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Activity Pattern and Time Budget Analysis of Asian Elephant (*Elephas maximus*) in Alipore Zoological Garden, India

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Abstract: Diurnal activity pattern and time budgeting of female Asian elephant (*Elephas maximus*) was studied at Alipore Zoological Garden, Kolkata, India, for seven hours observation period from 10.00 to 17.00 h between August, 2022 to June, 2023 by using focal sampling method with 23,520 minutes of observations. The study identified 14 different high frequency behaviour and 16 low frequency behaviour of the elephant during the observation. The elephant exhibited significant variations in activities among the seasons and in the different hours within a day. For all the studied seasons, foraging activity was dominant with significantly ($P < 0.05$) maximum time spent, followed by ear flapping ($9.91 \pm 0.09\%$), standing ($9.52 \pm 0.69\%$) and walking ($8.76 \pm 0.10\%$) during monsoon, walking ($11.14 \pm 0.62\%$), ear flapping ($9.33 \pm 0.33\%$) and standing ($7.85 \pm 0.52\%$) during winter and, standing ($11.95 \pm 0.37\%$), ear flapping ($11.14 \pm 0.31\%$) and dusting ($10.29 \pm 0.45\%$) during summer. Among seasons, significantly higher ($P < 0.05$) mean time spent percentage was noted in playing and mudding activities during monsoon, in foraging, walking and stereotypic behaviour, bobbing during winter and in standing and dusting during summer. Similarly, significantly lowest ($P < 0.05$) time spent was observed, during monsoon for dusting activity, during summer for foraging, playing, walking, mudding and bobbing activities and during winter for standing, ear flapping and bathing. In hourly activity time budget, the peak hour of foraging was 15.00-16.00 h for all the studied seasons. The findings of the present observational study on activity time budget of a captive Asian elephant would be helpful for comparing the behavioural patterns of captive and wild elephant which would be ultimately useful in improving the management strategies for the welfare of captive Asian elephants.

Keywords: Time budgeting, Asian elephant, Behavioural patterns, Focal sampling, Bobbing, Foraging, Mudding, Ear flapping, Dusting

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Introduction

The Asian Elephants (*Elephas maximus*) are the second largest and heaviest living terrestrial

mammals in world (Lukacs *et al.*, 2016). In wild they live in a diverse habitat such as grassland,

forest and scrubland (Choudhury, 1999). They are one of the last few mega-herbivores weighing over 1000 kg at adult stage (Owen-Smith, 1988). They are generalist feeder, grazer during wet season and browser during dry season (Lukacs *et al.*, 2016). The amount of feed, normally consumed per day by them is from 1% to 1.9% of their body weight (Roehrs *et al.*, 1989). To acquire these huge amounts of feed, they generally spent 60% to 80% of time by walking (Owen-Smith, 1988). They currently occur in isolated populations in South and South-East Asia and the total range of area of their distribution is over 486,800 km² (Sukumar 2003; Choudhury *et al.*, 2008). Their home range size could vary from 10 to 800 km² (Clubb and Mason, 2002; Fernando *et al.*, 2005). The estimated global population size of the Asian elephants in wild is 48,323 to 51,680 individuals (Menon and Tiwari, 2019) and they are listed as endangered in the IUCN Red List of Threatened species. Their Population size has declined by an estimated range of 50% over the past 65 to 75 years and their survival is threatened due to their habitat fragmentation, habitat loss, illegal trade, poaching, accidents and human elephant conflict (Sukumar, 2003, 2006; Choudhury *et al.*, 2008). Asian elephants are considered as ecosystem engineer due to their contribution in the health of environment in various ways (Fritz, 2017). Thereby, implementation of different coordinated conservation initiatives is needed to revive the Asian elephant population and to pull them back from the verge of extinction. In Asia, about 16,000 Asian elephants might be kept in captivity as work animal (Clubb and Mason, 2002), whereas about 1800 kept in national park, sanctuary, zoos and safari parks (Koehl, 2001). According to report of Asian elephant range states meeting (2017), in India about 3,467 to 3,667 Asian elephants were kept in captivity. The large captive population of this endangered long living animal poses a number of ethical and practical challenges, but sometimes also with opportunities (Campos-Arceiz and Steve, 2011). Understanding of behaviors, activity patterns is very much crucial for the translocation of elephants as well as for the

in situ conservation.

The activity time budget of an elephant describes that an elephant is involved in or displayed different activities in a specified time period (Baskaran, 2013). The time budget of diverse activities in a particular time period gives an opportunity to make comparisons between the behaviours expressed by wild and captive elephants, to point out the differences observed and to find out the causes of such differences and to interpret their strategies related to behavioural pattern (Vinod and Cheeran, 1997). The activity time budget combines with energy cost of different activities displayed by the studied animal, could be useful in estimating the total energy expenditure for that species (Ahamed, 2015; Samarasinghe and Ahamed, 2016).

A significant knowledge from the data of earlier studies on the activity pattern and time budgeting of zoo elephant might be helpful to understand the differences in behavioural pattern between the wild and captive one as well as to find out stereotypic behaviour, if observed. Stereotypic behaviour might be denoted as abnormal behaviours where any movement pattern occurs repeatedly, in an invariant form, without having apparent function or goal by the studied animal. Typical stereotypic behaviours in elephants are repetitive pacing, swaying and rhythmic head movements (Rees, 2009). Hence, the amount of stereotypic behaviour displayed by the studied captive animal, might be considered as an indicator of their poor welfare (Mason and Veasey, 2010). These simple observation-based reports ultimately would be useful for a better and improved management of elephants in zoos.

Prior studies on the behavioural pattern of several mammal species recommended for the detailed studies on their activity pattern and time budget (Deag, 1985; Chattopadhyay and Bhattacharya, 1986). The activity time budget was studied for the African elephants (Kalempera, 1987) as well as for the Asian elephant (Easa, 1988; Sivaganesan and Johnsingh, 1995; Vinod and Cheeran, 1997; Baskaran, 1998; Baskaran *et*

al., 2010a). These studies reported considerable variation in activity pattern among individuals, in both wild and captivity, which might be due to change in habitat, temperature and seasons (Sukumar, 1992; Rees, 2009). In captivity, the different form of management and housing activities could result in the variation of their behaviors (Posta, 2011).

Few studies have well estimated the detailed activity budgets and behaviour pattern in zoo elephants. Clubb and Mason (2002) identified only 10 studies which have quantified elephant behaviors, among those studies, only four were of the zoo elephants (Rees, 2008). Most of the studies on the captive elephant behavior were carried out in a short sampling period during a limited time span of a year. For this reason, a detailed activity time budget of captive Asian elephant cannot be determined (Lukacs *et al.*, 2016).

Asian elephants exist in a basic unit, comprising of mother and dependent-offspring (Mckay, 1973; Sukumar, 1989). In southeastern Sri Lanka and southern India, 'joint family groups' of Asian elephants is noticed where two or more mothers are the family head and the oldest one is considered as the repository of critical ecological information (McComb *et al.*, 2000, 2001). She guides movement pattern and habitat utilization by the family group. Besides the leadership role of maintaining the family, females have the responsibility of managing their population size through reproduction. Therefore, female's fitness plays a key role in determining a female's status in the breeding hierarchy (Vidya and Sukumar, 2005) and thereby females are the most dominant and the crucial member of the family. Knowledge of the detailed behavioural pattern of female elephant will enable a better understanding of their activity budget which would provide a more informed practical decisions for their successful breeding programme in captivity and for their management.

Due to scarcity of detailed activity budgets of zoo elephants, this study was attempted to establish a detailed diurnal activity time budget of

a female Asian Elephant kept in Alipore Zoological Garden, Kolkata over a period of approximately 10 months. In this study, different behavioural pattern such as foraging and feeding, locomotion, ear-flapping, dust bathing, bathing, playing activities and other diurnal activities were observed. The objective of this study was to design an ethogram of a female zoo Asian elephant and to quantify the seasonal variation in behavior between the observation days.

Materials and Methods

Study Site:

The present study was conducted at India's oldest zoological park, Alipore Zoological Garden (22°32'9.29" N, 88°19'55.39" E), Kolkata, West Bengal, India. The zoo was established around 1800 by Governor General of India, Richard Wellesley. The inauguration of Alipore zoo was on 1st January 1876. It covers area of about 18.811 ha (46.48 acres). It is the home of approximately 1,266 animals and about 108 species of mammals, birds and reptiles are present. Soil structure of zoo is loamy alluvial. Summer season starts in March and ends with the onset of rainy season in June, maximum temperature shoots up to 40°C with an average of 36°C. Winter season sets in December and ends in 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.

Studied Animal:

The studied animal is a female Asian Elephant (*Elephas maximus*) kept along with another female Asian elephant in an enclosure. The elephant was sent to Alipore zoo by Directorate of Forests Government of West Bengal on 6th November, 2014. The food is provided by the Alipore zoo authority to the elephants. Their diet basically includes rice, soaked gram, paddy, lentil, wheat, molasses, green leaves/fodder, sugarcane top, banana etc. The food is provided to them twice in a day (before 09:30 am and after 04:30 pm inside

the elephant enclosure). Rest of the time they forage for grasses, leaves, etc.

Enclosure of the Animal:

The elephant enclosure consists an area of the 12,000 sq.m. It is an open-air enclosure bounded by concrete walls as barriers (Fig. 1). The entire enclosure has a grass carpet. Inside the enclosure, the base of the trees such as Aswattha, Neem, Deodhar and Krishnachura, have been surrounded by brick walls so that the elephants do not uproot them. Smaller varieties of plants, such as corn and banana, have also been planted in the enclosure. The enclosure has two night-shelters and as many water bodies. A big water pool is also provided for bathing of the animals. The elephant was chained in the shade at 5:00 pm till the morning at 8:30 am.

Data collection:

For the study on diurnal activity pattern of female Asian elephant at the Alipore zoo, data were collected from monsoon to summer seasons (11 months study, 3 months from monsoon, 4 months from winter and 4 months from summer). Data were recorded during day time from 10 am to 5 pm twice in a week, through direct observation with unaided eye by using focal sampling methods (Altmann, 1974) and marked on sheet. All the activities were recorded in each minute with a gap of 1 minute in every five minutes from a suitable point without creating any disturbances to animal. Total observations were carried out for 23,520 minutes.

Ethogram:

An ethogram is a list of typical behaviours performed by an animal and it could be described as a complete catalogue of the behavioral patterns of a series. An animal's activity pattern is naturally occurring continuous flow from one event or state to another. Breaking it down into categories allows a researcher to make distinctions and measurements of a particular behaviour, displayed by that animal. At the time of preparing an ethogram, suitable name is given to denote each of the behaviors with a definite description.

On the basis of previous behavioural studies on Asian elephant (Rees, 2009; Ahamed, 2015; Lukacs *et al.*, 2016) and preliminary observations, an ethogram was constructed for this study on Asian elephant (Table 1).

Data Analysis:

The observations were categorized into different activities. For each activity duration was recorded. To determine activity time budget, the displayed activities by the studied elephant were analyzed 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 performed for multiple comparisons at the significance level of 0.05 to compare the differences in activity patterns for hourly and seasonal data.

Results

Present study identified 14 high frequency behaviours and 16 low frequency behaviours (infrequency of occurrence) termed as "infrequent behaviours" for the studied Asian elephant (Table 1) during the study period. Analyzed data were presented as percentage of time spent in different behavioural categories during monsoon by the Asian elephant in Figure 2. Amongst the high frequency behaviours, feeding activity was dominant (36.38%) which was almost exclusively by foraging activity (mean % $\pm$ SE: 32.67 $\pm$ 0.69), followed by ear flapping (9.91 $\pm$ 0.09), standing (9.52 $\pm$ 0.69), walking (8.76 $\pm$ 0.10), trunk swing (6.86 $\pm$ 0.44) and then to the other miscellaneous activities like bathing (4.67 $\pm$ 0.34), playing (2.95 $\pm$ 0.15), mudding (2.67 $\pm$ 0.25), lying down (2 $\pm$ 0.17), and dusting (1.62 $\pm$ 0.09), whereas in stereotype category, elephant spent in bobbing for 1.71% of time. But the elephant spent 10.48% of the time for the infrequent behaviours. Among these infrequent activities, trunk lifting behaviour was observed maximum with 2.57% time.

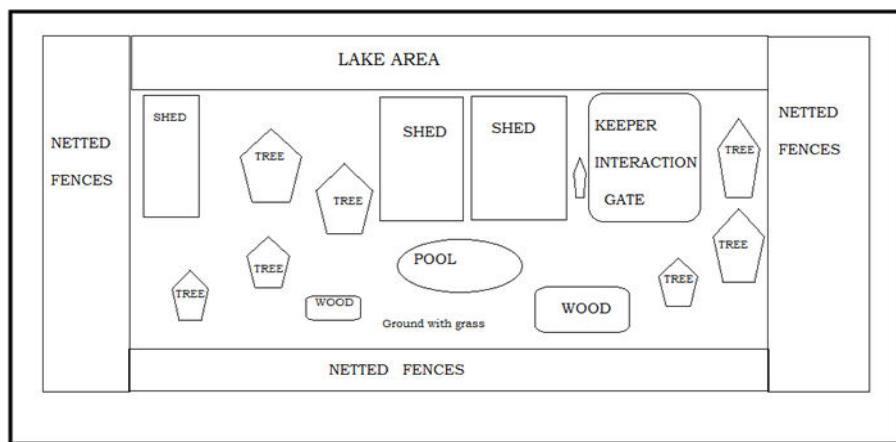


Fig. 1: Layout of Asian Elephant enclosure at Zoological Garden, Alipore, Kolkata (based on visual observations during present study).

Table 1: Ethogram used for collecting behavioural data of Asian elephant, *E. maximus* in captivity at Alipore Zoo, Kolkata, India

Behaviour	Description
High frequency behaviours	
Feeding offered feed	Eating food mixture provided by zoo
Foraging	Eating grasses, tree leaves and moves in relation to feed
Playing	Playing with another elephant
Walking	Locomotion except while foraging or stereotyping
Standing	Standing with no movement
Bathing	Standing/laying in pool
Spraying Self	Taking water through trunk & spraying over itself
Spraying Environment	Taking water through trunk & spraying it not on self
Lying Down	Lying down in ground
Dusting	Collecting soil and throwing it over the body using trunk
Mudding	Lies down on sides, rubs itself with wet mud
Ear Flapping	To-and-fro movements of ears
Trunk swing	Swinging trunk back and forth while standing still
Bobbing	Up or down or sideways movements of head (stereotyping)
Low frequency behaviours, grouped as "infrequent behaviours"	
Drinking	Takes water using trunk, passes water into its mouth
Running	Moves fast
Rolling	Rolling in soil or mud
Digging	Digging in soil using foot
Kicking	Kicking objects with legs
Object pick up	Use trunk to pick up non-food items
Object throwing	Use trunk to throw non-food items
Object in mouth	Use trunk to put non-food items inside mouth
Trunk lifting	Lifting trunk to get access to tree leaves or during dusting, spraying
Trunk curling	Curling the trunk
Trunk in Mouth	Placing trunk inside mouth (except feeding)
Urination	Urination occurrence
Defecation	Defecation occurrence
Exploring	Investigates any object using its trunk in its environment
Aggression	Hitting, pushing or throwing objects due to antagonistic encounter (not a part of playing)
Trainer Interaction	Interaction with elephant trainer

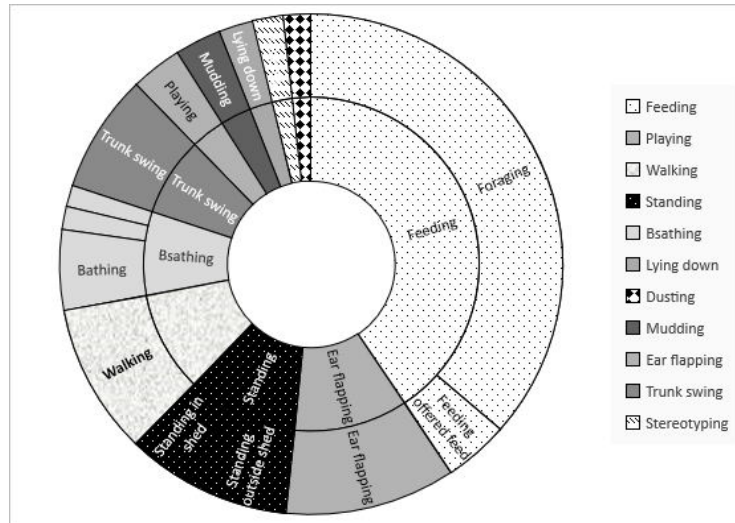


Fig. 2: Percentage of time spent in different behavioural categories by *E. maximus* during monsoon season at Alipore Zoo, Kolkata.

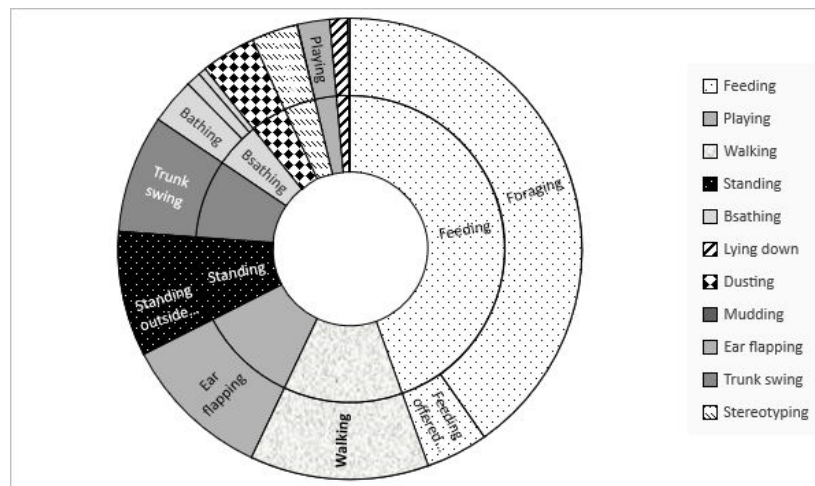


Fig. 3: Percentage of time spent in different behavioural categories by *E. maximus* during winter season at Alipore Zoo, Kolkata.

When allotted percentage of time for the high frequency behaviour were compared during winter season (Fig. 3), it was found that elephant devoted maximum time in foraging activity (mean % $\pm$ SE: 35.85 ± 0.85), followed by walking (11.14 ± 0.62), ear flapping (9.33 ± 0.33), standing (7.85 ± 0.52) and then in trunk swing (7.39 ± 0.69). Some other activities such as feeding of offered feed mixture, dusting, bathing and playing were observed with the amount of time spent of 3.89%, 3.43%, 2.86% and 2%, respectively, whereas bobbing was observed with 2.90% of time. In winter, elephant spent least amount of time to other infrequent activities such as drinking,

kicking, running, rolling, trunk lifting and curling, object picking and throwing, digging, exploring, trainer interaction, defecation, urination and aggression behaviour (a total of 10.70%) with the higher value of trunk lifting behaviour of 1.60%.

During summer season, the mean percentage of time spent in different high frequency behaviours by *E. maximus* are displayed in Figure 4. Among these behaviours, in winter the elephant devoted maximum time in foraging activity (mean % $\pm$ SE: 30.43 ± 0.40), followed by standing (11.95 ± 0.37), ear flapping (11.14 ± 0.31), dusting (10.29 ± 0.45), trunk swing (6.81 ± 0.55), walking

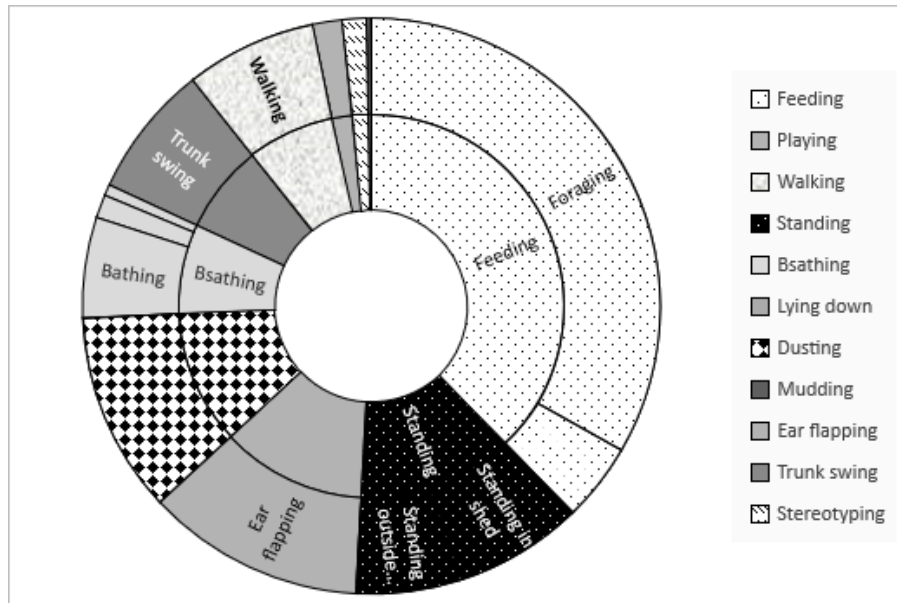


Fig. 4: Percentage of time spent in different behavioural categories by *E. maximus* during summer season at Alipore Zoo, Kolkata.

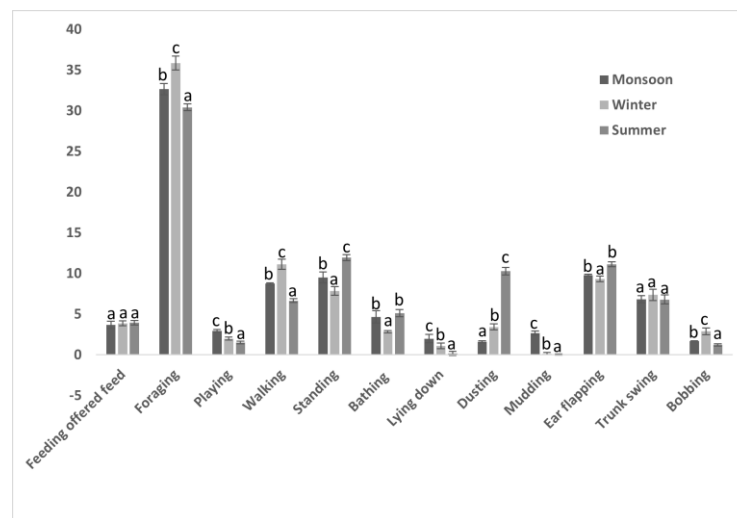


Fig. 5: Percentage of time spent in major behavioural categories by *E. maximus* in three different seasons at Alipore Zoo, Kolkata. Values are mean $\pm$ SE. Bars with different letters are significantly different ($P<0.05$) using DMRT after one way ANOVA.

(6.67 ± 0.23), bathing (5.14 ± 0.44) and other behaviours. In summer, elephant was found to be spending 1.24% of time by displaying stereotypic behaviour, bobbing. Under infrequent behaviours (8.86%), elephant dedicated significantly more time in drinking activity (1.61 ± 0.21).

The mean percentage of time spent in highfrequency behaviours by the studied elephant in three different seasons at Alipore Zoo are

presented in Figure 5. Significantly higher ($P<0.05$) values for playing and mudding activities were observed in monsoon, whereas lower in summer season. Time spent for foraging, walking activities and for the stereotypic behaviour, bobbing, were found significantly ($P<0.05$) higher during winter season, whereas lower during summer season. Time devoted for standing and dusting activity by the elephant was observed

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

Behaviour	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
Feeding offered feed	0.00	0.00	0.00	0.00	0.00	0.00	25.33
Foraging	38.00	37.34	18.67	34.67	35.34	42.67	18.67
Playing	0.00	1.34	8.67	6.67	0.67	2.00	1.33
Walking	14.00	6.67	4.00	8.00	12.67	10.00	6.00
Standing outside shed	5.34	6.00	4.00	3.34	8.67	6.67	7.33
standing inside shed	0.00	0.00	0.00	5.34	12.67	3.34	4.00
Bathing	0.00	14.00	15.34	3.34	0.00	0.00	0.00
Lying down	0.00	0.00	5.34	6.00	0.00	2.67	0.00
Dusting	8.00	2.00	1.34	0.00	0.00	0.00	0.00
Mudding	0.00	2.67	10.67	4.67	0.00	0.67	0.00
Ear flapping	10.67	9.34	6.67	8.67	10.00	10.67	12.67
Trunk swing	8.00	6.00	4.67	9.34	6.00	8.00	6.00
Bobbing	2.67	1.34	2.00	0.00	0.67	2.00	4.67

significantly ($P < 0.05$) maximum in summer and lower in winter and monsoon respectively. The values of spent time percentage for bathing and ear flapping were significantly lower in winter and in the other two seasons, values of both the activities did not vary significantly (DMRT). Time spent for feeding of offered feed and trunk swing activities did not show any significant variation among the three seasons.

During monsoon, the mean percentage of hourly activity pattern of *E. maximus* from 10.00 to 5.00 h are presented in Table 2. The peak hour for foraging was 15.00-16.00 h, followed by 10.00-12.00 h and then 13.00-15.00 h, whereas feeding of offered feed was only found at 16.00-17.00 h, when zoo keepers supplied mixed feed to the enclosure of the elephant. Playing activity was found maximum from 12.00-14.00 h where peak hour was at 12.00-13.00 h. Peak hour for walking activity was at 10.00-11.00 h, followed by 14.00-15.00 h and then at 15.00-16.00 h. Both the activities i.e., standing inside and outside the shed were reached the maximum value at 14.00-15.00 h. Bathing and mudding reached the peak at 12.00-13.00 h. The elephant displayed the lying down activity from 12.00-14.00 h and then at 15.00-16.00 h, in which maximum amount of time spent at 13.00-14.00 h. A decreasing trend of

engaged time for dusting activity by the elephant was noted from 10.00-13.00 h, with the higher value at 10.00-11.00 h. Ear flapping, trunk swing and bobbing were found more at 16.00-17.00, 13.00-14.00 and 16.00-17.00 h, respectively. From 10.00 to 17.00 h, among all the studied activities, the elephant spent most time for each hour was the foraging activity.

During winter (Table 3), the elephant devoted her most time for foraging activity from 10.00-16.00 h, while the peak hours was at 11.00-12.00 and 15.00-16.00 h, followed by 10.00-11.00 h and then at 14.00-15.00 h. Whereas at the last hour of observation foraging activity was reduced from 43.7% to 16.6% as in that hour zoo authority supplied feed mixture in her enclosure and the elephant involved in feeding of offered feed and therefore, 16.00-17.00 h was the peak hour for the feeding of offered feed activity. Standing outside the shed was noted maximum at 15.00-16.00 h, whereas standing inside the shed was recorded maximum at 16.00-17.00 h. Walking, ear flapping and trunk swing activities were observed peak at 10.00-11.00 h and bobbing behaviour reached the peak at 16.00-17.00 h. Dusting was mostly observed at 13.00-14.00 h, whereas mudding at 12.00-13.00 h. Bathing was noted from 12.00 hr to 14.00 h, but mostly at 12.00-13.00 h. Lying down

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

Behaviour	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
Feeding offered feed	0.00	0.00	0.00	0.00	0.00	0.00	27.20
Foraging	42.80	43.70	30.10	34.40	40.10	43.70	16.60
Playing	2.00	1.80	2.54	2.00	2.94	2.00	1.10
Walking	13.70	11.80	9.80	10.30	11.20	12.90	9.50
Standing outside shed	4.94	5.10	4.00	4.14	4.80	5.40	5.10
Standing inside shed	0.00	0.00	1.20	5.87	4.14	3.34	7.07
Bathing	0.00	0.00	16.00	4.00	0.00	0.00	0.00
Lying down	0.00	0.00	0.00	1.87	5.47	0.54	0.00
Dusting	1.74	3.60	3.34	5.47	2.80	4.40	2.67
Mudding	0.00	0.00	0.54	0.00	0.14	0.40	0.00
Ear flapping	11.47	9.47	8.00	10.13	8.94	9.60	7.60
Trunk swing	9.34	6.80	5.20	8.00	6.67	7.34	7.47
Bobbing	1.60	2.40	2.53	3.46	2.54	3.07	4.54

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

Behaviour	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
Feeding offered feed	0.00	0.00	0.00	0.00	0.00	0.00	27.67
Foraging	34.67	30.34	30.67	31.34	37.00	39.00	10.00
Playing	1.67	0.34	2.34	0.67	2.67	1.67	1.34
Walking	7.34	6.00	5.67	7.00	5.67	8.00	7.00
Standing outside shed	6.67	4.00	2.34	4.67	6.67	8.00	5.00
Standing inside shed	3.67	7.34	5.00	12.00	9.34	5.00	4.00
Bathing	0.00	13.34	14.34	2.34	0.00	1.34	4.67
Lying down	0.00	0.00	0.00	0.00	0.00	1.34	0.00
Dusting	10.67	8.67	10.34	11.34	12.00	10.67	8.67
Mudding	0.00	0.00	0.00	0.00	0.34	0.00	0.00
Ear flapping	14.67	8.00	9.00	12.00	10.67	11.34	12.34
Trunk swing	9.67	5.67	5.34	6.34	6.67	6.67	7.67
Bobbing	1.00	0.67	0.34	1.34	1.34	1.34	2.67

activity was found from 13.00 h to 16.00 h but reached the peak at 14.00-15.00 h.

During summer (Table 4), 10.00-11.00 h was the peak hour for ear flapping and trunk swing, 14.00-15.00 h for playing and dusting and, 15.00-16.00 h for foraging, walking and standing outside the shed activities, while 13.00-14.00 h for the standing inside the shed activity. The stereotypic behaviour, bobbing was noticed higher at 16.00-17.00 h. During the observation period of 10 am to 5 pm, mudding and lying down activities were only observed at 14.00-15.00 and 15.00-16.00 h, respectively.

Comparison of hourly activity budget of elephant among the three different seasons at Alipore Zoo are displayed in Figure 6. When activity patterns were compared within hours, it was observed that during all the three seasons, in each hour of observational period of 10.00-17.00 except the last hour (16.00-17.00 h), the studied elephant spent maximum percentage of time, almost one third of total time for foraging activity and in the last studied hour (16.00-17.00 h), time spent for feeding of offered feed was observed higher. No bathing, lying down and mudding activities were observed at the 1st hour of all the seasons and standing inside shed at 1st two hours

of monsoon and winter season. When 10.00-11.00 h was considered, among the seasons it was found that time spent for foraging was maximum in winter, then in monsoon. After foraging activity, the elephant devoted most time in walking activity which was noted higher in monsoon, then in winter. Standing both the inside and outside the shed, dusting, ear flapping and trunk swing activities were noticed more in summer season in comparison to other two seasons, whereas bobbing was more in monsoon and least in summer.

From 11.00 to 12.00 h (Fig. 6), when mean time spent percentage of the elephant was compared within monsoon season, it was found that time spent for the foraging activity was the maximum with 37.34%, followed by bathing (14%), ear flapping (9.34%), walking (6.67%) and then in standing outside shed and trunk swing, both with 6% time spent. During winter season, after foraging 2nd highest time spent activity was walking (11.8%), followed by ear flapping, trunk swing and then standing outside the shed activity. During summer, the elephant devoted most time in foraging, followed by bathing (13.34%), dusting (8.67%), ear flapping (8%), standing inside shed (7.34%) and then in walking (6%).

During the 2nd hour of observation, when time spent percentages for the standing inside and outside the shed were compared, it was noticed that during monsoon and winter, time spent was more in the standing outside the shed, whereas in summer in the inside shed.

From 11.00-12.00 h (Fig. 6), when data were compared within the activity, among the seasons, it was observed that time spent for foraging, playing, walking, ear flapping, trunk swing and bobbing activities were maximum during winter. Standing outside shed was more in monsoon and inside shed in summer. Value of bathing was noted higher in monsoon, then in summer, but no bathing was noticed in winter. Dusting is more in summer, whereas mudding in monsoon.

From 12.00 to 13.00 h (Fig. 6), when time

spent by elephant in different activities were compared within monsoon season, it was observed that elephant devoted more time for the foraging activity (18.67%), followed by bathing (15.34%), mudding (10.67%) and then in playing activity (8.67%). During winter season the elephant spent highest time in foraging activity, followed by bathing and then walking activity and during summer the highest displayed activity was also the foraging activity, followed by bathing and then dusting activity. When the time spent for standing outside and inside the shed were compared, it was observed that during monsoon and winter, the elephant preferred to stand outside the shed, whereas during summer inside the shed.

When data of time spent by the elephant were compared within behaviour from 12.00-13.00 h, it was found that time given for foraging and dusting was more in summer, walking and bobbing in winter and, playing, mudding and dusting in monsoon season.

From 13.00-14.00 h (Fig. 6), during monsoon, most displayed behaviour was foraging, followed by trunk swing, ear flapping, lying down activity and during winter, it was also foraging, followed by walking, ear flapping and then in trunk swing. Similarly, during summer most performed behaviour was foraging followed by ear flapping and standing activity. Standing inside shed was noted more in all the three studied seasons, when compared with standing outside the shed.

Among the three seasons, foraging was found almost equal in monsoon and winter (ns in DMRT), and less in summer. Time spent for playing and lying down was noted higher in monsoon, for walking, bathing and bobbing in winter and, for dusting in summer. Mudding activity was only noticed during monsoon from 13.00-14.00 h (Fig. 6).

From 14.00-15.00 h (Fig. 7), during monsoon after most displayed foraging activity, elephant was found to be spending most time in walking and standing inside shed, followed by ear flapping, during winter in walking and then in ear flapping,

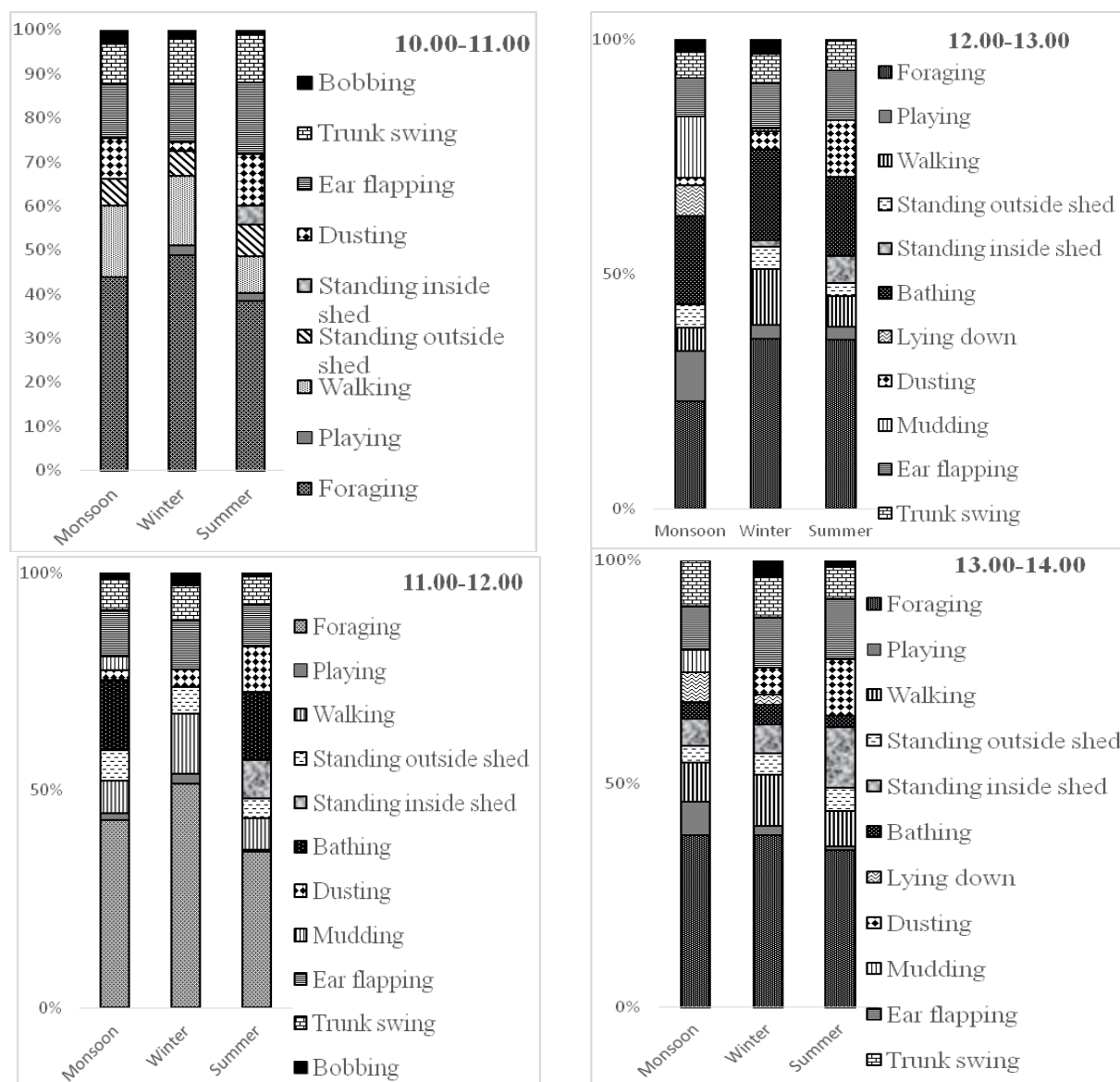


Fig. 6: Hourly activity budget of *E. maximus* in different seasons at Alipore Zoo, Kolkata in first four hours of observation period.

and, during summer, in ear flapping then in standing inside shed. Between the amount of time spent in standing inside and outside the shed activity, it was noted that the standing inside shed was more during summer and monsoon, but in outside the shed during winter.

Among the three seasons, elephant spent higher percentage of time for foraging, playing and bobbing during winter, followed by summer, whereas for walking and standing during monsoon. From 14.00-15.00 h, elephant did not show bathing activity in all the studied seasons,

while dusting and mudding activities were observed during winter and summer and lying down was only found in winter season.

From 15.00-16.00 h (Fig. 7), during monsoon and winter, the elephant devoted most of the time in foraging, followed by in walking. Similarly, during summer, after foraging most observed activity was the ear flapping, followed by dusting and then in walking. When standing behaviour was considered it was found that standing outside the shed was more than inside the shed from 15.00-16.00 h.

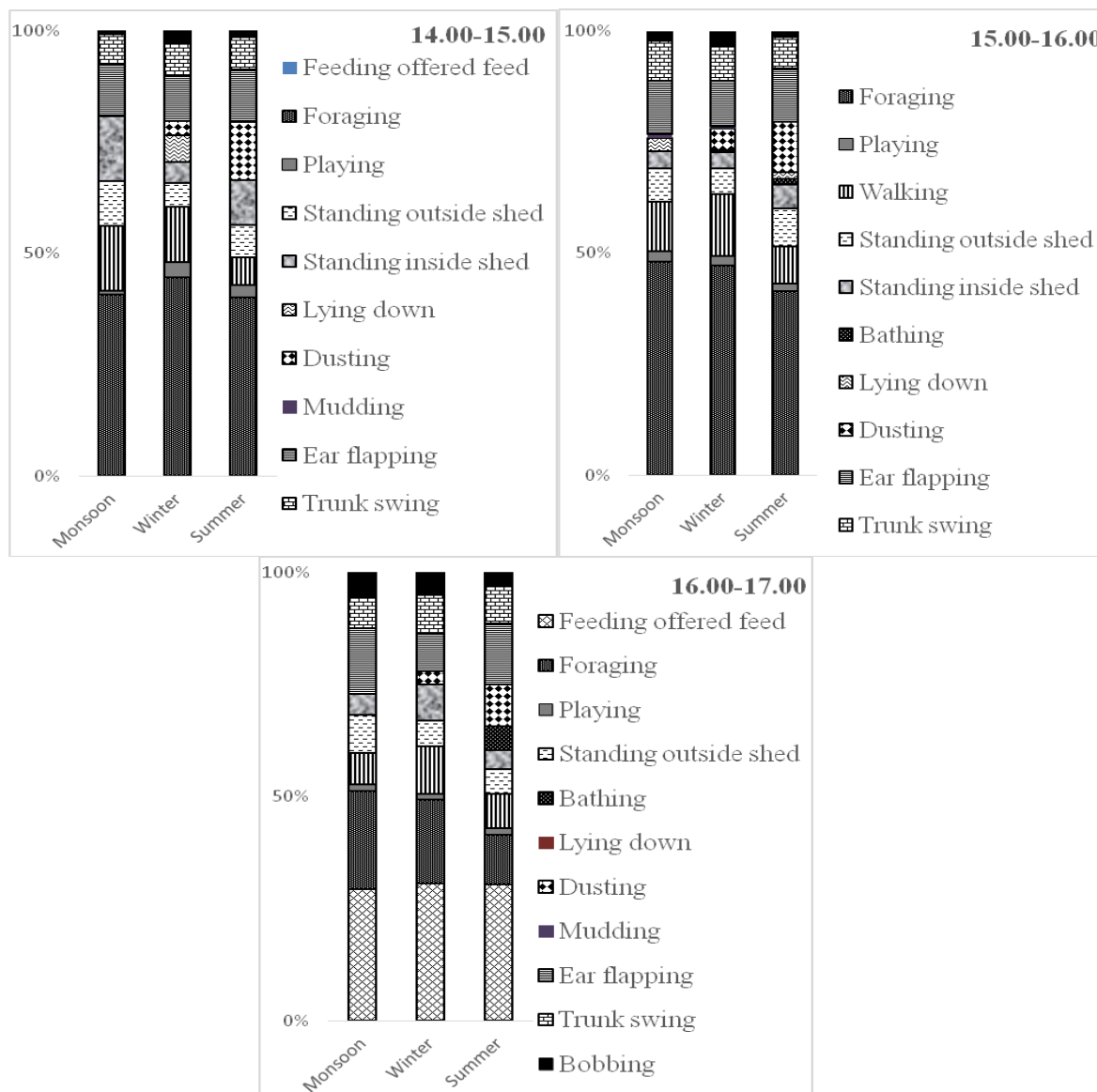


Fig. 7: Activity budget of *E. maximus* in different seasons at Alipore Zoo, Kolkata in last three hours of observation period.

From 15.00-16.00 h (Fig. 7), when data were compared within the behaviour among the seasons, time spent for the activities such as foraging, walking and bobbing was found higher in winter and, standing both the inside and outside shed, dusting and ear flapping in summer, whereas mudding in monsoon season. In that mentioned hour, bathing was only observed during summer.

From 16.00-17.00 h (Fig. 7), during all the studied seasons, the highest time spent activity was the feeding of offered feed activity, followed

by foraging activity. During summer and monsoon, standing outside the shed was more than standing inside the shed but during winter standing inside the shed was more. Time spent for the feeding of offered feed was maximum during summer, but foraging was more during monsoon. In the last hour of observation, bathing was only found during summer, while lying down and mudding activities were not noticed. Bobbing was found with higher value during monsoon.

Discussion

Few studies were conducted on behavioural

pattern of Asian elephants. As most of the earlier studies used short sampling periods, therefore reports on detailed activity time budget of Asian elephants are limited. The prior observational studies those looked at Asian elephant's behavioural patterns, noticed that there were considerable variations in their activities between individuals, habitats and seasons, and also between the wild and captive ones (Sukumar, 1992; Rees, 2009). According to Posta (2011), one of the main causes of the variations in behavioural pattern of captive Asian elephant was the differences in housing and management strategies.

Eating Behavior:

Posta (2013) reported that most of the captive elephant's day spent on eating (40%). Lukacs *et al.* (2016) and Rees (2008) stated that the female Asian elephant in captivity spent 23-34% and 24.2-41.8% of day in feeding activity, respectively. A similar result was found in the present study that the captive female Asian elephant devoted about 34% to 40% in feeding activity. In this regard, Samarasinghe and Ahamed (2016) and Sitompul *et al.* (2013) observed in their study of captive Asian elephant that foraging was the dominant behavior, spending 50.59% and 82% of the day in foraging activity, respectively. Whereas, Schmid *et al.* (2001) and Rees (2009) reported 29-64% and 27-41% of the observation period was spent in foraging by female Asian elephants in captivity, respectively. In the previous reports, variations in time spent for the foraging activity was noticed, but in all the cases, Asian elephant spent maximum time of a day in foraging activity. Present study agreed with the opinion as it was found that elephant spent 30.43% to 35.85% of the day in foraging. Rees (2008) observed that feeding activity reached peak from morning to 11:00 h, but the current study found that it was a dominant activity occurring in all the hours of observation period.

In the present study, time spent for feeding activity is found much lower than the wild elephants. In the behavioural studies on wild

elephants, it was reported that they spent much of the time of day and night (16 h of 24 h) in foraging. For example, mean activity percentages for foraging of wild elephant were 65% in Parambikulam (Easa, 1988), 68% in Nilgiri (Baskaran *et al.*, 2010b), 74% in Mudumalai (Sivaganesan and Johnsingh, 1995), 65% to 81% in Idukki (Vinod and Cheeran, 1997) and 75% in Sri Lanka (Mckay, 1973; Vancuylenberg, 1977). Wild elephants feed variety of grasses, twigs, bark, roots and leaves which are mostly low-quality vegetation (Samarasinghe and Ahmed, 2016). Hence, they can digest only 35-46% of their consumed food (Roehrs *et al.*, 1989). To fulfil their nutritional requirements, they need to consume huge amount of food. In search of food, they dedicated almost all the time in the foraging activity (Lukacs *et al.*, 2016). Mostly they spend 60% to 80% of day and night in foraging, when they eat about 150 kg to 350 kg (wet weight) of food in 24 h (Owen-Smith, 1988). In this context, Mckay (1973) found foraging time of a wild elephant could be more than 90% time of the day and night, when they consumed very low-quality food due to seasonal and habitat differences. In the captive condition, elephants are given processed food. Hence, ready availability of feed in a zoo might be the cause of devoting less time for eating compared to wild ones as in wild much time was spent in searching the food (Veasey, 2006). In a study, it was reported that an adult Asian elephant at zoo, consumed about 4.3 kg of feed per hour, whereas wild elephant consumed only 2.3 kg/h, which might be due to the availability of food. On the contrary, Wiedenmayer (1998) stated that in the zoo elephant consumed smaller volume of feed as they were given higher quality of feed, which was adequate to meet their nutritional requirements. Hence, food quality and availability specify the explanation of the time spent for feeding activity by elephants. Apart from these, the time spent for feeding activity showed variation between individuals and also between observational times. Dominant one gets more access to the resources compared to other

elephants in wild (Freeman *et al.*, 2004) and, physically more active and fit one consumes more food due to their higher digestion ability (Hatt and Clauss, 2006). During monsoon, wild elephants consumed less quantity of food which is more nutritious than in summer and winter as in these time grasses become dry and are less nutritious. However, in zoo, food was given *ad libitum* and elephants get equal access to the resources throughout the day as observed in current study.

Drinking, Urination and Defecation:

In the wild, drinking activity usually occurring in the early evening, but they may take water one to many times in a day (Owen-Smith, 1988). Lukacs *et al.* (2016) reported that in captive condition, Asian elephant consumed water less than 1% of the day. While Sitompul *et al.* (2013) and Samarasinghe and Ahamed (2016) observed that Asian elephants in captivity spent up to 1.7% and 1.4% of the day in drinking activity, respectively. Time spent for the drinking activity of the female Asian elephant, seen in the current study (1.04% to 1.61%) is nearly similar to the above-mentioned reports. In the present study, the elephant spent more time in drinking during the summer might be due to high environmental temperature.

In this study, the observed elephant defecated and urinated one to two times in day time. While, Lukacs *et al.* (2016) observed that the captive Asian elephant defecated one to seven times and urinated two to six times in a day. Lukacs *et al.* (2016) reported urination of captive elephant was found on average of 5 times per day. Wild elephants defecate around 12-18 times in day, in captivity the decreased frequency of defecation might be due to difference of food quality in zoo and in wild (Hatt and Clauss, 2006). As zoo elephants were given nutritious and highly digestible feed, they consume less quantity of feed that might equate to low frequency of defecation in captivity. Urination frequency is similar with the earlier study reports (Laforest *et al.*, 2011; Lukacs *et al.*, 2016). In few studies it was observed

that urination frequency in African elephants was higher (Schotsman *et al.*, 2008) than the Asian elephants.

Standing and Walking Behavior:

Activity budget for walking is implausible to compare with earlier studies because some studies considered walking while eating also (Rees, 2009) and some studies considered certain distance or steps as locomotion (Wilson *et al.*, 2006). In this study walking activity is mentioned for the movement of four feet in forward or backward motion. Here, time spent for walking (6.67-11.14%) was found in the range of some earlier studies such as the reports of Lukacs *et al.* (2016), Sitompul *et al.* (2013) and Rees (2009) where 1% to 9%, 1% to 9.5% and, 6.1% to 19.2% of the day was observed to be spending in walking by the captive Asian elephants, respectively. While captive African elephant spent about 27% of a day in walking activity (Posta, 2011).

Ahamed (2015) found that time dedicated for standing activity by wild Asian elephants was 7.44% which was in the range of time spent percentage (7.85% to 11.95%) for standing by the captive Asian elephant of the present study. While, some previous studies reported that captive Asian elephants spent in standing for 26-41% (Lukacs *et al.*, 2016) and 15-42% (Rees, 2009) of a day.

Dusting:

When displaying the dusting behaviour, elephants collected soil by digging it and scraping it towards its trunk with her forefeet and then threw the soil by lifting its trunk over her body. A study of activity budget of Asian elephants in Chester Zoo, was found that the elephants spent 3.9-9.6 % of the day by dusting (Rees, 2009). A similar range of time spent percentage for dusting (1.62-10.29%) by the studied elephant was noticed in the present study.

Mudding:

Rees (2009) noted the captive Asian elephants spent 0.6-17.2% of the observation period in

mudding. While in the current study it was 0.05-2.67%. The studied captive female Asian elephants spent 0.5-1.33% of the observation period by spraying water towards self and towards environment. Lukacs *et al.* (2016) observed that the elephants spent 0-1% of the day in these activities. They found the elephant spent 0-1% of the observation period in swimming. Swimming behavior was not observed in the current study.

Lying Down Behaviour:

Lying down activity displayed by captive Asian elephant, was up to 6.6% of a day (Sitompul *et al.*, 2013). While the elephant of the current study spent relatively less time for the lying down activity (0.19-2%). Lukacs *et al.* (2016) did not find lying down activity during their study period.

Ear flapping Behavior:

Constant back and forth movements of ears is called ear flapping. Due to the large surface area of ear, ear flapping has a thermoregulatory role under warm environment. In some previous studies, ear flapping behaviour was observed for 23.45% (Samarasinghe and Ahamed, 2016) and 6.85% (Ahamed, 2015) of a day in captive condition and wild. Whereas, it was recorded 9.33-11.14% in the present study of captive female Asian elephant.

Trainer Interaction:

Time spent for trainer interaction is totally dependent on the management strategy of the zoo authority and therefore exist a wide variation in mean time spent percentage for trainer interaction among the zoos. In this study, the observed elephant interacted with the trainer only for one hour (16:00-17:00 h), showing at a mean frequency of 0.95-1.09% of observation period. Trainer interaction was noted about 4-23% of the observation period in the zoological park at Busch Garden Tampa, Florida, USA (Lukacs *et al.*, 2016).

Stereotypic behavior - head bobbing:

A stereotypic behavior is any behavioral pattern which is performed repeatedly and has no proper

goal or function (Odberg, 1978). In elephants this type of behavior mainly consists of rhythmic head movements. In the present study, the elephant showed frequent head bobbing during feeding. Head bobbing was recorded in the highest percentage in winter. Rees (2004) also found stereotypic behavior at highest rate in winter.

Seasonal Variation in activity budgets:

In the present study, the captive female Asian elephant showed seasonal variation in high frequency behaviours such as walking, dusting, bathing etc. Highest foraging and walking activity was recorded in winter season. Walking activity increased in winter might be due to huge crowd interference during the visiting hours at the zoo and hence, the elephant exhibited active behavior walking. Rees (2009) did not find any seasonal pattern in mean feeding frequency, but observed highest walking behavior of captive Asian elephants in winter as found in the current study.

The observed elephant displayed standing in shed activity at the highest percentage in summer due to scorching heat of summer. The elephant showed the highest bathing activity percentage in summer, that also might be due to the rising temperature of summer. In rainy days, the elephant enjoyed bathing, playing and mud bathing activity. During monsoon, the studied elephant bathed for longer period and engaged in playing activity with higher mean time percentage and also displayed highest lying down along with mud-bathing behavior.

The constant ear flapping helps in evaporative heat loss (Athrupana *et al.*, 2015). In the current study, ear flapping was found at the highest percentage during summer and in winter the percentage was lowest. A prior study supported this finding and reported that ear flapping activity of captive Asian elephants showed an increased rate with the rise of environmental temperature above 25°C (Mckay, 1973).

As observed in the present study that highest percentage of dusting activity in summer, Rees

(2002, 2008) also found the highest frequency of dusting in warmer months when the radiation from sun was high. Dusting behavior has various functions including skin care, temperature regulation and in prevention from insect bites.

Conclusion

Studied female Asian elephant showed considerable seasonal as well as hourly variations in activity time budgets. Among the various displayed behaviours, the elephant spent maximum time in feeding activity. The results of this observation-based study on the time budgeting of different activities of the elephant, which conducted for a longer period will allow to compare the behavioural patterns exhibited by the captive studied elephants with the wild ones as well as with the other captive elephants, which will provide an opportunity to analyze their behavioural patterns that would be helpful in making proper need-based management strategies for the welfare of captive Asian elephants.

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