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Activity Budgeting of Rhesus Monkey (*Macaca mulatta*, Zimmerman 1780) Along Altitudinal Gradient in Nepal

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ABSTRACT
The activity budgets of Rhesus monkey vary depending on altitude, topography, climate, food resource, vegetation and other factors. This study was done to compare the activity budget of Rhesus monkey along the altitudinal gradient of Eastern Nepal from 93 to 1250 meter for one year (May 2022 to April 2023). We followed scan sampling method to record the behavioural activities. We found no relation between the altitude of habitat and composition of population of monkey (df= 8, χ^2= 0.318, p<0.05). Foraging and moving were found increased with altitude but grooming decreased. The time spent by monkey for different activities was strongly related to changing seasons in habitats of different elevations. There was strong relation of activities with the elevation of habitat on the annual analysis (df = 14, F = 140.73, p value= 9.57E-09). The time budgeting was strongly related with the part of diurnal time (Plain (r =0.33), Churia (r = 0.75) and Mahabharat (r= 0.95)). The places for foraging, moving, grooming, inactive and fighting were varied in different elevations. Our study gives crucial information for the sustainable management of this species.

Key words: Dhankuta, foraging, morning, seasons

INTRODUCTION

Non-human primates can thrive in a variety of ecosystems that humans have altered because their diets and activity budgets are flexible (Alami et al. 2012). Investigating a species' adaptive strategies is made possible by the opportunity provided by the variation in activity budgets caused by habitat changes (Sarkar et al. 2012). Activity budgets are trustworthy markers of how monkeys deal with their surroundings and are frequently connected to how animals conserve energy (Milton 1998). Activity budgets are affected by factors like the quality of habitat and the size of the group (Wong et al. 2006). In response to fresh environmental cues, primates can expand their behavioral repertoire. For example: explore human food resources, and display variations in activity budget and social behavior in *Macaca mulatta* Zimmermann, 1780 (Jaman and Huffman 2013), stone handling in *Macaca fuscata* Linnaeus, 1758 (Leca et al. 2008); food extraction abilities in *Macaca radiata* Geoffroy, 1812 (Mangalan and Singh 2013).

The monkey can serve as highly valuable predictors of their outcomes in specific ecosystems by using their activity patterns and time limits (Korstjens et al. 2010). For the actual conservation of wild animals, it is crucial to go thorough behavioral analysis (Manning and Dawkins 1998). The activities pattern along with the home range and population density of rhesus monkey varied according to the altitude in India (Neville 1968).

According to Srivastava (1999), the Rhesus macaque (*Macaca mulatta*) is found in Nepal, China, Vietnam, Thailand, Cambodia, Afghanistan, Pakistan, Myanmar, Bangladesh, and India in south Asia. Rhesus macaques can be found in Nepal from low-lying flatlands to elevations of 4,000 meters at the foot of the Himalayas. Commensal rhesus macaques demonstrated a high degree of behavioral flexibility to environmental and resource variability (Jaman and Huffman 2013).

The Rhesus macaques spent the major proportion of their time resting (38.5%) and least in playing (4.6%) (Neha et al. 2021). Not matching this, they spent a major proportion of their time in moving (42%) (Khan 2017). Khatiwada et al. (2020) found that the Rhesus macaques spent the majority of their time engaging in social activities (33.7%). The long-tailed macaques spent maximally in moving

(20.27%) (Hambali et al. 2012). The yellow-tailed woolly monkeys used maximum time in moving (29.0%) (Shanee and Shanee 2011).

The study in the Amazon forest showed the altitudinal gradient, season change and availability of resources influenced the activities of primates in the case of sympatric living (Kinap et al. 2021). It was found that higher elevation environments and colder temperatures resulted in more time spent feeding and less time resting (Kraus and Strier 2022). Very few studies recorded the place where the monkeys spent their time. In Sivapuri Nagarjun National Park (hill site), Nepal one troop of Asamese monkeys spent 14.3% of time on the ground for foraging and the next group spent only 1.5% on the ground (Koirala and Chalise 2014), the least time on trees for foraging (Adhikari 2023). In Trinidad the work report said *Alloutta* species performed the activities at high levels (above 30m) of the forest, whereas *Cebus* are concentrated in the lower (below 20 m) and medium strata (20-30 m) (Phillips et al. 2003).

In Nepal, most of the previously done research works covered the activities budget of particular places but they did not compare them in reference of climatic, topographic and other parameters. We set a hypothesis that the altitude affects the climate, composition of vegetation and food resources so that the activities budget of monkey also varies on the basis of altitude. This study aims to explore the variation on activity budget of rhesus monkeys relating to seasonal changes and elevation of habitat. It investigates the percentage of time spent in different activities in different altitudinal habitats, the places of doing activities (foraging, moving, resting, grooming and fighting) and part of a day on which the special activities were done mostly. In this work we did not mention the vegetation type, climate and availability of food resources of monkey. It is also limited to only three habitats of different elevations. Since the behavioural record provides accurate documenting and quantification of animal activities, it helps for the planning of any ethological investigation (Stanton et al. 2015). Studying

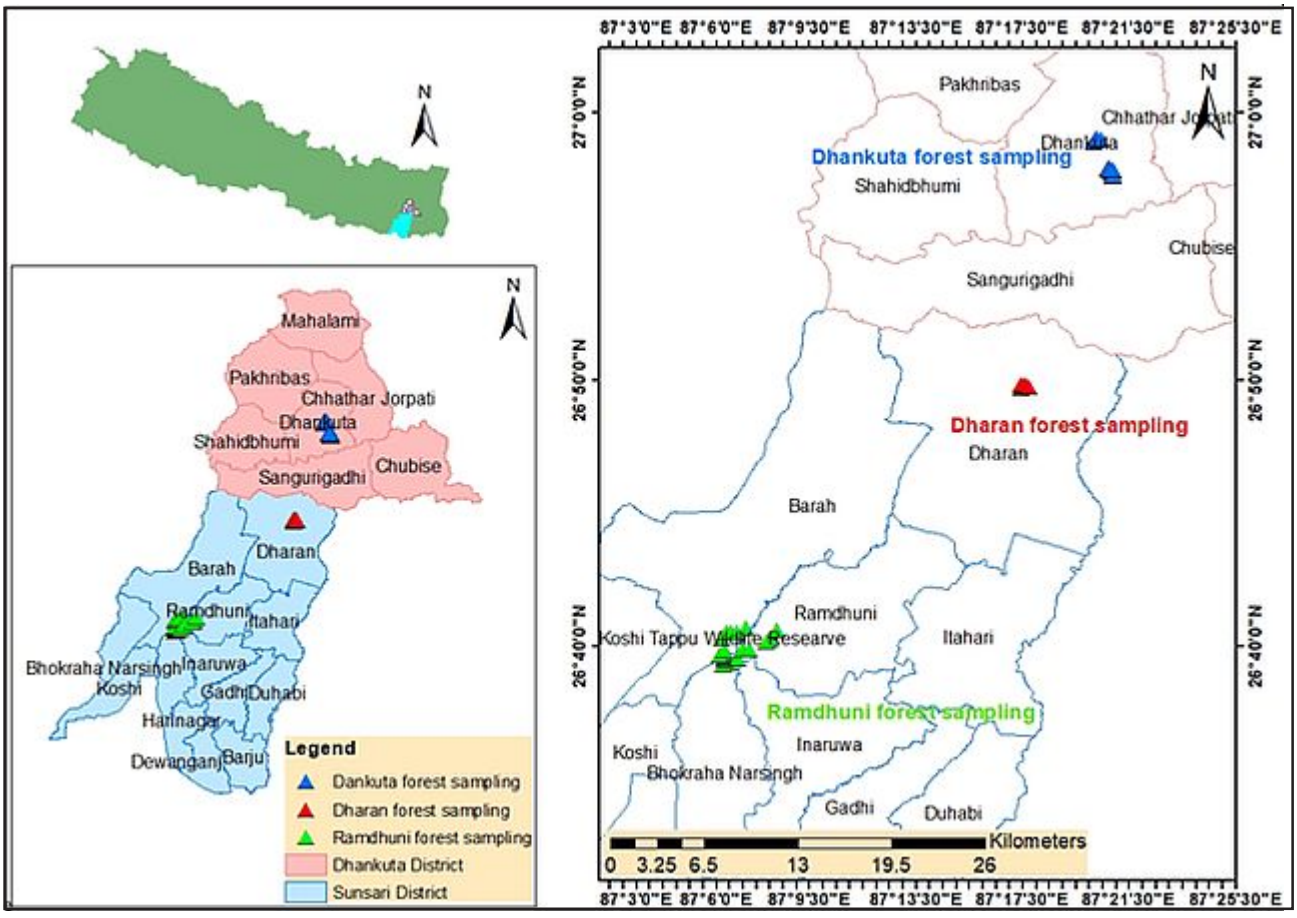

Figure 1. Location of study area and monkey observation points

behavior is crucial because it identifies patterns that have changed, lessens human-wildlife conflict and crop damaging, and enables effective conservation, management of monkeys.

MATERIALS AND METHODS

Study area

From eastern part (Koshi province) of Nepal, habitats at different elevations were selected. Study area at Ramdhuni, Sunsari district is plain or Terai (93 m amsl, 26.68^0 N and 87.11^0 E, tropical natural forest, 10 to 40^{0}C, 1600 mm precipitation (Ramdhuni Bhasi Municipality 2022)). Study area at Dharan forest, Sunsari district is Siwalik or Churia hill (428 m amsl, 26.69^0 N and 87.17^0 E, tropical natural forest, 14 to 35^0 C, 1796 mm precipitation (Dharan Municipality 2022)). Study area at Dhankuta, Dhankuta district is Mahabharat range (1155 to 1250 m amsl, 26.98^0 N and 87.32^0 E, subtropical and temperate natural forest, 12 to 23^{0}C, 2603 mm precipitation (Dhankuta Municipality 2022)).

METHODS

Troop selection

Regular watching of group of monkeys was done for few days in Ramdhuni forest, Dharan forest and Dhankuta forest area. We detected particular individuals by observing marked colour, body size, tail size, behaviour, leadership in the group. Then, we clearly identified the troop by observing their body colour, body proportion, height and body size (Roonwal and Mohnot 1977, Chalise 1995).

Composition of troop

The composition of the troop was differentiated into adult males, adult females, sub adult males, young adult females, juveniles and infants according to their body size, coloration and behaviour as described by (Chalise 1995). According to this: 1). Adult male: Adult males were distinguished by large and hanging scrotal sacs. 2). Adult female: They are distinguished with small head and protruded nipple.3). Young and sub adult: They are independent, mostly attained the height however not matured in body fitness and sexual activities. 4). Juvenile: They are the individuals that are left nipple contact (weaned) and depend on natural foods and mostly following their kin. 5). Infant: They are those who still suck the nipple as their main food on attaching or following mother. Hence, we grouped young and sub adult, juvenile and infant into immature category.

Behaviour recording

The scan sampling method (Altmann 1974) was followed to record the activities of rhesus monkey for the focal troop. Data collection was done for all four seasons from May 2022 and April 2023. Activities of individuals were documented to calculate the time budget. The activities were recorded in every 10 minutes with two minutes scanning. The observation time started from 7:00 A.M. before sun rising and terminated to 5:00 P.M. Study period was May 2022 to April 2023 (12 months). The field work was done 10 days per month per study area. Activities were recorded on work sheet with the help of binoculars. The study was done only in day time so nocturnal activities were not

Table 1. Ethogram for the categorization of behavior

S.N.	Activities	Description
1	Foraging	The time use for searching of food and consuming food or drinking water.
2	Locomotion	Movement from one location to other by pedal or jumping movement
3	Inactive	Resting, inhabiting and sleeping on tree, roof or on any support and sitting, stretched legs situation
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

documented. The categories of behaviour was done according to McHugh (1958), Jerman and Jerman (1973), Jingfors (1980) broadly categories as foraging, resting (Inactive), moving (locomotion), grooming and fighting (Table 1).

Data analysis

The numerical value 1 was given to each activity of each individual in a scan. All the events were summed up for each period of time. Total time budgeting for each day, month and season was calculated and presented using percentage of time allocated for particular activity. In most of the cases the digits behind decimal were converted to round figures. The overall activities of Rhesus monkey of focal troop were calculated by using the formula (Khatiwada et al. 2020)

Activity = (Number of behavior records for each activity ´ 100)/Number of behavior records for all activities

Statistical analysis

Time allocation for different activities in different habitats, fragments of day, place etc. was calculated. Chi square, correlation and Analysis of Variation (ANOVA) test were done and analyzed. All the statistical analysis was calculated in Microsoft Excel 2010 and Statistical Package for Social Sciences (SPSS).

RESULTS

Population composition

The male and female ratio in Ramdhuni was 1: 1.70, in Dharan 1: 1.56 and in Dhankuta 1: 1.63. The matured to immature ratio was 3.06:1 in Ramdhuni, 3.57:1 in Dharan and 3.6:1 in Dhankuta (Table 2). There was no relation between the elevation of habitat and composition of population of monkey ($df = 8$, $\chi^2 = 0.318$, $p<0.05$).

Table 2. Population composition of troops

Study area	Male	Female	Immature	Total
Ramdhiuni	19	27	15	61
Dharan	9	16	7	32
Dhankuta	7	11	5	23

Season wise time budgeting

Study period began from May 2022 and continued to April 2023 (12 months). Total Jungle days were 110 days for each spot. Monkey watching hours were 918 hours in each study area and totally 2754 hours.

Summer season (June to August)

We observed the activities and diurnal time budgeting in different seasons. We found foraging and moving increased with elevation whereas grooming decreased (Table 3). There was no significant relation between behavioural activities and elevation of habitat in Summer season ($df = 8$, $\div^2 = 6.11$, $p<0.05$).

Table 3. Activity time budgeting in habitats of different elevationin during summer

Activities	Time spent (%)		
	Ramdhuni (93 m asl)	Dharan (428 m asl)	Dhankuta (1155 m asl)
Foraging	29	33	37
Moving	30	31	32
Grooming	21	18	12
Inactive	13	14	10
Fighting	7	4	9
Total	**100**	**100**	**100**

Autumn season (September to November)

In Autumn season foraging and moving were found increased with elevation and grooming decreased (Table 4). There was no significant relation between overall activities and elevation of habitats in Autumn season ($df = 8$, $\chi^2 = 2.68$, $p<0.05$).

Table 4. Activity time budgeting in habitats of different elevationin during autumn

Activities	Time spent (%)		
	Ramdhuni (93 m asl)	Dharan (428 m asl)	Dhankuta (1155 m asl)
Foraging	30	31	36
Moving	29	30	31
Grooming	23	22	21
Inactive	11	11	9
Fighting	7	6	3
Total	**100**	**100**	**100**

Winter season (December to February)

In Winter foraging and moving were found increased

with the elevation of habitat and grooming decreased. But inactive time was not in fixed (Table 5). There was no significant relation between overall activities and height of habitat in Winter season (df = 8, χ^2 = 2.09, p<0.05).

Table 5. Activity time budgeting in habitats of different elevationin during winter

Activities	Time spent (%)		
	Ramdhuni (93 m asl)	Dharan (428 m asl)	Dhankuta (1155 m asl)
Foraging	31	33	37
Moving	30	31	32
Grooming	23	21	18
Inactive	12	11	11
Fighting	4	4	2
Total	**100**	**100**	**100**

Spring season (March to May)

In spring season, foraging and moving were found increased with elevation of habitat but grooming decreased. There was no significant relation between activities and elevation of habitat in spring season (df = 8, χ^2 = 2.22, p<0.05). In all seasons the foraging and moving were gradually increased with increase of elevation of habitat and grooming decreased. But resting or inactiveness and fighting were not affected by elevation (Table 6).

Table 6. Activity time budgeting in habitats of different elevationin during spring

Activities	Time spent (%)		
	Ramdhuni (93 m asl)	Dharan (428 m asl)	Dhankuta (1155 m asl)
Foraging	38	40	41
Moving	26	27	28
Grooming	19	17	15
Inactive	12	13	14
Fighting	5	3	2
Total	**100**	**100**	**100**

Effect of season change on activity budgeting

Ramdhuni

We recorded time budget of monkey at Ramdhuni and calculated the allocation to each activity of the year. On average they used maximum time for foraging (32%) followed by moving (28.75%), grooming (21.5%), resting or inactiveness (12%) and least in fighting (5.75%) (Table 7). The time spent by monkey for different activities was strongly related to changing seasons (df = 14, F = 62.92, p = 4.7 E-07).

Table 7. Effects of change in season on activity budgeting in Ramdhuni (low elevation)

Activities	Time spent (%) for different activities				
	Summer	Autumn	Winter	Spring	Average
Foraging	29	30	31	38	32
Moving	30	29	30	26	28.75
Grooming	21	23	23	19	21.5
Inactive	13	11	12	12	12
Fighting	7	7	4	5	5.75
Total	**100**	**100**	**100**	**100**	**100**

Dharan

In Dharan the season wise activities indicate they spent maximum time on foraging (34.25%) followed by moving (29.75%), grooming (19.5%), inactive (12.25%) and fighting (4.5%) (Table 8). The time spent by monkey for different activities was strongly related to changing seasons (df = 14, F = 61.98, p = 5.084 E-07)

Table 8. Effects of change in season on activity budgeting in Dharan (mid elevation)

Activities	Time spent (%) for different activities				
	Summer	Autumn	Winter	Spring	Average
Foraging	33	31	33	40	34.25
Moving	31	30	31	27	29.75
Grooming	18	22	21	17	19.5
Inactive	14	11	11	13	12.25
Fighting	5	6	4	3	4.5
Total	**100**	**100**	**100**	**100**	**100**

Dhankuta

At Dhankuta maximum time was allocated to foraging (37.75%) followed by moving (30.75%), grooming (16.5%), inactiveness (11%) and least time to fighting (4%) (Table 9). The time spent by monkey for different activities was strongly related to changing seasons (df = 14, F = 114.16, p = 2.66 E-08).

Table 9. Effects of change in season on activity budgeting in Dhankuta (high elevation)

Activities	Time spent (%) for different activities				
	Summer	Autumn	Winter	Spring	Average
Foraging	37	36	37	41	37.75
Moving	32	31	32	28	30.75
Grooming	12	21	18	15	16.5
Inactive	10	9	11	14	11
Fighting	9	3	2	2	4
Total	**100**	**100**	**100**	**100**	**100**

Comparison of time allocation annually in different altitude

Tabulating and calculating the annual average time spent for the activities it was explored that time allocated by rhesus monkey for foraging and moving increased with increase of elevation of habitat. But time allocated for grooming and fighting was found decreased with increase of height of habitat. The inactiveness went not through defined way (Table 10). There was powerfully built relation with the activities with the type / altitude of habitat on the annual analysis (df = 14, F = 140.73, p = 9.57E-09)

Table 10. Comparison of time allocation (%) annually at different elevations

Activities	Ramdhuni (Low)	Dharan (Middle)	Dhankuta (High)
Foraging	32	34.25	37.5
Moving	28.75	29.75	30.75
Grooming	21.5	19.5	16.5
Inactive	12	12.25	11
Fighting	5.75	4.5	4
Total	**100**	**100**	**100**

Diurnal activity budjet

In all habitats foraging and moving were done mostly in the morning. But both foraging and moving occupied gradually in the decreasing order in morning and increasing order in day time with the increase of altitude. The grooming, inactiveness and fighting occupied less time in morning than day time. In the altitudinal gradient grooming and inactivity were increasing in morning and decreasing in day. Fighting was decreasing in both the shifts gradually with height of habitat. The time spent for different activities by monkey was found strongly related with the part of diurnal time (morning and day) (Table 11) with the correlation values of Ramdhuni (r = 0.33), Dharan (r = 0.75) and Dhankuta (r = 0.95).

Place for the activities

Place for foraging

We watched the place for foraging of monkeys. It was recorded that in Ramdhuni the monkeys used top canopy of tree most and they did not use fencing and rock (assemblage stone). In Dharan we noted monkeys used middle canopy of tree maximally and in Dhankuta they used top canopy of trees maximally (Table 12). It was found that there was a significant relation between place of foraging with the habitat of different altitude (df = 12, $\div^2$ = 33, $p<0.05$).

Place for moving

During observation of diurnal activities of monkeys, it was noted that monkeys used maximally (29%) the top canopy of tree for moving in Ramdhuni. In Dharan they moved on ground (30%). Similarly, at Dhankuta they spent most of time (27%) on top canopy of tree (Table 13). It was found that there was a significant relation between place of moving with the habitat of different elevation (df = 12, χ^2 = 37.58, $p<0.05$).

Table 11. Diurnal allocation of time

Activities	Morning (Time spent in %)			Day (Time spent in %)		
	Ramdhuni	Dharan	Dhankuta	Ramdhuni	Dharan	Dhankuta
Foraging	41	40	36	23	28	39
Moving	37	34	33	21	25	27
Grooming	11	14	17	32	25	19
Inactive	5	7	10	19	18	12
Fighting	6	5	4	5	4	3
Total	**100**	**100**	**100**	**100**	**100**	**100**

Table 12. Place for foraging in different elevation habitats

Place	Ramdhuni	Dharan	Dhankuta
Ground	13	13	14
Middle canopy	25	28	22
Top canopy	29	17	27
Shrub	24	20	19
Rock	-	-	7
Fencing	-	13	5
Others	9	9	6
Total	**100**	**100**	**100**

Table 13. Place for moving in different elevation of habitats

Place	Ramdhuni	Dharan	Dhankuta
Ground	12	30	15
Middle canopy	26	21	21
Top canopy	29	14	27
Shrub	24	19	19
Rock	-	-	7
Fencing	-	7	5
Others	9	8	6
Total	**100**	**100**	**100**

Place for grooming

Regarding with the place for grooming we found differences in three elevations of habitats. In Ramdhuni and Dharan they spent maximum time (31 and 32%, respectively) on middle canopy of tree. But in Dhankuta they spent maximum time (31%) on top canopy of tree (Table 14). There was significant relationship between the place for grooming and the habitat of different elevation (df = 12, $\chi^2 = 58.44$, $p<0.05$).

Place for Inactive

We found the monkey spent maximum inactive time (35%) on top canopy of trees in Ramdhuni, middle canopy (32%) in Dharan and top canopy (30%) in Dhankuta (Table 15). There was significant relationship between the place for inactivity and the habitat of different elevation (df = 12, $\chi^2 = 50.29$, $p<0.05$).

Place for fighting

It was noted that at all three habitats monkey fight mostly on ground. The recorded time percentage was in the order of Ramdhuni, Dharan and Dhakuta (45>43>40, respectively) (Table 16). There was significant relationship between the place for fighting and the habitat of different elevation (df = 12, $\chi^2 = 31.84$, $p<0.05$).

Table 14. Place for grooming in different altitudinal habitats

Place	Ramdhuni	Dharan	Dhankuta
Ground	13	31	11
Middle canopy	31	32	20
Top canopy	20	14	31
Shrub	27	20	22
Rock	-	-	12
Fencing	-	2	1
Others	9	1	3
Total	**100**	**100**	**100**

Table 15. Place for inactivity in different elevation habitats

Place	Ramdhuni	Dharan	Dhankuta
Ground	9	10	12
Middle canopy	27	32	15
Top canopy	35	29	28
Shrub	25	29	22
Rock	-	-	19
Fencing	-	-	-
Others	4	-	3
Total	**100**	**100**	**100**

Table 16. Place for fighting in different elevation habitats

Place	Ramdhuni	Dharan	Dhankuta
Ground	45	43	40
Middle canopy	12	19	13
Top canopy	22	26	27
Shrub	21	8	11
Rock	-	-	8
Fencing	-	2	-
Others	-	2	1
Total	**100**	**100**	**100**

DISCUSSION

In our study the sex ratio of Rhesus monkey was highest (1:70) in low land (Ramdhuni) and least

(1:1.56) in higher elevation (Dharan). The sex ratio of a troop of Asamese monkey in Sivapuri Nagarjun National Park (SNNP) was slightly lower (1:1.4) but in the same habitat in the other troop it was 1:1.5 (Ghimire and Chalise 2021), 1: 1.6 in Nepal (Chalise 2003), 1:0.81 (Paudel and Chalise 2018). In mid hill of Nepal, in Assamese monkey it was 1:2 (Ghimire 2023), In Bangladesh it was 1:2.86 (Hasan et al. 2013). All the studies showed the number of males was lower than that of females.

In different seasons the time spent on various activities was found varied in our study as also in Bangladesh in dry and wet seasons (Jaman and Huffman 2013). Sikerwal et al. (2023) showed variation in the time budgeting, season wise and gender wise, which might depend upon the availability of food and other climatic factors. The ratio of time spent on different activities of behaviour was found vary because of habitat differences (which supported the result of this work) and age-sex specific physiological factors (Jaman and Huffman 2008). However, the study in Delhi showed no seasonal variation in time activities of Rhesus monkey (Ganguly and Chauhan 2018).

Chalise et al. (2013) in Sivapuri Nagarjun National Park (SNNP) found maximum (46%) of the day time was dedicated to foraging and eating and least in playing (1%) of their activities. It matched to the finding of present work in the regards of foraging. Adhikari and Chalise (2014) documented similar type of time budgeting for the Assamese monkey which used maximum time for foraging (45%) in Lamjung, Nepal. Pandey and Chalise (2015) noted the monkey spent 39.53% time in foraging in SNPP. Paudel and Chalise (2017) calculated the maximum time budgeting for foraging (47.25%), moving (27.25%), resting (14%) and grooming (11.50%) along Kaligandaki river basin. Adhikari et al. (2018) found the monkey accounted maximum time for foraging/feeding (41.10%) followed by resting (30.24%), moving (4.65%) and grooming (23.99%) in Palpa district.

Several works pointed out the seasonal changes in time investment with the increase in time investment on feeding during dry season than in rainy season. In the natural habitat, it is evident that they should allocate a greater amount of time to obtaining food compared to engaging in other social activities (Chalise 2005). The differences in behavioral activities may be due to different season, food resources availability and day length as well. Langur monkey occupied much time on foraging (45.99%), inactive (17.67%), locomotion (14.12%), grooming (9.15%) and sleeping (9.11%) in Gorkha district in Summer season (Paudel 2020). The study in Cameroon showed individuals maximum percentage of time in feeding in the season when the fruits were mostly available and occupied least time in leaf lean season (Poulsen et al. 2001). The next finding stated that the Titi monkeys behaviour in relation to feeding, foraging, resting, and traveling differed season wise (Sauza-Alves et al. 2021). The study on Velvet monkeys showed when there was scarce of food in winter they attracted to provisioned food and in summer the number of conflicts decreased in relation to feeding and other activities (Borgeaud et al. 2021). There was a vast variation in the feeding and ranging activities of monkey in Rwanda because change in season brings the changes in food availability (Tuyisingize 2022). While moving time increased with longer days and the availability of new leaves, resting time increased with a decrease in temperature. While playing time increased with longer days, grooming time increased with shorter days and rising temperatures. Other research documented the significance of diet, food availability, temperature, and day length in adjusting to seasonal changes in ecological parameters (Li et al. 2020). Next study showed a difference in time spent in different activities of same species at different altitude due to the uniqueness of topography and climate and also the floristic composition of forests (Montilla et al. 2021). This work matched mostly to the finding of this work. In south Asia, in the behaviour of monkey was found that with higher elevation environments and colder temperatures resulting in more time spent feeding and less time resting (Kraus and Strier 2022). That outcome also supported this result of our work. The study in Amazon forest showed the altitudinal gradient influenced the activities of primates in the case of sympatric living. The impact of season and availability of resources were also mentionable (Kinap et al. 2021).

In all habitats foraging and moving were done mostly in the morning. Contrary to this, there was a record of maximum time for foraging was day (3:00

to 6:00 PM) in Kaligandaki river basin (Paudel and Chalise 2017). We found grooming, inactiveness and fighting occupied less time in morning than day time. But opposite to this moving was high at noon to 3:00 PM and resting was maximum at 3:00 to 6:00 PM. The next finding partially supports our result as it showed that Tibetan macaques had two foraging peaks (9:00–10:00 and 14:00–15:00) and a resting peak at 12:00–13:00 (Zhou et al. 2014). Koirala and Chalise (2014) documented the Asamese monkeys spent highest time on feeding and foraging activities 12 noon to 3:00 PM. It did not match with this study. Time spent on moving was too hight during 12 noon-3:00 pm which also did not support to the finding of this study. The study on SNNP showed the troop spent highest time being inactive in morning (Ghimire and Chalise 2021). It did not resemble to this study. The work on Ramdhuni forest on rhesus monkey noted foraging and inactive activities accounted much time in morning and moving grooming fighting occupied much in day time (Adhikari 2023). It matched only in case of foraging, grooming and fighting to this study. Mattison et al. (2017) mentioned monkeys were fed in morning by following the hypothesis morning feeding was good for health. It supports to this study of natural habitat.

In this study the mostly used place for foraging was top canopy of tree on Plain (low elevation), middle canopy on Churiya (middle elevation) and top canopy on Mahabharat hill (high elevation). It was similar to the findings in SNNP where one troop of Asamese monkey spent 14.3% time on ground for foraging. On the same study the next group spent only 1.5% on ground (Koirala and Chalise 2014). The second finding stood on against of our finding. The study on Assamese macaques in China found that they spent most of the time on trees (Zhou et al. 2014). In Ramdhuni rhesus monkeys spent only least time on trees which was not matching to this study because that troop was adapted on provisioned food around the temple (Adhikari 2023).

This study showed in low altitude the monkey used top canopy maximally in middle height they used ground and in high altitude they used top canopy of trees. The research work in Ramdhuni of Sunsari district revealed that rhesus monkey used maximally (32%) the roof of temple and least on roadside for moving (Adhikari 2023). It indicated monkey used the suitable place whatever available. Assamese macaques in SNNP performed 94.0% of their moving activities in trees and rhesus monkey used maximally (58.5%) at ground (Khatiwada et al. 2020). The movement of proboscis monkeys at cage trapped situation was observed and found that the walking movement was done maximally on wire, net, wooden and iron bars (Nurliani 2022). The resemblance of all three was they can walk on any means in their habitat.

In Ramdhuni a previous study showed that maximum time (27%) spent for grooming on shrub and followed by tall trees and roof of buildings (Adhikari 2023). This study matched somehow with previous one. In Trinidad the work report said *Alloutta* species performed the activities at high levels (above 30 m) of the forest, whereas *Cebus* are concentrated in the lower (below 20 m) and medium strata (20-30 m) (Phillips and Abercrombie 2003).

The study of Ramdhuni stated the monkeys rested on tall trees maximally which was followed by temples floor (Adhikari 2023). The study on rhesus monkeys in SNNP, it was recorded they spent maximum time on *Schima wallichi* (tree) and least time in time in next species *Myrica esculenta* (tree) for resting/sleeping/sitting (inactive) (Ghimire and Chalise 2021). The study on Assamese monkey in midhill region of Nepal mapped that about 26.20% of time spent for resting state in different parts of tree and ground or rock (Ghimire 2023) which did not analyze the places of activities in detail. In west Africa, *Colobus* species They choose the place for resting where no threat of hunting and other disturbances (Djego-Djossou et al. 2015).

Previous study in SNNP explored that the aggressive behaviour including threat, fight the rhesus macaques used 26.6% time but the Assamese monkey allocated only 14.6% time (Khatiwada et al. 2020). The study in Ramdhuni temple area showed that the monkeys used maximum time (27%) on ground which was followed by roof of construction (24%) and least on tall trees (Adhikari 2023). Some works have been completed in relation to fighting behaviour of monkey but we did not find more literature belonging to the place. One work confirmed that fighting activities belonged to air pollution since the researcher found more fighting events in polluted air (Xu et al. 2021). Monkeys fight to defend the

offspring and in mating (Arseneau 2015) but it did not mention where the monkeys fought.

CONCLUSION

The study of one year compared the time budgeting of Rhesus monkeys in three habitats of different altitudes in eastern Nepal. Field survey, scan sampling method with two minutes scanning in interval of 10 minutes was applied and chi square and ANOVA test were used to analyze the data. The foraging and moving were found increasing with the increase of altitude but grooming was found decreasing in different season. The trend of inactivity and fighting were not in defined way. The time spent by monkeys for different activities was strongly related to changing of seasons. There was a powerfully built relation with the activities with the altitude of habitat on the annual analysis. In all habitats foraging and moving were done mostly in the morning. But both foraging and moving occupied gradually in the decreasing order in the morning and increasing order in day time with the increase of altitude. It was found that there was a significant relationship between the place of activities (foraging, moving, grooming, inactive and fighting) with the habitat of different altitude.

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