



## Diurnal activity pattern of Indian Muntjac (*Muntiacus muntjak*) in captivity at Jawaharlal Nehru Biological Park, Bokaro, Jharkhand

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### Abstract

Animals are continuously adoptive to fit in their environment by expressing their activities. They adopt as per their surrounding environment, climate, food availability, size of inter and intra-species group and prey-predator relationship. In captive environment, some of their activities are minimise or express more due to their dependency on park management and visitors' presence. Indian Muntjac, *Muntiacus muntjak* (Zimmerman 1780) is a species under cervidae family, naturally found in the forested regions of south and south-east Asia. To understand their activities, a study was made on the adult male and female *Muntiacus muntjak* in the captivity of Jawaharlal Nehru Biological Park, Bokaro, Jharkhand in different season using Scan Sampling Method.

It was observed that barking deer spent nearly 70 percent of time in activity while rest of time they were in resting during the diurnal hours. Among the daily activities, 20% of time spent in feeding, followed by 19 % of time in walking, and approximately 12% time in scanning and social activities. Further, the comparative study of the male and female individuals, it was found that male spent more time in feeding, movement and other activities compared to the female while, female spent more time in scanning and resting activities compared to male.

The study concludes that though in the captivity all the individuals get equal habitat type, food supply and security from the predators, they have difference in their daily activities. This might be due to their difference in morphology, size, sex, age, etc. More observation needs to be made to understand their activities for the survival and management of barking deer in captivity as well as in their natural habitats.

**Keywords:** Barking deer, muntiacus, captivity, activity, bokaro

### Introduction

Animal living and adopted in a particular environment and habitat needs some basic pattern in activities to sustain in local environmental condition (Koladiya *et al.*, 2012; Quasin *et al.*, 2014) [13, 30]. Each kind of animal adopted some strategy in their basic activities and behavior to sustain successfully in a habitat, and according to the changing environment (Koladiya *et al.*, 2012; Mahato *et al.*, 2013) [13, 20]. Time allocated to different activities affected by the sex of individual, time of day, season (Martinez, 2000) [21], habitat type (Eberhardt *et al.* 1989) [8] and on habitat utilization (Caraco 1979) [5].

Southern Red Muntjac or Indian Muntjac (*Muntiacus muntjak*, Zimmermann 1780) are small solitary tropical forest ruminant deer species (Dubost, 1970; Barrette, 1977; Kurt 1981) [4, 6, 14] is a native to Southeast Asia, commonly called the "barking deer" due to its distinctive alarm call (Arini *et al.*, 2024). Muntjac deer have 9 known species (Shi and Ma 1988, Amato *et al.* 1991, Nowak 1991, Gao *et al.* 1998, Wang & Lan 2000) [3, 18, 24, 28] and 15 subspecies of the *Muntjac* in the world (Ohataishi & Gao, 1990). Barking deer is primarily a solitary species and can be seen occasionally in a group of 4 or 5 animals (Kurup, 1971) [15].

Indian muntjac prefer shrub grassland and thorny shrubland and used dry savanna (Teng *et al.*, 2004) [29]. Muntjac avoided woods, cultivated grass plot and deciduous monsoon forests (Teng *et al.*, 2004) [29]. The species is known to be predominantly a browser, and shrubs are expected to build a major part of its diet (Lekagul and McNeely, 1977) [16]. Barking deer is classified as an omnivore and is considered both browser and grazer with

grass, ivy, thorny bushes, low leaves, barks, twigs, grasses, fruits, eggs, and small blood animals (Habiba *et al.*, 2021) [9].

A comprehensive knowledge of the basic behavioural patterns is needed for understanding the social interactions of an animal (Torr and Shine, 1994). Behaviour is likely to vary with individuals and age- sexes; as such, an understanding of sex specific behaviour traits may assist in improving management techniques and practices (Lu *et al.*, 2009) [17]. Behavioural variation in ungulate populations is an area of research, which could provide insights not only into the evolution of ungulate behaviour, but also more generally into the evolution of the process in individual decision making (Isvaran, 2005) [11].

A total of 37 different types has been recorded under 13 major heads of behavioural patterns of *Muntiacus muntjak* by Mondal and Dutta (2023) [23], while Dwi Arini *et al.* (2024) [7] recorded 14 distinct behaviours in barking deer at captive condition. The behavioural patterns were almost similar for male and female with several patterns showing variations (Aker *et al.*, 2015).

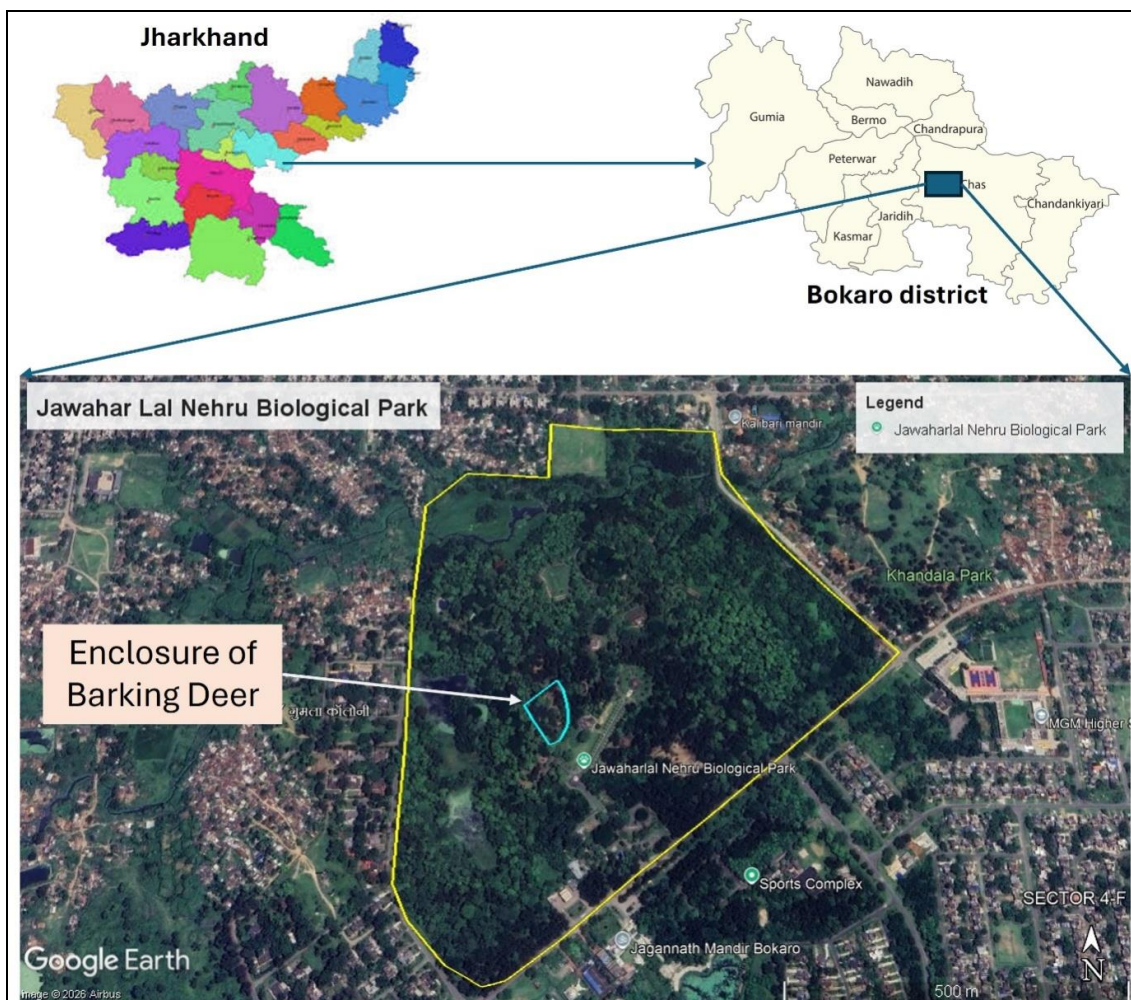
Jawaharlal Nehru Biological Park is located at the Bokaro Steel City, Jharkhand having large collection of herbivorous species including barking deer. The park is regularly visited by large number of city populace and tourist from other parts of the city. The daily activities of barking deer are normally influenced by diurnal hours, season, weather, food availability and visitors' presence. Hence, the study was conducted to assess the diurnal activity pattern of barking deer and tested with the diurnal hours and seasonal influence.

**Materials and Method**

**Study Area:** Study was conducted in the captivity at the Jawaharlal Nehru Biological Park (JNBP), Bokaro Steel City, Jharkhand (Figure 1). The total geographical area of the park is about 50 hectares. It maintains a variety of animals belonging to various vertebrate groups, collected from different parts of India and also from abroad. The present study on barking deer (*Muntiacus muntjac*) was carried out on the enclosure situated on the south-eastern portion of park. The size of the enclosure is approximately one (1) acre, containing a total number of 13 barking deer including 4 adult males, 7 females and 2 fawns. The surface of the enclosure during the time of the study was mostly bear with some patches of grasses. At the southern part of the enclosure has shed and rest of the area covered by the shed of large trees. The western side of the enclosure is separated by the enclosures of Blackbuck and Sambhar. Northern and Eastern sides of the enclosure is open for visitors.

**Methodology:** The classification and description of an animal's behavior is fundamental to quantitative ethological

studies (MacNulty *et al.*, 2007) [19]. We recorded activity patterns and social organization of adult male and female barking deer in captivity at the Jawaharlal Nehru Biological Park, Bokaro Steel City, Jharkhand. Observation was made to record data on the various basic activities of barking deer covering all seasons. For data recording, the activities of each animal were observed 5 minutes in an interval of 10 minutes continuously for 3 hours in each day of observation. Observation was conducting in three sessions (morning, noon, afternoon) in a day. Data were recorded on the data sheet designed for the study. Data were collected during the normal operating hours of the park, which were generally 0900h to 1800h. Observation hours were equally distributed between dawn and dusk. Activity of both male and female were sampled repeatedly in different hours of the day using focal animal sampling method (Altman, 1974) and at the same time numbers of visitors and social organization of Nilgai were counted by scan sampling method (Altman, 1974). The behavioural states recorded were feeding, walking, resting and social. Resting includes standing, scanning and lying activity of the individual.



**Fig 1:** Showing the location of enclosure of barking deer at Jawaharlal Nehru Biological Park, Bokaro Steel City, Jharkhand

The basic activities of barking deer were categorized into feeding, resting, scanning, walking and social behaviour. The definition of recorded activities as:

1. **Feeding:** means animal engaged in feeding or drinking.
2. **Resting:** means animal in rest with no body movement or very little body movement.

3. **Scanning:** means animal looking around by moving head in all directions.
4. **Walking:** means animal moving from one place to another by feet
5. **Social:** means other activities including grooming, fighting, chasing, mating, comfort & submissive behaviour etc.

The observed data were used to calculate the percentage time spent in each activity, frequency and bout duration of each activity and compared within diurnal hours and between seasons. The percentage times spent in various activities were calculated by using a formula:

$$\% \text{ Activity} = \frac{\text{Total time spent in particular activity during sample}}{\text{Total sampling time in all activities}} \times 100$$

**Results and Discussion**

A total of 216 hours were spent observing the behavioural activities of the barking deer at Jawaharlal Nehru Biological Park during the study period. Various activities such as feeding, resting, locomotion and grooming were recorded during the observation hours. The time spent in each activity was calculated to determine the percentage of activity. Time when the animal moved inside the enclosure without a specific activity was not included in the final calculation.

**Activity time budget**

The results of the study on the time spent in each of the activities in diurnal hours are shown table 1. The study recorded male barking deer spent nearly one-third time (29%) in resting and 71 percent of time they were active (Figure 2), while female spent 41% of time in resting and nearly 60% of time, they are active during the diurnal hours (Figure 3). Comparatively, male spent maximum time in resting, followed by movement, feeding and social

behaviour while minimum time in scanning. The female barking deer spent maximum time in resting, followed by feeding, walking and scanning and minimum time in social activity. The study highlighted that both male and female spent nearly equal time in social activities. Altogether, male barking deer were more active compared to the female barking deer at the JNBP, Bokaro Steel City.

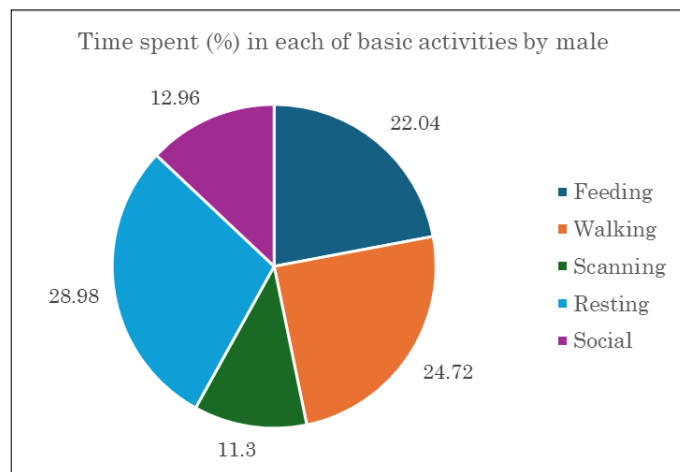
**Table 1:** Time spent (%) in each of the basic activity by the Barking deer at JNBP

	Male (Mean±SE)	Female (Mean±SE)
Feeding	22.04±3.13	18.14±3.25
Walking	24.72±2.87	14.54±2.25
Scanning	11.30±1.07	14.16±2.69
Resting	28.98±4.37	41.11±5.78
Social	12.96±1.29	12.03±1.53

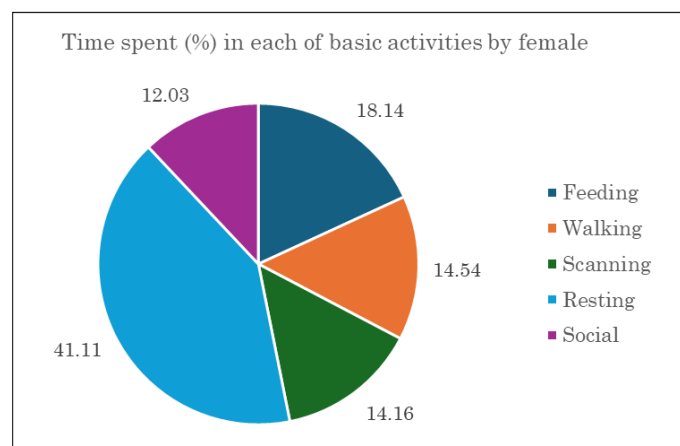
**Diurnal Activity Pattern**

The results of diurnal activity pattern of various basic activities are separately discussed in below section:

**Feeding:** Analysis of data revealed that among the various basic activities, the feeding activity of both male and female showed increasing trend from morning to evening hours (Figure 4). The male spent maximum time in afternoon hours between 3 pm to 6 pm, while minimum time in morning 6 am to 8 am. Similarly, female spent maximum time in 5 pm to 6 pm, followed by 10-11 am, while minimum time spent in feeding during 12-1 pm.



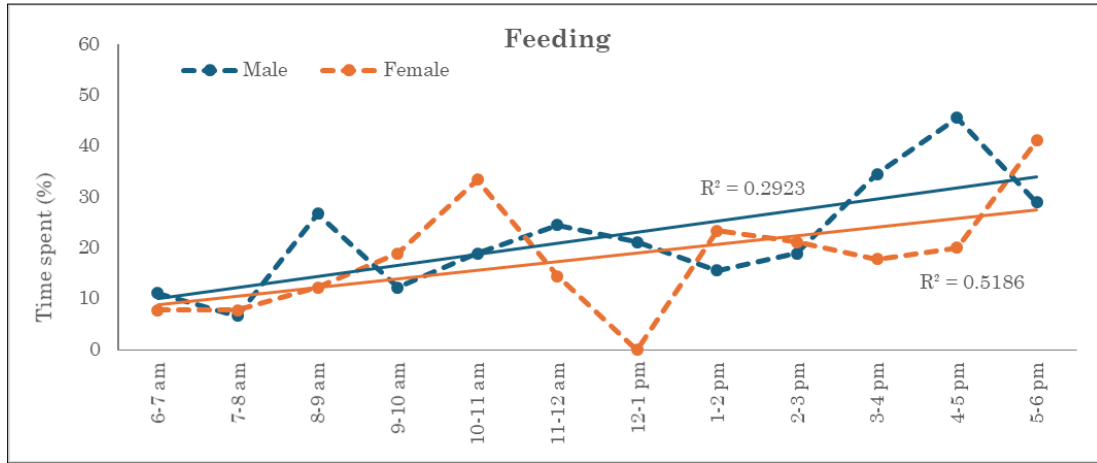
**Fig 2:** Daytime spent (%) on basic activities by adult male at Jawaharlal Nehru Biological Park, Bokaro, Jharkhand



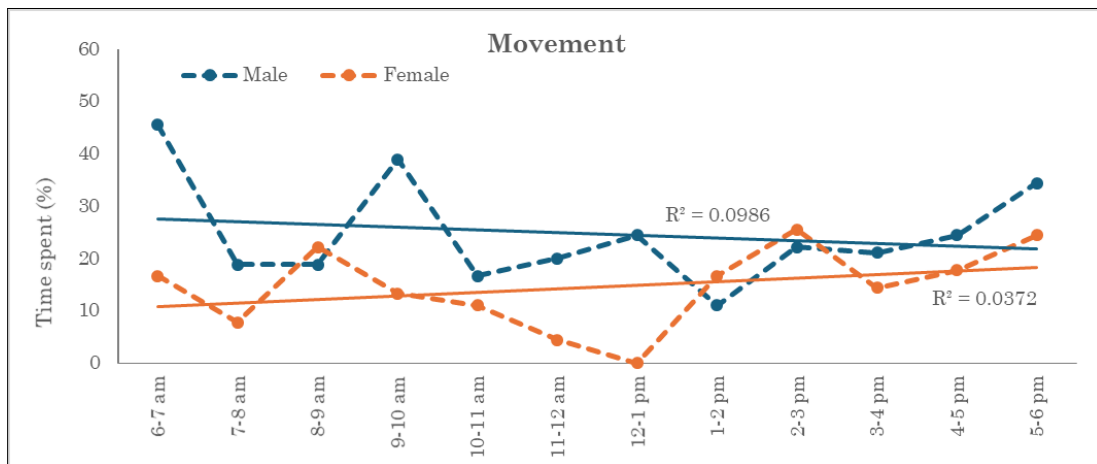
**Fig 3:** Daytime spent (%) on basic activities by adult female at Jawaharlal Nehru Biological Park, Bokaro, Jharkhand

**Movement:** The data recorded on the movement activity of barking deer at the captivity of JNBP, Bokaro steel city, it was found that movement activity of male was slowly decline from morning hours to evening hours with highest movement recorded during 6-7 am morning and lowest

during 1-2 pm (Figure 5). Reverse to that, the movement in female slowly increases from morning to evening hours with highest recorded during 2-3 pm and 5-6 pm, and lowest recorded during 12-1 pm (Figure 5).



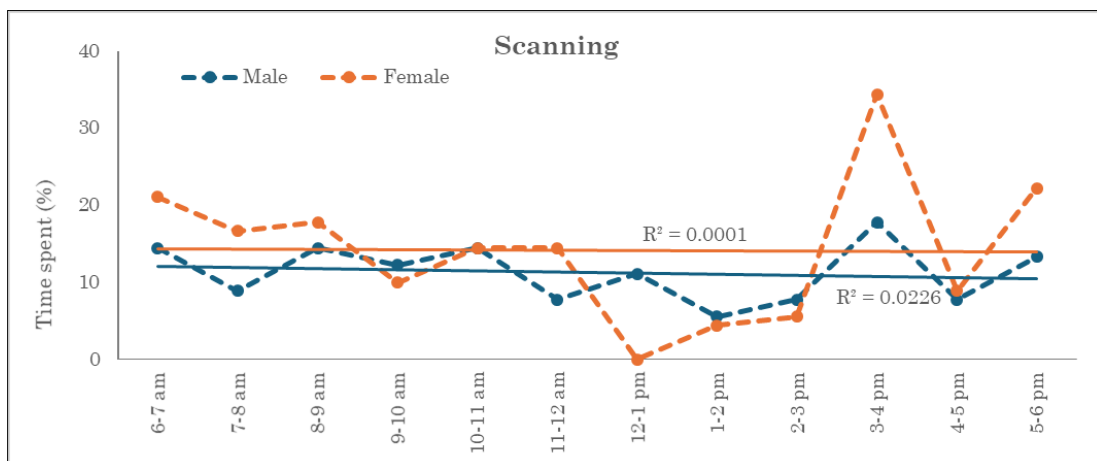
**Fig 4:** Diurnal pattern of feeding activity (%) of *Muntiacus muntjak* at JNBP, Bokaro, Jharkhand



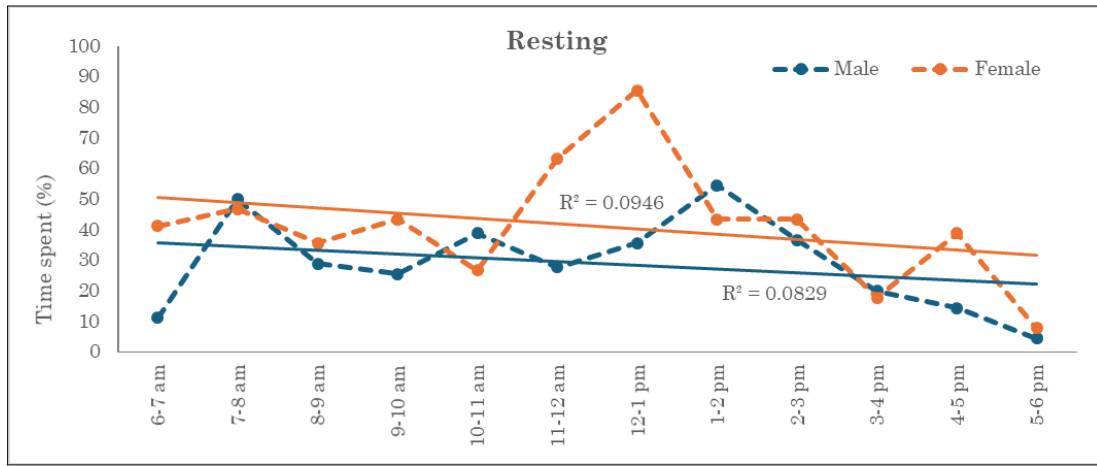
**Fig 5:** Diurnal pattern of movement (%) of *Muntiacus muntjak* at JNBP, Bokaro, Jharkhand

**Scanning:** The observation on the scanning activity of barking deer at the captivity of JNBP, Bokaro steel city, it was found that scanning of both male and female was similar and in all the diurnal hours scanning was also more or less similar in all hours of the day. The highest peak of

scanning was recorded in male during 3-4 pm and lowest during 1-2 pm (Figure 6). Similarly, in female scanning was recorded highest during 3-4 pm and lowest recorded during 12-1 pm (Figure 6).



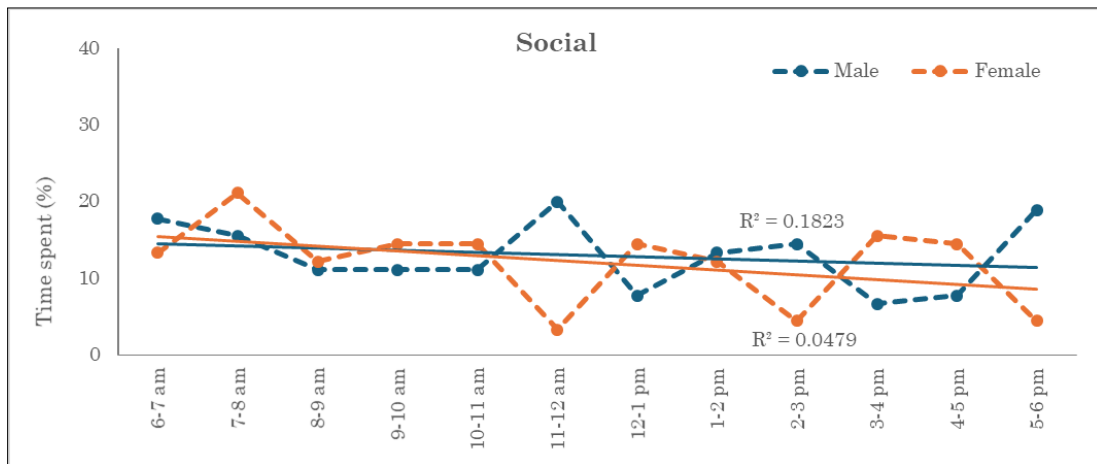
**Fig 6:** Diurnal pattern of scanning activity (%) of *Muntiacus muntjak* at JNBP, Bokaro, Jharkhand



**Fig 7:** Diurnal pattern of resting activity (%) of *Muntiacus muntjak* at JNBP, Bokaro, Jharkhand

**Resting:** Observation on the resting of barking deer at the captivity at JNBP, it was found that male highest time in resting during noon hours with peak of resting at 1-2 pm and lowest resting during the 5-6 pm (Figure 7). The resting was recorded in declining trends as move from morning to evening hours. Similarly, in female resting was recorded maximum in noon hours with resting peak at 12-1 pm and lowest recorded during 5-6 pm (Figure 7). Like male, the trend of resting in female during diurnal hours is declined between mornings to noon hours.

**Social behaviours:** Social behaviour are an important basic activity for the interaction and communication among the individuals of the group living animals. Observation on the social activity of barking deer at the captivity at JNBP, it was found that in both male and female have social activities slowly decline from morning to evening hours (Figure 8). The peak of social activities recorded in male during 11-12 am and 5-6 pm while in female 7-8 am. The lowest social activities were recorded in male and female barking deer during noon hours.



**Fig 8:** Diurnal pattern of social activities (%) of *Muntiacus muntjak* at JNBP, Bokaro, Jharkhand

The activities of barking deer in captivity were varied during diurnal hours like other similar or closely related species. Mondal and Dutta (2023) [23] observed highest frequency (33.25 %) of foraging and the lowest (1.28 %) of sexual behaviour in Barking deer at captive environment. They also found that males showed more sexual behaviour and less submission behaviour towards females (Mondal and Dutta, 2023) [23]. The present study recorded highest time spent by barking deer in feeding in male and walking in female.

Both sexes of (*Muntiacus reevesi*) showed somewhat more activity during daylight than night, with peaks of activity in morning and evening in most months (McCullough *et al.*, 2000) [22]. Average percent of time active over the year was 53.2% for males and 46.5% for females in *Muntiacus reevesi* (McCullough *et al.*, 2000) [22]. The study recorded similar trend in JNBP, as both the male and female

individuals of barking deer were most activate during morning and afternoon hours and less active during noon hours.

Females consumed food and took rest more frequently than males, who spent more time in foraging and movement. Males also showed higher frequency of sexual behaviours and less submissive behaviours (Akter *et al.*, 2015). The present study recorded similar time spent in social behaviours by the male and female individuals.

There are 14 distinct behaviours were identified by Dwi Arini *et al.* (2024) [7], with resting behaviour being the most frequent (59–69%), followed by consuming (14–20%), movement (5–6%), foraging and self-directed behaviour (2–3%), and other activities. Similarly, the present study recorded highest time spent by both male and female individuals in resting during the diurnal hours at JNBP, Bokaro Steel City.

## Conclusion

The present findings reveal that majority of the behaviours resemble that of other cervids at captivity. The pattern of activities during diurnal hours an important and vital adaptation for survival and determined by the local climate, weather, temperature, food availability, habitat condition, prey-predator presence, etc. In the captivity, some of the activities like feeding, movement and social behaviours are limited comparative to the barking deer found in wilderness due to the limited space available at captivity. Though, the scanning was more frequent in captivity as compared to the wilderness due to presence of visitors at captivity, while in wilderness, they are more vigilant due to the presence of predators.

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