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Time Budget and Activity Pattern of Capped Langur (*Trachypithecus pileatus*) in Barail Wildlife Sanctuary, Assam, India

Rofik Ahmed Barbhuiya, Nazimur Rahman Talukdar and Parthankar Choudhury*

Affiliation: Wildlife Conservation Research Laboratory, Department of Ecology and Environmental Sciences, Assam University, Silchar, India

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ABSTRACT

Time allocations for different activities of Capped langurs are depending on the environmental and habitat conditions. We observed time budgeting of Capped langurs for various activities on daily, monthly, seasonal and yearly basis from January 2017 to December 2019 in Barail Wildlife Sanctuary of Assam, India. Focal-animal sampling technique was used to record the diurnal active time spent by *T. pileatus* for different activities. From the observation it has been found that langur spent maximum time for resting (45%) followed by feeding (34%), locomotion (11%), grooming (5%) and others activity (5%). The amount of time allocates for different activities throughout the months was significantly different ($F= 341.95$, d. $f = 4$, $P < 0.001$). Time devoted to feeding was maximum in April (37%) and resting was 50% in August. In seasonal variation, it spent maximum (48%) time for resting in monsoon and lowest (41%) in winter. Highest (35%) feeding activity was in winter and summer followed by lowest (32%) in monsoon and the seasonal variation of all the activities was significantly varied. The diurnal time budget shows that it spent maximum (40.57%) time for feeding in evening hours $P < 0.001$, while resting was highest (57.58%) between (10hrs-11hrs) and lowest (37.8%) in evening $P < 0.001$.

Key words : *Activity, Assam, Behavioral ecology, Capped langur, Time budget*

Introduction

The Northeast India has the highest mammalian diversity in general and primates in particular (Talukdar *et al.,* 2021). The area falls under the Indo-Burma and the Himalayan global biodiversity hotspot (Myers *et al.*, 2000; Talukdar *et al.*, 2018). Besides, it also forms a part of two Endemic Bird Areas, the Eastern Himalaya and the Assam Plains (Stattersfield *et al.,* 1998). The southern part of Assam comprising the districts of Cachar, Karimganj, and Hailakandi covers a total area of 6962 km^2 and receives 2700-2800 mm annual rainfall. Of the total area, the Barail Wildlife Sanctuary (WLS; Cachar district), Katakhal and Inner Line Reserve Forest cover 1067 km^2 area. Other RFs of southern Assam include Badshatilla RF, Duhalia RF, Longai RF, Patharia RF, Singla RF, Tilbhum RF, and NC Hills RF of Karimganj district, which cover a total area of 73,295.437 ha; while, Barak RF, Inner Line RF (Assam portion), Katakhal RF, Lower Jiri RF, Sonai RF, Upper Jiri RF, and Barail RF of Cachar district cover an area of 86,284.54 ha. Currently, the only protected area in the region is the Barail Wildlife Sanctuary.

Capped langur, *Trachypithecus pileatus* (Blyth

1843) belong to Cercopithecidae family, and has four recognized sub-species (IUCN Red list). These include i) Capped langur (*Trachypithecus pileatus*), ii) Capped langur (*Trachypithecus pileatusssp. Brahma*) iii) Tenebrous capped langur (*Trachypithecus pileatus ssp. tenebricus*) and iv) Blond bellied langur (*Trachypithecus pileatus ssp. pileatus*). IUCN has categorized the first one as vulnerable, while the latter three as endangered. The species found in Barail wildlife sanctuary is the first one, i.e., *Trachypithecus pileatus.*

These are diurnal, arboreal and folivorous animals, but fruit is also a major component of the diet. It occurs in a wide range of habitat and behaves differently in order to maintain time-energy balances (Watanuki and Nakayama, 1993; Menon and Poirier, 1996; Li and Rogers, 2004). *Trachypithecus pileatus* is indigenous to the north eastern part of India (Srivastava, 1999). Its global distribution is restricted to Bangladesh, north-western Myanmar, Bhutan, southern China and north eastern states of India (Srivastava, 1999; Stanford, 1991; Ahsan, 1994).

Animal allocates their active time for various activities which provides a useful foundation to its overall ecological approach. Study on the activities of animals help the researchers to identify how they interact with the environment and also frame strategies for maximizing the energetic and reproductive success (Defier, 1995). The optimum utilization of resources by an animal in the habitat is paramount for their survival and reproduction (Janson, 1992). Degraded state of their habitat brings about survival challenges to them and this constraint exerts pressure on the animal for budgeting its available time in the most efficient manner (Pyke *et al.*, 1977; Altmann, 1980).

The Capped langurs live in a diverse array of habitats, the biology and behaviour of this primate has not been studied except by Stanford (Stanford, 1991) in Bangladesh, Solanki and Kumar (2010) in Arunachal Pradesh and a short study by Gupta (1994) and Alfred *et al*. (1998) in Tripura, India. In this paper, we have tried to portray the daily activities of Capped langur in Barail Wildlife Sanctuary (BWS) of Assam, Northeast India. We compared the time allotment for various activities by the langur species on daily, monthly, seasonal and yearly basis. The baseline data will be useful for evaluating the survival stress faced by the species that would in turn help in formulating their conservation strategies in their range of habitats.

Materials and Methods

The study area

The Barail wildlife sanctuary is located in the southern Assam districts of Cachar (Figure 1). The entire area comprises fourteen number of reserve forests, out of which Barail Reserve forest and North Cachar Reserve forests have been converted into Barail Wildlife Sanctuary in 2004. It is a major catchment area and watershed zone for Barak valley. It is not only a rain forest, but also known elephant habitat. It covers a total area of 326.24 km^2 and is located in the 92°46' E and 92°52′E longitude and 24°58' N and 25°58′N latitude. The highest point in the Barail Wildlife Sanctuary is *Nemotha Peak* with an altitude of 1105m above MSL. The southern slopes are steeper than the northern slopes. The elevation ranging is 55 to more than 1800 m and annual rainfall

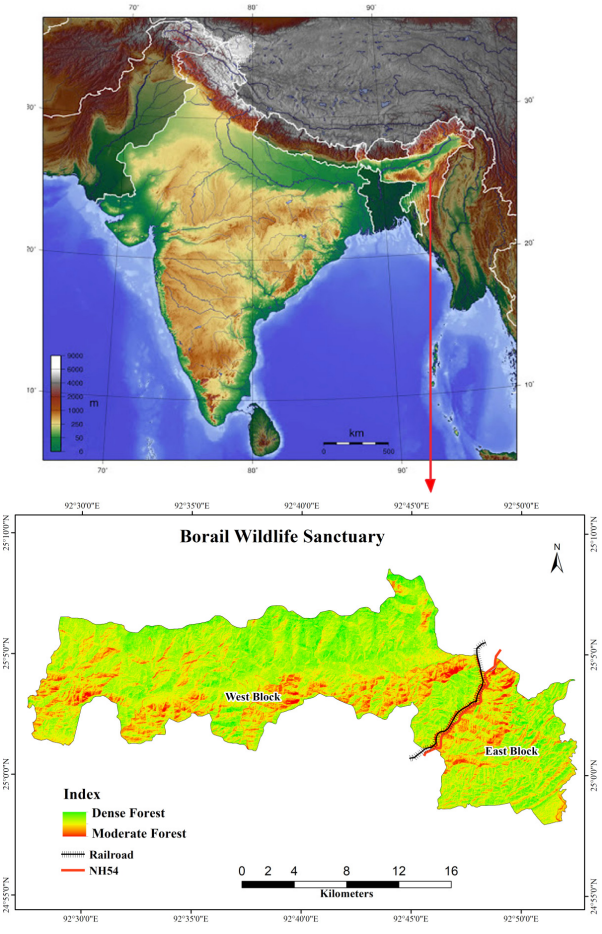


Fig. 1. Map of the study area.

ranges from 2500-4000m where temperature is 9 °C in winter and highest 37 °C in summer, humidity varies from 62% to 83%. The administrative control of the BWS is under the Southern Assam Forest Circle, Silchar, Assam (India).

The forests occupy the outlying ranges of hills that project out from the main ranges of the Jaintia Hills and North Cachar Hills and undulating at the base. The sanctuary is having a number of rivulets, viz, Jatinga, Daloo, Kayong, Gumra, and Boleswar River all of which drain into Barak, the main river basin of the valley. Vegetation of the sanctuary is tropical moist evergreen, semi-evergreen and deciduous forests which brings wide diversity of wildlife including mammals. Besides this it supports 19 species of mammals, 7 species of primates, 250 species of avifauna, 23 species of amphibians and 43 species of reptiles which are globally rare, vulnerable, and endangered species and the biodiversity of Barail Wildlife Sanctuary comprises of 81 tree species and 8 species of bamboo and several species of herbs and shrubs.

Data Collection

Two groups of Capped langurs, *Trachypithecus pileatus* were identified in the study area. From them one male–multi-female group was chosen to collect data during the study period in between January 2017 to December 2019. The composition of the study group was 1 adult male, 5 adult females, 2 sub-adult, and 3 infant in one group. Another group has 1 adult male, 4 adult females, 3 sub-adults and 1 infant.

For the study, *ad libitum* focal animal sampling technique was used (Altman, 1974). The group was followed from 06:00 hrs to 17:00 hrs per day and data were collected at five minute intervals. The observations were carried out twice a week. Thus six entries of the focal animal were recorded in an hour considering 5 minutes as sampling unit, followed by 5 minutes gap. Daytime were divided into two sessions namely, forenoon (06:00 hrs to 11:30 hrs) and afternoon (11:30hrs to 17:00 hrs) on different focal langurs (Bartlett, 1999). The focal animal was selected among all adult female members of the group to ensure a balanced representation of each adult individual. On two occasions during study, if the focal animal was out of view for 15 minutes then we followed another female langur of similar age to continue the observations (Solanki and Kumar, 2007). Sub-adult and infant langurs were not included except interaction with focal animal for grooming and other behaviors (sexual mating, playing etc.). Animals were identified on the basis of morphology and marks on their body. Besides, we divided the observation period into three seasons; winter (November-February), summer (March-May) and monsoon (June-October). The activities of Capped langurs were categorized into five major classes (Table 1).

Data Analysis

Firstly, collected data were compiled separately in respect to every year with months. Secondly, all the data were amalgamate and take out the mean values in respective characters to get the overall result. Monthly data were used to analyse the seasonal variations and then calculated for its mean value. Analysis of Variance (ANOVA) was used to compare total time budget and yearly variations in the time spent on different activities. Chi-square test was used to analyse the highest and lowest time spent on daily, monthly, and seasonal variations.

Results

Total time budget and activity pattern

During the three years study period, a total of 19097 focal samples were recorded from different adult

Table 1. Description of behavioral activities.

Activities	Description
Feeding	When an individual was actively manipulating a potential food source, putting food into the mouth or masticating also when moving and masticating at the same time.
Resting	Adding inactive period, when the Capped langur is remained ideal at a place.
Locomotion	It included this time when an individual is directly or indirectly moving from one place to another place.
Grooming	It embraces all types of care and attention i.e., picking of foreign particles, scratch, nibble, bite, picking hair parting, licking and other skin performed by the individual langurs.
Others	Besides these other activity such as playing, calling, mating and monitoring.

female langurs. Percentage of time allotted for different activities of capped langurs are shown at (Fig. 2). It was observed that they spend maximum time for resting (45% ± 3.15) resting, followed by feeding (34% ± 2.07), locomotion (11% ± 1.64) grooming (5%±0.54) and other activities (5%±0.39). The first two activities cover more than 3/4th time of a day while remaining activities cover only 21% of the total active time. All the three activities cover very less time (21%) compared to resting and feeding. The Analysis of Variance (ANOVA) shows that time spent by Capped langur for different activities were significantly distinct ($F= 341.1$, d. f. = 4, $P < 0.001$).

The yearly differences on time distribution for various activities were not significant ($F= 1.91$, d. f. = 2, $P> 0.001$). It spent maximum time for feeding (34%) in 2018 and resting (45%) in 2019. Time devoted for locomotion was highest (11%) in 2017 and lowest (10%) in 2019. For grooming and others activities it spent almost similar time (5%) in every year. The time allocation for different activities on yearly basis is shown in Fig. 3.

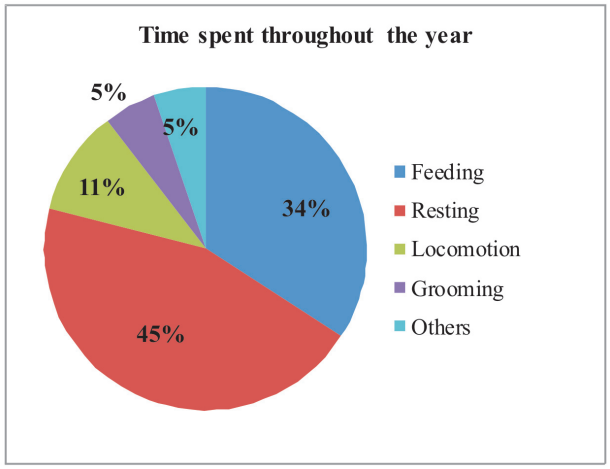
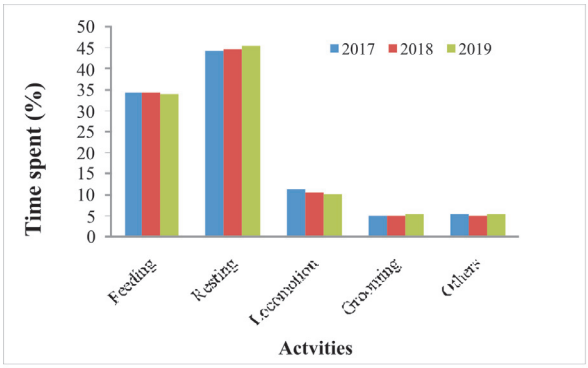


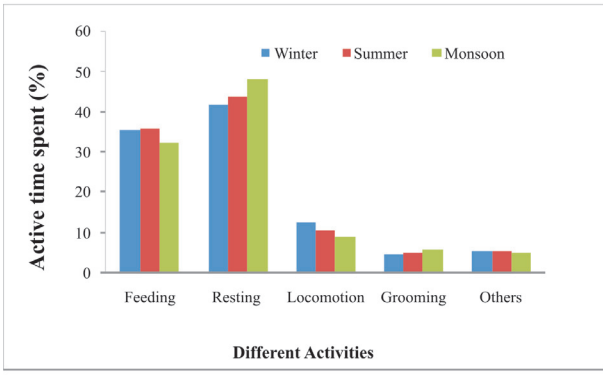
Fig. 2. Proportion of time spent in different activities of capped langur in Barail Wildlife Sanctuary.

Monthly time budgeting and activity pattern of Capped langur

The time expended on different months for various activities by Capped langur is presented in Fig. 3. It spent maximum (36%) time for feeding in April and lowest (30%) in August. The time used for resting was highest in August (49%) and lowest in January (40%). Activities were found varied significantly among the months (feeding: $\chi^2 = 191.41$, d.f. = 11, $P < 0.001$, resting: $\chi^2 = 221.6$, d.f. = 11, $P < 0.001$, locomotion: $\chi^2 = 65.03$, d.f. = 11, $P < 0.001$, grooming: $\chi^2 = 30.32$, d.f. = 11, $P < 0.001$, and others: $\chi^2 = 34.77$, d.f. = 11, $P < 0.001$). Langur spent maximum (13.26%) time for locomotion on December and lowest (8.4%) in July. The highest grooming (6.28) occurred in July and minimum (4.53%) in April, while for others activities are almost same in all the months; highest in January (6%) while lowest (4.62%) in August.



(A)



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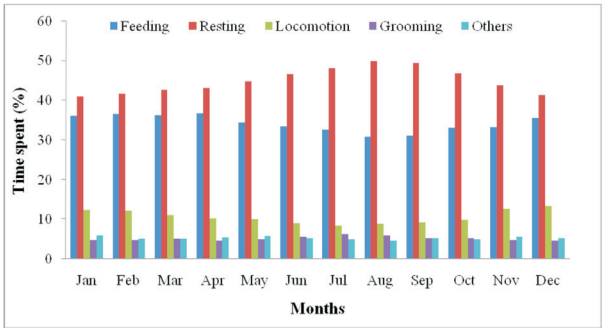

(C)

Fig. 3. Behavioral activities of capped langur in Barail Wildlife Sanctuary from 2017 to 2019. (A) Behavioral activities in yearly basis (B) Behavioral activities in different seasons (C) Behavioral activities in all the months of a year.

Seasonal variations of time budget and activity pattern

Seasonal time distributions for different activities during the study period were given in Fig. 3. Time allocation for resting was highest (48%) in monsoon followed by 43% in summer and lowest (41%) in winter. The variations of resting activity in three seasons were significant ($\chi^2 = 740.59$, d.f. = 2, $P < 0.001$). Capped langur spent approximately same time (35%) in feeding in winter and summer seasons but lowest (32%) in monsoon. The time spent in feeding was varied significantly in all the seasons ($\chi^2 = 152.23$, d.f. = 2, $P < 0.001$). The time devoted for locomotion was highest in winter (12%)and lowest (9%) in monsoon. It spent similar time (4%) for grooming both in winter and summer season and 5% for others activities. Similarly, grooming was found highest in monsoon (5%) and lowest (4%) in summer. Over all time spent in three seasons for different activities were significant ($\chi^2 = 44.44$, d.f. = 2,

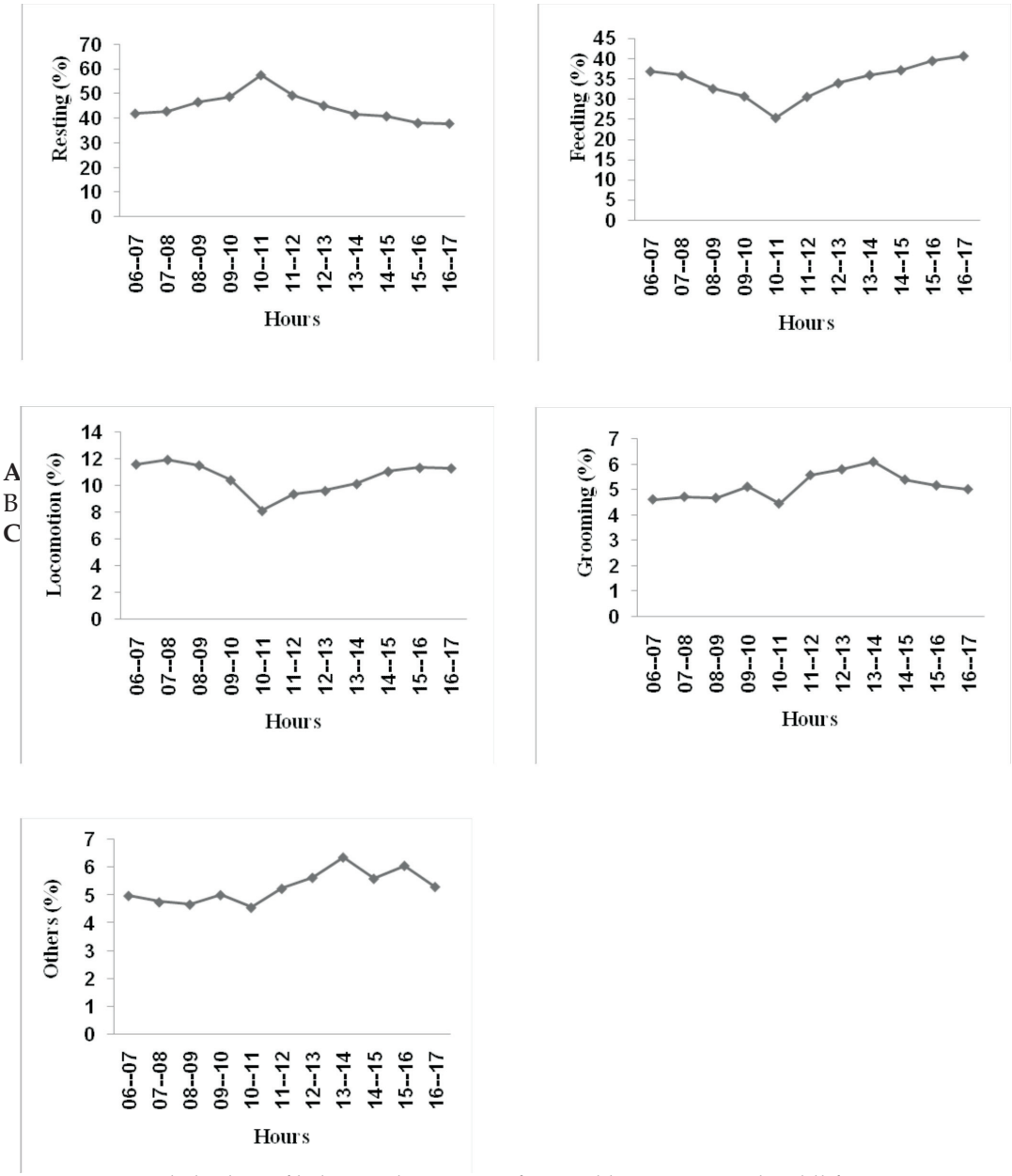

Fig. 4. Daily budget of behavioral activities of capped langur in Barail Wildlife Sanctuary.

$P < 0.001$) for travelling, grooming ($\chi^2 = 109.57$, d.f. = 2, $P < 0.001$), and for miscellaneous activities ($\chi^2 = 24.8$, d.f. = 2, $P < 0.001$).

Daily time budget and activity pattern

Time spent by capped langur on day time during study period is given in Fig. 4. Capped langur spent highest time in feeding (40.57%) in evening times (16:00-17:00) and lowest (25.27%) was in between 10:00 and 11:00.hours. They were very active in feeding about one hour of sunrise (i.e., 06:00 and 07:00) and then it declined gradually till the afternoon, when their feeding activities again gradually increase till the sunset. Time spent for feeding was significantly distinct in different parts of a day ($\chi^2 = 59.53$, d.f. = 10, $P < 0.001$). The resting time of the species gradually increased after initial feeding in early morning and it was maximum (57.58%) in between 10:00 and 11: 00. At the onset of noon, the resting time started declining till the sunset (16:00-17:00). During the sunset, resting time was only 37.8%. The resting time of a day also varied significantly ($\chi^2 = 619.89$, d.f. = 10, $P < 0.001$). Time spent for locomotion of the species was although maximum in between 07:00 and 08:00 it did not vary in different parts of a day ($\chi^2 = 9.41$, d.f. = 10, $P > 0.001$). Similarly, time spent for grooming and other activities were also not varied in a day (Fig. 4).

Discussion and Conclusion

The study observed that capped langur spent maximum time in resting than other activities. Similar findings also observed by Fleagle (Fleagle 1999) and Solanki and Kumar (Solanki and Kumar, 2007) under similar conditions. Generally folivorous primates spent maximum time on resting than insectivorous or frugivorous primates (Fleagle, 1988). Seasonal variation on different activities is due available food. Leaves accounted for major diet share of capped langur (Kumar, 2005; Solanki *et al.,* 2008) and activities vary on the availability of leaves. Similar reports also found in case of white-headed langur, leaves accounted for >90% (Li *et al.,* 2003) of their annual diet and resting ranged from 51 to 69.1% of the daytime activity budget (Li, 1992). In contrast to frugivorous primates, *Macaca mulatta* and *M. silenus* spent 16–39% of daytime resting (Malik, 1986; Menon and Poirier, 1996) conceivably because of fruits distribution increases foraging and thus decreases resting time (Oates, 1987). Maximum time spent on resting appears to be the physiological and behavioral adaptation with a diet of low nutritional quality (Da silva, 1992). The optimal foraging theory assume that animal should organize their feeding activity so that they can balance with their energy expenditure (Pyke, 1977). The time spent for feeding (34%) by capped langur in our study is similar to that reported for the same primate species by Stanford (1991) in Bangladesh and by Gupta (1994) in Tripura, India. However, In contrast to our study, Kumar (2005) reported that langurs spent highest time on each day in feeding.

As for their feeding components, it spent maximum time for consuming leaves and less in fruits. During the study, capped langur spent morning hours on consuming fruits and less leaves compare to the afternoon hours. This type of events are also seen in case of other primates, likely black crested gibbon (Fan *et al.,* 2009), the Cao Vit gibbon (Ma *et al.,* 2014)(Ma *et al.,* 2014), *Nasalis larvatus* (Matsuda *et al.,* 2009), *Nomascus nasutus* (Ma *et al.,* 2014), and the hoolock gibbon (Ahsan, 2001) are mostly select fruits in the early morning to raise their glucose level in blood. Fruits are more affluent in sugar, easily digestible, and further quickly converted into energy than leaves and also to compensate the energy insufficiency caused by the foregoing night's break (Chapman and Chapman, 1991).

Socialization patterns of the study group are almost similar in day time along with different seasons. Slight variation has been seen which could be, at least partly, due to the seasonal variations in length of the day time. While, many studies confirmed that animals must distribute sufficient time for socializing that is essential for grouping patterns (Dunbar and Dunbar, 1998; Dunbar, 2009). In a report it has been seen that, when socializing is too much compromised, the gelada baboons shows group instability or even permanently fission from the troop (Dunbar and Dunbar, 1998). In our study, the Capped langurs socialized almost with similar frequency in shorter day lengths, i.e. fruit lean seasons, differing to the fruit rich season that featured longer day lengths. Such kind of grooming patterns likely to intend preserving group concentration. Moreover, grooming is a relatively low energy consuming activity which largely facilitates them to conserve energy in the winter fruit-lean months.

Animal's biological activities also influence the diurnal time budget pattern. The study animal spent maximum time for feeding and travelling in winter

season but resting was low as the species need to search for food. It has been seen that langurs mating takes place in winter season which is the longest period compare to summer. In a study, Solanki *et al.* (2007) reported that, winter and summer are the two mating season and winter is the longest period which we have also observed during the study. In this season langurs endure socialization or coupling and mating activities so their energy demand is also increases ultimately it impacts on time budget pattern (Solanki and Kumar, 2008). Monsoon is the highest resting season (Fig. 3) because uninterrupted rains takes place at this time which reduces the feeding, travelling and grooming activities hence animals restricted them to rest. The seasonal variation might be legitimate to the temperature and humidity fluctuations, which is reliable with other diurnal primates (Huang *et al.,* 2003; Matsuda *et al.,* 2009).

The habitat conditions and availability of foods also influence the time distribution of herbivore animals. During the study it was seen that langur was less active in rainy days and in sunny days due to due to unfavorable weather. Dietary resources also influence the patterns of animal's activity budget. From April to September the animals spend maximum time for resting followed by other activities (Fig. 3). There may be some other reasons like availability of food and had options to consume more protein rich food items. Whereas, summer is the fruit rich season and winter is the fruit lean season. As for their feeding intensity, capped langur also changes time allotment with the season. This could be due to the low calorie, young plant leaves, and reduced fruit intake in the fruit lean season which has seen in others primates also (Huang *et al.,* 2015; Zhou *et al.,* 2018).

The long-term conservation initiatives should be taken for the capped langur in the Barail Wildlife Sanctuary. Success on this could be achieved with reforestation in fragmented areas and creating continuous habitats. The study on activity budgeting on the species provides an idea of time allocation based on the food availability and weather of a particular day.

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