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Analyses of Diurnal Behaviour of Captive Giraffe (*Giraffa camelopardalis*) in Alipore Zoological Garden, Kolkata, India

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Abstract: Wild herbivorous animals are difficult to house in captivity due to their wide home range and specific diet. As wild captive animal's behavioural data are used as a welfare indicator, diurnal behavioural study and time budgeting of a male giraffe (*Giraffa camelopardalis*) was carried out from August 2022 to June 2023 in Alipore Zoological Garden, Kolkata, India. This study aimed to explore the overall seasonal behavioural patterns and hourly activity budget from 10.00 to 17.00 h by using focal sampling method with 23,520 minutes of observations. During the observation period, the giraffe spent maximum time in standing in alert condition, followed by resting. The mean time spent percentage for feeding of offered feed was 5.07% to 6.86% of total observation period. Feeding of offered feed was found significantly ($P < 0.05$) higher during monsoon season and lower during winter, while grazing activity showed an inverse trend. The giraffe spent more time in standing alert activity during monsoon compared to other two seasons which might be due to more visitor pressure of winter season. Walking activity was observed more during monsoon, while resting during summer. The giraffe exhibited no social negative behaviour, only during winter when maximum social positive behaviour was noted. The giraffe spent a larger amount of time performing oral stereotype, licking behaviour during summer. Feeding of offered feed was noted maximum at 16:00-17:00 h during monsoon and winter, while it was at 11:00-12:00 h during summer. Standing in alert condition was occurred at higher frequency at 10:00-11:00 h during winter and summer, whereas at 15:00-16:00 h during monsoon. Licking activity was found most at 13:00-14:00 h during winter and summer and at 11:00-12:00 h during monsoon.

This study suggests the improvement of feeding strategy with the provision of natural browsing to encourage their foraging activity as well as to mitigate the observed oral abnormal stereotypic behaviour. Additionally, this study will provide a better understanding and baseline information of the behavioural pattern of giraffe in captivity that could aid future conservation efforts.

Keywords: Activity budget, Behavioural patterns, Focal sampling, *Giraffa camelopardalis*, Alipore Zoological Garden

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Introduction

Giraffe (*Giraffa camelopardalis*) is the world's tallest, largest, long-necked, long-lived, non-territorial, browsing ruminant (Bjornhag, 1989; Baxter, 2001; Muller *et al.*, 2021). Giraffe, an artiodactyla belonging to the family Giraffidae, having six different sub-species which are distinguished by their coat pattern (Brown, 2007). In past, nearly ten thousand years ago, giraffe was distributed throughout Africa, from Algeria and Morocco to South Africa (Dagg, 1976) but at present they can only be found at a few areas, south of Sahara Desert in savannas, grasslands, and open woodlands (Feldhamer, 2003). Due to habitat loss, extensive poaching and rinderpest, their natural populations have declined by 30% to 40% over the last thirty years, with rapid decline in two of their subspecies (Brandes *et al.*, 2021). Hence, in the IUCN Red List (www.iucnredlist.org 2020), the category of the species *Giraffa camelopardalis* was changed from 'least concern' to 'vulnerable' in 2016 (Muller *et al.*, 2016).

Animal behaviour is a "fundamental part of its biology" (Shepard *et al.*, 2008). Behaviour could be described as a response of an animal to the environment and its components and, also response to its intrinsic stimuli such as craving, anxiety etc. (Shepard *et al.*, 2008). Animal behaviour could also be depicted as the way of communication of an animal with the surroundings, environment and with each other. Behavioural pattern of an animal is species specific as generally it varied with the habitat conditions (e.g., availability of food), environmental factors (climatic factors like temperature, rainfall etc.) and the social factors (Hazarika and Saikia, 2010). Behavioural patterns of an animal depend on how the animal distribute its time and energy budget in order to maximize its fitness (Adolfsson, 2009). The activity time budget of an animal, describes that the animal involved in or displayed different activities in a specified time period (Baskaran, 2013). Knowledge about animal behaviour and their activity time budget in wild are essential for the analyses of the habitat uses (Tanaka *et al.*, 2001)

and for the prediction of certain responses to varying influences (Sutherland and Gosling, 2000) that provide information for an integrated conservation management of that studied species (Swaisgood and Greggor, 2019). Observation based study on wildlife behaviour is also important and useful tool to improve the health and welfare status of the animals in captivity (Sutherland and Gosling, 2000; Tanaka *et al.*, 2001).

When considering the available behavioural data for the giraffe, most of the contributing studies only cover behavioural pattern and activity budget of giraffe in wild. There is limited data on the captive giraffe's ethology and its variation. Giraffe is an endemic species of Africa, in India they are protected in captivity, their behavioural patterns might be affected or altered due to change in environment as well as their habitat. Hence, monitoring of behavioural pattern of giraffe in captive condition in India, by making an activity budget would be a beneficial approach of detecting the abnormal, stereotypic or stress behaviours displayed by the studied animal. Abnormal behaviours could be described as behaviours which are displayed by wild animals in captivity but not found in the free-ranging one. Whereas, stereotypic behaviour is a type of abnormal behaviour where the studied animal performs repeatedly any movement pattern, in an invariant form, without having apparent function or goal. Therefore, the percentage of stereotypic behaviour obtained from the activity time budget of the studied captive animal, might be considered as an indicator of their poor welfare (Mason and Veasey, 2010). Animal welfare is the prime aim of the behavioural investigations of captive species, housed in zoos. Simple observation-based reports ultimately would be useful for a better and improved management of giraffe in zoos.

Due to scarcity of detailed behavioural investigation reports on giraffe housed in zoo in India, the current study therefore aimed to assess the general behaviour of a giraffe in terms of

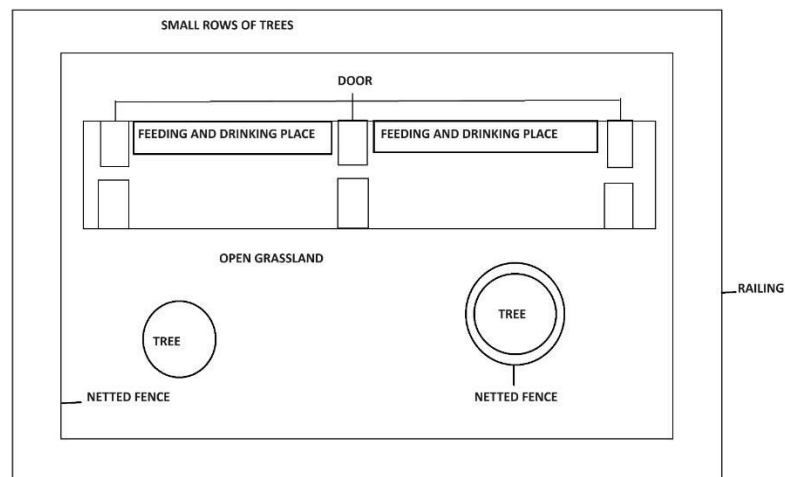


Fig. 1: Layout of giraffe enclosure at Zoological Garden, Alipore, Kolkata (based on visual observations during present study).

detailed diurnal activity time budget and the seasonal effect on the activity time budget of the giraffe, kept in Alipore Zoological Garden, Kolkata over a period of approximately 11 months.

Materials and Methods

Study Site:

The current study was carried out from August 2022 to June 2023 at Alipore Zoological Garden (22°32'9.29" N, 88°19'55.39" E), Kolkata, West Bengal, India. It covers area of about 18.811 ha. Summer season commence in March till the onset of rainy season in June, maximum temperature rises to 40°C with an average of 36°C. Monsoon ends in the month of September. Average rainfall experienced within the region is about 1641.4 mm per annum. Winter season starts in December and ends in February. The lowest temperature during winter season is around 10°C with an average of 13°C.

Studied Animal:

The studied animal is a ten years old male Giraffe (*Giraffa camelopardalis*) named Mangal by the zoo authority and kept along with another two males, four females and four calves in an enclosure. The food is offered by the Alipore zoo authority to the giraffe, basically includes higher amounts of

concentrates and sugar rich food like different types of vegetables and fruits. The food is provided to them twice in a day at 08:30 and 16:30 h inside the enclosure.

Enclosure of the Animal:

The giraffe was kept in an open-air moated enclosure of about 400 sq.m with a shaded shelter which is in east side of the zoo, called the Ezra house where drinking and feeding area are made (Fig. 1). The entire enclosure is covered by grass. Inside the enclosure, there are two trees which are surrounded by metal fence of about ten feet high. From outside to inside, the enclosure is guarded by the steel-made railing, followed by a row of small trees and then iron-made chain-link fence.

Data collection:

For the study on diurnal behavioural pattern of a male giraffe at the Alipore zoo, data were collected from monsoon to summer seasons having 11 months of study period including 3 months from monsoon, 4 months from winter and 4 months from summer. Primary observations were carried out on the giraffe for recognizing the behavioural patterns. All the activities displayed by the giraffe throughout the day from 10.00 to 17.00 h were recorded twice in a week, through direct observation with unaided eye by using focal

Table 1: Ethogram used for collecting behavioural data of giraffe, *G. camelopardalis* in captivity at Alipore Zoo, Kolkata (based on Garry, 2012; Razal *et al.*, 2017; Kulkarni, 2020)

Behaviour categories		Types of behaviour	Description
General activities	Active behaviours	Feeding of offered feed	eating food mixture provided by zoo
		Ruminating	rechewing and swallowing a bolus of already ingested and regurgitated food for proper digestion.
		Grazing	eating the grass from the enclosure field
		Drinking	engulping water from water source.
		Standing alert	Standing with head up and alertness to its surroundings
		Standing non alert	standing with head up and down, closed eyes and not paying attention to its surrounding
		Bending neck	lowering its head to the ground for drinking, grazing etc.
		Walking	movement from one location to another at a normal walking pace.
		Self-maintenance	grooming itself, urinating, defecating, wagging its tail to remove fly, insect from its skin, licking itself for cleaning its body.
		Social positive	appealing for associative contact with the other individual
		Social negative	interacting with another animal with aggressive mode and sometimes chasing the other one, performing head butt, head slap, kick or stomp and stomp
		Manipulating enrichment	trying to discover some new things, unknown to the animal.
		Keeper interaction	interacting with the zoo keeper when food is offered
Abnormal behaviours	Inactive behaviours	Resting	lying or sitting in a resting posture.
	Licking		engaging in repetitive licking of walls, door, fence along with other tongue activities.
	Other abnormal behaviours		showing an uncertain repetitive abnormal action

sampling methods (Altmann, 1974). All the activities were recorded in each minute with a gap of 1 minute in every 5 min from a suitable point from where the enclosure can be best seen without creating any disturbances to the animal or environment. A total of 23,520 min observations were recorded.

Ethogram:

An ethogram is a list of behaviours performed by an animal or it could be defined as a complete catalogue of the behavioural patterns displayed by an animal. The activities performed by an animal, are the naturally occurring continuous flow from one event or state to another. This flow of activities displayed by that animal, is fragmented, and is categorized into a list, in which a particular behaviour is distinct and could be measured in terms of time budget. In ethogram, each of the behaviour is denoted by a proper name with a

definite description. Based on previous behavioural studies on giraffe (Garry, 2012; Razal *et al.*, 2017; Kulkarni, 2020) and preliminary observations, an ethogram was prepared for this study on giraffe (Table 1). A total of 16 activities were identified for the giraffe in Alipore Zoological Garden. Those activities were categorized into two major types named general activities and abnormal behaviours. Again, under the major types, there were subtypes, such as under major type, the general activities, two subtypes were identified, those were active behaviours and inactive behaviours. Licking and other abnormal behaviours were under the other major type, abnormal behaviour. The identified activities under the subtype, the active behaviour, were feeding, ruminating, grazing, drinking, standing alert, standing non-alert, bending, walking, self-maintenance, social positive, social negative, manipulating enrichment and keeper interaction.

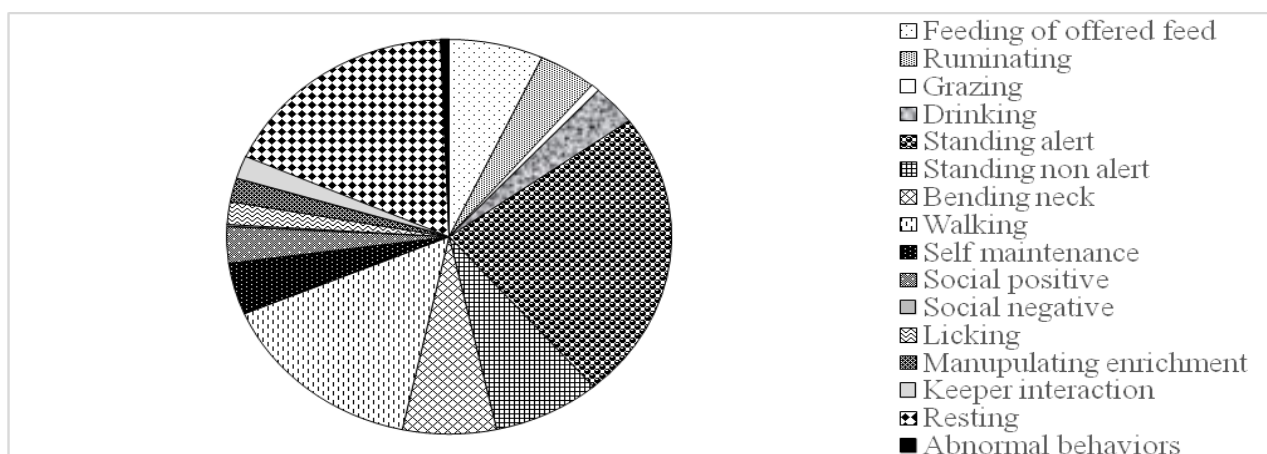


Fig. 2: Percentage of time spent in different behavioural categories by *G. camelopardalis* during monsoon season at Alipore Zoo, Kolkata.

Resting was identified under subtype, the inactive behaviour.

Data Analysis:

The observations were recorded under different activities. The total duration for each activity per day and then per season, was calculated. For the determination of the activity time budget, the recorded observations on displayed activities by the studied giraffe, were analysed and calculated as mean percentage of observation period, spent in performing each activity. All the graphical representations were prepared by using MS-Excel software. The experimental data were presented as mean percentage $\pm$ standard error (SE). One-way analysis of variance (ANOVA), followed by Duncan's multiple range tests (DMRT) was done for multiple comparisons at the significance level of 0.05 to compare the differences in activity patterns for hourly and seasonal data.

Results

A total of 7,840 minutes of diurnal behavioural data of *G. camelopardalis* were obtained for the current study from each of the three studied seasons. Analysed data were presented as percentage of time spent by the giraffe.

Diurnal activity budget of giraffe during monsoon season (Fig. 2):

The giraffe spent 97.52% time of total observation

period during monsoon season, in general activities, whereas abnormal behaviour was found with 2.48%. Under general activities, the inactive behaviour, resting was observed with 17.71%. Under abnormal behaviours, 1.86% licking and 0.62% other abnormal behaviours were noticed in the studied giraffe during monsoon.

Standing was shown to be the dominant behaviour displayed by the giraffe with 31.57%, followed by resting (17.71%), walking (15.24%) and bending activities (6.81%). For feeding the giraffe spent 7.48% time including 0.62% time for grazing activity. The giraffe spent relatively the same amount of time (4.24%) in ruminating and self-maintenance activities. Least observed activities were grazing and social negative activities, which were accounting for less than 1% of total observations.

Diurnal activity budget of giraffe during winter season (Fig. 3):

During the winter season, the mean time spent for the general activities by the giraffe was 96.45%, in which almost all the time accounting for the active behaviours (84.29%). The primarily exhibited activities of winter, by the giraffe, were standing (37.93%), walking (13.71%) and resting (12.17%). The remainder of the recorded activities were observed less than 7.21% each of the total observed period. Feeding accounted for only 6.33% of the observed period of winter

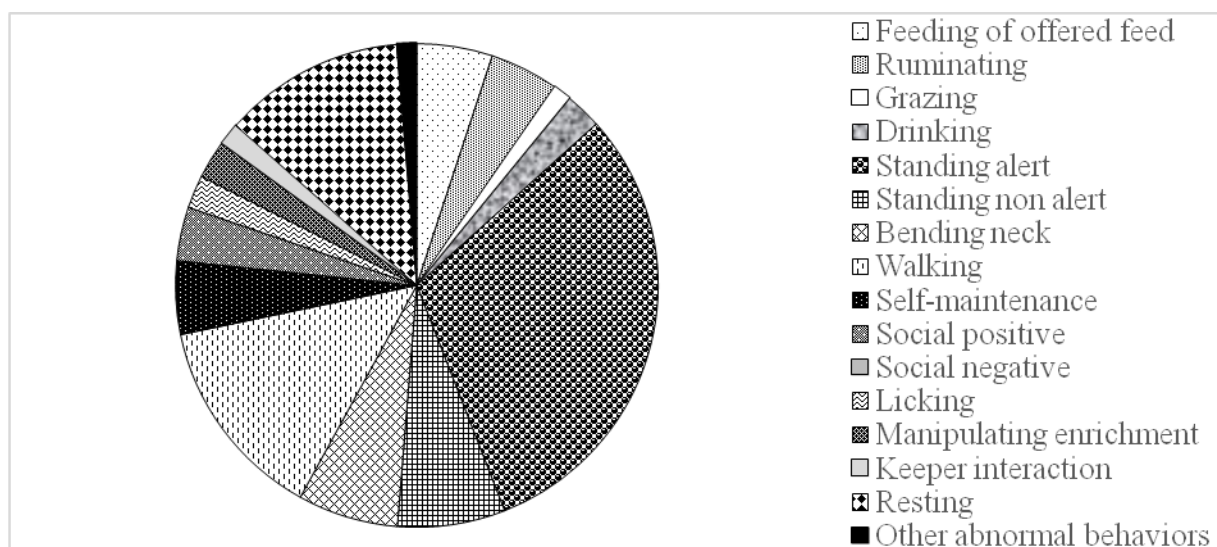


Fig. 3: Percentage of time spent in different behavioural categories by *G. camelopardalis* during winter season at Alipore Zoo, Kolkata.

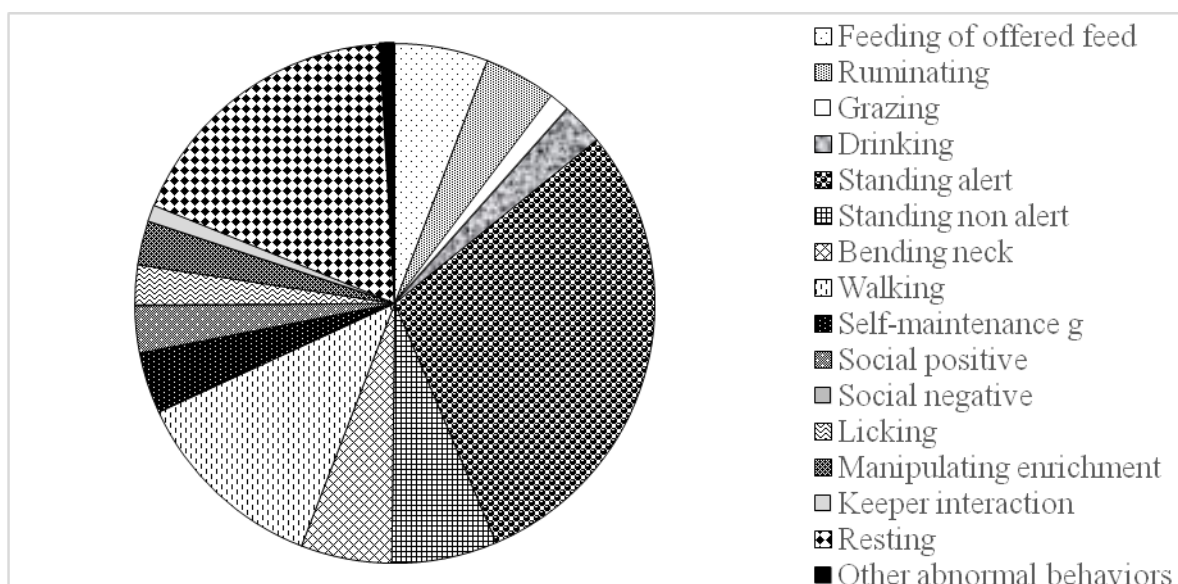


Fig. 4: Percentage of time spent in different behavioural categories by *G. camelopardalis* during summer season at Alipore Zoo, Kolkata.

season, and was almost exclusively by feeding of offered feed (5.07%). Mean time spent percentage for ruminating by the giraffe was 4.60%. Abnormal behaviours were observed with the frequency of 3.55% including 2.21% of licking behaviour. No social negative behaviour was found in the study period of winter.

Diurnal activity budget of giraffe during summer season (Fig. 4):

During summer season, the mean percentage of

time, allotted by the giraffe for general activities was 96.62%, which include 17.95% of resting and remainder time for active activities. The most observed activities performed by the studied giraffe were standing (36%), resting (17.95%) and walking (12.29%). Feeding was mainly by feeding of offered feed (5.81%) by the zoo authority, with very little time spent in grazing (1.24%). The giraffe spent 4.52% of total observed time of summer in ruminating behaviour. The mean time spent for the abnormal behaviour by the giraffe

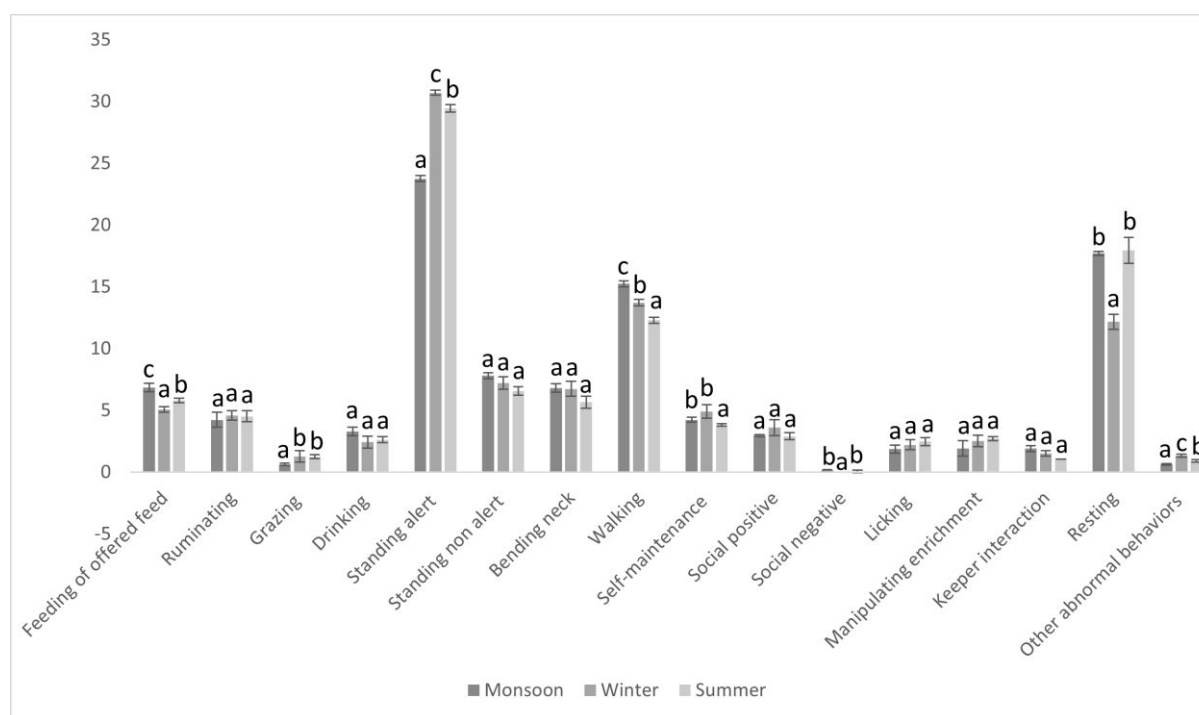


Fig. 5: Percentage of time spent in different activities by *G. camelopardalis* in three different seasons at Alipore Zoo, Kolkata. Values are mean $\pm$ SE. Bars with different letters are significantly different ($P<0.05$) using DMRT after one way ANOVA.

was 3.38%, which include 2.48% licking behaviour. The least observed behaviour was the social negative activities which were accounting for less than 0.5% of total observed data.

Comparison of diurnal activity budget of giraffe among seasons (Fig. 5):

Time spent for feeding of offered feed was found significantly maximum ($P<0.05$) during monsoon and minimum ($P<0.05$) in winter, whereas grazing activity by giraffe was observed an inverse trend with lower mean percentage of time spent during monsoon. The giraffe showed the standing alert behaviour with the highest ($P<0.05$) mean time spent during winter and the lowest ($P<0.05$) during monsoon. The time spent for walking was found significantly ($P<0.05$) maximum in monsoon, whereas minimum in summer. Time dedicated for the self-maintenance and resting behaviours by the giraffe, were found significantly lower ($P<0.05$) in summer and winter season respectively, while for the rest two seasons their values did not vary significantly (DMRT). The giraffe hardly ever showed social negative

behaviour during the time they were observed, during winter no negative behaviours were noticed, whereas in other two seasons, giraffe perform these behaviours in low extent. No significant variation (DMRT) in mean time spent for ruminating, drinking, standing non-alert, bending neck, social positive, manipulating enrichment and keeper interaction activities were observed among the three studied seasons. While considering the abnormal behaviours, though time spent for licking among three seasons, did not vary significantly (DMRT), time spent for other abnormal behaviours was significantly more in winter and less in monsoon.

Hourly activity time budget of giraffe during monsoon season (Table 2):

The result showed that the feeding activity of offered feed by the giraffe was relatively consistent throughout the day, from 10:00 to 16:00 h, with insignificant variation in their proportion (DMRT). Although a large peak of feeding of offered feed was noticed from 16:00 to 17:00 h. Grazing occurred mainly from 11:00 to

Table 2: Mean percentage of hourly activity pattern of *G. camelopardalis* from 10.00 to 17.00 h during monsoon season at Alipore Zoo, Kolkata

Behaviour categories		Behaviours	Hours							
			10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	
General activities	Active behaviours	Feeding of offered feed	7.00	6.67	5.67	6.00	5.67	7.67	9.33	
		Ruminating	3.67	5.33	5.33	4.67	3.67	4.67	2.33	
		Grazing	0.67	1.67	1.00	0.33	0.00	0.33	0.33	
		Drinking	1.33	5.67	4.33	4.33	1.33	2.67	3.33	
		Standing alert	29.67	18.33	22.67	29.00	20.33	30.67	15.67	
		Standing non alert	7.67	7.00	7.33	12.00	8.00	6.67	6.00	
		Bending neck	9.33	7.67	7.33	7.00	5.00	7.00	4.33	
		Walking	16.33	16.33	16.67	16.67	13.00	19.33	8.33	
		Self-maintenance	5.33	5.33	3.67	5.00	4.33	4.00	2.00	
		Social positive	5.00	3.67	2.33	3.00	2.67	2.67	1.33	
		Social negative	0.00	0.00	1.00	0.00	0.00	0.33	0.00	
		Manipulating enrichment	4.67	1.67	1.67	2.00	1.33	1.67	0.33	
		Keeper interaction	0.00	0.00	0.00	0.00	0.00	0.00	13.33	
	inactive behaviours	Resting	7.33	17.33	19.00	7.33	31.00	9.67	32.33	
Abnormal behaviours	Licking Other abnormal behaviours		2.00	2.00	1.00	2.00	2.67	2.33	1.00	
			0.00	1.33	1.00	0.67	1.00	0.33	0.00	

13:00 h, with a peak in the 2nd hour of observation (11:00-12:00 h). Drinking activity also reached peak in the 2nd hour of observation. Ruminating behaviour was significantly highest ($P<0.05$) between 11:00 to 13:00 h (5.33%) and lowest ($P<0.05$) between 16:00 to 17:00 h (2.33%). Standing in alert condition and in non-alert condition were found to be highest ($P<0.05$) at 15:00-16:00 h (30.67%) and 13:00-14:00 h (12%), respectively, whereas both the activities under the standing behaviour, were lowest ($P<0.05$) at 16:00-17:00 h (15.67% and 6%, respectively). The giraffe spent relatively same amount of time in walking (16.33% - 16.67%) from 10:00 to 14:00 h, while 14:00 h onwards walking activity was found more varied with highest at 15:00-16:00 h (19.33%) and lowest at 16:00-17:00 h (8.33%). Self-maintenance, social positive and manipulating

enrichment activities showed a similar pattern where the highest values ($P<0.05$) were noted at 10:00-11:00 h and lowest ($P<0.05$) at 16:00-17:00 h. Keeper interaction was only found at 16:00-17:00 h, whereas social negative behaviour did not observe in any hour of the observation period of monsoon. The peak hour of resting behaviour was at 15:00-16:00 h (32.33%), then at 14:00-15:00 h (31%). Abnormal behaviours were found most at 11:00-12:00 h (3.33%) and 14:00-15:00 h (3.67%).

Hourly activity time budget of giraffe during winter season (Table 3):

Analysis showed that feeding activity, both the feeding of offered feed and grazing were reached peak at 16:00-17:00 h and the lowest frequency of grazing and feeding of offered feed was noted at 12:00-13:00 h and 13:00-14:00 h, respectively.

Table 3: Mean hourly activity pattern of *G. camelopardalis* from 10.00 to 17.00 h during winter season at Alipore Zoo, Kolkata

Behaviour categories		Behaviours	Hours							
			10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	
General activities	Active behaviours	Feeding of offered feed	4.50	4.67	5.50	3.50	5.33	4.50	6.50	
		Ruminating	6.67	5.83	3.50	4.50	5.00	4.00	2.50	
		Grazing	1.67	0.83	0.50	1.00	1.50	0.83	2.17	
		Drinking	2.17	3.17	2.83	2.00	3.00	2.17	2.00	
		Standing alert	38.33	31.67	23.67	35.00	32.17	23.33	32.00	
		Standing non alert	6.00	8.33	7.17	9.00	7.33	7.83	5.83	
		Bending neck	8.17	8.00	5.67	6.33	7.83	5.83	5.00	
		Walking	16.33	16.67	10.83	13.83	17.50	11.00	10.17	
		Self-maintenance	6.50	5.17	3.67	6.50	5.33	3.00	3.83	
		Social positive	3.50	5.67	3.00	4.00	4.00	2.83	2.33	
		Social negative	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		Manipulating enrichment	3.00	4.00	1.00	4.33	2.50	0.67	2.00	
		Keeper interaction	0.00	0.00	0.00	0.00	0.00	0.00	10.50	
	Inactive behaviours	Resting	0.67	2.67	30.50	4.83	4.00	30.67	11.50	
Abnormal behaviours	Licking Other abnormal behaviours		1.33	2.67	1.67	2.83	3.17	2.33	1.50	
			1.17	0.67	0.50	2.33	1.33	1.00	2.17	

The peak hour for ruminating, standing alert and self-maintenance activities were at 10:00-11:00 h, whereas for ruminating, drinking and social positive behaviours were at 11:00-12:00 h and for standing non-alert, self-maintenance and manipulating enrichment were at 13:00-14:00 h. Keeper interaction was only found at 16:00-17:00 h and no social negative behaviour was noticed during winter season. Resting was found with high frequency at 15:00-16:00 h and then at 2:00-13:00 h. Abnormal behaviours was found at high frequency at 13:00 to 15:00 h, while peak hour for licking behaviour was at 14:00-15:00 h.

Hourly activity time budget of giraffe during summer season (Table 4):

Under the feeding activity, feeding of offered feed was found with maximum time spent at 11:00-

12:00 h and then at 15:00-16:00 h, while grazing was more at 12:00-13:00 h and 14:00-15:00 h. The peak hour for ruminating and standing alert activities was 10:00-11:00 h. Drinking, self-maintenance and resting activities were recorded maximum at 11:00-12:00 h. 12:00-13:00 h was the peak hour for bending neck, walking and social positive activities. Standing non-alert and manipulating enrichment activities was observed with higher percentage at 13:00-14:00 h. Social negative and keeper interaction behaviours were only observed at 12:00-13:00 h and 16:00-17:00 h, respectively. Abnormal behaviour was noted most at 13:00-14:00, while licking behaviour was found in higher frequency at 10:00-11:00 h and 15:00-16:00 h.

Comparison of hourly activity budget of giraffe (Fig. 6):

Table 4: Mean hourly activity pattern of *G. camelopardalis* from 10.00 to 17.00 h during summer season at Alipore Zoo, Kolkata

Behaviour categories		Behaviours	Hours						
			10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00
General activities	Active behaviours	Feeding of offered feed	5.33	8.67	4.67	6.67	2.67	7.00	5.33
		Ruminating	7.00	3.33	5.00	5.00	3.33	4.33	3.00
		Grazing	0.00	0.33	2.33	0.33	2.33	2.00	1.33
		Drinking	3.00	4.00	3.00	2.33	1.67	1.33	3.00
		Standing alert	46.00	21.67	30.00	24.33	30.67	29.33	23.00
		Standing non alert	6.00	7.33	4.00	9.67	4.00	7.00	6.33
		Bending neck	5.67	4.33	7.33	6.33	5.67	5.67	5.00
		Walking	12.00	11.00	14.00	11.00	12.33	12.33	12.00
		Self-maintenance	4.00	4.33	4.00	3.67	4.00	4.00	2.00
		Social positive	3.00	2.67	3.67	3.33	2.00	2.67	2.33
		Social negative	0.00	0.00	0.33	0.00	0.00	0.00	0.00
		Manipulating enrichment	1.00	1.00	3.00	3.67	3.67	3.33	3.00
		Keeper interaction	0.00	0.00	0.00	0.00	0.00	0.00	7.33
	inactive behaviours	Resting	4.33	28.33	15.00	19.33	25.00	17.00	23.00
Abnormal behaviours	Licking		2.67	2.33	3.00	2.33	2.33	2.67	2.00
	Other abnormal behaviours		0.00	0.67	0.67	2.00	0.33	1.33	1.33

From 10.00 to 11.00 h (Fig. 6):

When mean time spent percentage of the giraffe was compared within season, it was found that time spent for the standing in alert condition was the maximum, followed walking in case of all the studied seasons. In the 1st hour of observation social negative and keeper interaction were not found.

When data were compared among the seasons, it was observed that for standing-alert behaviour, time spent was maximum (46%) during summer and for walking, minimum time spent (12%) was noted during summer, while in other two seasons giraffe spent same amount of time for walking (16.33%). The activities like feeding of offered feed, standing non-alert, social positive and manipulating the enrichment and resting were observed in higher frequency during monsoon

than the other two seasons. For grazing, bending neck, self-maintenance and other abnormal behaviours, time spent was more in during winter and for ruminating, drinking, and licking activities during summer than other two seasons.

From 11.00 to 12.00 h (Fig. 6):

When mean time spent percentage of the giraffe was compared within season, a similar trend of result was noted that was maximum time spent by the giraffe in standing alert, followed by waking for all the seasons and, in the 2nd hour of observation no social negative and keeper interaction were found.

When data were compared among the seasons, both the activities under standing behaviour and walking was noted maximum during winter than other studied seasons. For grazing, drinking and

self-maintenance, higher time spent by giraffe was noticed during monsoon, for ruminating, bending neck, social positive and manipulating the enrichment during winter and for feeding of offered feed and resting during summer than the other two seasons. Within abnormal behaviours, mean time spent percentage for licking was more in winter, but other abnormal behaviours in monsoon season.

From 12.00 to 13.00 h (Fig. 6):

Among all the activities, standing in alert condition was the dominant activity, followed by resting activity for the monsoon and summer seasons, while for the winter season, resting activity was dominant, followed by standing alert activity.

When mean time spent percentage of the giraffe was compared among seasons, it was observed that feeding of offered feed, ruminating, drinking, walking, social negative and the other abnormal behaviours were found to occur at high frequency in monsoon, while grazing, standing alert and resting in winter and social positive, manipulating enrichment and licking in summer season than the other two seasons.

From 13.00 to 14.00 h (Fig. 6):

When mean time spent percentage of the giraffe was compared within season, in case of all the studied seasons, the most predominant behaviour was standing in alert condition, followed by walking activity.

When data were compared among seasons, standing alert was found more in winter, while standing non-alert in monsoon. The activities like drinking, bending neck and walking were noticed to occur in higher time spent percentage during monsoon, while grazing, self-maintenance, social positive and manipulating enrichment were during winter and feeding of offered feed, ruminating and the resting during summer than the other two remaining seasons. Both the licking and the other abnormal behaviours was found in higher frequency during the winter season.

From 14.00 to 15.00 h (Fig. 6):

Among all the activities, time spent for resting was maximum, followed by standing alert activity during monsoon season. But during winter and summer, most observed behaviour was standing in alert condition among all the behaviours displayed by the giraffe.

When data were compared among seasons, feeding of offered feed and resting activities were noted to happen in maximum frequency during monsoon. Ruminating, drinking, standing alert, bending neck, walking, self-maintenance, social positive and the abnormal behaviours occur at high frequency during winter, while grazing and manipulating enrichment was more during summer season.

From 15.00 to 16.00 h (Fig. 6):

Among all the activities, during monsoon, most performed behaviour by the giraffe was standing alert, followed by walking, during winter, resting followed by standing alert and during summer standing alert, followed by resting activity.

When data were compared among seasons, feeding of offered feed, ruminating, drinking, standing alert, bending neck, walking and social negative activities occur at high frequency during monsoon, resting, standing non-alert and social positive activities during winter and grazing, licking and the manipulating enrichment during summer season.

From 16.00 to 17.00 h (Fig. 7):

Among all the activities, during monsoon, most displayed behaviour by the giraffe was resting (32.33%), followed by standing alert activity (15.67%). During winter, the result showed inverse of monsoon, standing alert followed by resting. During summer, both standing alert and resting were the predominant behaviours with same frequency (23%), followed by walking activity (12%).

When data were compared among seasons, feeding of offered feed, drinking and resting was observed to occur at high frequency during monsoon, grazing, standing alert, self-

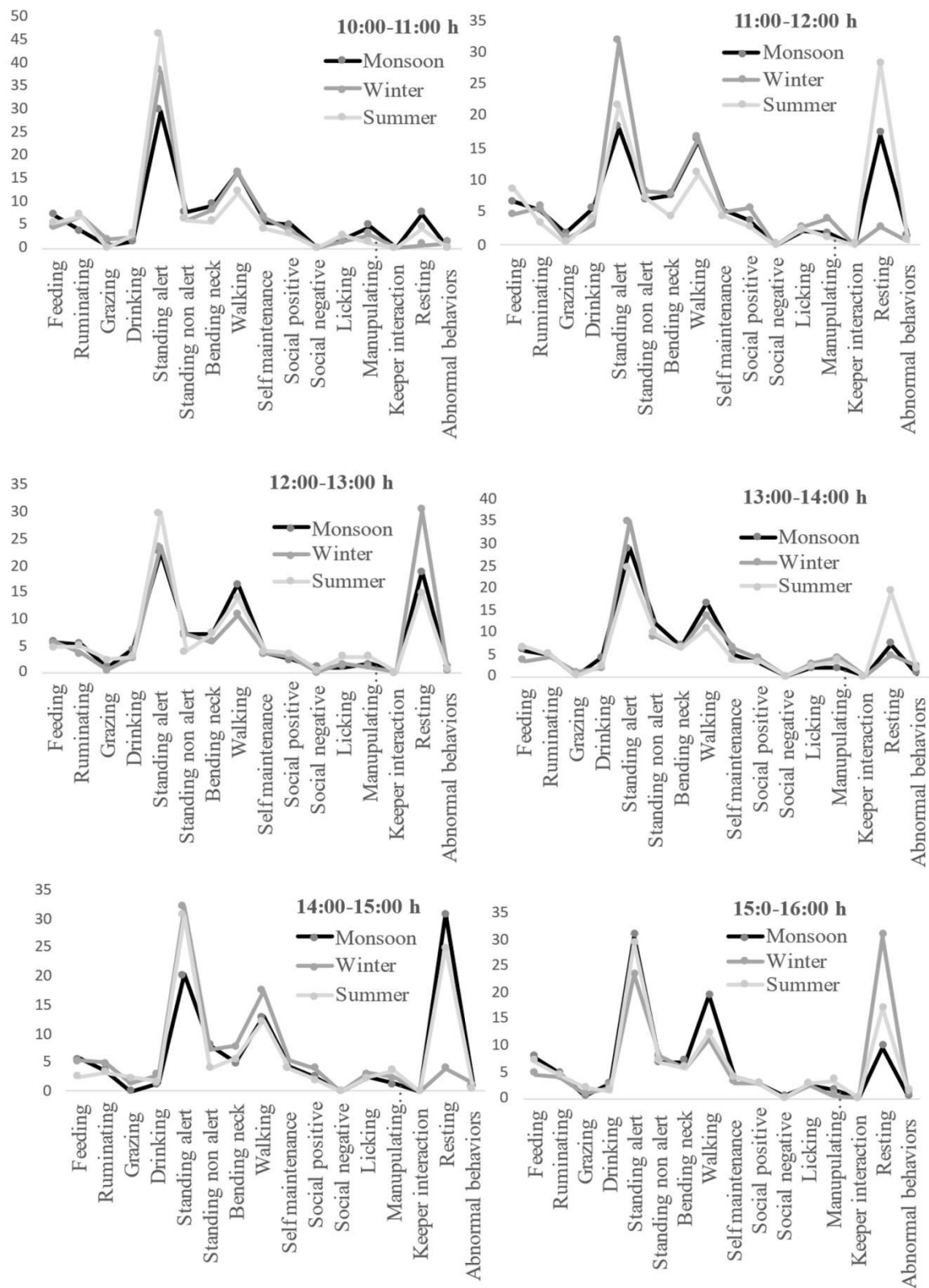


Fig. 6: Hourly activity budget of *G. camelopardalis* in different seasons at Alipore Zoo, Kolkata in first six hours of observation period.

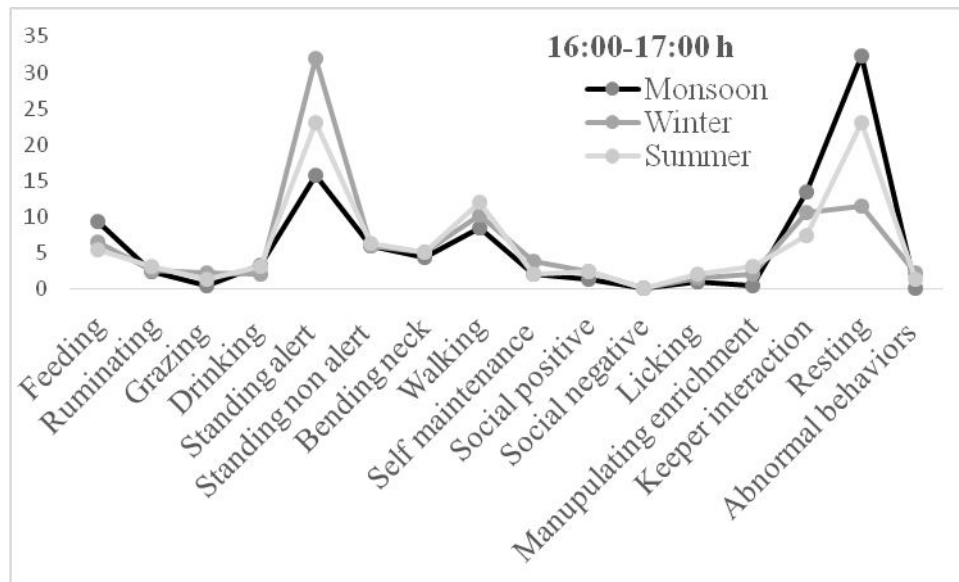


Fig. 7: Activity budget of *G. camelopardalis* in different seasons at Alipore Zoo, Kolkata in last hour of observation period.

maintenance during winter and, walking, ruminating, standing non-alert and manipulating enrichment during summer season. Under abnormal behaviour, both the licking and other abnormal behaviours were found most during winter season. Keeper interaction was only found in the last hour of observation with higher time spent percentage during monsoon among the studied seasons.

Discussion

Most of the behavioural studies on giraffe were conducted in the aspect of enclosure size and its impact on their behavioural pattern, how giraffe utilize their enclosure throughout the day and, the utility and requirement of enrichment tools for their enclosure (Garry, 2012; Kulksrni, 2020). Although, data on detailed long-term seasonal and hourly activity budget of captive giraffe are insufficient which are useful for zoo management to understand their behavioural pattern not only within different hours of a day but also in different seasons and, to ensure their welfare in the field of *in situ* conservation.

Feeding and ruminating behaviour:

Under feeding activity, browsing was the

dominant behaviour displayed by the wild giraffe, was found in earlier studies (Paulse *et al.*, 2022). However, the studied captive giraffe did not show browsing as in the enclosure there were no provision of browsing. As browsing has a great importance on giraffe behaviour as well as their nutrition, they should be given the provision of browsing at least 40 to 60 pounds of browse per giraffe per day, for their well-being in captivity (Miller and Fowler, 2012). Hence, browse plantation (Hollerl *et al.*, 2006) is recommended for the giraffe of Alipore Zoological Garden. Feeding of offered feed found with higher frequency during 1st and last two hours of observation period of a day, with an additional large peak at 15:00-16:00 h. A similar trend of feeding behaviour was reported for the captive giraffe of British Zoological Institute (Duggan *et al.*, 2016). Ruminating was found maximum during 1st two hour of observation period, might be the result of maximum feeding in the morning at 08:30 h, when they were offered feed before the starting of observation period. This pattern of ruminating activity was found similar with the earlier investigation that the ruminating activity followed the feeding activity throughout the day (Duggan *et al.*, 2016). Wild giraffe showed the

feeding activity in the highest frequency at dawn and dusk and ruminating behaviour maximum just after midday (Dagg and Foster 1976), supporting with the present study's finding.

Razal *et al.* (2017) reported that captive giraffe displayed a higher rate of active foraging activity during winter compares to summer, while the giraffe of current study found to follow a similar trend in the grazing activity as they did not get the provision of foraging inside their enclosure.

Standing alert:

Standing in alert condition was the predominant behaviour found in the present study. In captivity, they were housed in a place where the habitat and environment were quite different from their native, which could be the cause of their increased alertness. Among the three seasons, standing alert behaviour was noticed at higher frequency during winter which might be the result of higher visitor pressure during winter. In the previous studies, it was interpreted that more diverse stimuli make the giraffes more alert and dynamic to their surroundings (Hoff *et al.*, 1994; Bashaw *et al.*, 2001).

Locomotion and resting activity:

Locomotion in terms of walking by wild giraffe, was 21% to 24%, whereas resting was 4% to 6% (Paulse *et al.*, 2023). In the current study, mean time spent percentage for walking by the studied giraffe was relatively lower than the wild giraffe, while the time spent for the resting activity was found to follow a reverse trend of their wild conspecifics. In search of food, wild giraffe covers a larger distance per day that might be the cause of spending less time on resting activity. Less walking and more resting behaviour displayed by the captive giraffe might be due to the supplying of offered feed to them and housing them in a restricted sized enclosure.

The giraffe of the current study was found to rest more during summer season than the winter and monsoon. Deacon (2015) explained that this contrasting seasonal differences might be due to

ambient temperature, giraffes tend to take more rest when ambient temperatures are high. According to Veasey *et al.* (1996) resting activity had a significant correlation with the substrate of zoo, in which resting was found most in the captive giraffe housed in a grassy enclosure, whereas no or very little amount of time spent was seen in hard-surfaced (paved) enclosures. This finding is supported by Haley *et al.* (2001) who stated that cattle also spent less time in resting behaviour when housed in a concrete substrate.

Razal *et al.* (2017) found higher rate of locomotor and standing alert behaviours in the giraffe of Brookfield Zoo, US, during the summer than the winter season, while an inverse results with higher rate of mentioned behaviours during winter, was noticed in the current study at Alipore Zoo, India. The variations of the behaviours between seasons might be due to the differences in temperatures of the studied areas, Brookfield's summer temperature is almost similar with the winter temperature of Kolkata, India.

Stereotypic behaviour: licking:

Time budget shift in the daily activity pattern might be the cause of developing abnormal repetitive behaviours in the captive animals (Bashaw *et al.*, 2007). Based on the prior survey on wild giraffe, Veasey *et al.* (1996) stated that giraffe rarely perform stereotypic behaviour in the wild, whereas nearly 80% captive giraffe display at least one type of stereotypic behaviour (Bashaw *et al.*, 2001)). In this regard Mason *et al.* (2007) estimated over 2,000 giraffids display stereotypic abnormalities throughout the world. The most common stereotype behaviour noted in giraffe is the oral stereotypes (Bashaw *et al.*, 2001). Free ranging giraffe use their prehensile tongue to remove leaves from trees. In captivity, they display licking of non-food objects or frequent tongue movement with no reason. This oral stereotype behaviour might be the result of reduced feeding duration which is not enough to satisfy their tongue and chewing stimulation (Baxter and Plowman, 2001; Fernandez *et al.*,

2008). Oral stereotype behaviour, licking activity was observed at high frequency from 14:00-16:00 h, when the additional peak hour of feeding activity was noticed. According to previous investigations oral stereotypes reached peaks in frequency at relatively parallel times with feeding or ruminating or slightly afterward, indicating a relationship between feeding, ruminating and the oral stereotypes (Carlstead, 1998; Bashaw *et al.*, 2001). Duggan *et al.* (2016) and Veasey *et al.* (1996) noticed a similar trend in the oral stereotypes, mostly following the bouts of feeding, interpreting a functional role. Oral stereotypic behaviour might be a derivative of natural behaviour and is not abnormal behaviour, but the captive giraffe performs it at abnormal rates (Veasey *et al.*, 1996). Though it is thought functionless, but it confers them satiety and might have role in their anxiety relief (Bergeron *et al.*, 2006) and in the buffering of rumen pH (Hummel *et al.*, 2006). Oral stereotypes of captive giraffe could be reduced by providing *ad libitum* hay to their enclosure that will increase their roughage intake with required tongue manipulation (Baxter and Plowman, 2001; Hatt *et al.*, 2005; Hummel *et al.*, 2006; Hummel and Clauss, 2006).

Duggan *et al.* (2016) observed that giraffe from the British Zoological Institute displayed the active behaviour with the frequency of 77% of total mean time spent. Similarly, the present study on diurnal activity budget of the giraffe, showed that they spent 72% to 77% of total observation period in active behaviours.

The size of enclosure, where the studied giraffes were housed, has an influential role on their behavioural activity budget (Garry, 2012). In wild, the ranging giraffes' mean home range size is around 282 sq.km (du Toit, 1990). Though, it was observed that the captive giraffe cope well in a restricted area of their enclosure, frequency of stereotypic behaviour like licking found to increase (Bashaw *et al.*, 2007) due to their confined enclosure. The Central Zoo Authority (CZA), Ministry of Environment and Forests, Government of India instructed that the minimum

space for the giraffe outdoor enclosure should be 1500 sq.m for housing two giraffes (Bonat *et al.*, 2014).

Though the results of the current study depicts that the giraffe displays seasonal variations in some behavioural patterns, there are considerable differences in the behavioural patterns between the giraffe housed in Alipore zoo and the other zoos. Individual variations might be due to their different individual histories that could have an impact on their ability to adapt varying environments (Hill and Broom, 2009). Freeman and Gosling (2010) and Gosling (2001) termed these individual behavioural differences as "personality" or behavioural temperament in individual. Individual-specific distribution of time in different activities and management of energy budget was observed in wild and captive animal in order to maximize its own fitness (Adolfsson, 2009). Hence, individual behavioural study should not be overlooked as at present, researches on animal welfare are inspiring towards the direction of assessing overall welfare of individual animals rather than considering the species as a whole (Whitham and Wielebnowski, 2013). In recent times, personality studies and activity budgeting obtain a special importance in zoo research as the data on individual-based behavioural patterns and individual behavioural differences are being profusely utilized by the zoo authorities as a tool towards understanding animal welfare and management (Powell and Gartner, 2011; Watters and Powell, 2012). Variation in individual-based activity pattern might be the results of an animal's response to the environment differently. Hence, individual-based behavioural study would reveal the significance of evaluating the welfare at an individual level and simultaneously would be useful to meet each one's behavioural needs.

Conclusion

Zoological garden, where the animals are housed, has a profound influence on the behavioural pattern and activity budget of animals as the wild animals were restricted in a captive condition and most of them face the environment and habitat,

quite different from their native. Giraffes had been found to cope well in the Alipore Zoological Garden; however, the daily activity budget displayed by the studied giraffe differ from their wild conspecifics. Oral stereotypy (licking) and other stereotypic behaviour were noticed, but at a very low frequency. Moreover, the behavioural data on the studied giraffe, would be useful in adopting improved and need-based management strategies by the zoo authority, for their overall welfare.

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References

- Adolfsson UG. (2009) Diurnal behaviour and utilization of shade in Masai giraffes (*Giraffa camelopardalis tippelskirchi*). Degree project, Swedish University of Agricultural Sciences, 1: 4-19.
- Bashaw MJ, Tarou LR, Maki TS and Maple TL. (2001) A survey assessment of variables related to stereotypy in captive giraffe and okapi. *Appl Anim Behav Sci.* 73: 235-247.
- Bashaw MJ, Bloomsmith MA, Terry LM and Bercovitch FB. (2007) The structure of social relationships among captive female giraffe (*Girafa camelopardalis*). *J Comp Psychol.* 121: 46-53.
- Baskaran N, Balasubramanian M, Swaminathan S and Desai AA. (2010) Feeding ecology of the Asian Elephant *Elephas maximus* Linnaeus in the Nilgiri Biosphere Reserve, Southern India. *J Bombay Nat Hist Soc.* 107(1): 3-13
- Baxter E and Plowman AB. (2001) The effect of increasing dietary fibre on feeding, rumination and oral stereotypes in captive giraffes (*Giraffa camelopardalis*). *Anim Welf.* 10: 281-290
- Bergeron R, Badnell-Waters AJ, Lambton S and Mason G. (2006) Stereotypic oral behaviour in captive ungulates: Foraging, diet and gastrointestinal function. 2nd edn. In: *Stereotypic Animal Behaviour*, (eds.) Mason G. and Rushen J., Fundamentals and Applications to Welfare. Wallingford. CABI.
- Bonal BS, Dhamija I, Sharma BR, Sharma SC and Gupta BK. (2014) *Zoos in India-legislation, policy, guidelines and strategy*, 5th revision. Central Zoo Authority (Statutory Body under the Ministry of Environment, Forests and Climate Change, Govt. of India), India, pp 271.
- Brandes S, Sicks F and Berger A. (2021) Data set-Behaviour classification on Giraffes (*Giraffa camelopardalis*) using machine learning algorithms on tri-axial acceleration data of two commonly used GPS-devices and Its possible application for their management and conservation. *Sensors (Basel)* 21(6): 2229.
- Brown DM, Brenneman RA, Koepfli K, Pollinger JP, Milá B, Hergiadis NJ, Louis EL, Grether GF, Jacobs DK and Wayne RK. (2007) Extensive population structure in the giraffe. www.biomedcentral.com/1741-7007/5/57.
- Carlstead K. (1998) Determining the causes of stereotypic behaviours in zoo carnivores: toward appropriate enrichment strategies. In: *Second nature: Environmental Enrichment for Captive Animals*, (eds.) Shepherdson D.J., Mellen J.D. and Hutchins M., Smithsonian Institution Press, Washington D.C., pp. 172-183.
- Dagg AI and Foster JB. (1976) *The Giraffe: Its biology, behavior, and ecology*, 6th edn., Van Nostrand Reinhold, New York, NY, USA.
- Deacon F. (2015) The spatial ecology, habitat preferences and diet selection of giraffe (*Giraffa camelopardalis giraffe*) in the Kalahari region of South Africa. Ph.D. thesis, University of the Free State.
- Du Toit JT. (1990) Feeding-height stratification among African browsing ruminants. *Afr J Ecol.* 28: 55-61.
- Duggan G, Burn CC and Clauss M. (2016) Nocturnal behavior in captive giraffe (*Giraffa camelopardalis*)-A pilot study. *Zoo Biol.* 35: 14-18.
- Feldhamer GA, Drickamer LC, Vessey SH and Merritt JF. (2003) *Mammalogy: adaptation, diversity, ecology.* Q Rev Biol. 83(3): 322-323.
- Fernandez LT, Bashaw MJ, Sartor RL, Bouwens NR and Maki TS. (2008) Tongue twisters: feeding enrichment to reduce oral stereotypy in giraffe (*Giraffa camelopardalis*). *Zoo Biol.* 27: 200-212.
- Freeman HD and Gosling SD. (2010) Personality in nonhuman primates: A review and evaluation of past research. *American J Primatology* 72: 653-671.
- Garry S. (2012) Analyses of captive behaviour and enclosure use in Rothschild giraffes (*Giraffa camelopardalis rothschildi*) housed at Paignton Zoo Environmental Park. *The Plymouth Student Scientist* 5(2): 4-30.
- Gosling SD. (2001) From mice to men: What can we learn about personality from animal research? *Psychological Bull.* 127: 45-86.

- Haley DB, de Passillé AM and Rushen J. (2001) Assessing cow comfort: Effects of two floor types and two tie stall designs on the behaviour of lactating dairy cows. *Appl Anim Behaviour Sci.* 71: 105–117.
- Hatt JM, Schaub D, Wanner M, Wettstein HR, Flach EJ and Clauss M. (2005) Energy and fibre intake in a group of captive giraffe (*Giraffa camelopardalis*) offered increasing amounts of browse. *J Vet Med.* 52: 485–490.
- Hazarika BC and Saikia PK. (2010) A study on the behaviour of Great Indian One-horned Rhino in the Rajiv Gandhi Orang National Park. *NEBIO.* 1(2): 62–74.
- Hill SP and Broom DM. (2009) Measuring zoo animal welfare: Theory and practice. *Zoo Biol.* 28: 531–544.
- Hoff MP, Forthman DL and Maple TL. (1994) Dyadic interactions of infant lowland gorillas in an outdoor exhibit compared to an indoor holding area. *Zoo Biol.* 13: 245–256.
- Höllerl S, Stmm B, Hummel J and Clauss M. (2006) Browse provision for captive herbivores. Design and management of a browse plantation. In: *Zoo Animal Nutrition*, (eds.) Andrea F, Clauss M., Eulenberger K., Hatt J-M., Hume I., Janssens G. P. J. and Nijboer J., Filander Verlag, Fürth, 3: 211–212.
- Hummel J and Clauss M. (2006) Feeding, EAZA husbandry and management guidelines for *Giraffa camelopardalis*. *Burger's Zoo, Arnheim: European Association of Zoos and Aquaria*, pp 29–61.
- Hummel J, Clauss M, Baxter E, Flach EJ and Johansen K. (2006) The influence of roughage intake on the occurrence of oral disturbances in captive giraffids. In: *Zoo animal nutrition III*, (eds.) Fidgett A., Clauss M., Eulenberger K., Hatt J-M., Hume I., Janssens G. and Nijboer J., Filander Verlag, Furth, pp 235–252.
- Kulkarni TP. (2020) Analysis of stereotypic behaviour and enhanced management in captive Northern Giraffe *Giraffa camelopardalis* housed at Zoological Garden Alipore, Kolkata. *J Threat Taxa* 12(4): 15426–15435.
- Mason GR, Latham CN and Vickery S. (2007) Why and how should we use environmental enrichment to tackle stereotypic behavior? *Appl Anim Behav Sci.* 102: 163–188.
- Mason G and Veasey J. (2010) How should the psychological well-being of zoo elephants be objectively investigated? *Zoo Biol.* 29: 237–255.
- Miller RE and Fowler ME. (2012) *Fowler's Zoo and Wild Animal Medicine*, Volumes 6, 7 and 8. Saunders, USA.
- Muller Z, Bercovitch F, Brand R, Brown D, Brown M, Bolger D, Carter K, Deacon F, Doherty JB, Fennessy J, Fennessy S, Hussein AA, Lee D, Marais A, Strauss M, Tutchings A and Wube T. (2018) *Giraffa camelopardalis*. The IUCN Red List of Threatened Species 2016: e.T9194A51140239.
- Muller Z, Bercovitch F, Fennessy J, Brown D, Brand R, Brown M, Bolger D, Carter K, Deacon F and Doherty J. (2016) *Giraffa camelopardalis* (Linnaeus, 1758). In: *The IUCN Red List of Threatened Species*. The International Union for Conservation of Nature: Gland, Switzerland.
- Paulse J, Couldridge V, Cupido C and Deacon F. (2023) The diurnal activity budgets of extralimital giraffe (*Giraffa camelopardalis giraffa*) in the Western Cape Province, South Africa. *Afr J Ecol.* 61: 746–751.
- Powell DM and Gartner MC. (2011) Applications of personality to the management and conservation of nonhuman animals. In: *Primate monographs: from genes to animal behaviour*, (eds.) Murayama M.I., Kawamura S. and Weiss A., Springer, Tokyo, Japan, pp. 185–199.
- Razal CB, Bryant J and Miller LJ. (2017) Monitoring the behavioral and adrenal activity of giraffe (*Giraffa camelopardalis*) to assess welfare during seasonal housing changes. *Anim Behav Cogn.* 4(2): 154–168.
- Shepard ELC, Wilson RP, Quintana F, Laich AG, Liebsch N, Albareda DA, Halsey LG, Gleiss A, Morgan DT and Myers AE. (2008) Identification of animal movement patterns using tri-axial accelerometry. *Endanger Species Res.* 10: 47–60.
- Sutherland WJ and Gosling LM. (2000) Advances in the study of behaviour and their role in conservation. In: *Behaviour and Conservation*, (eds.) Gosling L.M. and Sutherland W.J., Cambridge University Press, Cambridge, UK, pp. 3–9.
- Swaigood RR and Greggor AL. (2019) Application of animal behavior to conservation. In: *Encyclopedia of Animal Behavior*, 2nd edn., Elsevier, Amsterdam, The Netherlands, pp. 220–229.
- Tanaka H, Tagaki Y and Naito Y. (2001) Swimming speeds and buoyancy compensation of migrating adult chum salmon *Oncorhynchus keta* revealed by speed/depth/acceleration data logger. *J Exp Biol.* 204: 3895–3904.
- Veasey JS, Waran NK and Young RJ. (1996) On comparing the behaviour of zoo housed animals with wild conspecifics as a welfare indicator, using the giraffe (*Giraffa camelopardalis*) as a model. *Animal Welfare* 5: 139–153.
- Watters JV and Powell DM. (2012) Measuring animal personality for use in population management in zoos: Suggested methods and rationale. *Zoo Biol.* 31: 1–12.
- Whitham JC and Wielebnowski N. (2013) New directions for zoo animal welfare science. *Appl Anim Behav Sci.* 147: 247–260.