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A Study on Diurnal Activity Pattern of Captive Sloth Bear (*Melursus ursinus*) in Alipore Zoological Garden, Kolkata, India

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Abstract

The diurnal behavioral pattern and activity time budget of a male sloth bear (*Melursus ursinus*) was studied at Alipore Zoological Garden, West Bengal, India from October 2022 to June 2023. This study aimed to make a comparison of the overall diurnal activity between winter and summer seasons, and hourly activity budget from 10.00 to 17.00 h by using focal sampling method with 12,600 minutes of observations. The daily activity pattern of the sloth bear reached the peak at 1st three hour of observation period during summer season, while the last three hour of the observation period during winter season. The bear was more active during the summer season than the winter. Basking was significantly higher ($P < 0.05$, DMRT) during winter, possibly due to low environmental temperature, whereas panting was significantly higher ($P < 0.05$, DMRT) in summer, might be related to thermoregulation of the animal during the summer. The sloth bear exhibited the stereotypic behaviors in very low frequency (2.23% to 3.87%) which was a sign of the animal's good health and also depicted that the animal was in a less stressed condition. Moreover, the results of this observational study allow comparison between the captive sloth bears from different zoos as well as between the captive and wild sloth bears. Additionally, the findings of the current study on activity time budget of a captive sloth bear will provide a baseline information of their behavioral pattern that would be useful in improving the management strategies for their welfare.

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Introduction

The sloth bear (*Melursus ursinus*) is a medium-sized bear of the family Ursidae with a peculiar shaggy and dusty-black body coating, a long dorsal ruff of hairs and an inconsistent cream coloured V or Y-shaped chest mark (Prater, 1980). It is widely distributed in the Indian sub-continent and Sri Lanka (Dharayia *et al.*, 2016). It naturally inhabits both the dry deciduous and moist deciduous forests and also in tall grasslands and small scrub areas (Desai *et al.*, 1997). By nature, sloth bears are nocturnal or crepuscular, though the females are found more active during the daytime with their cubs (Yoganand *et al.*, 2006; Ramesh *et al.*, 2013; Dharaiya *et al.*, 2016). They are well-known myrmecophagous and also an avid omnivore, feed on insects, fruits, honey, larvae, groundnuts etc. (Bargali *et al.*, 2004; Sukhadiya *et al.*, 2013). Their population is declining day by day due to illegal poaching of their body parts and, habitat destruction and habitat fragmentation that leads to human-bear conflict (Johnsingh, 2003; Chauhan, 2006). Hence, it is enlisted in the 'vulnerable' category of IUCN Red Data Book.

Zoos play a pivotal role in ex-situ conservation of wild animals by providing the best possible house for them with establishing their natural habitat (Shepherdson, 1992). The purpose of keeping the wild animals in the restricted environment of zoo, might be to increase their reproductive success and to enhance public awareness, and importantly to assure wild animal's welfare (Young, 2003; Montaudouin and Pape, 2005; Byers *et al.*, 2013; Barongi *et al.*, 2015).

Behaviour study defines the study of the evolution of animals and, their natural behaviour, coherent abilities and psychological conditions (Jayne *et al.*, 2019). Zoos take the responsibility of increasing the wild animal's behavioural diversity, maintaining their normal behavioural patterns and reducing the frequencies of abnormal behaviours like stereotypic behaviours. Nowadays, behavioural study in zoos is crucial to enlighten the evidence-based approach to the management of zoo animals (Melfi, 2009). Moreover, studies on zoo animals offer sufficient

information regarding the welfare, health and behaviours of the captive animal. The information obtained from simple observations could be used to develop their activity time budget which ultimately is useful to establish the behavioural profile of captive animal, to determine any alteration of their wild behaviour and to find out the stereotypical behaviours if observed stereotypical behaviour is a set of uniform behaviours performed by the animals repetitively, that have no functional value to the animals (Mason, 1991).

Captive animals are kept in a very small enclosure compared to free-ranging animals and thus, they become stressed (Anderson *et al.*, 2010) and exhibit abnormal behaviours (Rees, 2011). Limited space and restricted environment were responsible for their reduced natural behaviours (Swaisgood and Shepherdson, 2005). Artificial feeding is one of the main causes of diminishing their natural behaviours like hunting, tracking the prey over a long distance, which has a negative impact both on their physical and mental health of the animal and then the animal begins to exhibit the stereotypic behaviours (Prajapati and Koli, 2020). Bear kept in captivity displayed a diminished interaction with the environment which might be the cause of showing stereotypic behaviours (Veeraselvam *et al.*, 2013). According to Liu *et al.* (2003), the other factors behind the stereotypic behaviours are husbandry procedure, rearing history and genetic factors.

Behavioural analysis of captive sloth bear provides us with detailed knowledge about their well-being, health and management issues. It also offers vast information about the animal's basic needs and necessities, cognition and preferences. Hence, direct observational studies might be useful for the documentation of activity time budgets, and to access stereotypic behaviour by comparing the behaviours of captive sloth bear with their wild conspecific.

There is insufficient information on the behavioural ecology of sloth bear, especially under captivity (Ramesh *et al.*, 2013). Hence, the present study was

conducted on a male sloth bear (*M. ursinus*) to assess its activities inside the zoo enclosure in terms of diurnal activity pattern, activity time budget and also to determine the seasonal impact on its activities.

Materials and methods

Study area

The behavioural study was conducted at Alipore Zoological Garden, located in Kolkata, West Bengal (22.535913°N 88.332053°E; land area: 18.81 ha). The zoo was inaugurated on 1st January 1876. Summer season which starts in March and ends with the onset of monsoon in June. During summer season, maximum temperature shoots up to 40°C with an average of 36°C. Winter season begins in the month of December and ends in the months of February. The minimum temperature during winter season goes down to 10°C with an average of 13°C. Monsoon starts in the 1st week of June and ends in the month of September. The yearly rainfall of Kolkata is about 1641.4 mm.

Study animal

The study was carried out on one male captive sloth bear which was kept in an enclosure of 1074 square meter, situated in the southern part of the zoo. It is an open-air moated enclosure bounded by concrete walls as barriers, covered with dry deciduous vegetation. Wooden logs and artificial rocky dens are provided as enrichment tools for the sloth bear. His diet basically includes rice, wheat, milk, honey, sour curd, molasses etc., were given twice a day before 10 am and after 5 pm. In between he feeds insects by foraging.

Data collection

The study on diurnal activity pattern of sloth bear was carried out from 1st October, 2022 to 30th June, 2023. A preliminary observation was carried out on sloth to methodize the behavioural pattern exhibited by the studied animal, using unaided eye. Focal sampling method were used as adopted by Altmann (1974). The activities were recorded in each minute with a gap of one minute every 5 minutes, on a sheet between 10 am and 5 pm from a suitable point from where the enclosure can be best seen without creating any

disturbances to the animal or environment. Total observations were carried out for 12,600 minutes. Based on the previous behavioural studies (Veeraselvam *et al.*, 2013; Prajapati and Koli, 2020) and preliminary observations of behaviours, an ethogram (table 1) was created for the present study on sloth bear. An ethogram consists of a thoroughgoing descriptive catalogue of activity patterns of the study animal. The behavioural categories include active, passive and stereotypical behaviours. The recorded activities under the active behaviours were standing, walking, panting, grooming, scratching, sniffing, digging, feeding, playing, climbing, licking, urinating and yawning. The displayed activities under the passive behaviour were basking, resting and sitting, while the stereotypical behaviours were pacing, self-mutilation, circling and head tossing.

Data Analysis

The observations were categorized into different sub-types which were again grouped into different activities. For each activity duration was recorded. To determine activity time budget, the displayed activities by the studied sloth bear were analysed as mean percentage of observation period, spent in performing each activity. Activity budget was calculated both hourly and season wise. Activity distribution was analysed season wise and was subjected to t-test to find out any significance between the results. Cluster analysis with heatmaps were done in PAST 4.0 to analyse the connection between the behaviours. Two-way ANOVA was performed to find out the variance between the behaviours as well as the seasons. The seasonal variation of the behaviours was also subjected to a multivariate analysis of PCA in a variance covariance matrix.

Results

A total of 6,300 minutes of diurnal behavioural data of *M. ursinus* were collected for the present behaviour study from each of the two studied seasons. Analysed data were presented as percentage of time spent by the sloth bear.

Table 1. Ethogram used for collecting behavioural data of sloth bear *M. ursinus* in captivity at Alipore Zoo, Kolkata (based on Prajapati and Koli 2020, Veeraselvam *et al.* 2013).

Behavioural categories	Name of behaviours	Description
Active behaviours	Standing	standing with four feet and with no forward and backward movement
	Walking	movements in forward or backward motion quadrupedally or bipedally.
	Panting	breathing rapidly
	Scratching	scratching the body by paws
	Sniffing	taking air via noses for detection of smell
	Digging	making hole on the ground with its paws
	Grooming	Cleaning, scrubbing and rubbing of body coat
	Feeding	consumption of food items
	Playing	playing and wrestling with inhibited strikes
	Yawning	opening mouth wide and inhaling deeply due to fatigue or boredom
	Licking	engaging in repetitive licking of their body parts along with other tongue activities.
	Climbing	moving up the tree trunk
	Urinating	discharging urine
Passive behaviours	Resting	lying or sitting in a resting posture, keeping head down with closed eyes
	Sitting	sitting in a resting posture, keeping head down with open eyes
	Basking	sitting or lying in sunlight with maximum exposure of body parts towards sunlight
Stereotypical behaviours	Pacing	repetitive roaming on the same path
	Head tossing	moving the head up and down
	Circling	constant movement in a circular direction
	Self-mutilation	biting its own skin repeatedly to the extent of inducing trauma

Diurnal activity budget of sloth bear during winter season

Diurnal activity budget of sloth bear during winter season was presented in Fig. 1. During the winter season, the studied sloth bear spent 49.18% and 46.93% of time of total observation period, in performing the active and passive behaviours respectively, whereas stereotypic behaviour was found with 3.87%. Under the active behaviours, significantly the highest percentage of time spent was noted in walking activity (10.46%±2.34), followed by sniffing and digging behaviours (7.75%±0.98 and 6.27%±0.51). For the feeding and playing activity, the sloth bear spent 3.22% and 3.61% time, while significantly lowest percentage of time was spent for panting activity (0.26%). Under the passive behaviour, the bear dedicated maximum time for the resting (21.24%±4.47), followed by sitting with 17.07% and basking with 8.62%. Under the stereotypic behaviours, significantly highest time was spent by the bear in performing the pacing behaviour (2.41%±0.75), followed by head tossing with 0.61%, circling movement with 0.47% and self-mutilation with 0.38%.

Diurnal activity budget of sloth bear during summer season

During the summer season, the mean time spent on the active behaviour by the studied sloth bear (Fig. 2.) was 85.24%, for the passive behaviour was 12.54%, while for stereotypic behaviour was 2.23%. Under the active behaviours, walking activity was shown to be the dominant behaviour displayed by the bear with 17.28%, followed by sniffing (10.30%±0.78), panting (10.04%±1.94), digging (8.45%±0.45) and scratching activity (7.60 ±1.70). 5.02% and 6.45% of time were found to account for the feeding and playing activity respectively. The dedicated time for climbing and standing activity by the sloth bear was 3.57% and 3.47% respectively. Significantly least amount of time was spent on yawning activity (1.31%±0.28).

Under passive behaviour, sitting was predominant with 6.71%, followed by resting with 5.71% and then basking with 0.12%. Under stereotypic behaviours, most time was spent by the sloth bear in circling movement (0.69%±0.04), while the bear spent relatively the same amount of time (0.56%) in head tossing and pacing activities.

Table 2. Mean percentage of hourly activity budget for passive and stereotypical behaviour of *M. ursinus* from 10.00 to 17.00 h during Winter and Summer seasons at Alipore Zoo, Kolkata.

Behaviour	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	
	Win- ter	Sum- mer	Win- ter	Sum- mer	Win- ter	Sum- mer	Win- ter	Sum- mer	Win- ter	Sum- mer	Win- ter	Sum- mer	Win- ter	Sum- mer
Active behaviour														
Standing	0.94	4.72	0.65	5.83	3.26	3.06	2.61	2.08	4.06	0.97	1.74	3.19	3.04	4.44
Walking	9.93	29.86	3.41	16.11	8.84	15.83	9.57	18.19	12.83	8.75	14.64	11.53	13.99	20.69
Panting	0.36	11.25	0.00	8.61	0.00	6.53	0.22	23.33	0.00	12.64	0.00	3.61	1.23	4.31
Grooming	2.90	3.61	2.10	0.83	2.46	2.64	3.33	0.69	0.87	1.81	0.87	4.58	1.45	0.97
Scratching	4.49	3.19	6.96	4.72	3.12	11.25	4.93	0.83	3.91	15.42	2.68	11.11	4.71	6.67
Sniffing	4.13	21.53	4.49	15.00	1.67	7.78	7.61	5.97	10.58	3.06	12.32	5.69	13.48	13.06
Digging	2.90	10.69	3.12	13.33	3.04	5.97	7.83	8.75	7.61	4.86	9.57	6.81	9.86	8.75
Feeding	1.01	3.06	1.88	7.08	1.52	2.36	3.84	6.67	3.62	4.17	4.93	2.64	5.72	9.17
Playing	2.03	0.00	0.65	13.06	2.03	12.92	2.25	8.47	2.61	2.08	8.48	5.00	7.25	3.61
Climbing	1.67	1.11	0.00	4.03	2.17	5.00	1.23	5.83	2.25	1.94	4.35	3.89	6.16	3.19
Licking	2.03	1.53	1.23	4.17	1.74	10.00	1.81	2.36	3.91	12.22	2.97	13.33	4.86	4.44
Urinating	2.03	0.00	0.22	1.39	1.67	8.89	0.80	0.83	3.41	2.92	1.30	2.64	4.13	2.36
Yawning	2.10	0.00	1.30	0.56	1.45	0.42	2.61	1.81	2.39	2.22	1.52	3.06	0.94	1.11
Passive														
Basking	32.10	0.00	20.43	0.00	5.43	0.00	1.81	0.83	0.58	0.00	0.00	0.00	0.00	0.00
Resting	15.43	3.06	40.58	2.64	43.77	4.72	20.29	1.81	17.68	12.36	7.39	10.97	3.55	4.44
Sitting	15.94	4.58	12.97	2.64	13.55	2.64	28.99	11.53	17.75	10.69	17.83	7.22	12.46	7.64
Stereotypical														
Pacing	0	0	0	0	3.48	0	0.29	0	3.26	3.89	5.43	0	4.42	0
Self- mutilation	0	0	0	0	0	0	0	0	0.94	0	1.38	2.22	0.36	0.69
Circling	0	0	0	0	0.80	0	0	0	0	0	0.51	2.50	1.96	2.36
Head tossing	0	1.81	0	0	0	0	0	0	1.74	0	2.1	0	0.43	2.08

Comparison of diurnal activity budget of the sloth bear between seasons

Between the winter and monsoon seasons, time spent for all the activities under active behaviours, except grooming, urinating and yawning, were found significantly higher ($P < 0.05$, DMRT) during summer season (Fig. 3). While the time dedicated to grooming, urinating and yawning activities between the two studied seasons did not show significant variation in DMRT (ANOVA, $P < 0.05$). Under passive behaviours, time spent for all the displayed activities such as basking, sitting and resting was found maximum ($P < 0.05$, DMRT) during winter season. Among stereotypic behaviours, except pacing, time spent for self-mutilation, circling movement and head tossing did not show any significant variation in

DMRT (ANOVA, $P < 0.05$), whereas pacing was significantly higher ($P < 0.05$, DMRT) during winter season.

Hourly activity time budget of the sloth bear

Hourly activity time budget of the sloth bear was depicted in table 2. During winter season, under the active behaviour, feeding, climbing, panting, sniffing, digging, licking and urinating activities were reached peak at 16:00-17:00 h, while walking and playing at 15:00-16:00 h and, standing and yawning activities at 14:00-15:00 h. Under passive behaviour, basking, resting and sitting was found to occur at high frequency at 10:00-11:00 h, 12:00-13:00 h and 13:00-14:00 h respectively. Under stereotypical behaviour, the peak hour of pacing, self-mutilation and head

tossing behaviour was at 15:00-16:00 h, while the circling movement was at the last hour of observation period.

During summer season, under the active behaviour, walking and sniffing was found to occur with maximum frequency at 10:00-11:00 h, standing, digging and playing activities at 11:00-12:00 h, urinating at 12:00-13:00 h, panting and climbing at 13:00-14:00 h, scratching at 14:00-15:00 h,

grooming, licking and yawning at 15:00-16:00 h and feeding at 16:00-17:00 h. Under passive behaviour, basking activity was only noted at 13:00-14:00 h. Sitting and resting activities reached the peak at 13:00-14:00 and 14:00-15:00 h respectively. Under the stereotype behaviour, pacing was observed only at 14:00-15:00 h. The peak hour of the circling movement was 16:00-17:00 h, while both the self-mutilation and walking activities was found with maximum rate at 16:00-17:00 h.

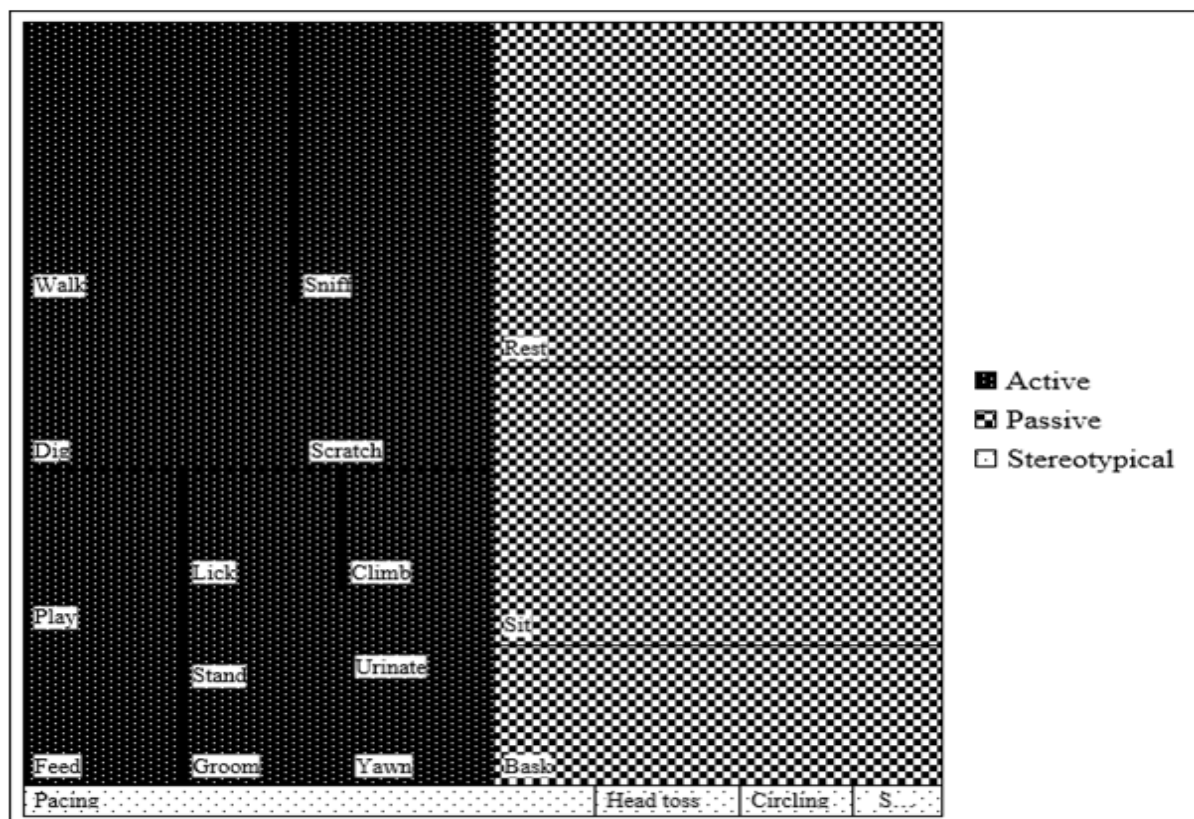


Fig. 1. Percentage of time spent in different behavioural categories by *M. ursinus* during the winter season at Alipore Zoo, Kolkata.

Comparison of hourly activity budget of sloth bear

From 10.00 to 11.00 h:

When mean time spent percentage of the studied sloth bear was compared within season from 10.00 to 11.00 h (table 2), it was found that during winter season, time spent for the basking activity (32.10%) was the maximum ($P < 0.05$, DMRT), followed by the resting and sitting activities where almost equal percentage of time spent was noted. During summer, the bear spent the highest time ($P < 0.05$, DMRT) in walking activity (29.86%). No stereotypical behavior

was noticed during the 1st hour of the observation in both the studied seasons except the head tossing activity which was only noted during the summer season. When data were compared between the seasons, it was observed that standing, walking, panting, grooming, sniffing, digging and feeding activities were significantly more ($P < 0.05$, DMRT) during summer season, while the other active behaviours and all the three passive behaviours were noted to occur in higher ($P < 0.05$, DMRT) frequency during winter season at the 1st hour of observation.

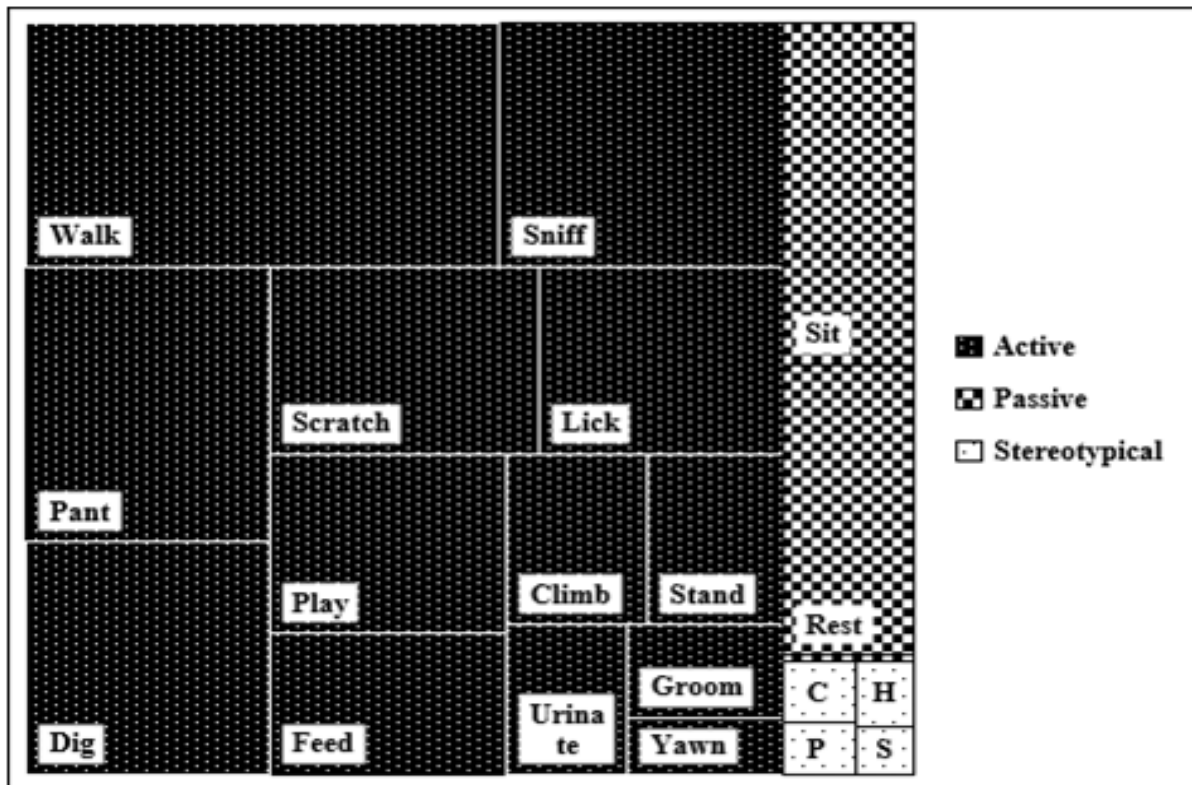


Fig. 2. Percentage of time spent in different behavioural categories by *M. ursinus* during summer season at Alipore Zoo, Kolkata.

From 11.00 to 12.00 h:

Among all the active behaviours, the bear dedicated significantly more time (table 2) ($P < 0.05$, DMRT) in scratching activity (6.96%) during winter and walking activity (16.11%) during summer, and among the passive behaviour in resting (40.58%) during winter, and during summer no basking activity was noticed, while the bear spent equal amount of time in resting and sitting activity. In 2nd hour of observation, stereotypic behaviours were not observed during both the studied seasons.

When data were compared between the seasons, it was observed that time spent for standing, walking, panting, sniffing, digging, feeding, playing, climbing, licking and urinating activities were significantly higher ($P < 0.05$, DMRT) during summer season, while the time spent for grooming, scratching and yawning and all the passive behaviours were more ($P < 0.05$, DMRT) during winter season.

From 12.00 to 13.00 h:

Among all the active behaviours, performed between

12.00 to 13.00 h (table 2), the bear spent maximum time in walking activity and among passive behaviour in resting activity during both the studied seasons.

When data were compared between the seasons, it was observed that time spent in walking, panting, grooming, scratching, sniffing, digging, feeding, playing, climbing, licking and urinating activities were found to occur at higher frequency ($P < 0.05$, DMRT) during summer season, while the time spent for standing and yawning, and for all the three passive behaviours were observed higher ($P < 0.05$, DMRT) during winter season. When stereotypic behaviours were considered, it was noted that during winter season only the pacing and circling movement were displayed by the studied sloth bear, while during summer season in between 12:00 to 13:00 h, the bear did not perform any stereotypic activity.

From 13.00 to 14.00 h:

When data were compared within season, among the active behaviours (table 2), the sloth bear was found to be spending more time in walking activity (9.57%)

during winter, while in panting (23.33%), followed by walking activity (18.19%) during the summer season. Among passive behaviours, sitting activity was found dominant in both the seasons. The bear did not perform any stereotypic behaviours in both the seasons except pacing and circling activities which were only noticed during winter season. When data were compared between the seasons, it was found that the bear dedicated more time in walking,

panting, digging, feeding, playing, climbing, licking and urinating activities during the summer season and in standing, grooming, scratching, sniffing and yawning activities and the passive behaviours such as basking, resting and sitting activities during the winter seasons. No stereotypic behaviours were noticed during winter as well as summer seasons except the pacing which was observed during winter season.

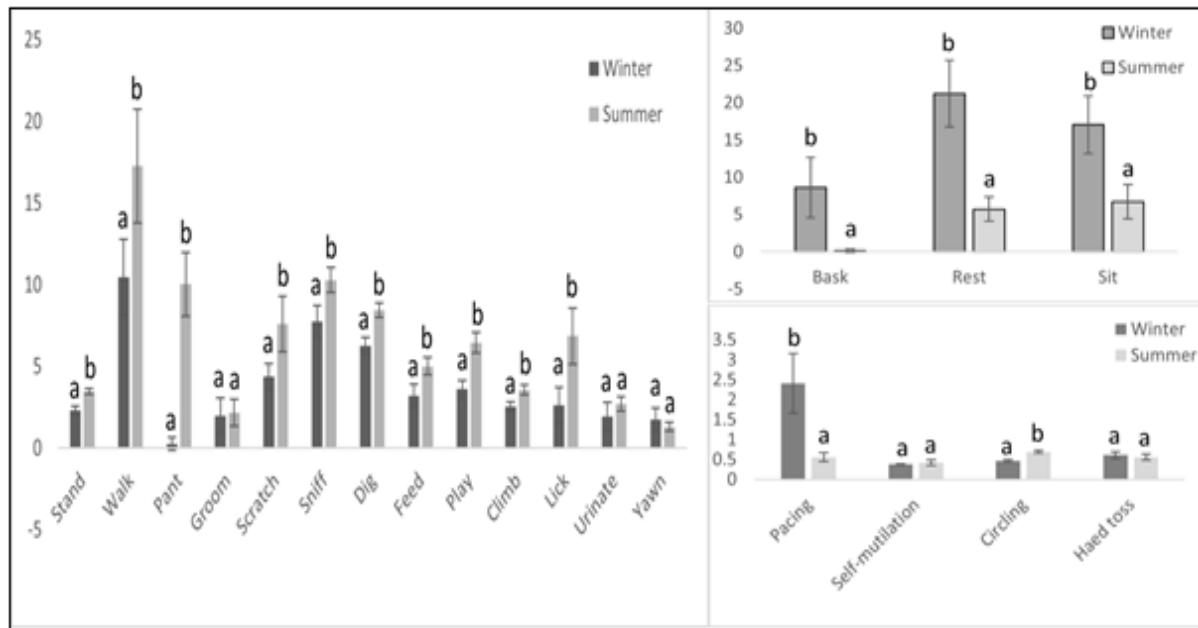


Fig. 3. Percentage of time spent in active, passive and stereotypic behaviours by *M. ursinus* in winter and summer seasons at Alipore Zoo, Kolkata. Values are mean \pm SE. Bars with different letters are significantly different ($P < 0.05$) using DMRT after one-way ANOVA.

From 14.00 to 15.00 h:

Within the active behaviours, the sloth bear dedicated more time (table 2) in walking activity (12.83%) during winter, while in scratching (15.42%), followed by panting activity (12.64%) during the summer season. Within the passive behaviours, time spent in resting and sitting activity was almost equal (around 17.70%) during winter and maximum time allotted in resting (12.36%) followed by sitting (10.69%).

In stereotypic behaviours, pacing was noted to occur at higher rate (3.26%), followed by head tossing (1.74%) and no circling movement was noted during winter season, while during summer season only pacing behaviour was observed with 3.89% time spent by the studied bear. When data were compared

between the seasons, standing, walking, sniffing, digging, playing, climbing, urinating and yawning activities were performed by the bear with higher rate during winter season, while panting, grooming, feeding and licking activities during summer season. All the passive behaviours displayed by the bear were observed to occur at higher frequency during winter season, when compared with summer. Stereotypical behaviour, pacing was more in summer.

From 15.00 to 16.00 h:

When data were compared within season between the activities, among the active behaviours (table 2), the sloth bear spent maximum time in walking activity (14.64%) during winter, while in licking (13.33%), followed by walking activity (11.53%) during summer

season. Among passive behaviours, basking was not found during both the seasons and resting was more in summer, whereas sitting in winter. During winter

pacing (5.43%) occur at higher rate among all the stereotypic behaviours, whereas during winter, it was the circling movement (2.5%).

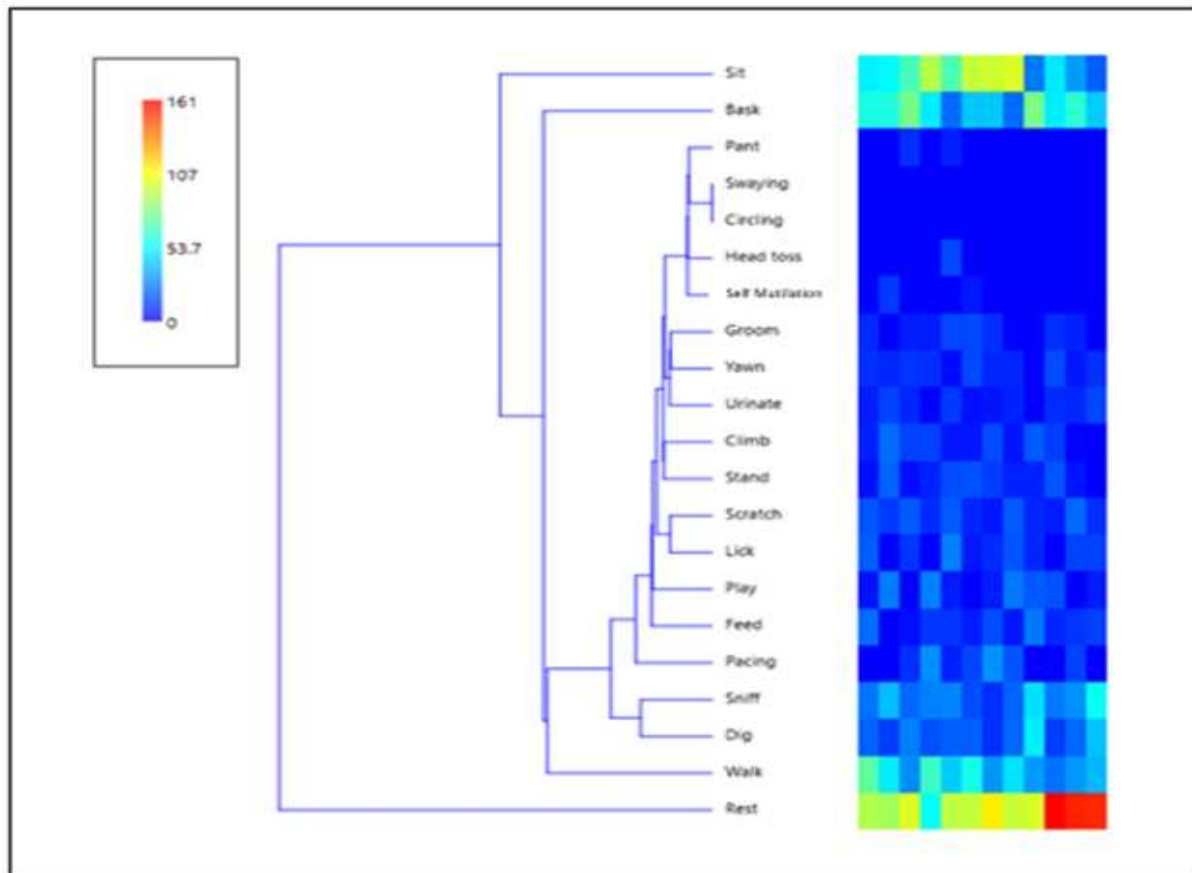


Fig. 4. Cluster analysis with a heat map of the active behaviour of *M. ursinus* during the winter season.

When data were compared between the seasons, the bear was found to spend more time in walking, sniffing, digging, feeding, playing, climbing and sitting activities during winter, while standing, grooming, scratching, urinating, licking, yawning and resting activities during the summer season. In case of stereotypic behaviours, the self-mutilation and the circling movement occurred at higher rate during summer season than the winter.

From 16.00 to 17.00 h:

Among all the active behaviours, the bear spent maximum time (table 2) in walking activity and among passive behaviour in sitting activity during both the studied seasons. When considering the stereotypic behaviours, frequency of occurring the pacing activity was more in winter, while circling movement was in summer.

When data were compared between the seasons, it was observed that time spent in grooming, sniffing, digging, playing, climbing, licking and urinating activities were found to occur at higher rate during winter, whereas standing, walking, panting, scratching, feeding and yawning activities were in summer. Sitting was more in winter and resting in summer. Except pacing, all the displayed stereotypic behaviours were found to occur at higher frequency during the summer season.

Cluster analysis

Cluster analysis along with heatmap revealed the relationship between the behaviours along with the frequency in which those behaviours was observed. In the summer it was seen that walking was the most dominant behaviour and its frequency was highest amongst other behaviours (Fig. 5). Second most

dominant behaviour was panting which is evident as the animal wanted to cool off the summer heat. Digging, playing and feeding behaviour were highly correlated together and occurred almost in the same frequency and hence are clustered together. It was found that several passive behaviours like basking, pacing was clustered along with stereotypical behaviours like self-mutilating and head tossing. This explained that in summer the passive and stereotypic behaviours were highly correlated and occurred nearly in a similar frequency. A contrasting image was observed in winter. With the change in diurnal

temperatures, behaviours like sitting, resting and basking in the sun took a centre stage for a sloth bear in captivity (Fig. 4). Overall behaviours in both active, passive and stereotypic categories were reduced and the animal's behaviour and movement were overall sluggish. Sniffing and digging behaviour were correlated together and behaviours like standing and climbing were correlated together according to frequency. Thus, an overall behavioural pattern for sloth bear differed considerably according to the seasons and was mostly active during the summer and sluggish and lethargic during winter in captivity.

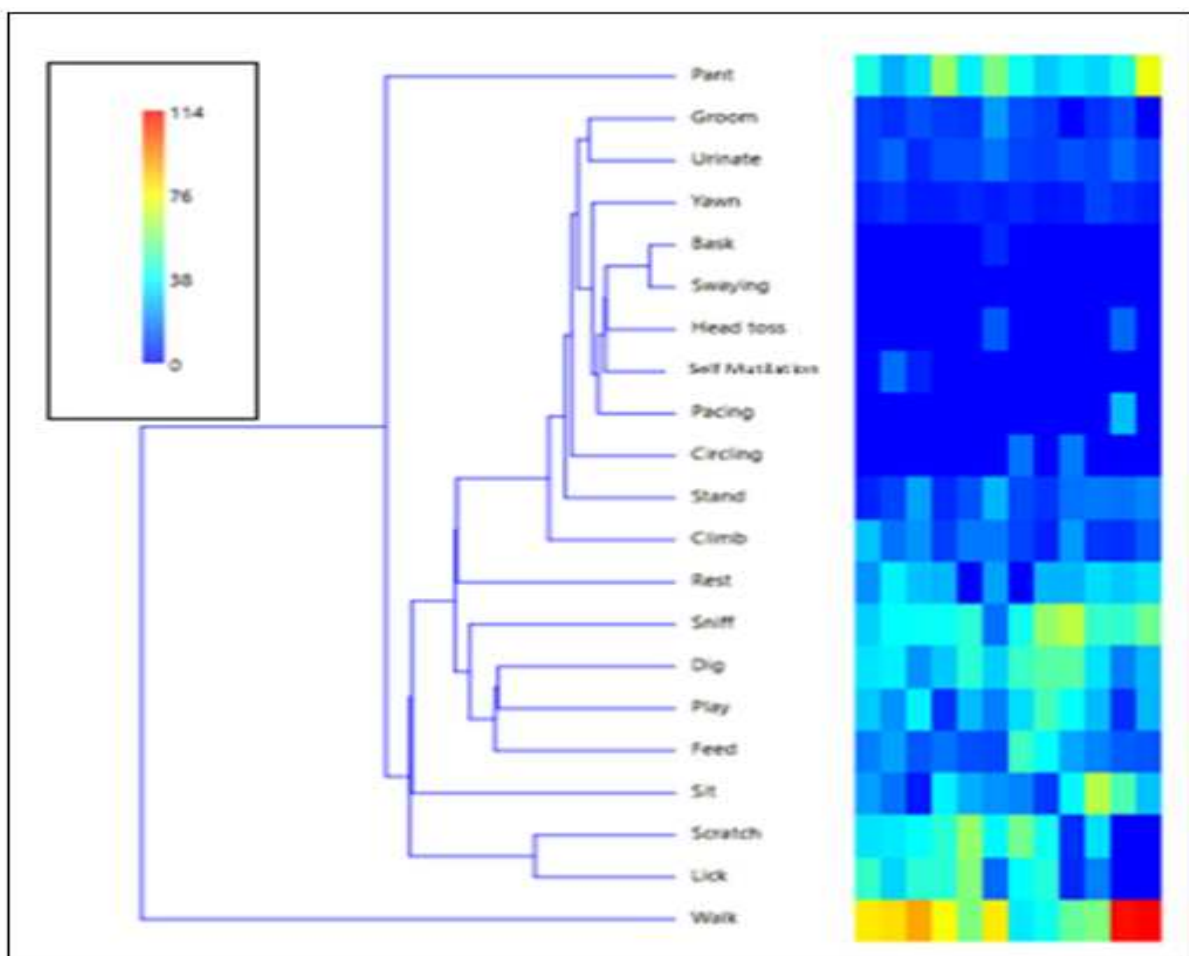


Fig. 5. Cluster analysis with a heat map of active behaviour of *M. ursinus* during the summer season.

PCA

Principal Component Analysis revealed that two components showed an eigenvalue of >1 . The analysis was done in correlation matrix. The image, depicted in Fig. 6., showed that during summer season the major variance was shown by behaviours like digging, sniffing, walking, playing, licking, scratching and

panting. Behaviours like walking and panting, scored the maximum among them. Whereas, behaviours like basking, sitting and resting comprised the maximum variation in winter season.

All other behaviours were not season-specific and showed the same frequency in both the seasons.

Discussion

Sloth bears, by nature, are nocturnal animals. Various authors remarked that they remained active all over the day time (Chauhan *et al.*, 2004; Yoganand *et al.*, 2005). Ramesh *et al.* (2013) also stated sloth bears were found active throughout the late evening to midnight hours and in the early mornings in Mudumalai Tiger Reserve of Western Ghats. In the

current observation, the studied sloth bear was apparently found active during the daytime in both the summer and winter season. The animal was found mostly spending its time resting, sitting, walking, basking, sniffing, scratching, digging, feeding and playing activities during winter, and walking, panting, sniffing, digging, scratching, playing, sitting, licking and feeding activities during summer.

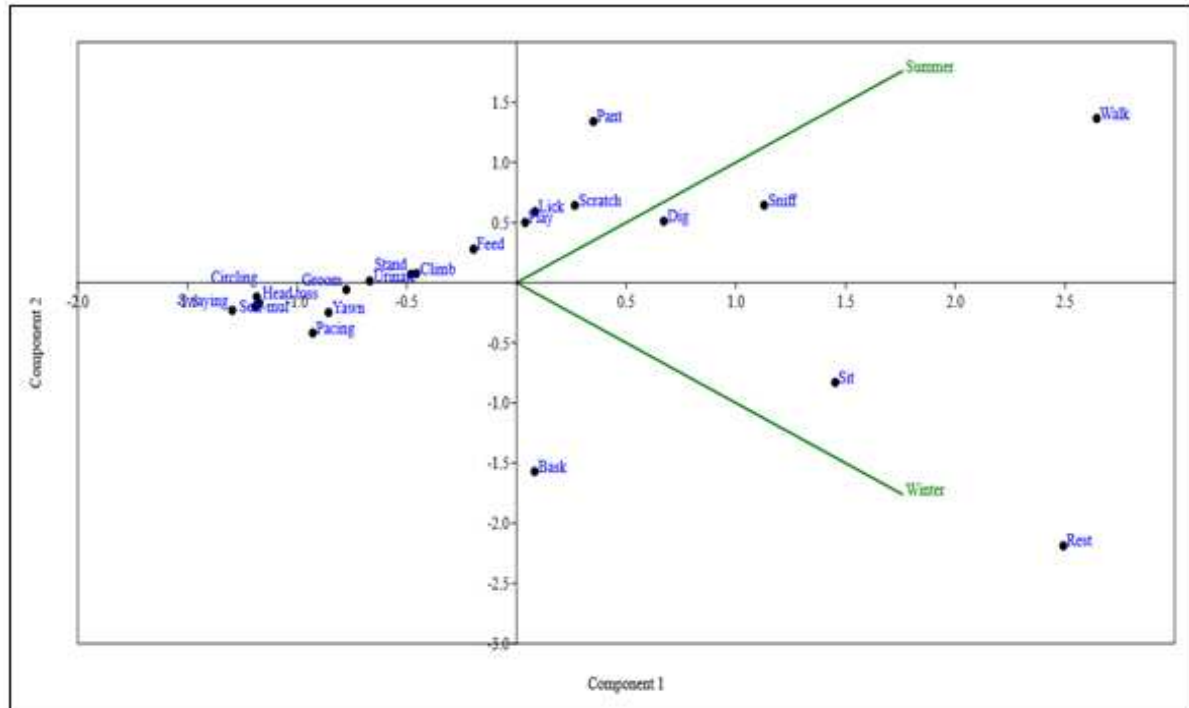


Fig. 6. PCA Biplot showing the variance of behaviours of *M. ursinus* during the seasons under study.

A previous study on the activity budget of sloth bear in captivity stated that they spent more time in feeding activity than any other behaviours (Pastorino *et al.*, 2017; Ramesh *et al.*, 2013; Bauer *et al.*, 2013). But, in the present study, time spent in feeding was only 3.60% during winter and 6.45% during summer, which might be due to feeding activity was not included in the observation period as the offered feed was provided early in the morning much before the starting of the observational study. Earlier studies also depicted that sloth bears spent an almost equal amount of time in passive behaviours and walking activity (Pastorino *et al.*, 2017; Ramesh *et al.*, 2013; Bauer *et al.*, 2013). This finding was quite similar to the present study of summer season. Sloth bear devoted a small percentage of time to affiliation and

exploration activity (Pastorino *et al.*, 2017; Ramesh *et al.*, 2013; Bauer *et al.*, 2013) which was also supported by the present study. This above-mentioned findings on the pattern of behaviour, regarding the feeding, walking, inactive behaviour, affiliation and exploring activities, was found to be consistent in the captive bears as well as their wild conspecifics (Veeraselvam *et al.*, 2013).

Pastorino *et al.* (2017) reported that the sloth bear of Whipsnade Zoo (United Kingdom) displayed the pacing stereotype which was 3% to 8% of their daily activity and the author also stated that the stereotype behaviours could be reduced by introducing enrichment tools in their enclosure. In this regard, Veeraselvam *et al.* (2013) reported that the bears of Arignar Anna Zoological Park (Chennai) spent about

16.43% time of observation period exhibiting stereotypic behaviours which could be improved to 4.21% by using enrichment techniques. This finding was in accordance with Vickery and Mason (2004), who stated stereotypic behaviours were very much common in captive bears. In the present, the time spent for pacing was 2.41% during winter and 0.56% during summer. The studied sloth bear showed the stereotypic behaviours in lower frequency (2.23% to 3.87%), which might be the result of including enrichment technique by the zoo authority and this result demonstrate that the bear is in healthy and active condition inside the enclosure of Alipore zoo, India. This is similar to the finding reported by Prajapati and Koli (2020) that no stereotypic behaviours were noticed during their study period (Prajapati and Koli, 2020). Several previous investigations on captive bear, documented a notable higher frequency of stereotypic behaviours (Anderson *et al.*, 2010; Veeraselvam *et al.*, 2013; Bauer *et al.*, 2013; Pastorino *et al.*, 2017). One probable cause of these variations in the amount of time spent in stereotypic activities by the sloth bear of different zoos, might be the enclosure size as large space of enclosure provide opportunity to the bear to perform natural activities and also make them less stressed. Moreover, larger enclosure size provides more natural habitat and environment. This finding would be useful in taking the strategies for the management of captive sloth bears in zoos and also in ex-situ conservation management as earlier reports on sloth bear's activity budget is very limited (Ramesh *et al.*, 2013; Prajapati and Koli, 2020).

In wild, sloth bears spent negligible amount of time in affiliative behaviour as they are solitary species (Montaudouin and Pape, 2005; Veeraselvam *et al.*, 2013). Whereas the captive sloth bear showed affiliative behavior (Pastorino *et al.*, 2017) and in the present study it was also noticed.

Daily activity pattern of the sloth bear exhibited peak at 1st three hour of observation period during summer season, while the last three hour of the observation period during winter season. In this context, Prajapati

and Koli (2020) documented that the captive bear of Sajjangarh wildlife sanctuary (Rajasthan), showed two peaks of the daily activity pattern, one was between 12:00-11:00 h and the other was between 14:00- 16:00 h. This earlier study also reported that the bear was more active during winter season than summer and most of the time was spent in resting in summer, while walking in winter. The current study obtained an inverse trend of result of the activity pattern which might be due to the variation of geographical position, and the environmental factors such as the climatic condition of Rajasthan is different from that of West Bengal. Basking was found to occur at higher rate during winter as in winter environmental temperature falls and they need to perform basking for their thermoregulation, while Prajapati and Koli (2020) obtained an inverse result, might be a person specific trait. Baskaran *et al.* (2015) reported that sloth bears from Mudumalai wildlife sanctuary, showed the walking and feeding activities in greater frequency in the morning and evening than the middle of the day. A similar result was obtained from the current study, where walking was more in the 1st hour of observation period, in the morning and also in the evening, and feeding was greater in the evening, while in the morning they were provided offered food before the starting of observation, hence it could be asserted that in the morning there was a peak of feeding activity. The bear showed resting behaviour in the 1st three hour of observation during winter, and in the mid-day period during summer. Due to low environmental temperature in the 1st few hours of winter seasons, the bear remained in less active condition, while due to scorching heat of mid-day during summer, the bear displayed resting behaviour. A similar trend of result was also noted in wild sloth bear (Baskaran *et al.*, 2015).

Activity budget of the studied sloth bear showed that the bear spent half of the observation period in active behaviours during winter season, whereas during summer the amount of time spent for active behaviour was found relatively more than winter, accounting for 85.24%. When considering the passive behaviours, during winter the bear spent nearly

remaining half (46.93%) of observation period in displaying the passive behaviours, while during summer, the bear devoted less amount of time (12.54%) for basking, resting and sitting activities. This study showed that stereotypic behaviours occur in high frequency during the winter season.

Conclusion

A detailed activity pattern and time budgeting of a male captive bear in Alipore zoo, West Bengal, India, was analysed and described in the present study. The daily activity pattern of the studied sloth bear showed a peak at 1st three hours of the observation period during the summer season and the last three hours of the observation period during the winter season. The bear was found to be more active and energetic during the summer season than in the winter. It spent the majority of time resting, sitting, walking, basking, sniffing, scratching, digging, feeding and playing activities during winter, and walking, panting, sniffing, digging, scratching, playing, sitting, licking and feeding activities during summer. Basking was higher during winter due to low environmental temperature, whereas panting was higher in summer as the animal wanted to keep itself cool from the scorching heat of summer. Sloth bear exhibited stereotypic behaviours in lower frequency, which depicted that the bear of Alipore Zoo was in a healthy and less stressed condition.

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