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Research Article

Activity pattern and habitat association of Assamese macaques *Macaca assamensis* McClelland, 1840 in Shivapuri Nagarjun National Park, Nepal

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Abstract

Assamese macaque *Macaca assamensis* McClelland, 1840 is one of the primate species with narrow distribution range and the least exploration. This study investigated the diurnal activity of Assamese macaque and association with the vegetation in Nagarjun Forest of Shivapuri Nagarjun National Park, Nepal. Behaviour sampling including Instantaneous sampling and Ad-libitum sampling (7:30 AM – 4:30 PM) along with vegetation survey (20 m × 20 m plots) were applied. The Raniban Barrack troop of Assamese macaque composed of 12 individuals was observed for a total of 225 hours to record the macaque's diurnal activity. The troop spent 28% time in inactive, 25% in grooming, 23% in foraging, 23% in locomotion and 1% in fighting. Assamese macaque troop spent more time in *Schima wallichii* possessing 25.91%, 36.29% and 41.22% for foraging, locomotion and inactive respectively of the diurnal time. Altogether, 67 plant species (herbs, shrubs, trees and climbers) were documented from vegetation analysis. *Schima wallichii* and *Ardisia macrocarpa* were dominated the habitat. Paired t-test revealed significant difference in foraging (df = 24, P = 0.010) and inactive (df = 24, P = 0.003) between the morning and day observational phases. The findings of this study shed light on the food preference and microhabitat use by the protected Assamese macaque in Nepal that assists to formulate the management plans for the species.

Keywords: Ad libitum sampling, Diurnal activity, Habitat association, Instantaneous sampling, Nagarjun

1 | Introduction

Assamese macaque *Macaca assamensis* McClelland, 1840 is one of the least studied primate species (Chalise 2008). It belongs to the *sinica*-group of macaques based on the male genitalia, sagittate and subacute glans in the dorsal view (Fooden 1976). Assamese macaque population of Nepal varies from India and Bhutan with differences in various aspects such as tail length, elevation wise distribution, facial colour and pelage to very close conspecific populations of *Macaca assamensis pelops* (Molur et al. 2003). Therefore, Assamese macaque in Nepal was doubted to be of distinct subspecies status and inferred as "*Macaca assamensis* Nepalese population" warranting further study on the taxonomy (Boonratana et al. 2020). Due to such unique characters of "*Macaca assamensis* Nepalese population" it is considered likely endemic to Nepal (CAMP 2003). Recent phylogenetic study using multiple mitochondrial and nuclear gene sequences suggested a distinct species status of the population (Khanal et al. 2021).

Due to the small population size, restricted distribution and its fragmented habitats the Assamese macaque is protected by Department of National Parks and Wildlife Conservation Act, 1973 of Nepal (Chalise 2013; Chalise et al. 2013). It is listed as Near Threatened in the IUCN Red List of Threatened Species (Boonratana et al. 2020) and is included in CITES Appendix II (CITES 2012). The species has a limited distribution in Nepal, India, Bhutan, northern Myanmar, northern Thailand (Chalise 1999) and southern China (Zhang et al. 1981). Assamese macaque in Nepal was recorded from 160 m–2,650 m covering the narrow elevational range of mid hills basically in sub-tropical regions (Chalise 2013; Khanal et al. 2019). The details regarding its socio-ecology are yet to be explored (Khanal et al. 2018). Various macaque troops are recorded even from the far-western Nepal, around 300 km west of the previously known range (Khanal et al. 2019).

Assamese macaques favour to reside in the subtropical evergreen and the deciduous forest on a high elevation (Srivastav & Mohnot 2001). The major food sources of the macaques are *Schima wallichii* and *Castanopsis* spp. in Shivapuri Nagarjun National Park (Chalise 1999). Besides leaf, the other foods which are consumed by the macaques are invertebrates, mushroom and mosses (Pandey & Chalise 2016). The aggressive nature was recorded for the long time when there was provisioned food supplied for the macaques (Mitra 2002).

In Shivapuri Nagarjun National Park, Assamese macaque troop allocates most of their time in foraging while that of least in playing (Chalise et al. 2015). In Raniban and Fulbari Gate, the macaque troop forage during day and stay night in the cliffs and initiate their daily activities in the next day (Chalise et al. 2013). In winter season grooming and playing activities are less common (Pandey & Chalise 2016). Assamese macaques form multi-male and multi-female social troops (Molur et al. 2003). They quarrel less with the member of Rhesus troops. In order to aware the troops about the possible threats to their territory a very high-pitched voice is usually common in them (Chalise 2003).

There are numerous factors that may affect the activity pattern of Assamese macaques. The range size and the habitat utilization of Assamese macaques impacted by the distribution and availability of the food can seriously influence on their activity (Zhou et al. 2014). Apart from this, the intrinsic factor such as temperature can contribute to the development of the stereotypic behaviour in the primates. Several environmental factors such as humidity, precipitation and cloudy environment can create serious effects on the basic activity pattern in primates and making them able to adapt in the environmental variations through the resting activity (Erkert & Grfber 1986).

Since Assamese macaque is the least studied primate species study regarding the activity pattern of Assamese macaques is very crucial in the conservation action. Thus, this study can be of great importance to assist in setting of the species management plans and prevention of future decline of the species for the long term. The study was carried to know the diurnal activity pattern and habitat association of Assamese macaque troop by behaviour sampling and the vegetation analysis.

2 | Materials and methods

2.1 | Study area

Shivapuri Nagarjun National Park encompasses an area of 159 square kilometers after the inclusion of 15 square kilometers of Nagarjun forest in 2009 covering the various districts such as Kathmandu, Sindhupalchowk, Nuwakot and Dhading (Pandey 2010). Its elevation ranges between 1350 – 2100 m. The mean monthly precipitation of this national park ranges from 3.43 – 444.56 mm while the mean monthly temperature is from 3.9 °C – 20.4 °C (minimum) and 18.6 °C – 29.6 °C of the maximum temperature (Koirala & Chalise 2014).

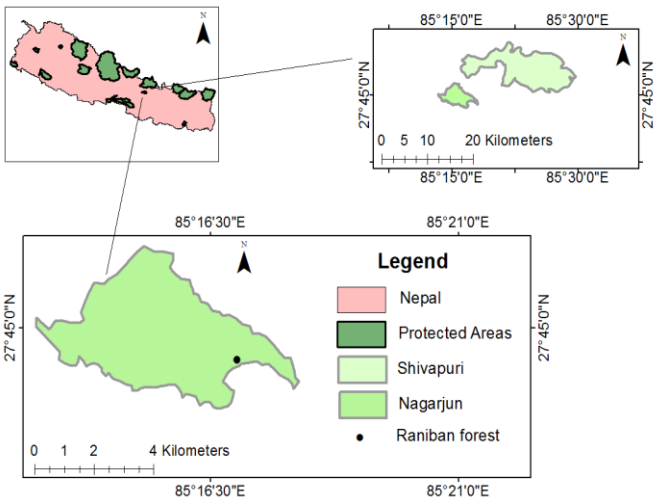

Figure 1. Location map of Raniban Forest, Shivapuri Nagarjun National Park, Nepal

Raniban Forest, Nagarjun of Shivapuri Nagarjun National Park was chosen for the study which comprises four types of vegetation viz. *Schima wallichii* forest, pine forest, dry oak forest and mixed broadleaf forest. Shivapuri Nagarjun National Park possess various mammals such as Clouded leopard (*Pardofelis nebulosa*), Himalayan black bear (*Ursus thibetanus*), Common leopard (*Panthera pardus*), Pangolin (*Manis* spp.) as protected by the National Parks and Wildlife Conservation Act, 1973 (Pandey & Chalise 2016). It is only the best habitat for Himalayan Dragonfly (*Epiophlebia laidlawi*) in Nepal (Tani & Miyatake 1979; Mahato 1993).

2.2 | Field survey

To detect the likely areas of macaque troop presence and its selection for the study preliminary survey was carried out during 19th–28th February, 2019. Total 6 transects were surveyed within 3 km from Fulbari Gate to Raniban on either side of the forest trail. Areas where the macaque troops encountered was considered as "focal areas" firstly. Two troops of the macaques were encountered. Among two troops Raniban Barrack Troop A and Raniban premises troop B encountered, Raniban Barrack Troop-A was selected for behavioural observations. Basically, two categories were chosen for selecting the macaque troops for the study. The categories included site feasibility in terms of terrain and the age of macaque's troop following the method of Chalise (2003) which included infants, sub-adult (males and females), adult (males and females).

Population census of the Assamese macaque troop was performed and age-sex classification was done following Chalise (2008). Two observers were involved from 20th to 23rd February, 2019 to count the head of macaques for nine hours. Individual counting and its troop identification in one observation phase were reciprocated for multiplex times to ensure the data accuracy. Each individual macaque's head of Raniban Barrack troop A was counted with the binocular aid.

2.3 | Behaviour sampling

Initially, the macaque troop was identified by observing the specific identifying characters such as their body size and colour, markings on the body and the behaviour they reflect. For the study Raniban Barrack troop A was habituated first and then only adult males and females were taken into account. Total five adult males and female individuals were chosen to record the behaviour. In accordance to Altmann (1974) instantaneous sampling was carried out which included foraging, locomotion, inactive (resting, sleeping and sitting), grooming and fighting behavioural states. The macaque troop behaviour was recorded continuously for two minutes in each interval of 15 minutes. The total instantaneous sampling was carried for nine hours from 7:30 AM – 4:30 PM per day dated 17th March – 21st May, 2019. Ad-libitum sampling was carried following the method of Altmann (1974). This sampling was carried from 7:30 AM – 4:30 PM dated 17th March – 21st May, 2019. Foraging, locomotion, inactive, grooming and fighting were the behaviours observed to study the activity pattern of Assamese macaque troop (Table 1).

2.4 | Vegetation survey

The purposive random sampling was carried for the vegetation analysis in the site covering all the four directions (East, West, North and South). Altogether, fifteen random plots having size of 20

Table 1. The ethogram used to record behavior of Assamese macaques

S.N.	Activity	Description
1.	Foraging	Wandering from here to there in search of food and consuming food or drinking water.
2.	Locomotion	Movement from one location to other.
3.	Inactive	Condition of resting, inhabiting and sleeping attached either to the tree or other supporting surfaces/position of lying on the ground and trees, stretched legs.
4.	Grooming	Searching for their own fur or other macaque's body fur for lice, ticks, fleas and bugs/activity of rubbing or scratching.
5.	Fighting	Expression of aggressive nature to each other by bare teeth, slapping or making noise which occurs mostly in groups.

m × 20 m following the method of Abunie and Dalle (2018) were established with threads, pegs and the measuring tape. The GPS locations of each of the four corner points of the established plots were recorded. The various life forms of flora which lied inside the plots were noted with tree DBH > 10 cm with the help of DBH tape. Besides these, the dominant plant species were recorded in each plot. The prepared herbarium having fixed size (42 cm × 28 cm) was identified in National Herbarium and Plant Laboratories, Godawari, Lalitpur, Nepal.

2.5 | Data analysis

The data was analysed by Karl Pearson Correlation Coefficient to know the relationship between behavioural states using R software. All the statistical tests were considered significant at P value < 0.05. The numerous variables used for determining the correlation between the macaque troop activity were foraging, locomotion, inactive and grooming. Paired t-test was used to seek the significant difference between the variables (behaviour) of the macaque troop between morning and day using R software.

The overall activity of Assamese macaque troop was determined using below formula:

$$\text{Activity} = \frac{\text{Number of behavior records for each activity}}{\text{Number of behavior records for all activities}} \times 100\ \%$$

$$\text{Sex ratio} = \frac{\text{Total number of males of that age group}}{\text{Total number of females of the same age group}}$$

$$\text{Adult Sex ratio} = \frac{\text{Total number of adult males of that age group}}{\text{Total number of adult females of same age group}}$$

$$\text{Food items} = \frac{\text{Total number of individual item consumed}}{\text{Total number of food items consumed}} \times 100\ \%$$

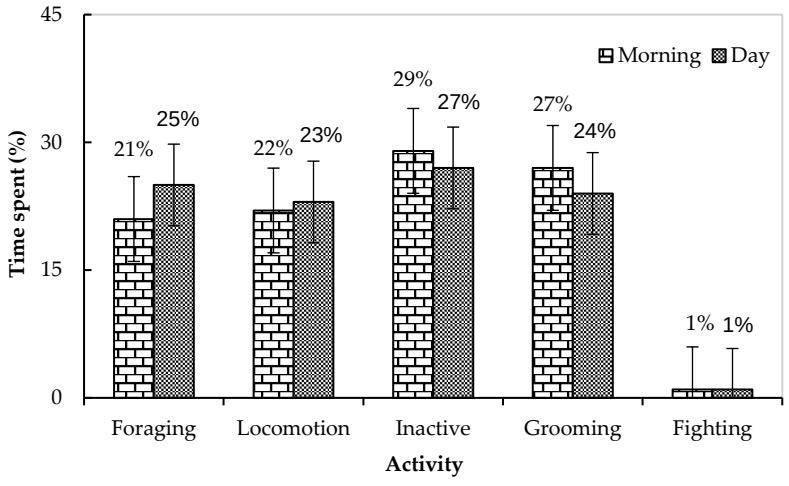

Figure 2. Time spent (%) by the macaque troop in Raniban Forest during morning and day

3 | Results

Total two troops of Assamese macaques were encountered from Fulbari Gate to Raniban. The first troop (Raniban barrack troop A) consisted 12 individuals and the second one (Raniban premises troop B) consisted 19 individuals. The sex ratio of male to female in Raniban Barrack troop A was recorded 1:1.4 while adult male to adult female ratio was found 1:1.5. Females comprised higher percentage (58.33%) than that of males (41.66%). In relation to the age composition, infant and adult females possessed the highest

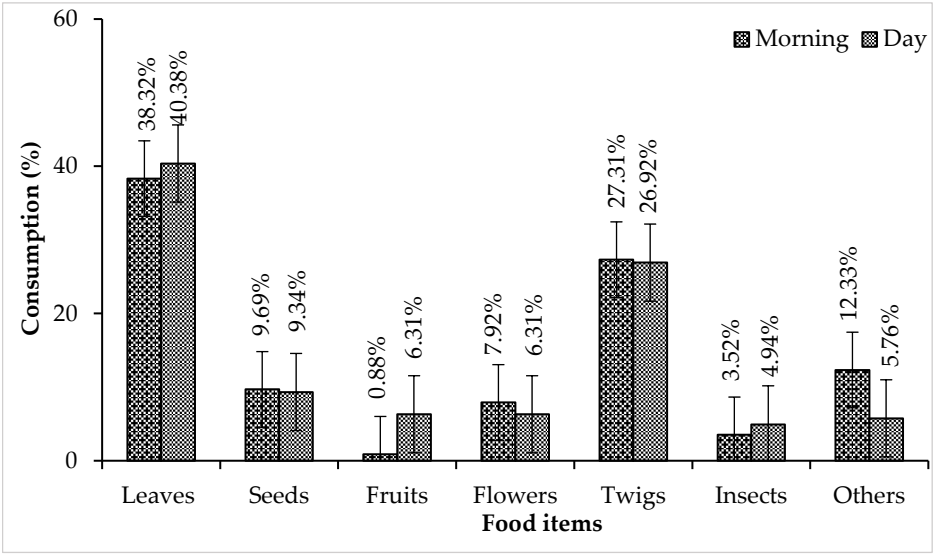

Figure 3. Food items (%) consumed by the macaque troop during morning and day

percentage (both 25%) and lowest in the sub-adult male and female (both 8.33%). During the study period the macaque population of Raniban Barrack troop A was increased since two adult female macaques had given birth to one male and one female infant during April (the breeding season).

For the behavioural study, Raniban Barrack troop A was selected and behaviour was observed for a total of 225 hours. Five adult males and females from Raniban Barrack troop A spent 29% of their time in inactive (highest) and 1% in fighting (lowest) during morning. Likewise, 27% of the troop activity was inactive (highest) and 1% was fighting (lowest) during day (Fig. 2).

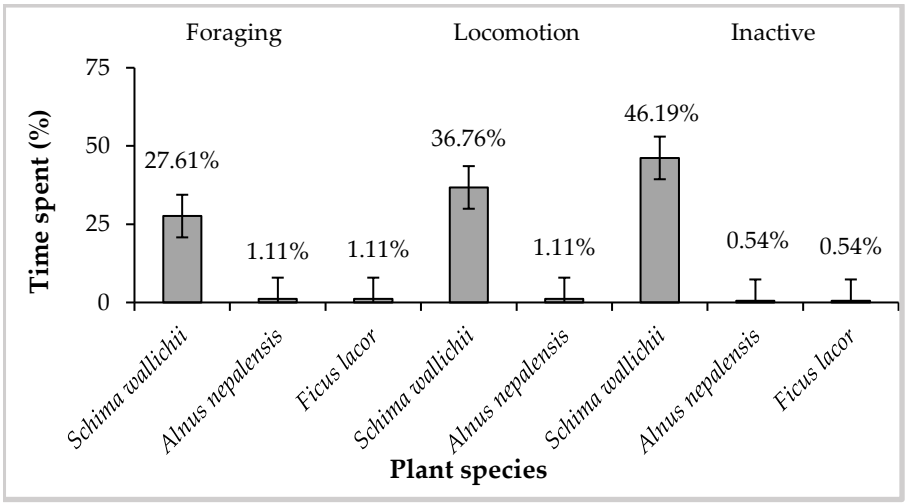

Figure 4. Highest and lowest time spent (%) in plant species by the macaque troop during morning

Food items categorized as leaves, seeds, fruits, flowers, twigs, insects and others (leftover rice, vegetables) were consumed by the troop. Leaf consumption was the highest in both morning and the day time (Fig. 3).

During the morning, the troop spent highest time in *Schima wallichii* tree, and for foraging (27.61%), locomotion (36.76%) and inactive (46.19%, resting sleeping/sitting). The macaque troop spent lowest time in *Alnus nepalensis* and *Ficus lacor* for foraging, locomotion and inactive (Fig. 4).

For foraging, locomotion and inactive during day Raniban Barrack troop A spent highest time in *Schima wallichii* (24.21%), (35.82%), and (36.26%) respectively (Fig. 5). Likewise, the macaque troop spent lowest time in *Myrica esculenta* for foraging, locomotion and inactive (resting/sleeping/sitting).

Various behaviours of Assamese macaque troop were tested by Shapiro-Wilk Normality test to test whether the data is normally distributed. The normality test revealed the normal distribution of data. Thus, Karl Pearson Correlation Coefficient considering variables such as foraging, locomotion, inactive and grooming was used (Table 2). It was applied to determine the strength of relationship between two or more than two variables and seeking how close the relationships are, whether one variable have impact on other variable in the macaque troop activity. Beside this, the significant

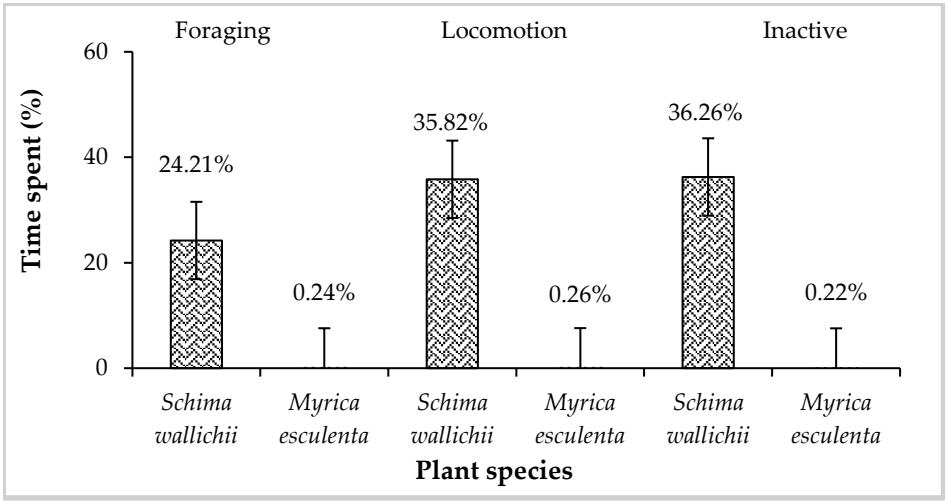

Figure 5. Highest and lowest time spent (%) in plant species by the macaque troop during day

difference in the macaque troop activity between morning and day observation phases was tested by paired t-test. From the vegetation analysis following plant species were recorded with the inclusion of their biological names, families and the life forms (Supplementary Table 1).

4 | Discussion

This study recorded female biased sex ratio in the Assamese macaques of Nagarjun Forest. Chalise et al. (2013) also recorded less male population than female in Raniban Forest of Shivapuri Nagarjun National Park which likely supports with our findings since we recorded less male population in Raniban Barrack troop A than the females.

4.1 | Assamese macaques' activity during morning

In our study, Assamese macaque troop in Raniban Forest spent 21% in foraging during the morning which is dissimilar to the findings of Chalise (2010) and Ghimire (2017). Locomotion alone accounted for 22% of their time which likely supports with our findings of Chalise (2010) and (Koirala & Chalise 2014) with 22%. Foraging by macaque troop may be less because of low consumption of the young leaves and fruits since young leaves possess phenolic compounds such as non-protein amino acids and alkaloids during early spring. The detoxification systems in most of the primates cannot handle the phenolic compounds which the plants use (Glander 1982). The study of Wrangham and Waterman (1981) revealed the effects of plant phenolic compounds on the food selection of the primates in Amboseli National Park, Kenya.

Twenty-nine percentage of the time, the macaques were inactive (resting, sleeping and sitting). This study contrasted to the findings of Ghimire (2017) in Nagarjun forest with 19%. Delgado et al. (2004) implied that the macaque troop spend their time in resting to avoid the sun-exposure in hot days. The sunrise time may influence highly in the activity pattern of monkeys. Moreover, the study of Pandey and Chalise (2016) insisted that the species is the lazy primate that allocates about 14.95% for sun basking and resting. They sleep and rest during early morning and the sun basks period which finds similarity to our findings that the macaque troop spent highest percentage of time in resting. Grooming accounted for 27% of the time during morning in our study. Grooming indicates the good social communication among the troop members (Cooper & Bernstein 2000). The macaque troop was recorded 1% in fighting. It may be due to the plenty of the food resources available in

Table 2. Correlation coefficient matrix between the behavioral states

		Foraging	Locomotion	Inactive	Grooming
Morning	**Foraging**	1			
	Locomotion	0.23	1		
	Inactive	-0.66	-0.42	1	
	Grooming	-0.76	-0.59	0.31	1
Day	**Foraging**	1			
	Locomotion	-0.08	1		
	Inactive	-0.74	-0.33	1	
	Grooming	-0.58	-0.65	0.80	1

Raniban Forest. Thus, the macaques may have less competition for the food resources.

4.2 | Assamese macaques' activity during day

The foraging of the macaque troop alone accounted for 26% during day. The study of Koirala and Chalise (2014) depicted that the foraging time of Assamese macaque troop was recorded highest (46%) during 12 noon to 15 pm and that of lowest during 15 pm to 18 pm in Shivapuri Nagarjun National Park. Our study supported the same findings that foraging was highest during the day time. Boonratana et al. (2008) revealed that it spends most of the diurnal time in feeding since they are omnivorous in nature. In the early morning, the Assamese macaques feed on leaf as their main food possibly due to hunger. In the late noon they search for the food they want (Pandey & Chalise 2016). Among 67 plant species recorded in Raniban, 11 tree species and one climber species (*Hedera helix*) were frequently consumed by Raniban Barrack macaque troop A.

The troop spent 23% of their time in locomotion, 27% in inactive and 24% in grooming during the day. Grooming was less in Langtang National Park with 9-13% (Chalise 1999) and 12-20% in Makalu-Barun National Park (Chalise 2003). Chalise and Adhikari (2014) revealed that the macaque troop usually invests low time in grooming which reflects vast difference with our findings. The macaque troop removes the various parasites such as fleas, bugs and ticks from their body either by self-grooming or grooming with their partners (Cooper & Bernstein 2000). In addition, grooming can provide relaxation to the primates and reduce the tension (Terry 1970). Raniban Barrack troop A spent 1% of the time in fighting during day. Since the fighting percentage seems very less, it reflects the mutual cooperation between the troop members in Raniban Forest.

4.3 | Relation between the macaque troop activity and its habitat

Vegetation analysis is very crucial during the study of the primate's behaviour since it provides crucial idea on the species composition and structure of the plant community in the macaques habitat. Raniban Barrack troop A carried most of its activity such as foraging, locomotion and inactive in *Schima wallichii* (March-May season). The troop consumed higher percentage of leaves. Milton (1987) insisted that the wild primates basically consume the high proportion of their daily diet from the plant items such as leaves, fruits and flowers which is similar to our study that the macaque troop fed highest on the leaves.

The activity of Assamese macaque is directly attached to its habitat. The more is the food availability; the more time macaque can do rest. Assamese macaque troop may have spent their huge time in *Schima wallichii* since there was record of *Schima wallichii* as dominant tree by the field observation. Most of the primate species resides in social troops in its habitat which may create the intragroup feeding competition among them (Lambert 2012). But during our study most of the troop members locomoted and took rest in *Schima wallichii* tree where there was no any intragroup competition. Because there was huge availability of the food resources in their habitat and have more time to rest.

Milton (1979) revealed that the wild primates such as howler monkey satisfies their diet through consumption of the leaves and fruits which provides them daily protein and the high energy. Many primates have the record of consuming the leaves, fruits and flowers of the forest trees (Milton 1987) on each day (Trevathan 1987) which finds similarity with our findings. Plant protein seems to be adequate in daily protein requirements for the primate's diet (Milton 1999). They mostly prefer plant items despite of availability of animal items in the forest which reveals similarity to our findings that Raniban Barrack troop A consumed the leaves as the major plant items in comparison to the animal items.

The positive correlation between foraging and locomotion (0.23), inactive and grooming (0.31) during morning lamented that the activity carried by *Macaca assamensis* troop had great influence on each other. When the foraging increases locomotion too increases in the macaque troop. The positive correlation between inactive and grooming (0.31 during morning and 0.80 during day) indicates that once the macaque troop are full of diet they may spent their time in resting and may groom each other to take care and maintain the troop relations stronger. In between other activity the correlation coefficient was recorded negative. Likewise, during day except between inactive and grooming (0.80) there was negative correlation between all activity which signifies that most of the variables don't depend and influence each other.

Paired t-test revealed that there was significant difference in foraging (df = 24, P = 0.010) and inactive (df = 24, P = 0.003) between morning and day. Since P values were less than 0.05 in 95% confidence interval there was significant difference. The foraging activity by the macaque troop during morning may be peak due to the food competition among the monkeys while afternoon peak may not be observed alike since the food distribution for the macaques may be restricted from 9:00 am-12:00 pm (Delgado et al. 2004). In our study too the foraging was peak during morning than the day which may have resulted significant difference in foraging. There was no significant difference in locomotion (df = 24, P = 0.383), grooming (df = 24, P = 0.158) and fighting (df = 3, P = 0.296) in between morning and day. This implies that once the macaque troop consume enough food for them they may spent their time in other activity such as grooming which may have resulted no significant difference of the diurnal time.

Schima wallichii and *Ardisia macrocarpa* were recorded dominant by field observation among total 67 plant species (herbs, shrubs, trees and climbers) documented in various established plots in Raniban Forest. But the research implied by Ghimire (2017) documented only 52 plant species possessing *Schima wallichii* as the dominant tree in Nagarjun forest. During our study the highest dBH was of *Bombax ceiba* with 106 cm. Among the different life forms, trees were recorded highest (34 species) followed by the herbs (14 species), shrubs (13 species) and the climbers (6 species). Around 55% of Raniban Forest was recorded invaded by field observation by the invasive plant species namely *Eupatorium adenophorum*, *Lantana camara* and *Parthenium hysterophorus* which affects the habitat of the macaque troop thereby restricting the proper growth and development of other plant species.

Further research in other parts of Nagarjun is foremost since whole Nagarjun (15 sq. km.) is crucial habitat for *Macaca assamensis*. Beside this, plantation of *Alnus nepalensis* and *Myrica esculenta* is also recommended in the macaques habitat for the higher availability of their food resources in Raniban Forest.

5 | Conclusions

Altogether 900 events of Raniban Barrack troop A were recorded. The major activities carried by macaque troop during the study period (March-May) in Raniban Forest were foraging, locomotion, inactive (resting, sleeping and sitting) and grooming. Among the major activities inactive was recorded highest during morning (7:30 am-11:30 am) and day (11:30 am-4:30 pm) followed by grooming and foraging. Fighting was very less. Furthermore, the troop spent more time in *Schima wallichii* possessing 25.91%, 36.29% and 41.22% for foraging, locomotion and inactive respectively of the diurnal time. There was positive correlation between foraging and locomotion, inactive and grooming during morning. Likewise, negative correlation was recorded between other activity during day except for inactive and grooming. In total, 67 plant species were documented indicating higher species diversity in Raniban Forest dominated by *Schima wallichii* and *Ardisia macrocarpa*. Plant species invasion was the major threat in the macaque habitat in Raniban Forest.

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Authors' contributions

Ghimire, K. carried the field work and prepared the manuscript. Chalise, M. K. designed and supervised the work. Both authors contributed in preparing the final manuscript and approved for the submission.

Conflicts of interest

Authors declare no conflict of interest.

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Supplementary Table 1. Plant species recorded in the habitat of the study troop in Raniban Forest

S.N.	Biological Names	Family	Life form
1.	*Achyranthes bidentata* Blume	Amaranthaceae	Shrub
2.	*Actinodaphne sikkimensis*	Lauraceae	Tree
3.	*Albizia julibrissin* Durazz.	Fabaceae	Tree
4.	*Alnus nepalensis* D. Don	Betulaceae	Tree
5.	*Ardisia macrocarpa* Wall.	Myrsinaceae	Shrub
6.	*Artemisia indica* Willd.	Asteraceae	Shrub
7.	*Bauhinia variegate* L.	Fabaceae	Tree
8.	*Berberis aristata*	Berberidaceae	Shrub
9.	*Bombax ceiba* L.	Bombacaceae	Tree
10.	*Carex baccans Nees*	Poaceae	Herb
11.	*Castanopsis indica* (Roxb.) Miq.	Fagaceae	Tree
12.	*Cestrum nocturnum*	Solanaceae	Shrub
13.	*Colebrookea oppositifolia* Sm.	Verbenaceae	Shrub
14.	*Craniotome furcata* (Link) Kuntze	Lamiaceae	Herb
15.	*Digitaria ciliaris* (Retz.) Koeler	Poaceae	Herb
16.	*Dioscorea deltoidea* Wall. Ex Griseb.	Dioscoreaceae	Climber
17.	*Drymaria cordata* (L.) *Willd. ex Roem. & Schult.*	Caryophyllaceae	Herb
18.	*Eupatorium adenophorum Spreng.*	Asteraceae	Herb
19.	*Ficus lacor Buch.-Ham.*	Moraceae	Tree
20.	*Ficus religiosa L.*	Moraceae	Tree
21.	*Hedera helix*	Aaliaceae	Climber
22.	*Hedera nepalensis K. Koch.*	Araceae	Climber
23.	*Justicia adhatoda* L.	Acanthaceae	Shrub
24.	*Lantana camera* L.	Verbenaceae	Shrub
25.	*Ligustrum indicum*	Oleaceae	Shrub
26.	*Lindera nacusua (D. Don)* Merr.	Lauraceae	Tree
27.	*Lindera nesiana*	Lauraceae	Tree
28.	*Litsea monopetala* (Roxb.) Pers.	Lauraceae	Tree
29.	*Lygodium japonicum*	Lygodiaceae	Climber
30.	*Macaranga pustulata*	Euphorbiaceae	Tree
31.	*Machilus duthieni* King ex Hook .f.	Lauraceae	Tree
32.	*Magnifera indica* L.	Anacardiaceae	Tree
33.	*Mahonia napaulensis* DC.	Berberidaceae	Shrub
34.	*Morus serrata*	Moraceae	Tree
35.	*Myrica esculenta Buch*-Ham. ex D. Don	Myricaceae	Tree
36.	*Myrsine capitellata* Wall.	Myrsinaceae	Tree
37.	*Oxalis corniculata* L.	Oxalidaceae	Herb
38.	*Parthenium hysterophorus* L.	Asteraceae	Shrub
39.	*Pinus roxburghii Sarg.*	Pinaceae	Tree
40.	*Pogonatherum paniceum* (Lam.) Hack	Poaceae	Herb
41.	*Pogostemon benghalensis* (Burm. f.) *Kuntze*	Lamiaceae	Shrub
42.	*Prunus cerasoides* D. Don	Rosaceae	Tree
43.	*Pteris biaurita*	Pteridaceae	Herb
44.	*Randia dumetorum*	Rubiaceae	Shrub
45.	*Schima wallichii* (DC.) Korth.	Theaceae	Tree
46.	*Smilax aspera* L.	Smilaceae	Herb
47.	*Solanum xanthocarpum* Schrad. & Wendl.	Solanaceae	Herb
48.	*Tetrastigma serrulatum* (Roxb.) Planch.	Vitaceae	Climber
49.	*Teucrium quadrifarium*	Lamiaceae	Herb
50.	*Urtica dioica* L.	Urticaceae	Herb
51.	*Zizyphus incurve* Roxb.	Rhamnaceae	Tree
52	Unidentified 16 plant species		