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A behavioural study of the captive *Muntiacus muntjak* (Zimmerman, 1780) at Zoological Garden, Alipore, Kolkata

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Abstract

A study on Barking deer, *Muntiacus muntjak* (Zimmerman, 1780) was carried out in captivity at Zoological Garden, Alipore, Kolkata from July to December, 2022 to evaluate their diurnal activity patterns. Focal animal sampling method was used to determine the different activity times of 19 individuals of Barking deer after observing them. Behavioural patterns of 37 different types have been recorded under 13 major heads, of which highest frequency (33.25 %) was recorded for foraging and the lowest (1.28 %) was sexual behaviour. Males showed more sexual behaviour and less submission behaviour towards females. The nursing behaviour was observed among females with 2 young ones. Although the value of the standard error of mean is inversely proportional to the population size, it is higher due to the decrease in the sample of time spent by females in the 3 behavioural categories viz., agonistic interaction, Sexual behaviours and Scent marking and deposition. Comparing the mean value of the two sets of data using unequal variance t-Test, it is found that time spent in different behavioural patterns by male is lesser.

Key words : Barking deer, Diurnal activity study, Captivity, Alipore Zoological Garden, Kolkata, West Bengal, India.

The muntjac or barking deer is a small forest dwelling ruminant [40]. In popular local language, it is known as *Kaakad* or *Kakad*[35]. The species found in Nepal, Bhutan and Northern India is *Muntiacus muntjak vaginalis*[39]. The barking deer is common species in Nepal and is called '*Rate*' or '*Ratuwa*' locally. It is supposed to be the smallest deer in shape among its family and colour variation is observed in different ecological zones of Nepal. It is seen scarcely distributed in small number due to habitat loss and hunting in the country except in protected areas[9]. They are classified into 9 known

species: *Muntiacus crinifrons*, *Muntiacus feae*, *Muntiacus gongshanensis*, *Muntiacus muntjak*, *Muntiacus putaoensis*, *Muntiacus reevesi*, *Muntiacus rooseveltorum*, *Muntiacus truongsonensis* and *Muntiacus vuquangensis*[4,13,30,38,42]. There are 15 subspecies of the Muntjak in the world[32]. Barking deer is primarily a solitary species[14,20] and rarely can be seen in a group of 4 or 5 animals[21]. They have large, obvious facial (preorbital, in front of the eyes) scent glands used to mark territories or to attract females. Males have larger glands than females[6]. Muntjacs exhibit two patterns of defecation in captivity and even in wild. They defecate through their enclosure without regard to existing pellet groups, and they repeatedly use specific areas, which are called latrines[11]. They are listed as "least concerned" in Red Data Book of the International Union of Conservation of Nature[41].

Alipore zoo has a huge number of variable animal and reptile conserved, which are the most attractive things here for the visitors. There is a gorilla house, a reptile house, a panther building, an elephant house. A wild lake is located in the middle of this zoo and various types of migratory birds come here from far away. One of the most popular tourist attractions in Kolkata, it draws huge crowds during the winter season, especially during December and January. Some research has been done on the environment and behaviours of barking deer in the wild as well as in captivity by Ogilby[31], Barrette[5,7,8], Mishra[29], Kassim[18], Oli and Jacobson[33], Heggdal[14], Chalise [10], Ilyas and Khan[16], Ganguly *et al.*[12], Ahammed *et al.*[1], Aktar *et al.*[3], Magintan *et al.* [26].

Where and how an animal spends its time in different activities, which is very important for their energy balance and survival, also their basic activities are influenced by their habitat and surrounding of the animal. This type of studies is very important for captive management of wildlife, it is emphasized. The aim of this paper was to study the activity patterns of Barking deer in various hours of the day in captivity at Zoological Garden, Alipore, Kolkata.

Study Area :

The study was conducted in captivity at Zoological Garden, Alipore, Kolkata (22.5372144°N 88.3320919°E) is India's oldest stated zoological park (open as a zoo since 1876) which covers 18,811 ha (46.47 acres) areas having verities of animal belonging to all vertebrate group (Sloth beer, Hippopotamus, Rhinoceros, Nilgai, Jungle cat, Giraffe, Chimpanzee, Striped hyena, Asiatic lion, Asian elephant, Bengal tiger, Jaguar *etc*.). Average temperature of Alipore zoological garden during study period as almost 30C to 35C. Temperature is usually maximum during noon hours, between 12:00 hr to 15:00 hr and minimum before 10:00 hr and after 16:00 hr. Everyday huge number of visitors come to visit Zoological Garden, Alipore attracted to huge number of variable animals and reptiles.

Studying animal :

The animal to be studied is Barking deer, whose number is 19 including 5 male, 12 female and 2 young, who are in an enclosure on the south side of the zoo. The Zoological Garden authority provides them food (wheat bran, soaked gram, crushed barley, red potato,

Fig. 1: Exact location of Barking Deer Enclosure in the study area at Zoological Garden, Alipore (https://www.google.com/maps/place/Barking+Deer+Enclosure)

carrot, leafy vegetables, boiled lentil, cabbage green fodder, oats, banana, common salt) per day three times (in the morning, between 8 am to 9 am; in the afternoon between 3 pm to 4 pm and between 8 pm to 9 pm at night).

Enclosure of the animal :

The enclosure is divided into two sections by netted fence. Ground of the enclosure, where there is plenty of grasses for barking deer to eat and there are some Giant Taro (Man-kachu; *Alocasia macrorrhiza* (L.) G. Don) on one side of one section of the enclosure under which they rest and also there is a large Banyan tree (*Ficus benghalensis* L.) in each section of the enclosure and a small tree, which provide shade. While this enclosure has one side open for the visitors through which they can see them, one side of the enclosure was bordered by enclosures of Sambar deer [*Rusa unicolor* (Kerr, 1792)] and another side was bordered by the Brow antlered deer [*Cervus eldiieldii* (M'Clelland,1842)]. There are two food containers in one section and one food container in another. There is also one room in each section for them and a water container near every room too (**Fig. 2**).

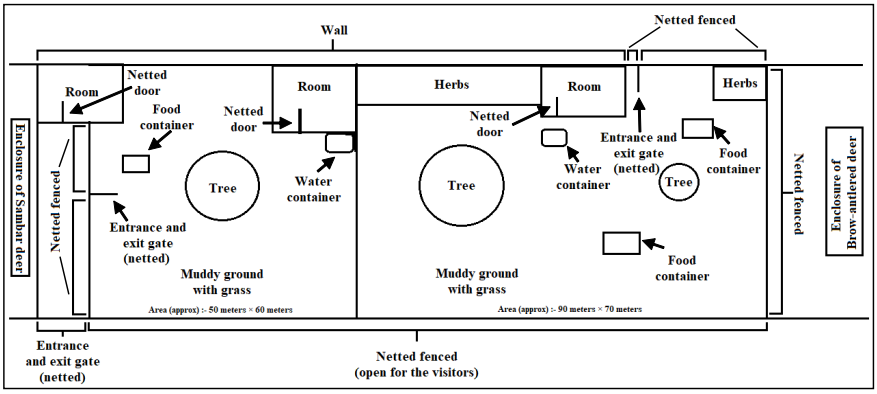

Fig. 2: Layout of the Barking deer enclosure at Zoological Garden Alipore, India (Based on visual observation during the present study the period of July to December, 2022).

Recording methods of behaviour :

We recorded activity patterns and social organization of Barking deer in captivity at the Zoological Garden, Alipore, Kolkata between 1st July and 31st December, 2022. For data recording, the activities of each animal were observed 5 minutes in an interval of 15 minutes continuously for 3 hours in each day of observation. Each individual of Barking deer was observed every week for 2 days in two separate sessions every week. Data were collected during the normal operating hours of the zoo, which were generally Tuesday (11:00 hr to 14:00 hr) and Friday (14:00 hr to 17:00 hr). Activity of both male and female were sampled repeatedly in different hours of the day using focal animal sampling method[2], and at the same time number of visitors and social organization of Barking deer were counted by scan sampling method[2]. The behavioural states of 13 different types have been recorded vitz., foraging, consuming, movement, relaxed state, investigative, self-directed behaviour, affinitive interaction, agonistic behaviour, submissive behaviour, scent marking and deposition, sexual, vocalization and elimination activity of the individual. Video camera was used when needed, photographs were taken using digital camera and observations were recorded.

Ethogram :

An ethogram when is a set of terms and descriptions of the behaviour of an animal may be comprehensive of all behaviours of a species or it may be for only one sex, age group or type of behaviour[22]. It gives the biological roots and meanings of animal actions and formulates a catalogue of behavioural patterns. On the basis of previous behavioural studies on different deer species by[1,24,25,36] and preliminary observations, the ethogram was constructed for this study on barking deer (Table-1).

Table 1. Ethogram used for collecting behavioural data of barking deer in captivity at Alipore Zoo, Kolkata

Behavioural categories	Description
Foraging (FG)	Searching for food
Consuming (CO)	Taking food or water for survival
Movement (MV)	Changing location
Relaxed state (RS)	Animal is in inactive state
Investigative (IV)	Response to stimuli or potential stimuli
Self-directed behaviour (SD)	Animal exhibits activities directed to itself
Affinitive interaction (Al)	Direct physical contact between individuals, without obvious conflict
Agonistic interaction (AG)	Obvious aggressive behaviours with or without direct body contact
Submissive behaviour (SB)	The behaviours of an inferior animal when approached by a dominant animal
Sexual (SE)	Behaviours related attract opposite sex for reproduction
Scent marking & deposition (MD)	Behaviours associated with exploring a new area or an object
Vocalization (VO)	Gives calls usually on sensing a predator or during withdrawal to an approaching male who attempt to mount
Elimination (EL)	Release urine or faces from body

Data analysis :

Behaviours were quantified by counting the number of events (frequency or rate measures)[2]. Graphical representation was prepared by using MS - Excel software (Ver, 2007). The percentage times spent in various activities were calculated by using a formula. Total time spent in particular activity during sample % Activity = (Total time spent in particular activity during sample/ Total sampling time in all activities) x 100

Standard deviation (SD), $\sigma=\sqrt{\Sigma(Xi-\overline{X})^2/N}$

Where, N= the size of the population

Xi= each value from the population

Standard error of the Mean (SEM)= $s/\sqrt{n}$

Where, s= standard deviation

n= Number of observations in the sample

Mean ($\overline{X}$) = The sum of the observations divided by the total number of observations The data of male and female individual activities have been compared by applying T-test[43].

A total of 37 behaviour patterns of barking deer with their essential maintenance behaviour, social encounters and interactions with environment under 13 major heads was recorded in captivity, of which 29 behavioural patterns were similar in both males and females and 9 showed sex difference (Table-2). The highest frequency (33.25 %) was recorded for foraging and the lowest (1.28 %) was sexual behaviour (Fig. 3).

Table-2. Time spent in major behavioural categories by barking deer at Alipore Zoo

Behavioural categories	Time spent (In minute)		Total time spent (In minute)	Percentage of time spent
	Male	Female		
Foraging (FG)	3643	4179	7822	33.25
Consuming (CO)	870	1123	1993	8.47
Movement (MV)	533	799	1332	5.66
Relaxed state (RS)	1506	2186	3692	15.69
Investigative (IV)	1377	1715	3092	13.14
Self-directed behaviour (SD)	985	1190	2175	9.24
Affinitive interaction (Al)	194	226	420	1.78
Agonistic interaction (AG)	421	167	588	2.50
Submissive behaviour (SB)	129	182	311	1.32
Sexual (SE)	283	19	302	1.28
Scent marking & deposition (MD)	435	485	920	3.91
Vocalization (VO)	107	205	312	1.33
Elimination (EL)	211	356	567	2.41
Total	10694	12832	23526	

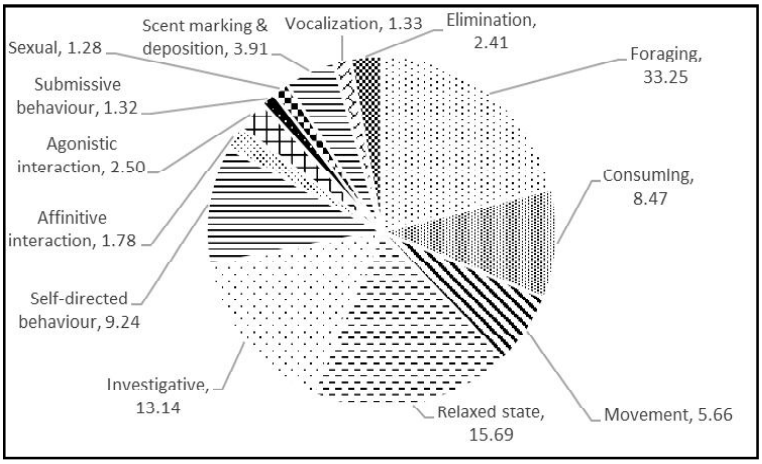

Fig. 3: Percentage of time spent in major behavioural categories by barking deer at Alipore Zoo.

The behaviour patterns were seen almost same between male and female, but variation was observed between them in some cases. Most of the time Barking deer engaged in foraging and resting activities. Male spent more time in affinitive and agonistic behaviour than female, who took rest and consumed food more frequently. Males showed more sexual behaviour and less submission behaviour towards female (Fig. 4). The nursing behaviour of the young can be observed in females for having 2 young. The deer were less active and spent most of the time in investigative behaviours followed by self-directed behaviours, consuming behaviours and scent markings and depositions.

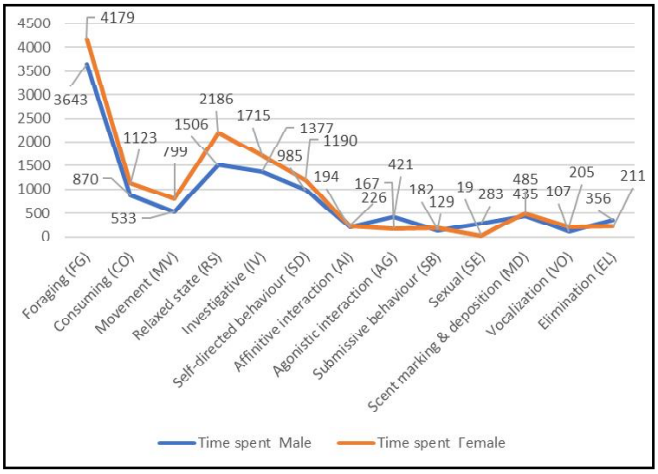

Fig. 4: Time spent in major behavioural categories by male and female barking deer at Alipore Zoo.

In captivity, ear movement (n= 479) was the most frequently encountered behaviour. Other more frequently encountered behaviour patterns were feeding (n= 438), sitting (n=351), ruminating (n= 306), self-licking (n=304), tail movement (n= 265), drinking (n= 247), browsing (n 235), withdrawal (n=234)), nibbling (n= 211), etc (Table-3). After our initial observations it can be said that most of the behaviour is similar to other cervids, but several behavioural patterns (e.g., nibbling, barking) distinguish this species from others.

Sparring, force up without contact, poke with antlers and chase these 4 behavioural patterns belong to agonistic interaction behavioural category; low stretch, place head on rump, flehmen these 3 behavioural patterns belong to sexual behavioural category and among scent marking and deposition behavioural category 1 behavioural pattern that is forehead rub; these 8 behavioural patterns could not be observed in females. In males, the meowing behavioural pattern is not observed, which belongs to the vocalization behavioural category.

Foraging behaviour: In enclosure the barking deer was observed to forage by means of grazing, browsing, nibbling and feeding. All the observed foraging behaviour of barking deer is found in other cervids except nibbling and the patterns were little bit different.

Consuming behaviour: The deer was observed to drinking water and also search and eat natural grass, leaves of the shading tree along with supplementary food. After foraging or feeding the deer was found to ruminate and this included series of rumination of herbivores *i.e.*, chewing, masticating and swallowing.

Movement: During walking the deer typically involved slow and careful walking, frequently pausing and standing still. After resting, feeding and defecation, males were observed to a short run.

Relaxed state: Deer sat in stretch position and the front feet are often tucked under the body. They often took rest in a standing position, remained immobile, staring straight ahead and with the head in an upward and the legs straight.

Investigative: During feeding and hearing sudden loud sound, deer was observed to investigate usually. During investigation of new areas or objects that had been previously licked, bite and lick object was primarily seen. They also performed flehmen to investigate environment by raising head vertically for a short duration.

Self-directed behaviour: It was found that the deer lick their body. After resting, feeding, walking and during flies' disturbance, higher frequency of tail movement was observed. They were shake their head and bodies usually after feeding, sitting and sleeping.

Affinitive interaction : The most dominant form of mutual play among deer was chasing. Both male and female licked their body to one another. Males more frequently licked female's body, while female licked male's body during rutting.

Table-3. Behavioural patterns observed on barking deer in captivity at Alipore Zoo

Behavioural categories	Behavioural patterns	Time spent (In minute)		Number and Percentage	
		Male	Female	Male	Female
Foraging	Grazing	677	628	83 (2.88)	91 (2.67)
	Browsing	563	681	104 (2.39)	131 (2.89)
	Nibbling	564	695	90 (2.40)	121 (2.95)
	Feeding	1839	2175	203 (7.82)	235 (9.24)
Consuming	Drinking	234	340	102 (0.99)	145 (1.45)
	Ruminating	636	783	137 (2.70)	169 (3.33)
Movement	Walking	446	676	90 (1.90)	120 (2.87)
	Running	87	123	20 (0.09)	28 (0.11)
Relaxed state	Standing	237	399	52 (1.01)	84 (1.69)
	Sitting	1126	1557	151 (4.79)	200 (6.62)
	Sleeping	143	230	17 (0.61)	26 (0.98)
Investigative	Flehmen	197	282	39 (0.83)	56 (1.20)
	Scanning	507	607	99 (2.16)	121 (2.58)
	Ear movement	528	600	222 (2.24)	257 (2.55)
	Bite and lick object	145	226	36 (0.62)	55 (0.96)
Self-directed behaviour	Self-lick	546	700	132 (2.32)	172 (2.97)
	Shake head and body	89	80	32 (0.38)	28 (0.34)
	Tail movement	350	410	123 (1.49)	142 (1.74)
Affinitive interaction	Lick body	89	73	35 (0.38)	30 (0.31)
	Playing	105	153	31 (0.45)	44 (0.65)
Agonistic interaction	Sparring	19	-	10 (0.08)	-
	Force up without contact	82	-	24 (0.35)	-
	Poke with antlers	46	-	14 (0.20)	-
	Chase	82	167	25 (0.35)	48 (0.70)
	Fight	192	-	39 (0.82)	-
Submissive behaviour	Withdrawal	129	182	98 (0.55)	136 (0.77)
Sexual	Low stretch	90	-	42 (0.38)	-
	Place head on rump	84	-	40 (0.36)	-
	Flehmen	67	-	31 (0.28)	-
	Taste urine	42	19	18 (0.18)	8 (0.08)
Scent marking and deposition	Sniffing	270	428	71 (1.15)	105 (1.82)
	Paw the ground	57	57	27 (0.24)	30 (0.24)
	Forehead rub	108	-	53 (0.46)	-
Vocalization	Barking	107	136	47 (0.45)	59 (0.58)
	Mewing	-	69	-	33 (0.29)
Elimination	Urination	96	172	43 (0.41)	78 (0.73)
	Defecation	115	184	45 (0.49)	70 (0.78)

Agonistic interaction: Males poked subordinates (both males and females) with their antlers, usually in the side or rump. Dominant males and females forced up without contact to dominated individuals that were bedded down. Sparring between deer also observed. Dominant muntjacs chased subordinates at a full run many times around the enclosure. Only during violent agonistic interaction fighting has been observed between them.

Submissive behaviour : The most common submission form seen in barking deer is withdrawal.

Sexual behaviour : Actually, low stretch was directed only by males to females and consisted of several elements. During this, the male walked rapidly toward a female, usually from behind or below the horizontal position. Male often placed his head on the female's back after flehmen Males also performed flehmen in response to urine. It is performed by males during sexual encounters. Flehmen was associated with anogenital sniffing.

Scent marking and deposition: It is usually united with forehead rubbing, sniffing, liking and flehmen. Both males and females paw the ground by repeatedly striking and pulling the forefoot sharply across the substrate, digging into the soil and sometimes uprooting grass. Both male and female rub their forehead against the objects. That means, scent deposition is done by sudoriferous glands in the forehead. They investigated a new area, wall of the enclosure, ground or an object by sniffing. They opened preorbital glands carefully to check ana object during marking.

Vocalization : Both male and female gave calls similar to barking i.e., the sounds of bark of a dog, usually on sensing a predator was recorded. Female produced mewing sounds during withdrawal to an approaching male who attempted to mount.

Elimination : The deer was observed to defecate throughout their enclosure without regard to existing nubble groups and they repeatedly use specific areas, which were latrines.

Intuitively, as the sample size increases, the sample becomes more representative of the population. Consider the time spent in major behavioural categories of 17 barking deer at Alipore Zoological Garden in Kolkata. Two classes male and female of 5 and 12 individuals, respectively, are extracted from the population. It is logical to assert that the average time spent in major behavioural categories in female will be closer to the average time spent of the whole population than the average time spent in major behavioural categories by barking deer in male.

Thus, the standard error of the mean in female will be smaller than that in male. The standard error of the mean will approach zero with the increasing number of observations in the sample, as the sample becomes more and more representative of the population, and the sample mean approaches the actual population mean.

It is evident from the mathematical formula of the standard error of the mean that it is inversely proportional to the sample size. It can be verified using the SEM formula that if the sample size increases from 5 to 12

(becomes more than two times), the standard error will be reduced. But here, despite the number of female individuals being more, in 3 behavioural categories (agonistic interaction, Sexual behaviours and Scent marking and deposition) the value of standard error of mean has come high, because some behavioural patterns under these 3 behavioural categories (for example, among agonistic behaviour sparring, force up without contact and poke with antlers these behavioural patterns, again, among sexual behavioural category, low stretch, place head on rump and vulva lick these behavioural patterns, among under the Scent marking and deposition behavioural category, the behavioural pattern of forehead rub) could not be observed in females.

This means that the value of the standard error of mean is higher due to the decrease in the sample of time spent by females in these 3 behavioural categories despite the fact that their number is more (Table-4).

Table-4: Mean and standard error of the Mean (SEM) of the time spent (percentage) in basic activities of Barking deer in Zoological Garden, Alipore, Kolkata, from July to December, 2022

Behavioural activities	(Mean ± SEM)	
	Male	Female
Foraging (FG)	7.577 ± 0.176	7.403 ± 0.161
Consuming (CO)	3.640 ± 0.101	3.576 ± 0.087
Movement (MV)	4.845 ± 0.249	5.399 ± 0.239
Relaxed state (RS)	6.845 ± 0.265	7.051 ± 0.223
Investigative (IV)	3.477 ± 0.104	3.507 ± 0.096
Self-directed behaviour (SD)	3.432 ± 0.102	3.479 ± 0.092
Affinitive interaction (Al)	3.054 ± 0.152	2.939 ± 0.148
Agonistic interaction (AG)	3.759 ± 0.180	3.479 ± 0.225
Submissive behaviour (SB)	1.316 ± 0.047	1.338 ± 0.040
Sexual (SE)	2.160 ± 0.060	2.375 ± 0.183
Scent marking & deposition (MD)	2.880 ± 0.133	3.592 ± 0.175
Vocalization (VO)	2.305 ± 0.119	2.228 ± 0.090
Elimination (EL)	2.398 ± 0.080	2.405 ± 0.068

Here, the data of the time spent in different behavioural patterns under the different behavioural categories of male and female Barking deer has been collected and separated into two groups in a table (Table-3) and need to compare the means (Table-5) of two independent samples, that's why two sample t- test used here. Because the number of samples in each group is different, and the variance of the two data sets is also different, so unequal variance t-Test has been used (also called Welch's t-test).

Table-5. Data analysis

Group	Male	Female
Mean ($\overline{X}$)	297.0556	442.4828
Standard Division (SD)	361.1302	467.4319
Standard Error of the Mean (SEM)	60.18837	86.79992
N	36	29
Variance	130415.0254	218492.5443

Though the mean of data collected from different behavioural patterns performed by the female is higher than that of data collected from different behavioural patterns performed by the male, it cannot be conclude from this that the mean collected from the data of time spent on different behavioural patterns of the female may be more than the mean of the data of time spent on different behavioural patterns of the male. The difference is mean from 297.0556 to 442.4828 due to chance alone. Actually, the problem established by assuming the null hypothesis that the mean is the same between the two sample sets constructed from time spent in different behavioural patterns by male and female Barking deer and conduct a t-test to test if the hypothesis is plausible.

Since the number of data records is different (N1 = 36 and N2 = 29) and the variance is also different, the t-value and degrees of freedom are computed for the above data set using MS - Excel software (Ver, 2007). Here it is specified that a level of probability (alpha level, level of significance) as a criterion for acceptance. In most cases, a 5% value can be assumed.

Now do the t test calculation assuming the hypothesized mean difference is 70, from which the p value is found 0.04649349 with which the α significance level (0.05) is compared. If it is less than α, reject the null hypothesis, this implies that the alternative hypothesis is correct, and that the data is significant (Fig. 5). The degree of freedoms (df) for the unequal variance t-test is 52.

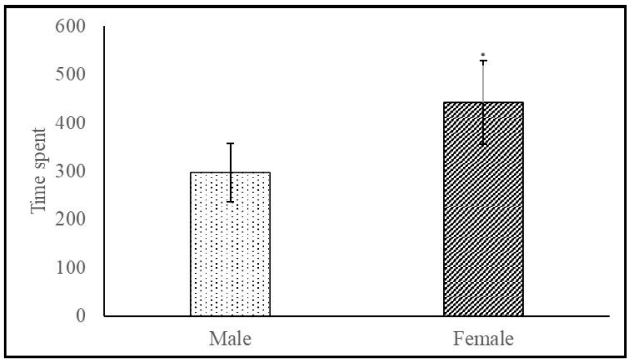

Fig. 5: An Unequal variance t-test was used to determine whether there was a significant difference between the time spent by male and female individuals on different behavioural patterns.

In the present study, different behavioural patterns belonging to different behavioural categories of barking deer in captivity of Alipore Zoological Garden of Kolkata were observed. Observation data reveals that total of 37 behavioural patterns have been found which belong to total of 13 behavioural categories. Of these, 4 behavioural patterns (grazing, browsing, nibbling and feeding) belongs to foraging, 2 behavioural patterns (drinking and ruminating) belong to consuming, 2 behavioural patterns (walking and running) belong to movement, 3 behavioural patterns (standing, sitting and sleeping) belongs to relaxed state, 4 behavioural patterns (flehmen, scanning, ear movement and bite and lick object) belong to investigative, 3 behavioural patterns (self-lick, shake head and body and tail movement) belong to self-directed behaviour, 2 behavioural patterns (lick body and playing) belongs to affinitive interaction, 5 behavioural patterns (sparring, force up without contact, poke with antlers, chase and fight) belongs to agonistic interaction, 1 behavioural pattern (withdrawal) belong to submissive behaviour, 4 behavioural patterns (low stretch, place head on rump, flehmen and taste urine) belong to sexual, 3 behavioural patterns (sniffing, paw the ground and forehead rub) belong to scent marking and deposition, 2 behavioural patterns (barking and mewing) belong to vocalization and 2 behavioural patterns belong to (urination and defecation) belong to elimination.

Ogilby[31], previously observed social Behaviour of Captive Muntjacs *Muntiacus reevesi*. Ganguly *et al.*[12] has compared the behaviour of different deer in captivity at the zoological garden of Kolkata. Aktar *et al.*[3] also studied various behavioural patterns in captivity at Dhaka Zoo in Bangladesh. In other cervids, all the observed foraging behaviour of barking deer (except nibbling and the patterns were little bit different) is found. Previously, the nibbling behaviour was also reported by Hofmann and Stewart[15] and Barrette[9]. Loe *et al.*[23], who reported the main activity pattern of ruminants consists of sequential series of foraging or feeding and rumination. Behavioural patterns observed within the movement behavioural category and barking behavioural pattern belong to vocalization were also observed by Kamruzzaman[17]. McNamara and Eldridge[25], also recorded resting, investigative, self-directed, aggressive, submissive, sexual and scent marking and deposition patterns in captive *Pudu pudu* and *Mazama americana*. Also, all the comfort self- directed behaviours were previously reported by Lu *et al.*[24] in captive *Moschus chrysogaste*. Also, Aggressive patterns observed in this study are more or less similar to previous findings in *Cervus duvaucelli* Schaller[37] Martin[27] and in all Muntjacs by Barrett[5,6,7]. In this study, the recorded sexual behaviour patterns are almost similar to the previous findings on Muntiacus by Barrette[5], and in *Cervus elaphus nannodes* by McCullough[28]. Scent marking and deposition patterns are typical to other cervids and similar patterns were reported by Quay and Muller-Schwarze[34] in *Antilocapra americana*, *C. capreolus* and *Odocoileus hemionus*. Barking behavioural pattern belong to vocalization was also reported by Khan[19] and also mewing produced by female during withdrawal to an approaching male who attempted to mount, which supported by Oli and Jacobson[33]. Barrette[4] also reported similar behavioural patterns during elimination in barking deer.

From this study, the nursing behaviour of the young (can be observed in females for having 2 young) and attraction towards visitors (they are sometimes excited seeing visitors and run about the enclosure, especially in

December) also observed.

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