facilities. These findings emphasise the need to investigate site-specific adaptations that may contribute to more effective conservation practices.

The present study was conducted at the Brigif-16/Wira Yudha captive facility in Kediri, East Java. The facility lies within a transitional lowland–upland zone at 70–120 meters above sea level, characterised by a tropical monsoon climate

with pronounced wet and dry seasons, average annual rainfall of 1,800–2,200 mm, and mean temperatures ranging from 25–32 °C. The enclosures consist of semi-natural paddocks with no grass cover, a little tree area, and artificial feeding points, providing a unique environment for observing behavioural adaptations under captive management. This geographical and ecological context offers valuable insight into how local conditions shape mating behaviour in Timor deer.

Therefore, this study aims to analyse the mating behaviour adaptations of Timor deer at the Brigif-16/Wira Yudha facility by assessing the influence of environmental conditions, social interactions, and enclosure management on reproductive activity. Focusing on species-specific behaviour in this unique captive setting will not only strengthen conservation management strategies for Timor deer but also provide a model applicable to other ungulates facing similar conservation challenges across Southeast Asia.

MATERIALS AND METHODS

This study employed a descriptive observational approach to analyse the mating behaviour of Timor deer (*Cervus timorensis*) in captivity at the Brigif-16/Wira Yudha deer breeding facility, Kediri, East Java. The facility is a semi-natural captive area with open paddocks, trees, and feeding points. A total of 55 Timor deer were observed, consisting of 15 males and 40 females. Observations were carried out over two months (September–October 2024), coinciding with the reproductive season.

Observation method

Behavioural data were collected using a combination of direct observation and continuous video monitoring. Direct observations were conducted by trained observers using binoculars and field notes during daylight periods. For night-time monitoring, three closed-circuit television (CCTV) cameras with infrared sensors were installed at strategic points covering feeding areas, resting areas, and water sources, allowing continuous 24-hour surveillance. Behaviour recording followed systematic scan sampling and focal animal sampling techniques, and behavioural categories were based on a predefined ethogram developed for cervids (modified from Caravaggi et al., 2017; adapted for *Cervus timorensis*). Data were divided into four periods: morning (06:00–12:00), afternoon (12:00–18:00), evening (18:00–24:00), and midnight (00:00–06:00), ensuring full daily coverage.

Age and sex classification

This study focused exclusively on adult Timor deer, consisting of 15 males and 40 females maintained at the Brigif-16/Wira Yudha facility. Individuals were categorised as adults based on fully developed body size, sexual maturity, and the presence of complete antlers in males or an evident reproductive condition in females. Sex identification was determined by external morphology, with males recognised by antlers and larger body size, and females distinguished by the absence of antlers and the presence of external genitalia.

Behavioral variables

The study focused on four main behavioural variables, which were defined and recorded through direct observation and CCTV monitoring. All behaviours were categorised using an ethogram, with each event counted as one occurrence. This classification allowed for quantitative analysis of daily patterns in mating and social behaviours of Timor deer under captive conditions.

Data analysis

Data were summarised descriptively to identify temporal patterns, frequencies, and variations across sex and age classes. The relative proportion of each behaviour was calculated as a percentage of total observed behaviours, while interaction frequencies were expressed as mean occurrences per individual per hour.

Table 1. Ethogram of Mating and Social Behaviours in Timor Deer

Category	Behavior	Operational Definition
Mating Behavior	Flehmen response	The male lifts its head, curls its upper lip, and inhales to detect the female's estrus condition.
	Sniffing/genital check	A male approaches a female and sniffs the anogenital area or body to assess receptivity.

Category	Behavior	Operational Definition
	Following/chasing	The male persistently follows the female, maintaining a close distance (<2 m) and sometimes nudging.
	Mount attempt	The male places its forelegs on the female's back without complete copulation.
	Successful copulation	Full mount with intromission and pelvic thrusts lasting several seconds.
Male–Female Interaction	Grooming/licking	One individual licks or grooms another, commonly between male and female, as part of social bonding or pre-mating behaviour.
	Resting in proximity	Males and females lie or stand within <1 m of each other, indicating tolerance or pair association.
	Courtship approach	The male moves toward the female slowly with his head lowered or gently nudging as part of mating initiation.
Male–Male Interaction	Antler clash (sparring)	Two males engage in horn or antler contact, pushing or wrestling to establish dominance.
	Threat display	Male lowers head, presents antlers, stomps forelegs, or vocalises toward another male.
	Chasing	The dominant male pursues the subordinate male to maintain hierarchy or defend a receptive female.
Female–Female Interaction	Grooming	One female licks or cleans another, promoting social cohesion and reducing tension.
	Resting in proximity	Two or more females rest or stand within <1 m, indicating social tolerance and herd bonding.
	Displacement	One female moves another from a feeding or resting spot, showing mild competition or social ranking.

RESULTS AND DISCUSSION

The analysis in Figure 1 shows that mating behaviour frequency and social interactions of Timor deer exhibited substantial diurnal variation, with the highest activity recorded in the morning (06:00–12:00). During this period, mating behaviours reached 45 occurrences, while male–female interactions peaked at 62, indicating that reproductive activity is most intense under cooler morning temperatures and after rest. Male–male competition and female–female interactions also increased significantly in the morning (31 and 30 occurrences, respectively), suggesting that social dynamics play an essential role in facilitating courtship and mating success. This indicates that the morning period is the most favourable window for reproductive monitoring and interventions in captive facilities.

In contrast, behavioural activity declined progressively during the hotter midday and darker nighttime hours. Afternoon observations still recorded moderate activity (35 mating behaviours; 49 male–female interactions), but evening and midnight showed a marked reduction, with mating frequency dropping to 25 and 19, respectively. Male–male interactions were also lowest at night (10), likely due to reduced visibility and decreased energy expenditure in resting phases. These results demonstrate that captive Timor deer follow a precise daily rhythm, concentrating reproductive and social behaviours during daylight, particularly in the morning. Such findings underscore the importance of aligning enclosure management, feeding schedules, and reproductive monitoring with these natural activity peaks to optimise breeding outcomes and animal welfare.

This study shows that the mating and social behaviours of Timor deer in captivity follow a precise daily rhythm, with the highest activity in the morning (06:00–12:00). At this time, mating behaviours (45 events) and male–female interactions (62 events) were much higher compared to other periods. The cooler morning temperature and higher energy levels after resting may explain why deer are more active during these hours (Hutabarat et al., 2025). Similar results have also been reported in sambar deer (*Rusa unicolour)* and axis deer *(Axis axis),* where reproductive activity was concentrated during cooler morning periods, supporting the idea that temperature strongly affects daily mating behaviour in cervids (Murad et al., 2023).

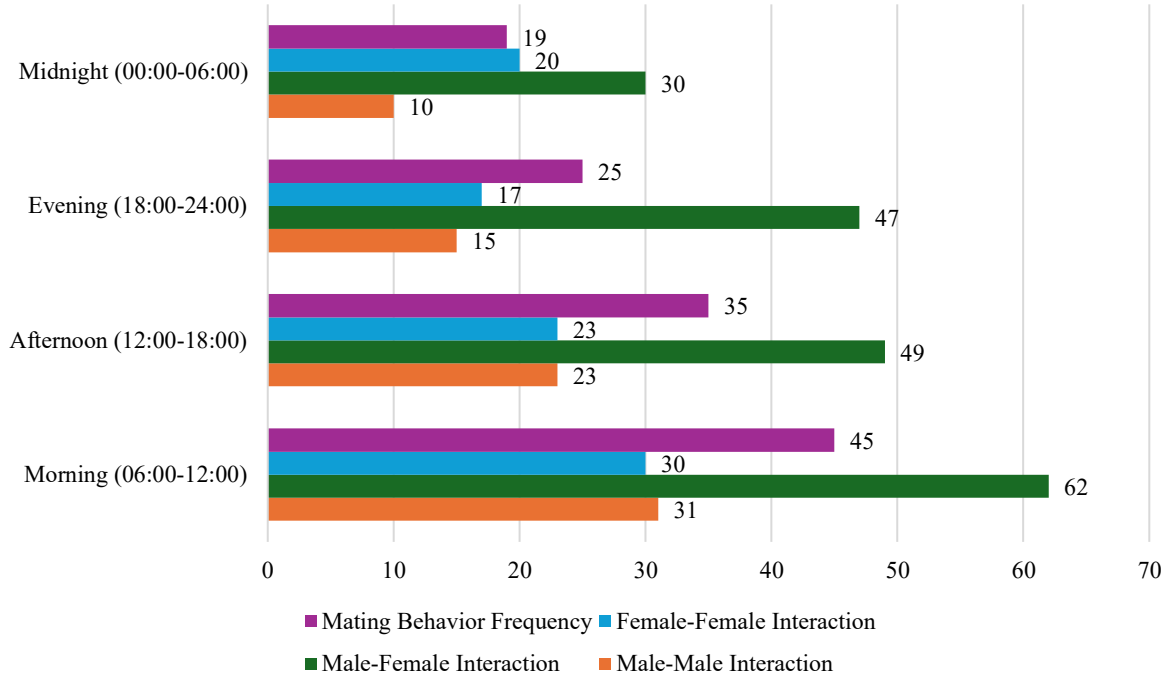

Figure 1. Daily Patterns of Social and Mating Behaviours in Captive Timor Deer (*Cervus timorensis*) at Brigif-16/Wira Yudha Captivity

Social interactions also increased in the morning. Male–male competition (31 events) was most common at this time, showing how males establish dominance to gain access to females. At the same time, female–female interactions (30 events) also peaked, which may help maintain social harmony and reduce stress during the reproductive period. According to (Bateman-Neubert et al., 2023) Male-to-male competition in the morning is often associated with efforts to establish dominance for greater access to females during the active reproduction period. The higher energy levels of animals after a night's rest also enable males to exhibit more intense competitive behaviour. Additionally, the stable but elevated morning interactions among females may be linked to social activities aimed at establishing group hierarchies, competition for mates or seeking protection from external threats (Wyman et al., 2021). The decline in social activity during the afternoon and nighttime is likely due to higher daytime temperatures, which can increase thermal stress, as well as reduced vision and energy levels at night. These comparisons suggest that Timor deer exhibit social dynamics like other polygynous deer, with dominance hierarchies and group cohesion playing key roles in reproductive success.

Activity dropped during midday and nighttime. Only 19 mating events were recorded at midnight, while afternoon and evening values were lower than morning but still moderate. Environmental conditions most likely cause this decline. Heat during midday makes deer less active, while limited visibility at night reduces communication and courtship (Millán et al., 2021). Studies on sambar deer also reported reduced mating behaviour during midday heat. In contrast, red deer populations in temperate regions showed increased activity at dusk instead, reflecting how local climate shapes behavioural rhythms (Selvarajah et al., 2022). Even so, the moderate activity in the afternoon (35 mating events, 49 male–female interactions) in Timor deer shows some flexibility in their reproductive activity, even under captivity.

Male competition in natural habitats is generally more intense due to the need to secure access to resources and females over a larger area. In captivity, although competition still occurs, its intensity is likely reduced due to the limited population and relatively more straightforward access to resources. Female interactions in natural habitats are often driven by the need to form social groups as a mechanism for protection against external threats. (Brucks et al., 2022). In contrast, in captivity, these interactions are more focused on routine social activities influenced by the limited space availability. Another significant difference is the influence of circadian rhythms. In

natural habitats, deer activity is strongly influenced by the day-night cycle and seasonal changes. In captivity, however, their activity rhythms tend to align more with human management practices, such as feeding schedules and artificial lighting. (Farooq et al., 2021).

The present findings emphasise the need for captive facilities to provide suitable environmental conditions that support the natural behaviour of Timor deer. Adequate shade, vegetation cover, and cooling areas are crucial to minimise heat stress, which often suppresses activity and reproductive behaviours during midday (Srivastava et al., 2025). As observed in this study, behavioural activity decreased sharply when temperatures increased, confirming the strong influence of thermal comfort on deer welfare and mating performance. Similar patterns have been documented in sambar and axis deer, where heat exposure reduced courtship frequency and increased resting time. Therefore, aligning enclosure design with the natural ecological preferences of deer is fundamental to maintaining normal behaviour and ensuring sustainable breeding success under captive management.

Furthermore, these results highlight that while Timor deer in captivity maintain their essential behavioural rhythms, the controlled environment also introduces behavioural modifications compared to wild populations. Limited space, absence of predators, and regulated feeding schedules can alter social interactions, leading to more concentrated and predictable activity patterns. (Maretta et al., 2022; Rasyidi, 2022). S. However, the overall similarity of daily patterns between Timor deer and other cervid species, such as red deer, suggests that the core biological rhythm of mating behaviour remains conserved across environments (Narami et al., 2023). These similarities strengthen the ecological relevance of this research and demonstrate that understanding species-specific needs is essential for improving reproductive outcomes. By integrating behavioural ecology into captive management strategies, facilities can enhance both animal welfare and the long-term conservation of threatened deer populations.

CONCLUSION

Research at the Brigif-16/Wira Yudha facility shows that the mating and social behaviours of captive Timor deer (*Cervus timorensis*) follow a distinct daily pattern, with the highest reproductive and social activity occurring in the morning (06:00–12:00). Male–female interactions were dominant during this period, reflecting optimal environmental and social conditions for mating. In contrast, activities decreased significantly during hotter midday and nighttime hours.

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