BEHAVIORAL PATTERNS AND CONSERVATION OF CAPPED LANGUR (*TRACHYPITHECUS PILEATUS*) OF MADHUPUR NATIONAL PARK, TANGAIL, BANGLADESH

A dissertation

Submitted to the University of Dhaka for the degree of

Doctor of Philosophy in Zoology (Wildlife Biology)

by

Shawkat Imam Khan
Registration No. 24
Session : 2014 – 2015

January 2020
Revised on October 2020

Department of Zoology
University of Dhaka
Dhaka 1000, Bangladesh

Ph.D. Thesis

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S. I. Khan

Capped Langur, *Trachypithecus pileatus* (Blyth, 1843)

SUPERVISOR'S RECOMMENDATION

I, hereby, declare that the dissertation entitled "Behavioral Patterns and Conservation of Capped Langur (*Trachypithecus pileatus*) of Madhupur National Park, Tangail, Bangladesh" submitted for the degree of Doctor of Philosophy (PhD) in Zoology (Wildlife Biology), University of Dhaka is based on self-investigation carried out under my continuous supervision.

I also declare that this work or any part of it has not been submitted for any other degree anywhere.

Dr. Mohammad Firoj Jaman
Professor and Research Supervisor
Department of Zoology
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DECLARATION

I do hereby; declare that the work presented in this thesis entitled **"**Behavioral Patterns and Conservation of Capped Langur (*Trachypithecus pileatus*) of Madhupur National Park, Tangail, Bangladesh" is the result of my own investigation. I further declare that this thesis has been composed by me. This is primary data collected directly from the field by me and no part of this thesis has been submitted anywhere in any form for any academic degree.

Shawkat Imam Khan
PhD candidate

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ABSTRACT

A study was carried out on 'Behavioral patterns and conservation of Capped Langur (*Trachypithecus pileatus*) at Madhupur National Park in Tangail of Bangladesh' during April 2015 to June 2018 (population census did during April 2015 to March 2016, data on behavioral patterns and diet were collected from January 2016 to December 2017 and conservation threats during July 2017 to June 2018). The aim of this study was to find out the total number of individuals, behavioral activities, diet, human-langur conflict and conservation threats of Capped Langur (*Trachypithecus pileatus*) in the Park. A total of 154 individuals of 18 groups and one isolated adult male (AM) were recorded. The group size ranged from 3 to 14 (8.6 ± 3.4) individuals. Among the 155 individuals (including isolated AM), 51% were adults and 49% immatures (sub-adult, juvenile and infant). Female was the highest (58.1%) in the total population. The ratio of adult male and female was 1:2.8, adult and non-adult 1:0.96. Four types of group structures (i.e., one-male, uni-male uni-female, uni-male multi-female and multi-male multi-female) were recorded. The Langur started their activities before sunrise except in the month of May and June. The duration of the diurnal total active period ranged from 665 min. to 795 min. (716.67 ± 41.41 min., n=12) in a day and it was the highest (795 min.) in August and the lowest (665 min.) in December. Langur spent the highest time in resting (32.68%), followed by foraging and feeding (28.51%), sleeping (18.15%), traveling (11.11%) etc. In a day, the adult-male spent maximum time (29.44%) in resting but adult-females for feeding (36.18% time). Resting time (35.78%) was the highest in monsoon and the lowest (28.55%) in summer, foraging and feeding was the highest in winter (29.96%) but the lowest during monsoon (27.73%), traveling was the highest in monsoon (15.05%) and the lowest in summer (8.23%), sleeping was the highest in summer (25.44%) but the lowest in monsoon (11.54%) and playing was the highest in winter (8.39%) and the lowest in monsoon (6.55%). There was a significant relationship between resting and traveling with average temperature and rainfall. The highest time spent in mating was recorded (68.18%) in the morning (0600 hr to 0930 hr) but the lowest (31.82%) in the afternoon (1400 hr to 1900 hr). Langur used 0 - 18 m (9.14 ± 4.5 m, n=288) height during feeding but during traveling, the substrate height ranged from 0 - 27 m. (16.03 ± 7.9 m, n=35). Langurs preferred to use canopy bridge for traveling but during long canopy gap they used forest floor. The daily path length varied from 102.76 to 1054.62 m. (388.46 ± 271.41 m., n=74), the size of which depended on the availability of the food plants. The food items were leaves (tender leaves, young leaves and mature leaves), fruit, bud, flower, seed and shoot, of which leaves were highly preferred (63.55%). A total of 82 food plant species (58 trees, shrubs 5, climber 18 and 1 parasitic plant) were recognized. The Langur highly damaged the crops in homestead areas (88%) than cultivated areas. Crops raided were the highest in winter (69%). In homestead areas, crops, fruits, leaves, flowers, shoot and vegetables were raided, of which fruits were the highest (52%) preference. Habitat destruction, forest encroachment, illegal logging for timber and fuelwood, forest fire, hunting, road accident, electrocution and hyper-enthusiastic tourist activities were the major conservation threats for this species in Madhupur National Park. Avoiding monoculture practices, enforcement of laws to reduce illegal logging, avoiding construction of roads inside the forest, using insulated electric power line inside the forest, creating speed breakers on the highway, establishing artificial canopy bridges over the highway and by controlling hyper-enthusiastic tourists activities may reduce the threats and mortality rates of primates especially, Capped Langur in the Madhupur National Park.

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CHAPTER 1 : INTRODUCTION

Capped Langur or Capped Leaf Monkey, *Trachypithecus pileatus* (Blyth 1843) is one of the three Colobine species found in Bangladesh. The genus *Trachypithecus* (Reichenbach 1862) consists of 17 species of leaf monkeys with 33 sub-species (Borah 2010). *Trachypithecus pileatus* is an endangered species in Bangladesh (Kabir 2015) but vulnerable in the world (Das *et al*. 2008). All South Asian populations are listed under Schedule I, Part I of the Indian Wildlife (Protection) Act (Srivastava and Mohnot 2001), amended up to 2002, and are also listed under Appendix I in CITES. Populations in Bangladesh are protected under Schedule III of the Wildlife (Conservation and Security) Act, 2012. This species is considered as the First Class protection under the Wildlife Protection Act in China (Das *et al*. 2008). In Myanmar it is nominally protected under the Wildlife Protection Act (Das *et al*. 2008).

It inhabits a variety of forest types including tropical dry deciduous, subtropical, broad-leaf and dense evergreen hill forest, bamboo forest up to 2,000 m and teak or *Sal* plantation forest areas (Srivastava 1999, Majupuria 1990). It is distributed in Bangladesh, north-eastern India, north-western Myanmar, Bhutan and southern China (Srivastava and Mohnot 2001). Srivastava and Mohnot (2001) found capped langur in subtropical evergreen, broadleaf, deciduous and bamboo forests. In the early 1970s and 1980s it occurred in Gazipur District to Jamalpur, Sherpur, Netrokona and Mymensingh under Mymensingh Division to the forests in Sylhet and Chittagong Divisions (Khan 2015). At present, there are only a small number of individuals left in the Mymensingh Division while the remaining populations are only present in the mixed-evergreen forests of Sylhet and Chittagong Divisions (Kabir 2009, Khan 2015).

Capped Langur lives in small groups, mostly single-male, multi-female, but occasionally with more than one male (Green 1981, Stanford 1991a). It is diurnal, predominantly arboreal and folivorous (Choudhury 1989, Molur *et al*. 2003, Stanford 1991b). The feeding strategy is adapted to cope with seasonal food scarcity (Stanford 1991b). It has bimodal feeding schedule (Green 1981). Its diet includes leaves, fruits, flowers, seeds, etc. (Kabir 1991). In dry season, Capped Langurs survive on mature

leaves, seeds and bamboo shoots, occasionally feeding on gum (Stanford 1991b, 1992).

Study on population status and conservation of Capped Langur was done in India (Kumar and Solanki 2008). Choudhury (2014) reported distribution and current status of Capped Langur in India. Solanki *et al.* (2008a, 2008b) conducted the study on winter food selection, diet composition and feeding ecology in India. Kumar and Solanki (2004a) studied a rare feeding observation on water lilies by the Capped Langur. Kumar *et al*. (2005) also did a work on observation on parturition and allomothering in India.

A few studies have reported on the population status of Capped Langur in Bangladesh (Gittins 1980, Feeroz 2001). Green (1978, 1981) had done a preliminary study on the population, habitat, ecology and behavior of Capped Langur in Bangladesh. Stanford (1987, 1989, 1991a, 1991b) carried out extensive studies on ecology and behavior in the deciduous forest of Bangladesh. Kabir and Islam (1995) and Kabir (2006) studied the ecology and activity pattern of Capped Langur in semi-evergreen forest of Bangladesh. Mandal and Kabir (2014) conducted a study on activity patterns of Capped Langur in a moist deciduous forest of Bangladesh.

Extensive deforestation and habitat fragmentation are main threats throughout the world and the survival of innumerable forest species mainly in the tropics is in jeopardy (Marsh and Mittermeier 1987). Some other causes are habitat loss and degradation (Srivastava *et al*. 2001a) and hunting for food, medicinal purposes and artifacts for socio-cultural practices and religious and cult ceremonies (Kumar and Solanki 2004b). Hunting, poaching and habitat destruction is the threats in India (Kumar and Solanki 2004b). Habitat destruction for agricultural activities, permanent settlement, fuel and fodder and for minor forest produce is also a threat in Arunachal Pradesh in India (Kumar and Solanki 2008). Some major causes are jum cultivation, plant monoculture, timber and firewood harvests and other development, resulting in a loss of fruiting and lodging trees. Also, these animals are subject to trade for their meat and other body parts and as pets (Molur *et al*. 2003).

In Bangladesh the population of Capped Langur is declining at an alarming rate. Habitat loss is the main cause of population decline. Especially in Madhupur forest its population is under extensive pressure. Madhupur *Sal* forest is a fragmented

and disturbed forest in Bangladesh (Naher *et al.* 2016, 2017). The park is under high pressure for fuel wood, fallen dry leaves for cooking, grazing, illicit felling and fire hazards (Khan 2010). In winter, some areas of the park are cleared up by the cultivators and utilized for growing various crops (Khan 2010). The forests are being destroyed at an unprecedented rate to clear land for Pineapple (*Ananus comosus*), Banana (*Musa* spp.) and Kachu (*Colocasia* spp.) cultivations and human settlement (Khan 2010). Large number of human population (about 60,000) of this area, with its increasing need for fuel wood, timber, building material and cultivable land exert heavy pressure on the remaining forest area. The biotic and abiotic interferences led the forests to become an unproductive forest area. On the other hand, natural *Sal* stock has lost its vigorous coppicing ability to a great extent, bole becomes malformed, and the growth of the trees seems to be stunted (Hossain *et al*. 2004). A recent estimate reveals that over 70% of the *Sal* forest area is either degraded or encroached by this time (Nishat *et al*. 2002). Thus the most important underlying causes of this destruction are high population pressure and weak forest management system. As no attempts has been taken to conserve the Capped Langur (*T. pileatus*) in Madhupur Forest in Bangladesh. Therefore, it is needed to estimate the present status, behavioral patterns and conservation threats of the Capped Langur in Madhupur forest to take long term conservation measures of this species. If necessary measures should not yet be taken on conservation of Capped Langur (*T. pileatus*) in Madhupur forest, it would be extinct from this forest in the near-future. Thus an attempt was taken to study the behavioral patterns and conservation of Capped Langur (*T. pileatus*) of Madhupur National Park, Tangail, Bangladesh. This study will help the Bangladesh forest department or other researchers to take necessary measures for the protection of the species.

1.2 Aims of this study

The aims of this study were to :

1) study the group numbers, group size, group composition and age-sex ration of the Capped Langur;
2) to investigate activity patterns;
3) to find out the food habits and feeding behavior in relation to availability and scarcity of food items; and
4) to evaluate crop damage and human-langur conflicts in the study area.

CHAPTER 2 : STUDY AREA

The study was carried out at the Madhupur National Park (Fig. 2.1), Tangail, Bangladesh. Population survey was done during April 2015 to March 2016, behavioral data were collected during January 2016 to December 2017 and the questionnaires surveys were done from July 2017 to June 2018 to find out the conservation threats in the study area. The detail description of the study area is given below.

2.1 Madhupur National Park (MNP)

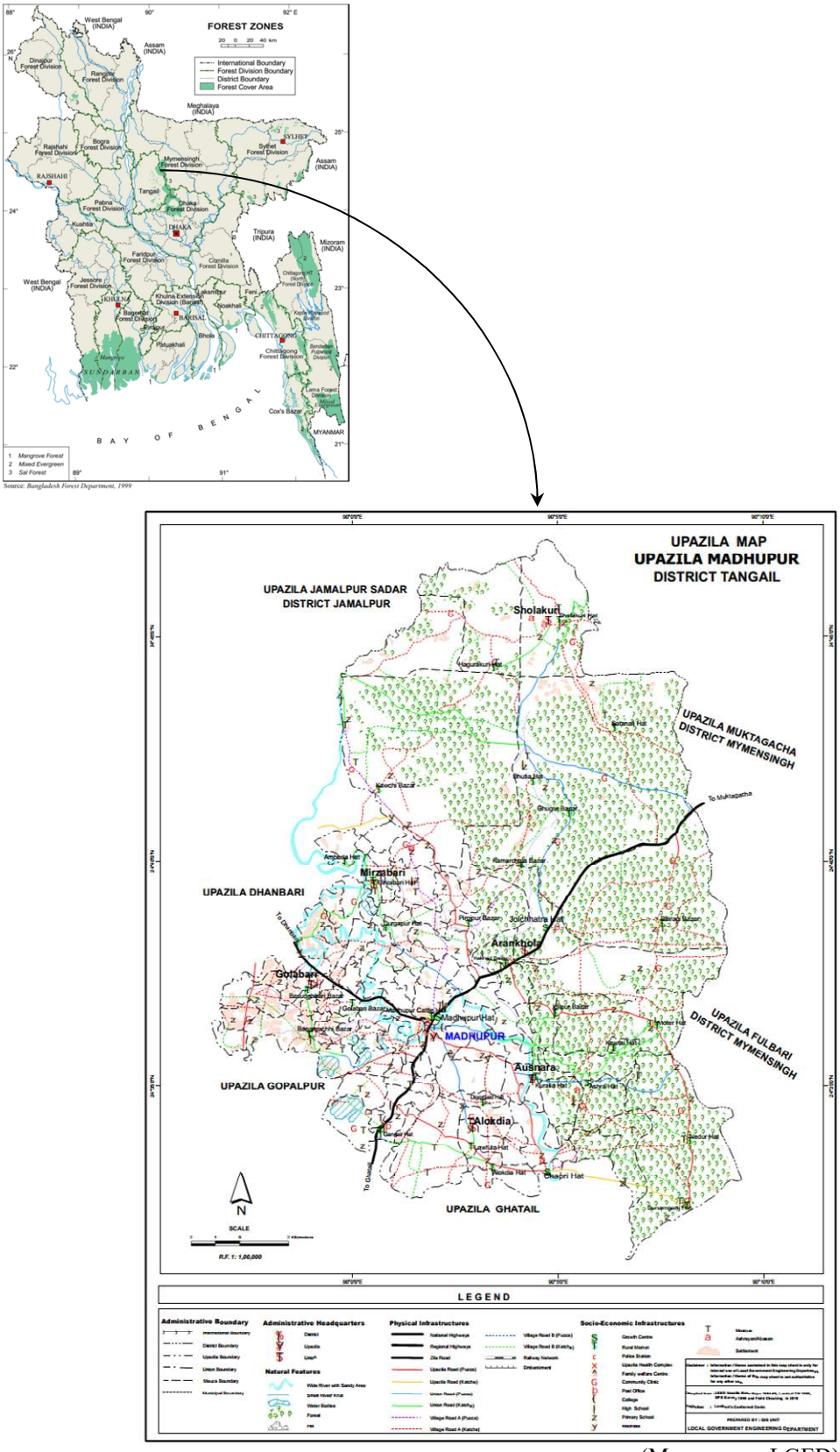
The Madhupur forest is the largest deciduous forest of Bangladesh. It was privately owned until 1925 during the British Indian Government, when it was called Atia forest after the name of a landlord (Khan 2010). In February 1925, it was declared as protected forest under the control of the then Government. Then after a long time, a portion (8,430 ha.) of the forest was declared as 'Madhupur National Park' on 24 February 1982, under the Bangladesh Wildlife (Preservation) (Amendment) Act, 1974. It is the first National Park of the Bangladesh (Bangladesh Forest Department 2015).

2.1.1 Location

The park is situated in the northern part of Bhawal-Madhupur *Sal* (*Shorea robusta*) forest tract, somewhat 50 km south of the Garo Hills of the Meghalaya State of India, and about 151 km north of Dhaka (Khan and Ahsan 2015), the capital of Bangladesh. Geographically, it lies between 24°36' to 24°42' North latitudes and 90°00' to 90°06' East longitudes. The altitude of the park is about 20 m above the mean sea level (Monirujjaman and Khan 2018).

2.1.2 Boundary

The southeast boundary of the park lies on both sides of the Tangail–Mymensingh Highway. Except a portion of the southeast corner that falls in the Mymensingh District, the park is within the administrative District of Tangail. The Divisional Forest Officer of Tangail Forest Division, based at Tangail town, is responsible for the management and conservation of Madhupur National Park. The river Banar on the east and the Bangshi on the west practically limit respectively the eastern and western boundaries of the Madhupur forest. The rivers run north to south and have many streams and streamlets draining the forest tract to these rivers.



(Map source: LGED)

Fig. 2.1. Map of the study area.

2.1.3 Area

Madhupur *Sal* forest includes an area of about 24,150 ha, but the Madhupur National Park (wildlife and recreation area) encompasses an area of 8,436 ha distributed partially over Jatiya Uddan and Dokhola Ranges (Khan and Ahsan 2011).

2.1.4 Physical features and topography

The Madhupur forests, commonly known as 'Madhupur Garh', forms a slightly elevated tract of approximately 1-2 m in height over the surrounding plains. There are numerous depressions with gentle slope intercepting the ridges (Ismail and Mia 1973). Flat ridges run north to south forming the irregular masses of high lands with gentle slopes. These high lands are locally known as 'Chalas'. The 'Chalas' are intercepted by numerous depressions in the form of long and narrow ditches. These ditches are locally known as 'Baids', where paddy is cultivated. In rainy season the low-lying depressions accumulate water and become marshy. These marshy places dry up in summer and winter seasons but they expand into broad shallow areas in the rainy season. These shallow swampy areas are covered with grasses and reeds. These areas harbour some aquatic birds.

The forest is partly dense, partly thin and there are scrub jungles also (Plate 2.1). The park is under high pressure from fuel wood, fallen dry leaves for cooking, grazing, illicit felling and fire hazards.

In winter almost all leaves fall down on in one hand and on the other hand some areas of the National Park are cleared up by the cultivators and utilized for growing various crops. Therefore, it is a fragmented and disturbed forest.

2.1.5 Climate

In general Bangladesh prevails tropical monsoon climate, characterized by hot, humid summer and dry, mild cool winter. There are distinctly three seasons in Bangladesh (Ahmad 1968) namely, the summer (pre-monsoon, hot season): March to June, the monsoon (rainy season): July to October, and the winter (dry season): November to February.

In MNP the climate is moderate. Warm weather spread over March to October, maximum average temperature was 36.7° C in June 2016. The cold weather

lasts from November to February with a minimum average temperature of 14.1° C recorded in February 2017 (Fig. 2.2). The monthly average precipitation was about 187.74 mm and the yearly total was 2252.9 mm (Fig. 2.2). Most of the precipitation occurs between early May and end of September and lowest in December (8.7 mm). The average maximum humidity varied from 75 to 93% and minimum 52 to 83% (Fig. 2.2).

2.1.6 Vegetation

In general, the MNP is dominated by *Sal* trees associated with other tree species like *Grewia laevigata*, *Zizyphus oenoplia*, *Phyllanthus embelica*, *Terminalia belerica*, etc. (Khan 2010). The shrub consists of species like *Leea crispa*, *Glycosmis arborea*, *Thespesia lampa*, and *Urena lobata*. The MNP also sustains some climbers such as *Mucuna pruriens Fucus scandens*, *Pothas scandens* and *Smilax macrophylla*, and herbs like *Ageratum conyzoides*, *Desmodium gangeticum*, *Cleome viscosa*, and *Clerodendrum viscosum* are also present (Khan 2010).

2.1.7 Forest inhabitants

Usually, two types of tribe (*Garos* and *Koch*) are used to live inside the Madhupur forest area and Bengali in the fringe areas. At present, the *Koch* is practically merged with the Bengali Hindu community. But the *Garos* are still maintaining their identities as one of the ethnic minorities. Most of the *Garos* have been converted to Christianity due to missionary activities in the area for long time (Adhikari 2008, Kubi 2012).

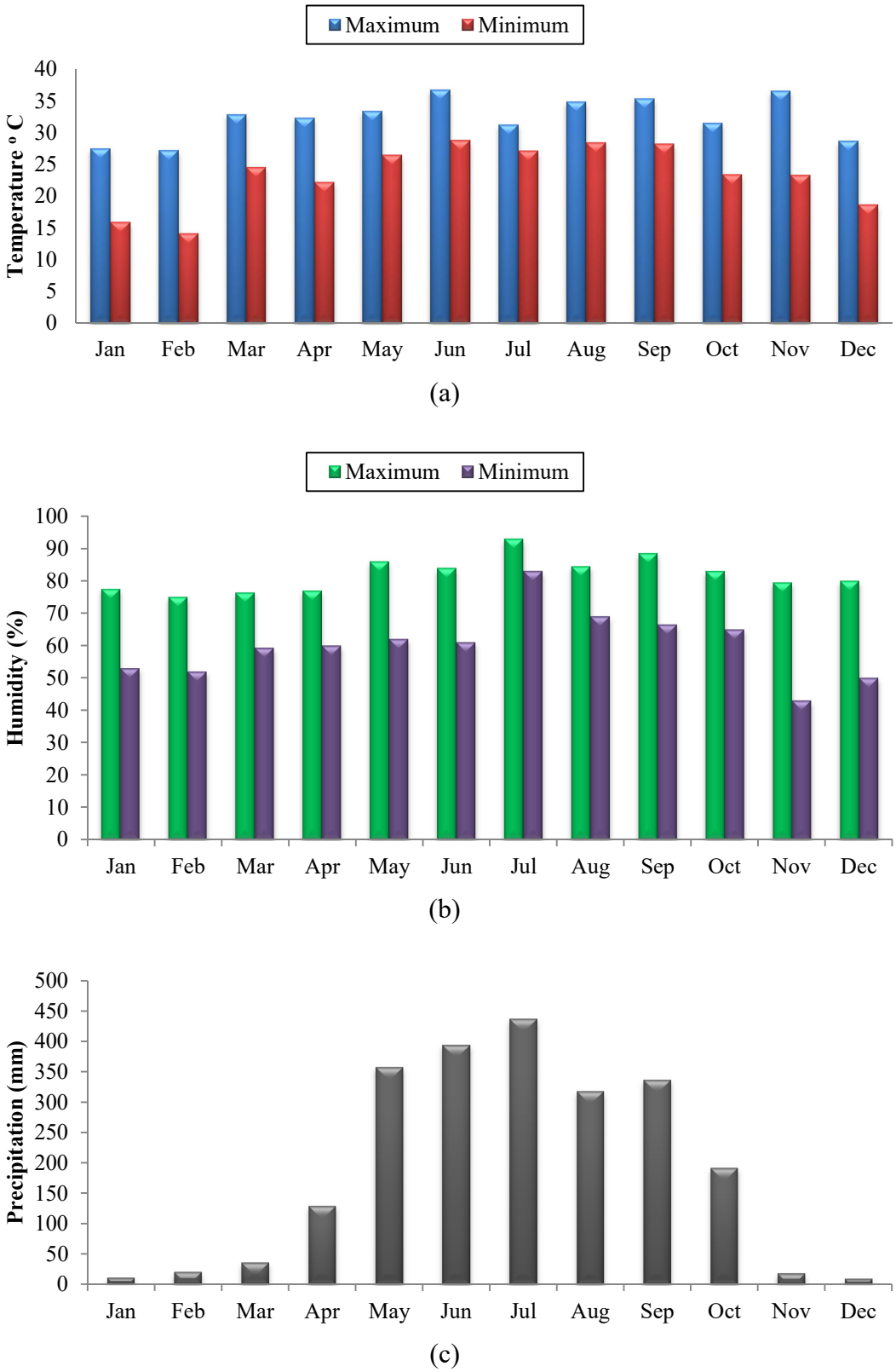


Fig. 2.2. Meteorological data of the study area during the study period: a. Temperature, b. Humidity, c. Precipitation (data source: personally collected from the study site).

2.1.8 Forest management

Madhupur forest areas are under the administrative control of Tangail (includes 4 ranges) and Mymensingh (include 1 range) Forest Divisions. Formerly, the forests were managed under coppice systems with a rotation of 25 years (Das 1982). Areas where *Sal* trees were comparatively less were managed through clear felling system followed by artificial regeneration mostly with *Sal* and other suitable species (White and Ali 1979, Das 1982, Mohiuddin 1982). Large human population of the area with its increasing need for fuel wood, timber, building material and cultivable land exert heavy pressure on the remaining forest area. The biotic and abiotic interferences led the forests to become an unproductive forest area. On the other hand, natural *Sal* stock has lost its vigorous coppicing ability to a great extent, bole becomes malformed and the growth of the trees seems to be stunted (Hossain *et al*. 2004). An estimate reveals that over 70% of the *Sal* forest area is either degraded or encroached by this time (Nishat *et al*. 2002). The total Madhupur area is divided into 5 Ranges and 10 Beats for the management of the forest.

The forests are being destroyed at an unprecedented rate to clear land for Pineapple (*Ananus comosus*), Banana (*Musa* spp.), Lemon (*Citrus aurantifolia*) and Kachu (*Colocasia* spp.) cultivations and human habitation. The most important underlying causes of this destruction are high population pressure and weak forest management system (Khan 2010).

PLATE 2.1

Plate 2.1. Glimpse of forest habitat of the study area.

CHAPTER 3 : POPULATION STATUS, GROUP SIZE AND DISTRIBUTION

3.1 INTRODUCTION

The habitat of capped langur is mostly tropical wet evergreen and semi-evergreen forests in the foothills, and subtropical and temperate broadleaf forests in the higher hills and mountains, as well as rocky cliffs with sparse vegetation (Choudhury 2008). Occasionally this species occur in subtropical and temperate conifer forests (Choudhury 2008). The Capped Langur is well adapted in changing habitat in secondary forest and in bamboo thicket (Biswas *et al.* 2009). The occurrence of the species ranges from 30m to 3000m altitudes that depict brilliant ecological adaptability and behavioral flexibility (Biswas *et al.* 2009).

The populations of Capped Langur have been declining due to habitat loss and degradation (Ahsan 1984, Srivastava *et al.* 2001a, 2001b, Khan 2015,) and hunting for food, medicinal purposes, artifacts for socio-cultural practices, religious and cult ceremonies (Solanki 2002, Kumar and Solanki 2004a).

Due to habitat loss, competition for food and living area, hunting and pet trade all Asian primate populations are facing extreme ecological pressure (Southwick and Siddiqi 1994). In many countries nonhuman primates have protected through the religious credence and cultural beliefs (Strum 1994). For future conservation and management actions of primate species, it is important to know population status (Southwick and Siddiqi 1994). Very little information on present status of Capped Langur in Madhupur National Park is available, except this, several researches work have been done on population status, group composition of Capped Langur in different parts of Bangladesh (Green 1978, Khan and Ahsan 1981, 1986, Islam and Husain 1982, Ahsan 1984, Stanford 1987, 1992, Kabir 1991, 2002, Hasan 2017, Naher and Khan 2018).

To minimize the research gap and to know the present status of Capped Langur in the deciduous forest of Bangladesh it is important to study the population status, age/sex composition of the groups and distribution of them in the Madhupur National Park. The objective of this study was to find out total individuals, group size, group composition, present status and distribution of Capped Langur in the study area.

3.2 METHODS

3.2.1 Population status, group size and distribution

To find out the number of individual, census was conducted in the national park and its adjoining village areas during April 2015 to March 2016. In each month fortnightly from dawn to 10:00 hr and 16:00 to 18:00 hr two days long survey carried out using the line-transect method (Brockelman and Ali 1987). A total of 48 days (288 hours) were spent to do the population census. Direct count method was used to estimate population in habitats (different areas of the national park and in the human settlement areas). Data were recorded from two habitats, i.e., natural forest areas of the national park and human habitation areas (fringe areas of the national park). In and around the forest thirteen transects (Fig. 3.1) were established in counting the population. Transect include the pre-established forest trails and roads. The length of transect varied depending on the trail lengths (range 1 - 9 km), vegetation types and accessibility in the forest. The total length of transects were 41 km (Table 3.1). During conducting census an experienced local field guide was accompanied. We collected data along the preexisting trail of the forest. The group was identified either by direct or indirect observation (rustling when feeding or foraging, jump from one to another branch or traveling). While finding the presence of a troop, sighting time, GPS co-ordinates, group size and age-sex composition were recorded. To get accurate data repeatedly counting of population of a group was done.

3.2.2 Age-sex determination

All transects were repeatedly surveyed, recording group size and age/sex class of all individuals. The langurs were classified in to four age categories: adult, sub-adult, juvenile and infant, based on the morphological differences described by Stanford (1991a). Sex was recorded for adult, sub-adult and juvenile. Sex identification was difficult for infant, thus sex determination for infant was ignored. Groups were differentiated on their group size, composition, locations and visible markings of members (injury, abnormalities or other characteristics features) as described by Hasan *et al*. (2013).

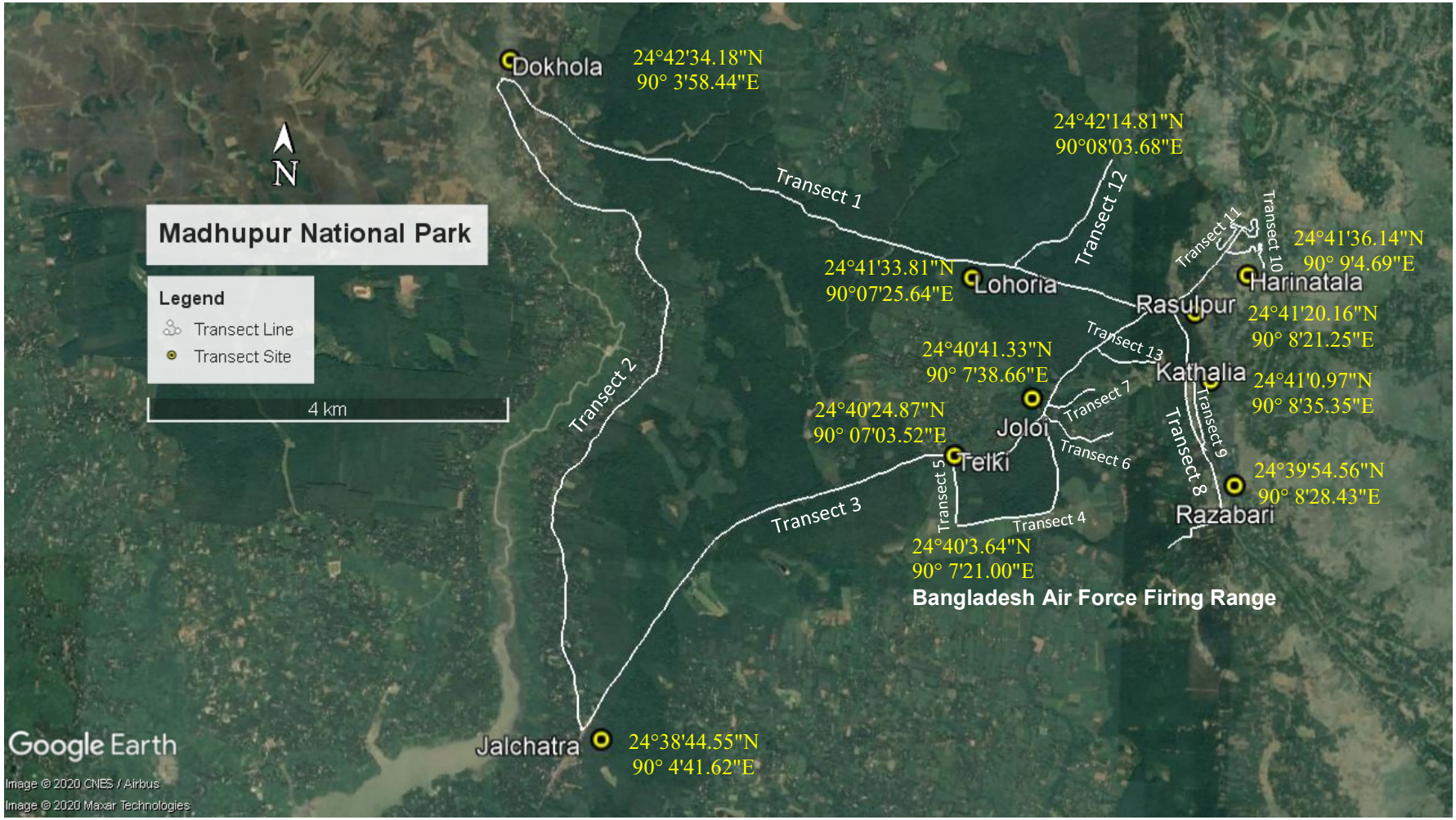


Fig. 3.1. Satellite image of the study area showing transect line, transect site and GPS Point (Source: Google Earth).

Table 3.1. Length of the transect line used in the study area.

Transect number	Transect site	Transect length (km)	GPS location	
			Start Point	End Point
1	Rasulpur – Dokhola	8	24°41'20.16"N 90° 8'21.25"E	24°42'34.18"N 90° 3'58.44"E
2	Dhokhola – Jalchatra	9	24°42'34.18"N 90° 3'58.44"E	24°38'44.55"N 90° 4'41.62"E
3	Rasulpur – Jalchatra	9	24°41'20.16"N 90° 8'21.25"E	24°38'44.55"N 90° 4'41.62"E
4	Bangladesh Air Force Firing Range	2	24°40'40.50"N 90° 7'38.70"E	24°40'3.64"N 90° 7'21.00"E
5	Telki	1	24°40'24.87"N 90° 07'03.52"E	24°39'59.82"N 90°07'05.57"E
6	Joloi 1	1	24°40'41.33"N 90° 7'38.66"E	24°40'35.18"N 90° 8'6.18"E
7	Joloi 2	1	24°40'44.90"N 90°07'40.03"E	24°40'48.58"N 90°08'01.66"E
8	Rasulpur – Razabari	3	24°41'20.16"N 90° 08'21.25"E	24°39'54.56"N 90°08'28.43"E
9	Kathalia	1	24°41'0.97"N 90°08'35.35"E	24°40'30.03"N 90° 8'42.96"E
10	Harinatala 1	2	24°41'22.79"N 90° 8'27.45"E	24°41'47.15"N 90° 8'47.34"E
11	Harinatala 2	1	24°41'41.94"N 90° 8'49.64"E	24°41'36.14"N 90° 9'4.69"E
12	Lohoria	2	24°41'33.81"N 90°07'25.64"E	24°42'14.81"N 90°08'03.68"E
13	Rasulpur	1	24°41'06.30"N 90°07'59.78"E	24°41'00.82"N 90°08'21.60"E

3.2.3 Material used

GPS coordinate of each sighted group was recorded by Garmin eTrex10. A pair of binoculars (Bushnell 10X42 Nature view) was used to identify the group size and age-sex determination from a safe distance. DSLR camera (Nikon D3200, Lens: Nikkor 55-300mm) was used to take photographs of the Capped Langur and their habitats.

3.2.4 Data analysis

Total individuals and group size was calculated by counted all recorded groups. Age and sex ratio estimated by analysed all encountered groups. Solitary individuals were included in estimation of total number of population but excluded in mean group size and sex ratio calculations. Mann-Whitney U-test was used to find any variation among the recorded group size of the two habitats (natural forest and human habitation area). Chi-square test was performed to estimate the differences of group composition and age-sex ratios in the groups. Microsoft Excel 2010 was used to compile and analysed the data.

3.3 RESULTS

3.3.1 Population status

A total of 154 individuals of 18 troops and one isolated adult male (AM) of Capped Langur (CL) were recorded in the study area (Table 3.2). This isolated adult male was sighted in several times at the Rasulpur (N24°41′22.7″, E90°08′26.3″). It was noted to take provisioned food (nut, bread, banana and biscuit) supplied by the local people and tourists who were visited the national park area (Plate 3.1). Except this adult male, no individual was recorded to take provisioned food during this study. This individual was also recorded in different areas (N24°41′03.3″, E90°07′54.5″, N24°40′46.0″, E90°07′37.3″) of the national park.

The highest number (44%) of Capped Langur was recorded near the forests of Joloi rest house (Fig. 3.2). The area of Joloi rest house and its adjacent forests are an undisturbed dense with highly diversified plant species than other areas of the national park. On the other hand 24 hours motorized and unmotorized vehicles move through the Tangail–Mymensingh highway which passes near the Joloi area. Beside this, forest officers and staffs are regularly patrolling this highway. That is why no hunting activities by the local ethnic people were recorded in this area. Due to availability of food plants and safe habitat maximum number of Capped Langur was recorded from this area.

Table 3.2. Group size, age-sex structure and GPS location of the recorded group.

Group	Group size	Recorded date and time	Recorded area	GPS	Group composition						
					AM	AF	SAM	SAF	JM	JF	In
Gr-1	7	03/04/2015 06:00 hr	Joloi	24°40'44.39"N 90° 7'37.87"E	1	1	2	3	0	0	0
Gr-2	4	24/04/2015 06:30 hr	Telki	24°40'22.61"N 90° 7'9.58"E	1	1	1	1	0	0	0
Gr-3	1	24/04/2015 18:18 hr	Rasulpur	24°41'6.37"N 90° 8'31.43"E	1	0	0	0	0	0	0
Gr-4	11	15/05/2015 06:00 hr	Joloi	24°40'44.48"N 90° 7'41.81"E	1	3	2	3	0	1	1
Gr-5	12	05/06/2015 06:00 hr	Joloi	24°40'48.10"N 90° 7'40.46"E	2	4	1	1	0	0	4
Gr-6	6	23/07/2015 14:00 hr	Lohoria	24°41'33.91"N 90° 7'28.89"E	1	2	1	1	0	0	1
Gr-7	5	23/07/2015 14:15 hr	Lohoria	24°41'32.77"N 90° 7'19.86"E	1	2	1	0	0	0	1
Gr-8	9	24/07/2015 09:00 hr	Lohoria	24°41'38.85"N 90° 6'54.36"E	1	3	1	1	0	2	1
Gr-9	10	24/07/2015 10:00 hr	Dokhola	24°41'55.20"N 90° 4'46.61"E	1	2	1	1	1	2	2

Gr-10	6	13/08/2015 17:45 hr	Joloi	24°40'37.86"N 90° 7'38.36"E	2	2	0	1	0	0	1
Gr-11	14	30/09/2015 07:45 hr	Joloi	24°40'41.14"N 90° 7'35.56"E	1	7	1	2	1	2	0
Gr-12	6	12/11/2015 11:15 hr	Human Habitation (Kathalia village)	24°40'44.40"N 90° 8'38.77"E	1	3	0	0	2	0	0
Gr-13	14	27/01/2016 12:00 hr	Rasulpur	24°41'17.57"N 90° 8'20.37"E	1	5	1	1	3	2	1
Gr-14	12	31/03/2016 10:30 hr	Human Habitation (Harinatala village)	24°41'42.79"N 90° 9'2.77"E	1	5	1	0	1	3	1
Gr-15	5	19/05/2016 11:30 hr	Joloi	24°40'32.23"N 90° 7'32.27"E	1	4	0	0	0	0	0
Gr-16	10	25/05/2016 11:20 hr	Joloi	24°40'26.61"N 90° 7'25.05"E	1	4	1	0	0	0	4
Gr-17	11	26/05/2016 10:30 hr	Human Habitation (Harinatala village)	24°41'41.25"N 90° 8'49.87"E	1	5	1	0	2	2	0
Gr-18	3	21/07/2016 12:30 hr	Joloi (Garo village)	24°40'32.71"N 90° 7'49.81"E	1	1	1	0	0	0	0
Gr-19	9	01/09/2016 10:30 hr	Human Habitation (Razabari beat)	24°40'27.19"N 90° 8'42.60"E	1	4	0	1	1	2	0
Total =					**21**	**58**	**16**	**16**	**11**	**16**	**17**
%					**13.6**	**37.4**	**10.3**	**10.3**	**7.1**	**10.3**	**11**

AM – Adult male, AF – Adult female, SAM – Sub-adult male,
SAF – Sub-adult female, JM – Juvenile male, JF – Juvenile female, In – Infant

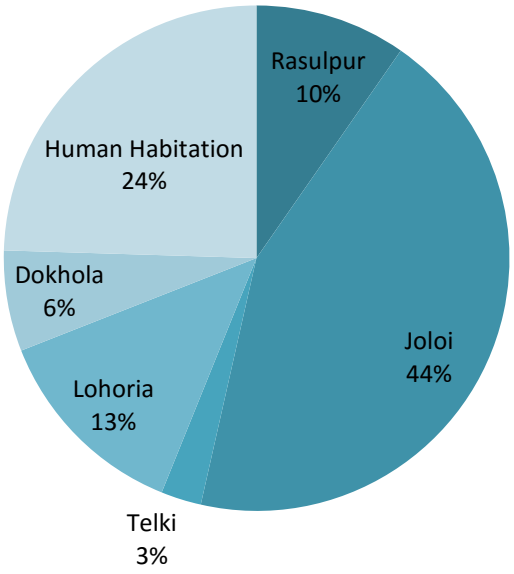


Fig. 3.2. Percentage of the recorded individuals in different area.

3.3.2 Group size

The group size ranged from 3 to 14 (8.6±3.4, n=18) individuals. The highest group size (14 individuals) and maximum number of groups were recorded from the Joloi area. It was early mentioned that food plants, dense forest with high canopy layer and patrolling of forest guard ensured the maximum group numbers in this area. The lowest group size (1 individual) was found in the Rasulpur area (Rasulpur Bazar, near Rasulpur forest range) where the forest was fragmented and canopy was scattered. Moreover, scarcities of food plants were recorded in this area. The group size between the forest and human habitation areas was statistically insignificant (Mann-Whitney U= 17.5, $p>0.05$).

3.3.3 Group composition

Of the 155 individuals (including isolated AM), 51% were adults, of which 13.6% were adult males and 37.4% were adult females. On the other hand, 49% of the total population was non-adult (sub-adult, juvenile and infant). Among the recorded groups, female was the highest (58.1%) (Fig. 3.3). The number of the sub-adult males (SAM), sub-adult females (SAF) and juvenile females (JF) were same (Fig. 3.3). The ratio of adult males and adult females was 1:2.8, adult and youngs 1:0.9, adult females and infants 1 : 0.3, adult males and sub-adult 1 : 1.5, and adult females and youngs 1 : 1.3. There was no significant differences in the proportions of adult males and adult females ($\chi^2 = 0.996$, df = 17, $p>0.05$), adult and youngs ($\chi^2 = 0.833$, df = 17, $p>0.05$), adult females and infants ($\chi^2 = 0.409$, df = 17, $p>0.05$), adult males and sub-adult males ($\chi^2 = 0.964$, df = 17, $p>0.05$) and adult females and youngs ($\chi^2 = 0.832$, df = 17, $p>0.05$).

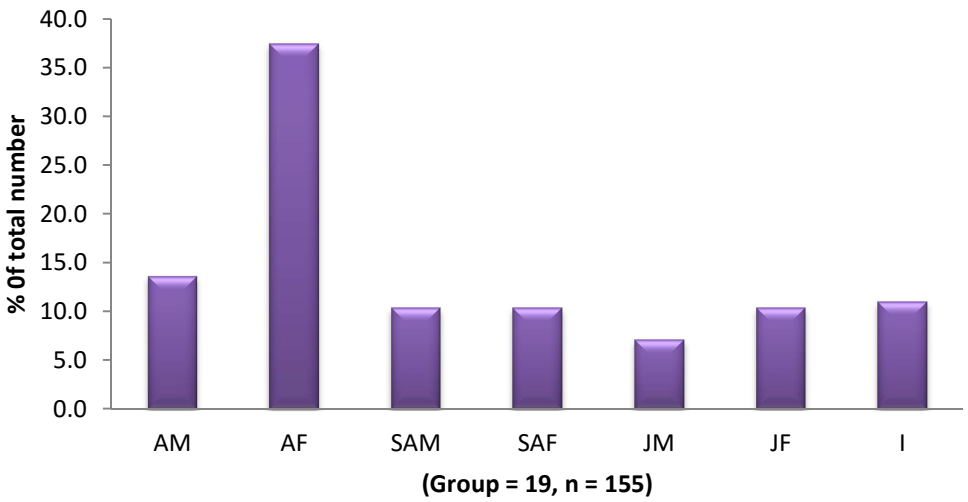


Fig. 3.3. Group composition of the Capped Langur.

3.3.4 Group structure

Four types of group structure (i.e., one-male, uni-male uni-female, uni-male multi-female and multi-male multi-female) were recorded during this study. Uni-male multi-female group structure was the highest (68%) than the others (Fig. 3.4).

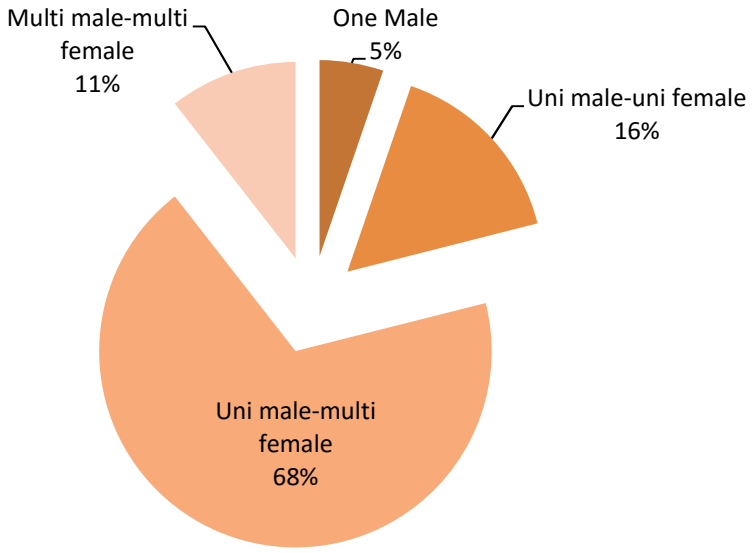


Fig. 3.4. Group structure of the Capped Langur.

3.3.5 Sex composition

The mean sex ratio of the adult male and adult female was 1:2.8. During this study different types of sex ratio was recorded (Fig. 3.5). The sex ratio in the forest habitat was 1:2.4 and in the human habitation area was 1:4.3 (see section 3.2.1). There was no significant difference in the proportions of adult males and adult females among the two habitat ($\chi 2 = 0.18$, df = 1, p = 0.67).

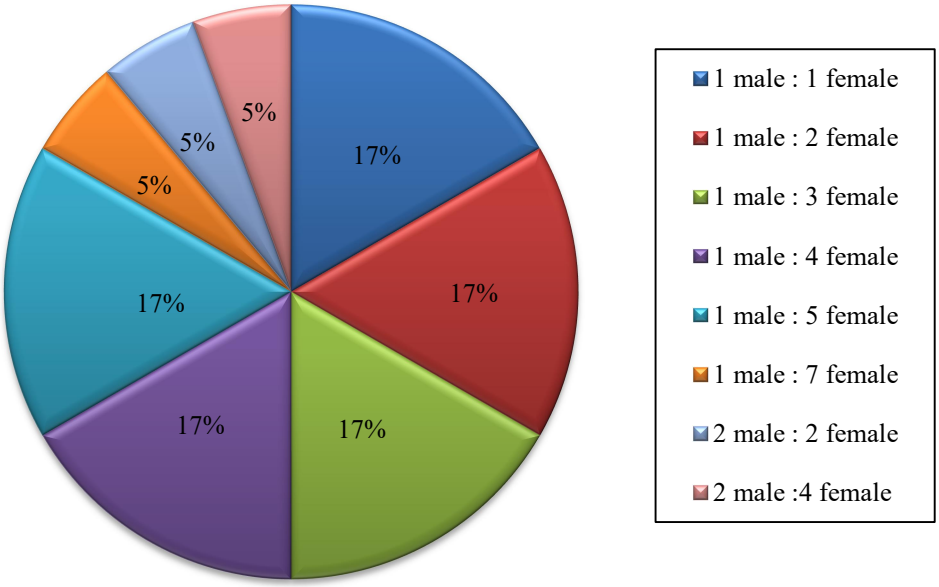


Fig 3.5. Sex ratio of the Capped Langur.

3.3.6 Distribution

During the study period, Capped Langur was recorded from undisturbed forest site with available food plant species. Except four (22%), all of the troops were recorded from the natural forest area (Figs. 3.6, 3.7). During lean period of food sources (especially in winter season) Capped Langur moved from natural forest to human habitation (village Harinatala and Kathalia; under the Muktagacha upazilla, Mymensingh district), near the eastern boundary of the national park, where food plants were available. All of the troops were confined with high canopy layer. Among the troops in the park, three (20%) were recorded from the undisturbed deep forest area and others (80%) were near the peripheral region of the park boundary. Along the Tangail–Mymensingh highway (which passes near the southern boundary line of the national park) in Beribaid Forest Beat area 57.9 % troops were recorded (Fig. 3.9).

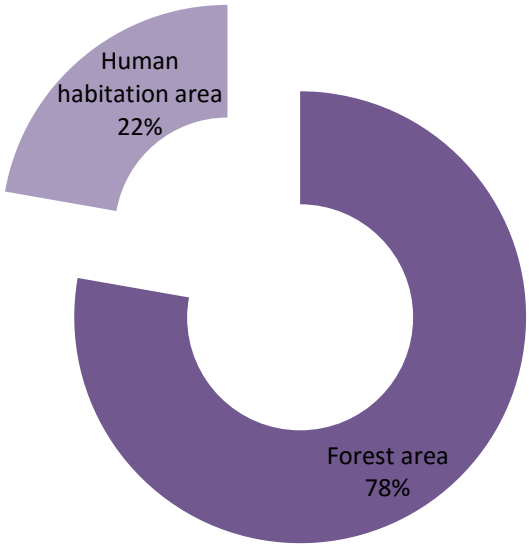


Fig. 3.6. Percentage of population in two habitats.

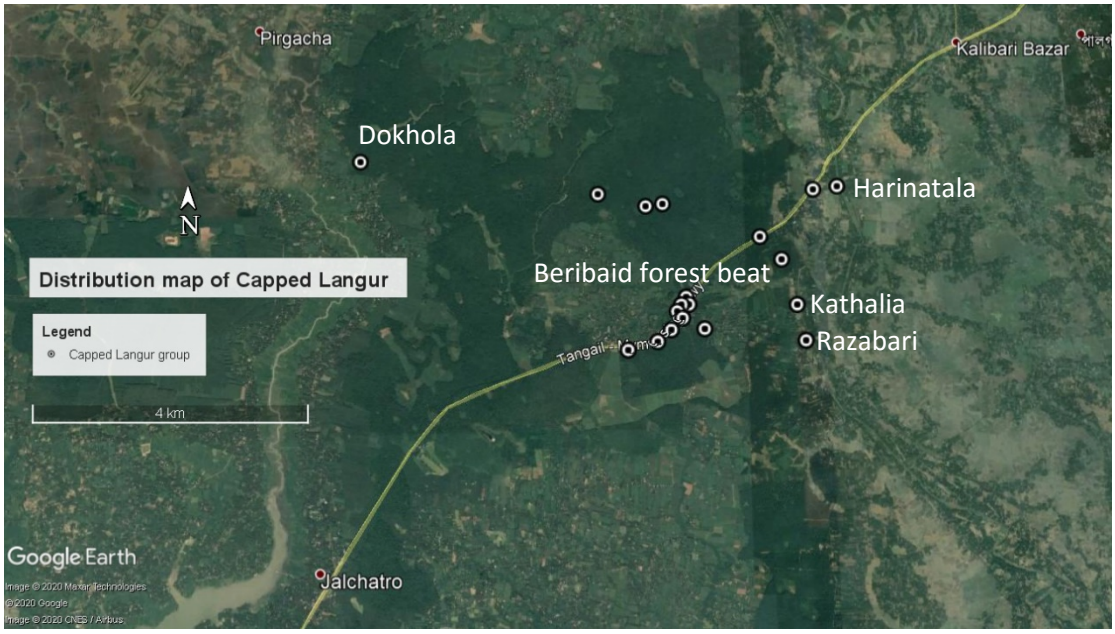


Fig. 3.7. Sighting records of the Capped Langur groups in and around the Madhupur Forest (Source: Google Earth).

3.4 DISCUSSION

In total 155 individuals of Capped Langur were recorded in the study area, while Naher and Khan (2018) recorded 99 from the same area. Hasan (2017) reported 43 from the Satchari National Park, Sylhet, Bangladesh. Biswas *et al.* (2009) noted 721 individuals in different protected areas of Assam in India.

I recorded 18 social groups along with one old solitary male in the study area, but Naher and Khan (2018) recorded 12 groups from the same area. Hasan (2017) reported 4 groups from the Satchari National Park, Bangladesh. Khan and Ahsan (1981) noted 47 groups from different forests of Bangladesh. Naher and Khan (2018) and Green (1981) also stated a solitary adult male in the Madhupur forest, Bangladesh. Old solitary males have also been reported for Hanuman Langurs *Semnopithecus entellus* (Dufresne) in India (Rajpurohit *et al*. 2004). During this study the group numbers and total individuals of Capped Langur were the highest than Naher and Khan (2018), this is because the duration of study period, area and transects covered in this study were more than the earlier study.

In the present study, the average group size of Capped Langur was 8.6. Geographically the group size and composition varies due to habitat structure and food availability (Kumar and Solanki 2008). This average group size is smaller or larger in compared to other study in Bangladesh (8.7 – Green 1978, 7.6 – Green 1981, 5.36 – Khan and Ahsan 1981, 6.4 –Islam and Husain 1982, 8.5 – Stanford 1991a, 6.6 – Feeroz 2001, 7.5 – Kabir 2002, 10.3 – Hasan 2017, 7.6 – Naher and Khan 2018) and India (9.4 – Biswas *et al.* 2009, 10 – Choudhury 1995/1996, 9.7 – Mukherjee 1978).

The group size of the Capped Langur ranged from 3 – 14 during this study but Naher and Khan (2018) recorded 4 – 14 in the Madhupur National Park. It was 8 – 13 individuals in the Satchari National Park (Hasan 2017). But Khan and Ahsan (1981) reported that it was 2 – 14 in Bangladesh. Mukherjee (1978) reported 7 – 13 in the Manas Wildlife Sanctuary, Assam, India but in Tripura 5 – 16 individuals (Mukherjee 1982). Choudhury (1995/1996) recorted 5 – 15 individuals in the Tinsukia district of Assam. Biswas *et al.* (2009) reported that the group size of the Capped Langur ranged from 3 – 22 individuals indifferent protected areas of the Assam. Choudhury (2008) mentioned that the average group size ranged from 9 – 13 in Bhutan. The group size of other species of *Trachypithecus* varied in different areas (Table 3.3). The distribution, abundance and quality of the food items in the habitat

Table 3.3. Social organization of *Trachypithecus* in different forest habitat.

Species	SO	AM	AF	IEI	Infant	MGS (range, n)	AM:AF	I:AF	Ad:Im	Habitat	Source
T. pileatus	OMG	1	3.3(1-7)	3.5(0-3)	0.75(0-4)	8.5(3-14, 16)	1:3.3	1:4.3	1:0.8	Deciduous forest	This study
	TMG	2(2-2)	3(2-4)	1.5(0-1)	2.5(1-4)	9(6-12, 2)	1:1.5	1:1.2	1:0.3		
	OMG	1	3(1-7)	3.5(1-6)	0.91(0-3)	8.4(4-14, 11)	1:3	1:3.3	1:0.8	Deciduous forest	Naher and Khan 2018
	TMG	2	2	1	1	6(6, 1)	1:1	1:2	1:0.3		
	OMG	1	3.5(3-4)	3(1-2)	1.5(1-2)	9(8-10, 2)	1:3.5	1:2.3	1:0.7	Mixed-evergreen forest	Hasan 2017
	TMG	2(2-2)	3(0-5)	2(0-2)	1.3(0-2)	8.3(2-13, 3)	1:1.5	1:2.3	1:0.4		
	OMG	1	4.7(4-5)	1.3(0-2)	0.7(0-2)	8.3(7-9, 3)	1:4.7	1:7	1:0.5	Evergreen-deciduous forest	Solanki *et al.* 2007
	TMG	2	4	1	0	7(7, 1)	1:2	0:4	1:0.2		
	OMG	-	-	-	-	7.5(2-13, 26)	1:3.6	-	-	Evergreen-deciduous forest	Kumar and Solanki 2008
T. shortridgei	OMG	1	2.9(2-3)	2.7(2-3)	1.4(1-2)	8(7-9, 5)	1:2.9	1:2.2	1:1.2	Evergreen-deciduous forest	Li *et al*. 2015
T. delacouri	OMG	1	5.4(2-8)	1.6(0-3)	3.6(0-6)	10.8(4-16, 5)	1:5.4	1:1.5	1:0.7	Limestone karst	Workman 2010
	TMG	2(2-2)	1.5(1-2)	2(1-3)	0	5.0(4-6, 2)	1:0.8	0:3	1:0.4		
T. geei	OMG	1	2	3	1	7(7,1)	1:2	0:2	1:1.3	Nature forest	Medhi *et al.* 2004
	TMG	2	4.5(2-7)	10(4-16)	6(6-6)	22.5(19-26, 2)	1:4.5	1:0.8	1:2.5		
T. leucocephalus	OMG	1	5.1(1-14)	2.6(0-10)	2.9(0-9)	11.7(3-30)	1:5.1	1:1.8	1:0.8	Limestone karst	Jin *et al.* 2009
T. vetulus	OMG	1	6	-	4	11	1:6	1:1.5	1:0.6	Dry zone forest	Vandercone *et al*. 2012
T. francoisi	OMG	1	3	-	5	9	1:3	1:0.6	1:1.3	Limestone karst	Huang *et al*. 2006
	OMG	1	5	-	3	9	1:5	1:1.7	1:0.5	Limestone karst	Huang *et al*. 2007
	OMG	1	2.8(2-3)	1.5(0-3)	0	5(4-6, 4)	1:2.8	1:2.8	1:0.4	Limestone karst	Li and Wei 2012
T. obscurus	OMG	1	5	11	1	18	1:5	1:5	1:2	-	Md-Zain and Ch'ng 2011
T. phayrei	OMG	1	4	4	3	9	1:4	1:1.3	1:0.8	Evergreen forests	Koening *et al.* 2004
T. p. crepusculus	OMG/MMG	1-5	3-12	0-12	1-11	19(6-33)	1:3.5	1:1.3	1:1.1	Dry evergreen forest	Koening and Borries 2012
T. crepusculus	MMG	10-11	30-31	30	20	90-91	1:3	1:1.5	1:1.3	Evergreen broad	Fan *et al.* 2014
T. johnii	OMG	1	2.0(2-2)	4(2-6)	0.5(0-1)	7.5(6-9, 2)	1:2	1:4	1:0.5	Evergreen-deciduous forest	Roy *et al.* 2012
T. auratus	OMG	1	14	8	1	24	1:14	1:14	1:0.7	-	Tsuji *et al.* 2013

SO: Social organization, AM: Adult male, AF: Adult female, IEI: Immature except infants, MGS: Mean group size, I: Infant, Ad: Adult, Im: Immature, OMG: One-male, multi-female group, TMG: Two-male, multi-female group, MMG: Multi-male, multi-female group

may be responsible for the variation of group size in different area (Kumar and Solanki 2008). The present study showed that the average group size of the Capped Langur was higher than the others findings in the same area (Green 1981, Islam and Husain 1982, Stanford 1991a, Naher and Khan 2018). This may be due to the opportunity to acquire more food (agricultural field, homestead vegetable and fruit garden) influenced the Capped Langurs to forage and live in human settlements.

This study showed single male and multi males groups. This was also documented by Islam and Husain (1982), Stanford (1987) and Hasan (2017). Stanford (1989, 1991a) and Kabir (2002) also found one male multi female groups of *Trachypithecus pileatus* in Madhupur National Park and Bangladesh, respectively.

In different protected areas of Assam, India Biswas *et al*. (2009) recorded single male (38.6%), two male (30.6%), multi-male bisexual groups (22.6%), all male band (4%) and lone males (4%). In and around Pakke Wildlife Sanctuary, Arunachal Pradesh, India almost 90% of the population was recorded in one male-multi female social system (Kumar and Sonalki 2008). Furuya (1962) and Kool (1989) observed multi male multi female group in colobines. In *Trachypithecus phayrei* both single and multi-male group structure recorded in Bangladesh (Stanford 1988) and in India (Mukherjee 1982, Gupta 1996). It was also the same for *Trachypithecus geei* (Mukherjee and Saha 1974, Mukherjee 1978, Srivastava *et al*. 2001b),

Single adult male group was also recorded in other colobine species in India, i.e., *Presbytis aygula* (Ruhiyat 1983), *P. hosei* (Payne and Davies 1982), *P. thomasi* (Gurmaya 1986, Sterck 1997), *P. melalophos* (Curtin 1976, Bennett 1983), *P. potenziani* (Watanabe 1981), *P. rubicunda* (Payne and Davies 1982, Davies 1984, Suprianta *et al.* 1986), *Trachypithecus cristatus* (Bernstein 1968, Wolf 1980, Ridley 1986), *T. auratus* (Hardy 1988), *Presbytis senex senex* (Rudran 1973).

The adult-female was the highest (37.4%) in Madhupur National Park, which was also observed by Hasan (2017) in the Satchari National Park (39%), Bangladesh and Biswas *et al.* (2009) in the protected areas of Assam (33.4%), India.

The adult sex ratio was 1:2.8 in the Madhupur National Park, which was almost the same of Hasan's (2017) findings (1:2.9) in Satchari National Park. While Green (1981) recorded 1:2 and Khan and Ahsan (1981) reported 1:2.32 in the Madhupur National Park. But Kumar and Solanki (2008) reported 1:3.6 in Pakke Wildlife Sanctuary, India and in the protected areas of Assam sex ratio was 1:1.65 (Biswas *et al.* 2009). In other colobine species (*Semnopithecus entellus*) adult males

to adult females ratio was 1:1.24 in Jessore, Bangladesh (Rahman *et al.* 2015), 1:3.2 in Morni hills of Haryana, India (Chopra *et al.* 2013), *Trachypithecus geei* 1: 2.1 in Assam, India (Srivastava 2006b), *Trachypithecus shortridgei* 1:2.9 in Yunnan, China (Li *et al.* 2015).

Capped Langur preferred to live in the natural forest but during food scarcity period, especially in winter season while most of the leaves were shed in Madhupur National Park the Capped Langur (21.1%) moved from natural forest to human habitation near the periphery of the national park to raid homestead vegetable and fruit gardens. But Kumar and Solanki (2008) documented 23.1% population on the periphery of Pakke Wildlife Sanctuary in Arunachal Pradesh in India.

PLATE 3.1

(a)

(b)

Plate 3.1. Isolated adult male (a, b) took provisioned food from local people.

CHAPTER 4 : BEHAVIORAL PATTERNS

4.1 INTRODUCTION

The percentage of time spent in different activities is vital for understanding inter-specific differences in the frequency of their behavioral patterns and for predicting intra-specific life style variations (Ahsan 1994). Activity budget is a useful resume of information to indicate important features of behavioral niche differentiation between sympatric species (Chalmers 1968, Stanford 1991a). Activity pattern is an important aspect of the behavioral ecology of an animal to determine the proportion of time spent in different activities and the distribution of those behaviors throughout the day, month and year (Mandal and Kabir 2014). The way in which primates use their time and organize activity patterns is an important aspect of behavioral ecology (Chalmers 1968). Important physiological and environmental factors such as energy balance, body size and food availability impact on activity budgets (Clutton-Brock 1974). Diet and habitat structure are also known to affect time spent in activities because of trade-offs between obtaining food and the costs in energy of doing so (Jaman and Huffman 2008). Temperature influences a plant's rate of growth and its nutritional content (Jaman and Huffman 2008). This has both direct and indirect effects on the seasonality of the activity budget of species dependent upon plants for food (Dunbar 1992).

The Capped Langur is diurnal, predominantly arboreal and folivorous (Molur *et al*. 2003). The feeding strategy is adapted to cope with seasonal food scarcity (Stanford 1991b). The food consumption of a primate's linked to seasonality, habitat quality, food abundance and distribution in the wild (Jaman and Huffman 2008).

Several studies on activity budget of *Trachypithecus* species were conducted in different parts of the world: *Trachypithecus pileatus* (Stanford 1991a, Kabir 2002, Mandal and Kabir 2014 and Hasan 2017) and *T. phayrei* (Kabir 2002, Hasan 2019) in Bangladesh, *T. auratus* (Kool 1989) in Indonesia, *T. obscurus* (Hardy 1988) in Malaysia, *T. francoisi* (Zhou *et al.* 2006) in China, *T. leucocephalus* (Zhou *et al.* 2010) in China, *T. delacouri* (Agmen 2014) in Vietnam, *T. poliocephalus* (Hendershott *et al.* 2016) in Vietnam.

Quantitative data on behavioral activities of Capped Langur are provided in this study to find out the proportion of time spent in activities in a day, month or season; to determine any significance difference in between the activities, age-sex

classes, month and season; to compare with previous studies conducted on activity budget of Capped Langur and to provide background information for future research.

4.2 METHODS

4.2.1 Study Plan and data collection

Fortnightly two days long study was made to collect the behavioral data during January 2016 to December 2017. From dawn to dusk scan sampling method at 5 minutes interval was followed (Altmann 1974). Scan sampling method was best suited in collecting a large dataset from which percentage of time spent in various activities can be calculated and also for extensive computer analysis in tropics (Kabir 2002, Ahsan 1994). Continuous observation was not possible in natural forest to select focal sampling method (Kabir 2002, Gupta 1996). The day was classified into four time blocks, i.e. early morning (0500 - 0830 hr), late morning (0831 - 1200 hr), early afternoon (1201 - 1530 hr) and late afternoon (1531 - 1900 hr). The time schedule was fluctuated depending on the seasonal variation. A total of 4168 scans were done to collect the data. In total 104 days and 1144 hours were spent in the study area to collect the behavioral data. Data was collected from the first sighting of the group in the early morning while any individual started its movement from and ended while the langur entered into night halt tree. Behavioral activities on different height were recorded through visual estimation and these heights were categorized as upper canopy (above 20m), middle canopy (10-20 m) and lower canopy (up to 10 m), followed by Solanki *et al.* (2008a) and Martin and Bateson (1986). The following ethogram was recorded during this study:

Activity	**Characteristics**
1. Resting:	starts when no other behavior occurs regardless of posture (Jaman and Huffman 2008).
2. Foraging:	is uninterrupted search for food items in vegetation where food is typically found, often but not always, ended by ingestion of food or water (Jaman and Huffman 2008).
3. Feeding:	is defined as the intake of solid food or water into the mouth, followed by chewing and/or swallowing (Jaman and Huffman 2008).
4. Traveling:	is defined as terrestrial or arboreal locamotion, lasting a minimum of

	5 sec, from one place to another, except when searching for food or another animal (Jaman and Huffman 2008).
5. Sleeping at day time	A natural periodic state of rest for the mind and body, in which the eyes usually close and consciousness is completely or partially lost.
6. Social	playing (social playing or solitary playing), groom (social or self), breastfeeding (occurred by mother), allomothering (carrying, provisioning, grooming, touching, nursing (allonursing), and protecting the infants from predators or conspecifics), vigilance (individual watching something for more than 10 sec while not engaged in other actions) (Jaman and Huffman, 2008), aggression (any aggressive physical contact, gesture or vocalization typically directed toward a subordinate individual) (Jaman and Huffman 2008) and mating.

4.2.2 Material used

A data sheet was prepared (Annexure 1) to collect behavioral data during study time. A pair of binoculars (Bushnell 10 x 42 Nature View) was used to observe the behavioral activities and DSLR camera (Nikon D3200, Lens Nikkor 55 - 300 mm) was used to take photographs of different activities of Capped Langur in the study area and GPS coordinate of the study group was recorded by Garmin eTrex10.

4.2.3 Data analysis

Microsoft Excel 2010 was used to compile and analysed the data and also to prepare pie charts, bar diagrams. Pearson Correlation Coefficient tests were applied to know relationship between sunrise or sunset and activity start or end time, day length and activity period, mating behavior with temperature and group size with daily path length. Kruskal-Wallis test was used to find out monthly variation of different activities. Chi-square test was performed to estimate the differences among the age-sex class and seasonal variation.

4.3 RESULTS

4.3.1 Starting and ending time of behavioral activities

The Capped Langur always started their activities (05:15 to 06:45 hr) before sunrise (05:10 to 06:44 hr) except in January (sunrise 06:44 hr, activity started 06:45 hr), April (sunrise 05:51 hr, activity started 06:00 hr), May (sunrise 05:11 hr, activity started 05:30 hr), June (sunrise 05:10 hr, activity started 05:15 hr) in 2016 and October in 2017 (sunrise 05:53 hr, activity started 06:00 hr). Starting time of the diurnal activities ranged from 27 min. before to 19 min. after (- 4.22 ± 11.61 min., n=18) sunrise but it stopped the activities (17:30 to 19:15 hr) always after sunset (17:10 to 18:49 hr), which ranged from 8 to 26 min. (16.33 ± 5.5 min., n=18). It varied in different months of the year. The starting time was early in November (27 min. before sunrise) and late in May (19 min. after sunrise) (Fig. 4.1). Hence, it was revealed that, the starting time of different activities depended on the length of daylight, i.e., it started activities early during short daylight period (winter) and late during long daylight period (summer). There was a positive correlation between sunrise with activities started time ($r=0.871$, $p<0.05$) and sunset with activities ended time ($r=0.942$, $p<0.05$). The individual started defecates and urinate just after departing the night halt tree and diurnal activities never stopped before sunset.

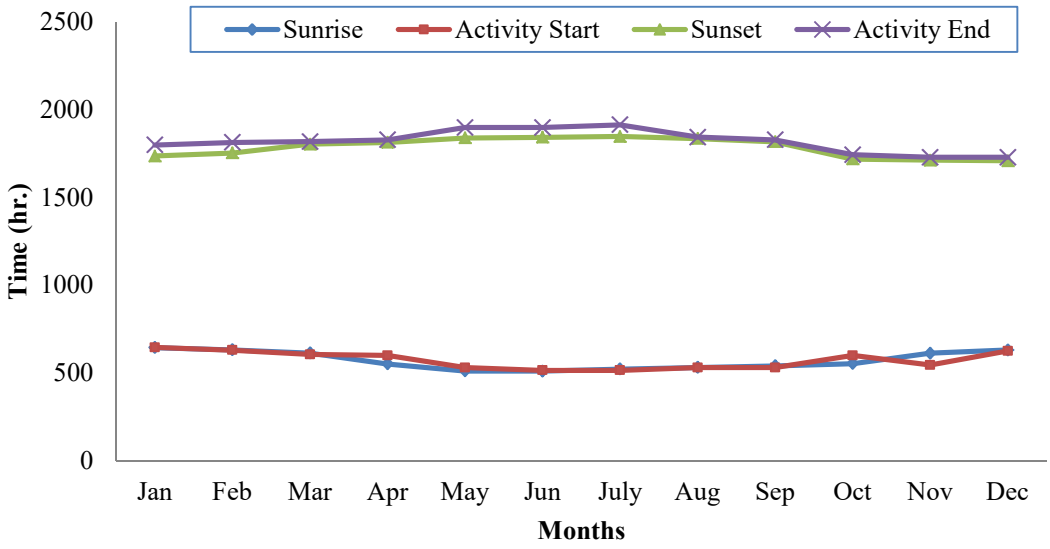


Fig. 4.1. Activity start and end time in relation to sunrise and sunset.

4.3.2 Diurnal active period

The duration of the diurnal total active period varied daily, monthly and seasonally. It ranged from 665 min. (11 hrs. 5 min.) to 795 min. (13 hrs. 15 min.) (716.67 ± 41.41 min., n=12) in a day (Fig. 4.2) and the day length varied from 639 to 814 min. (729.67±65.21 min., n=12). It was the highest (795 min.) in August, comparatively longer day length (786 min.) and the lowest (665 min.) in December due to shortest day length (639 min.) (Fig. 4.3). Seasonally the highest active period was recorded in monsoon (750±65.21 min., n=4) (Fig. 4.4). There was no significant relationship (r = 0.36, p = 0.25) among the diurnal active period and length of the day.

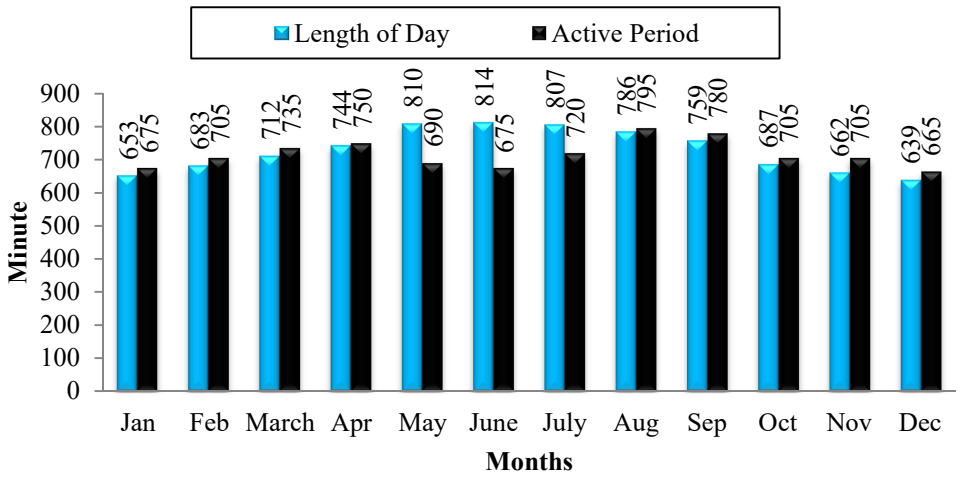


Fig. 4.2. Duration of a day and diurnal active period of the Capped Langur.

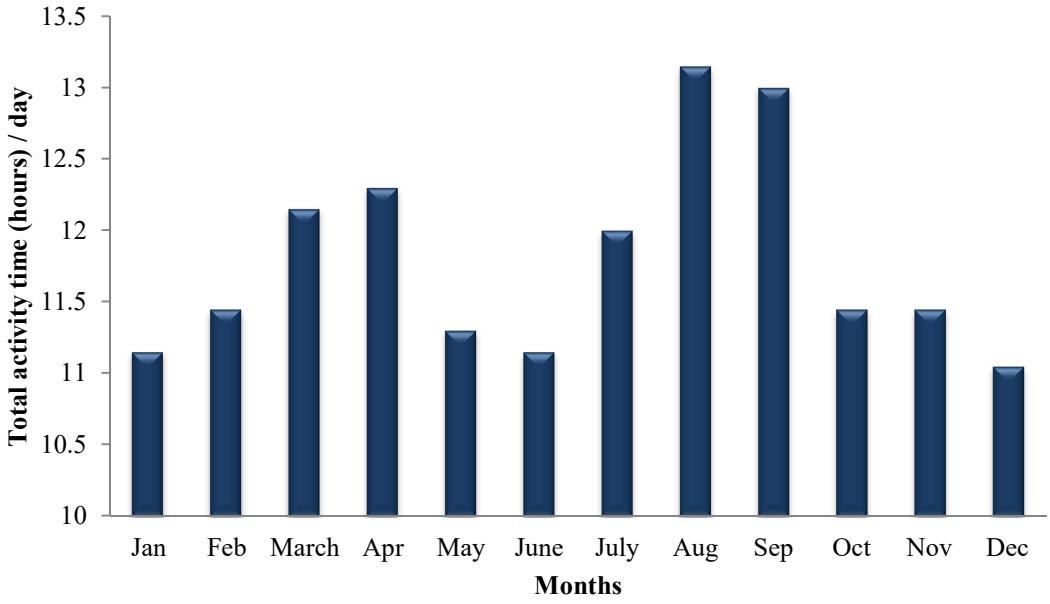


Fig. 4.3. Monthly variation of the total diurnal activity period.

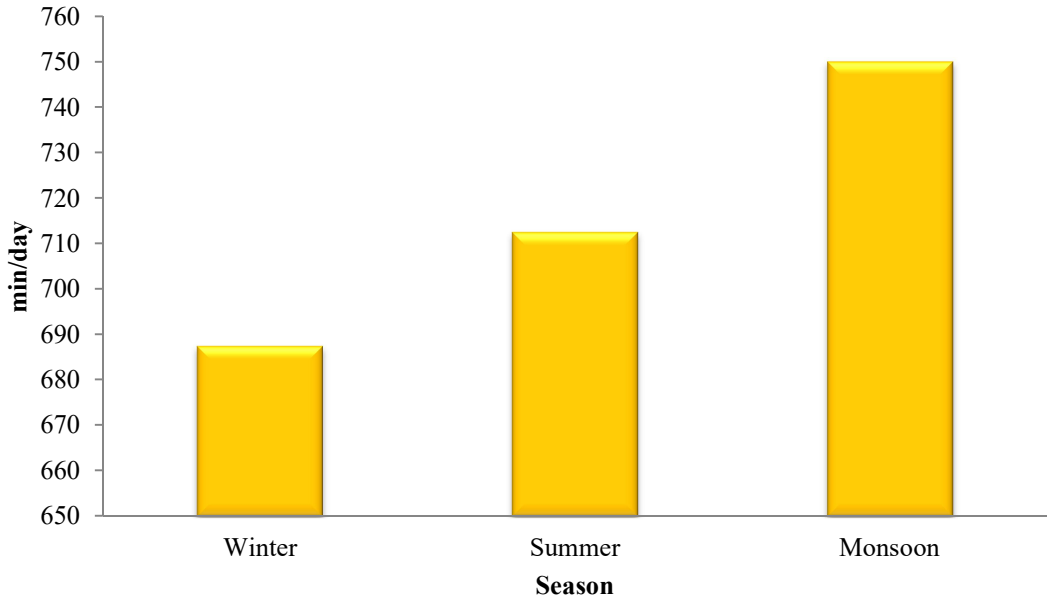


Fig. 4.4. Seasonal variation of the total diurnal active period.

4.3.3 Diurnal activity budget

Capped Langur spent the highest time in resting (32.68%), followed by foraging and feeding (28.51%), sleeping (18.15%), traveling (11.11%), playing (7.57%), mating (1%), grooming (0.98%) and other activities (0.97%). There was no significant relationship among the traveling and resting activities (r = 0.2832, p = 0.3724). Feeding was significantly inversely correlated with resting (r = -0.558, p = 0.059) and traveling (r = -0.503, p = 0.098).

4.3.4 Variation of activity budget in different age-sex classes

The daily activity budget varied in different age-sex classes. In a day, the adult-males spent its maximum time (29.44%) in resting. The adult-females and immatures (sub-adults and juveniles) spent the highest time for feeding in a day. Adult-females took more time to feed probably due to energy requirement for milk production for neonates and to recover its body after child birth. Sub-adults (male and female) and juvenile (male and female) feed more for requirement of nutrition for their growth. Infant was observed to be spent its maximum time (28.46%) for sleeping in a day due to the development of the body. There were significant difference found among the age-sex classes and the proportion of time spent in resting, foraging and feeding than other activities (Table 4.1).

Table 4.1. Percentage of time spent in different activities among the group members of Capped Langur.

	Adult Male n = 858		**Adult Female n = 1079**		**Sub-Adult n = 901**		**Juvenile n = 717**		**Infant n = 613**		**Total n = 4168**		**Kruskal-Wallis test**
Activities	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*p*
Resting	29.44	2.79	21.58	5.23	20.93	3.47	16.95	3.71	22.67	5.62	32.68	1.21	0.0089*
Foraging and feeding	27	2.91	36.18	6.79	38.29	4.31	50.93	5.43	15.62	4.5	28.51	1.44	0.00001*
Traveling	11.85	2.02	12.58	4.68	9.81	2.54	9.49	3.42	12.58	2.97	11.11	1.01	0.62547
Sleeping	25.78	2.96	27.17	6.71	28.16	4.22	20.77	4.71	28.46	6.24	18.15	1.53	0.15119

*Significant at $p < 0.05$

4.3.5 Monthly variation

The diurnal activity budget varied in different months (Fig. 4.5). The highest resting time recorded in October (42.69%) due to rainy weather and the lowest in June (25.03%) because of sunny weather. Time spent in foraging and feeding was the highest in February (33.70%), due to energy requirement for lactating mother and for low temperature (20.6° C) and the lowest in July (20.59%) due to the highest rainfall (436.3 mm). Sleeping time was the highest in April (30.02%) due to spent the lowest time in traveling and the lowest in July (4.03%) for heavy rainfall. The traveling time was the highest in July (27.98%) for searching food in rainy weather and the lowest in April (4.73%) due to spent most of the time in sleeping. The time spent in playing was the highest in February (15.32%) due to cold and the lowest temperature but least in July (1.96%) because of the highest rainfall. There was a significant differences among the activity budget in different months ($H = 42.44$, $df = 11$, $n = 60$, $p<0.05$).

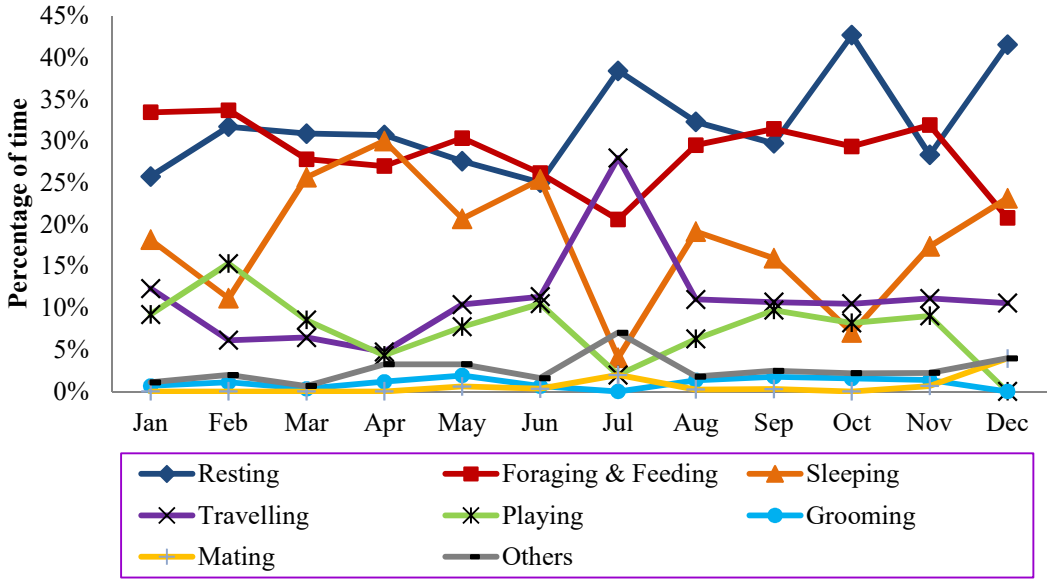


Fig. 4.5. Monthly variation of different activities.

4.3.6 Seasonal variation

The time spent in different activities varied seasonally (Fig. 4.6). The Capped Langur spent more time in resting during (35.78%) monsoon due to the highest rainfall and humidity and the least in summer (28.55%) because of sunny weather. Foraging and feeding was the highest in winter (29.96%) due to energy requirement for pregnant,

lactating mother and cold weather but lowest during monsoon (27.73%) due to the highest rainfall. Time spent in traveling was the highest in monsoon (15.05%) due to shortage of day time in search food plants for heavy rainfall and the lowest in summer (8.23%) due to available food plants. The highest sleeping was recorded in summer (25.44%) due to spent the lowest time in traveling but minimum in monsoon (11.54%) because of heavy rainfall. The highest playing time was recorded in winter (8.39%) due to lowest temperature and lowest in monsoon (6.55%) due to rainy weather.

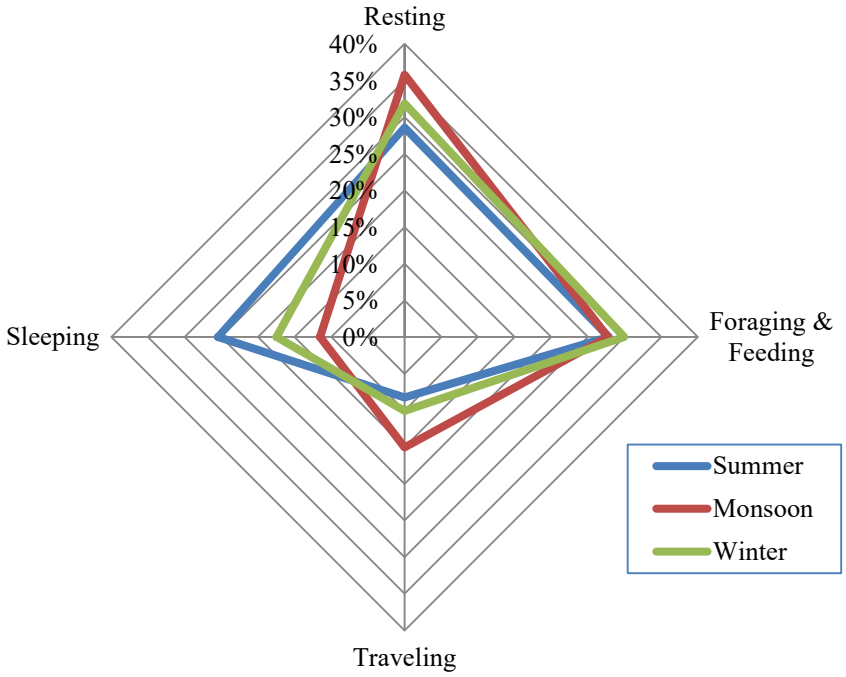


Fig. 4.6. Relative proportion of time spent in four major activities in different season.

4.3.7 Activity budget in different weather

The activity budget of the Capped Langur also varied in different weather condition. Time spent in resting was the highest (42.69%) in rainy day (rainfall 190.9 mm) but the lowest (25.03%) in sunny day (32.75°C). During heavy rain (436.3 mm), time spent in foraging and feeding (20.59%), sleeping (4.03%) and playing (1.96%) was the lowest but social activities was the highest (7.04%). Foraging and feeding (33.70%), and playing (15.32%) were the highest in sunny weather. Traveling was the

highest (27.98%) in cloudy weather and the lowest (4.73%) in rainy weather. There was a significant relationship between resting and traveling with average temperature and rainfall but insignificant in other activities (Table 4.2).

Table 4.2. Pearson correlation coefficient between the monthly average temperature and rainfall with monthly average activities.

Dietary diversity	Average Temperature (^{o}c)		Average Rainfall (mm)	
	r	p	r	p
Resting	0.6184	0.032077*	0.478	0.116004
Feeding	-0.3686	0.23922	-0.3412	0.27805
Sleeping	0.3282	0.297639	0.2175	0.4971
Traveling	-0.6659	0.018294*	-0.6246	0.031508*
Playing	0.3587	0.25221	0.4805	0.113838

*Correlation is significant at $p < 0.05$

4.3.8 Activity budget in different day periods

Resting and sleeping were the highest in early afternoon (Figs. 4.7, 4.8), due to required energy for foraging and feeding and traveling in late afternoon. Immediate after feeding it took rest and went to sleep. The highest feeding time was recorded in late afternoon period (Fig. 4.9) due to take overnight fasting preparation. The highest traveling time was recorded during early morning (Fig. 4.10) in search of food.

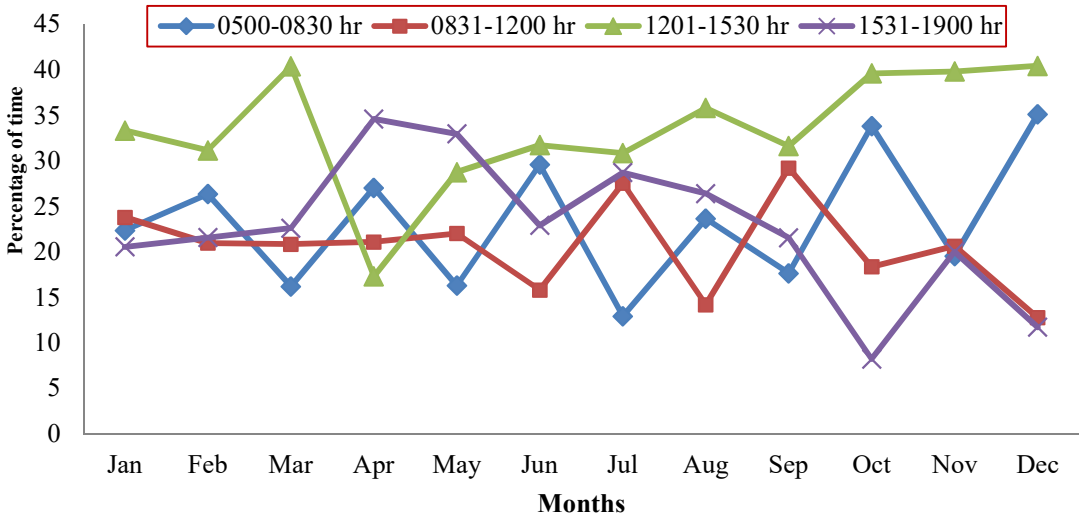


Fig. 4.7. Monthly variation of resting time in four block-hours of the day.

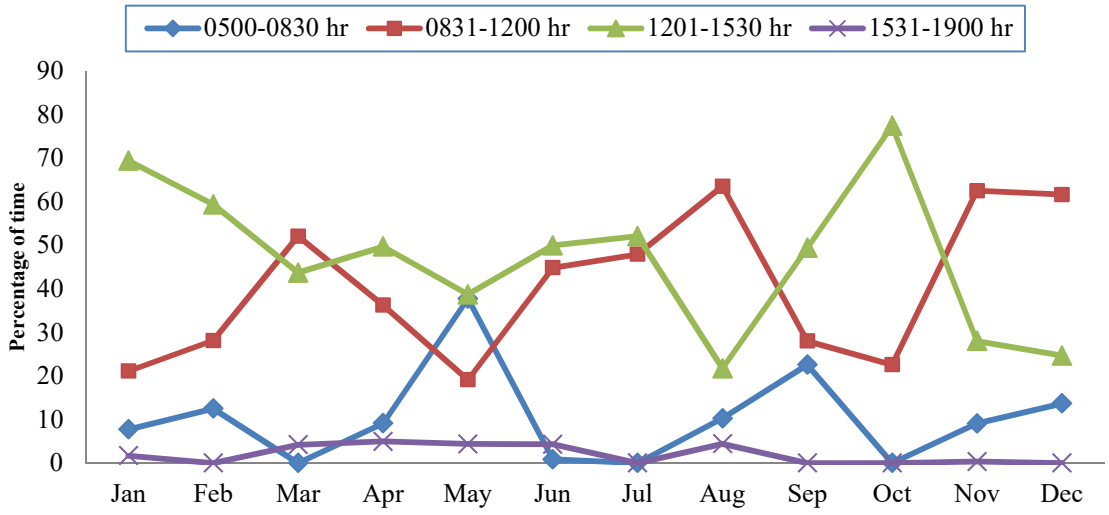


Fig. 4.8. Monthly variation of sleeping time in four block-hours of the day.

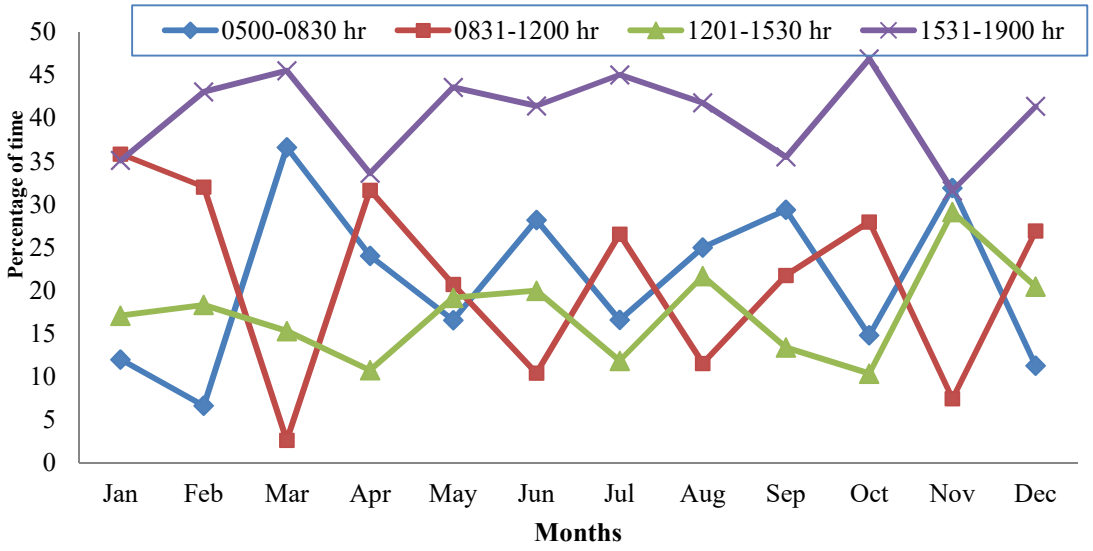


Fig. 4.9. Monthly variation of feeding time in four block-hours of the day.

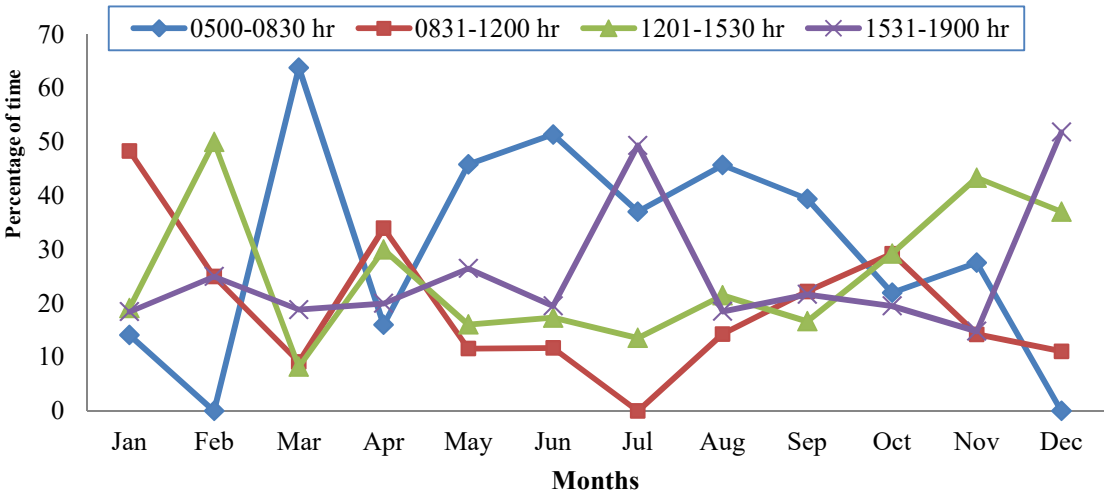


Fig. 4.10. Monthly variation of traveling time in four block-hours of the day.

4.3.9 Mating behavior

Mating behavior was recorded in five months (May, August, September, November and December). It was the highest (68.18%) in morning (0600 to 0930 hr) but lowest (31.82%) in afternoon (1400 to 1900 hr). The duration of mating time ranged from 5 second to 25 second (mean 14.82 ± SD 6.01 second, n=22). The mating bahavior varied monthly. It was the highest (49.69%) in November and the lowest (1.53%) in May. Seasonally it was peak in winter (85.28%) but low in summer (1.53%). The time and frequency of mating behavior varied in relation to temperature of the area but it was not statistically significant ($r = - 0.509$, $n = 5$, $p = 0.38$).

4.3.10 Substrate height used during different activities

The Capped Langur used different heights of substrate during performing different activities. They used 0 - 18 m (9.14 ± 4.5 m, n=288) height during feeding which was depending on types of food plants they consumed (Plate 4.1, 4.2, 4.3). All members joined together in feeding on same tree. They used middle (57.56%) and higher canopy (45.12%) in trees (69.9%) and lower canopy (6.10%) for shrub (6%) (e.g., *Citrus aurantifolia*). For traveling, the substrate height ranged from 0 - 27 m. (16.03 ± 7.9 m, n=35). They preferred to use canopy bridge (Plate 4.4) for traveling but if there was no canopy bridge they used forest floor (Plate 4.5). During resting or sleeping, they used cool shade place on a tree in same height (Plate 4.6a) [resting ranged from 3 - 14.6 m (9.48 ± 2.96 m, n=129), sleeping height varied from 3 - 14.6 m (9.72 ± 3.17 m, n=212)]. For mating Capped Langur used forked robust tree branch or on top most sturdy tree branch (Plate 4.6b) while the height ranged from 4 - 15.2 m (9.13 ± 4.25 m, n=22).

4.3.11 Daily path length

The Capped Langur moved from one place to another in searching of food, rest and night halt tree. In a day the daily path length varied from 102.76 to 1054.62 m. (388.46 ± 271.41 m., n=74) (Fig. 4.11). The daily path length size depended on the availability of the food plants in the study area; it was shorter (<200 m.) when the food was available but the day range size was larger (>200 m.) when the food was unavailable in a day. No significant relationship ($r = 0.2319$, $p>0.05$) was recorded among the group size and the daily path length in the study area. .

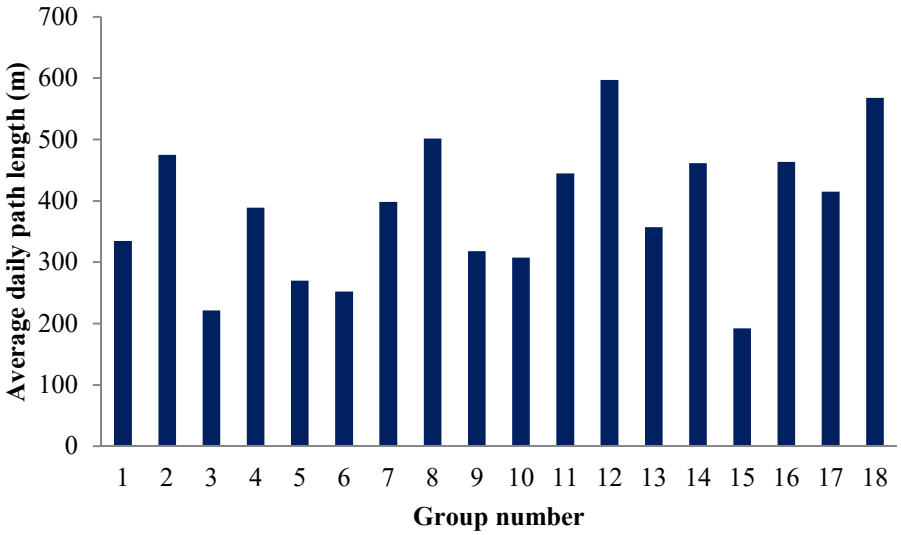


Fig. 4.11. Group number and the day range of the Capped Langur.

4.4 DISCUSSION

The Capped Langurs started their activities before sunrise and ended always after sunset (8 to 26 min. after sunset) but Mandal and Kabir (2014) mentioned that, it was 4 to 19 min. after sunset. Capped Langur was early riser in the months of monsoon and winter but Mandal and Kabir (2014) reported that it was late riser in the months of monsoon, than winter. The Capped Langur preferred to do their first defecation or urination immediate after leaving the night halt tree. Same observation was found by Mandal and Kabir (2014).

The highest diurnal active period was recorded in August but lowest in December, whereas Mandal and Kabir (2014) reported that it was in June and December, respectively

Resting occupied the highest time in activity budget per day which was the same in other research works in different parts of the country (Stanford 1991a, Kabir and Islam 1995, Kabir 2006, Mandal and Kabir 2014, Hasan 2017). The daily activity pattern of this study was varied than other study (Table 4.3).

Table 4.3. Behavioral activity of Capped Langur (*Trachypithecus pileatus*) in different studies.

Study Area	**% of the activities in a day**				**Sources**
	Rest	Feed	Traveling	Others	
Madhupur NP	32.68	28.51	11.11	27.70	This study
Satchari NP	35.1	30.2	15.6	19.1	Hasan 2017
Madhupur NP	36.38	35.67	10.5	17.45	Mandal and Kabir 2014
Rema-Kalenga	44.9	39.4	10.4	5.3	Kabir 2006
Tripura	32.6	43.4	18.2	5.8	Gupta 1996
Madhupur NP	47.0	40.0	8.0	5.0	Kabir and Islam 1995
West Bhanugacha	46.0	34.0	12.0	8.0	Kabir and Islam 1995
Madhupur NP	40.0	34.9	18.2	6.8	Stanford 1991b
Madhupur NP	49.0	32	13	6.0	Islam and Husain 1982

The time spent for different activities changed depending on age-sex classes, day length, seasons and climate. Capped Langur was more active in early morning and late afternoon than the midday. Adult-male was recorded to spend its maximum time for resting and adult-female for feeding. Mandal and Kabir (2014) reported that female feed more time than others. Hasan (2017) observed that adult spent more time for feeding than young and sub-adult spent more time in foraging and resting than the other age-sex classes.

Feeding was the highest in February during this study which was also same in the tropical mixed-evergreen forest at Satchari National Park (Hasan 2017). The highest resting time was recorded in October and traveling in July in present study but Hasan (2017) reported that it was May and September respectively.

Foraging and feeding was the highest in winter but the lowest in monsoon in MNP which was also reported by Hasan (2017) at Satchari National Park. Traveling was the highest in monsoon and the lowest in summer but Hasan (2017) stated that it was summer and winter, respectively.

Weather (temperature, humidity and rainfall) influenced the daily diurnal activity budget of Capped Langur during this study. Mandal and Kabir (2014) also reported that, activity budget of the Capped Langur influenced by climatic condition of the area.

The peak resting and sleeping was recorded during mid-day, due to high energy loss for foraging, feeding and traveling during morning. The highest traveling time was recorded during early morning while they searched food plant after long overnight period. The highest feeding time was also recorded at late afternoon due to overnight fasting preparation and during early morning after a long time fasting period. Bimodal feeding (morning and afternoon) activities was observed by several researchers for non-human primates (Clutton-Brock 1974, Aldrich-Blake 1980, Green 1981, Ahsan 1994, Beckwith 1995, Gupta 1996, Feeroz 1999, Kabir 2006, Mandal and Kabir 2014).

Adult-male approached mostly (86.36%) to adult-female for mating but adult-female also moved towards for a while (13.64%).

During feeding, no substrate height preferred by different age-sex classes which was also mentioned by Hasan (2017).

The daily path length depended on the availability of food plants, resting and night halt trees which varied seasonally.

Plate 1

(a)

(b)

Plate 4.1. (a) and (b) was the same tree species observed at same scan, all members of Capped Langur used different, at the same time almost equal feeding height, they had no specific substrate height preference.

Plate 2

(a)

(b)

Plate 4.2. (a) and (b) Capped Langur used same height during feeding.

Plate 3

Plate 4.3. Used of forest floor during feeding.

Plate 4.4

(a)

(b)

Plate 4.4. (a) Used forest floor and (b) top canopy during traveling.

Plate 4.5

Plate 4.5. All members made a queue to cross the canopy during traveling.

Plate 4.6

(a)

(b)

Plate 4.6. (a) All members used the same substrate height during sleeping. (b) Used robust tree branch during mating.

CHAPTER 5 : DIET AND FOOD PLANTS

5.1 INTRODUCTION

Primates, like other animals, require protein for growth and replacement of tissue and obtained leaves particularly young leaves for protein requirement (Jolly 1985, Solanki *et al.* 2008a). The diet of a herbivores influenced by various environmental factors, habitat condition, food availability, food value and its distribution in natural habitat (Ganguli *et al.* 1964, Majumder *et al.* 1967, Tejwani 1994). Phenological stages of a plant controls the food choice of primates (Freeland and Janzen 1974, Milton 1980, Solanki *et al.* 2008a). Primates may alter their feeding strategy in relation to the availability of specific resources, or even individual trees (Chapman 1988). The variations in seasonal resource abundance changed the diet composition of primates (Remis 1997, Tutin *et al.* 1997). Physiological status such as reproduction and lactation and sex category of an animal also influence its food selection (Altmann 1980, Clutton-Brock *et al.* 1989, Garber 1987). The size of the tree is an important parameter for its selection as food tree for arboreal primates (Stevenson *et al*. 1994, Yiming *et al*. 2002).

Capped Langurs are largely folivorous colobines (Choudhury 1989, Stanford 1991b) and they consumed the variety of food items (Solanki *et al.* 2008a). Leaves, fruits and flowers become the main source of energy supplements (Solanki *et al.* 2008a). Mature leaves are the staple food of Capped Langur in winter (Stanford 1991b, 1992) and have been observed occasionally feeding on aquatic plants (Kumar and Solanki 2004b). Floristic composition of the habitat appears to determine the spectrum of food plant species in the diet of *T. pileatus* (Solanki *et al.* 2008a). The total number of trees and density of tree species did not influence the preference of food trees (Solanki *et al*. 2008a). Habitat and vegetation type could modify food plant selection and diet of *T. pileatus* (Solanki *et al.* 2008a).

Colobines are strictly folivores (Ripley 1970, Clutton-Brock 1975, Struhsaker 1975, Wrangham 1980, Marsh 1981, Oates 1988, Davies *et al*. 1999, Li *et al*. 2003, Zhou *et al*. 2006, Wong *et al.* 2006, Solanki *et al.* 2008a, Matsuda *et al*. 2009, Hoang *et al*. 2009) and leaves comprise a significant proportion of the diet of some langur species, such as *Trachypithecus pileatus* in Pakhui Wildlife Sanctuary, India (Solanki *et al.* 2008a) and in Madhupur National Park, Bangladesh (Islam and Husain 1982, Stanford 1991b, Kabir 2002), *Semnopithecus entellus* in Keshabpur, Bangladesh

(Ahsan and Khan 2006), *T. pileatus, T. phayrei* and *T. geei* in north-east India (Gupta 1996), *Procolobus verus* in Sierra Leone (Oates 1988), *Presbytis senex* and *Presbytis entellus* in Sri Lanka (Hladik 1977).

The availability of young leaves indicates the quality of habitat that can support the langur population (Solanki *et al*. 2008a). Flowers, flower buds, fruits and seeds are important constituents of langur diets and the phenological stage of food plant species influences their availability (Solanki *et al*. 2008a). The variation in seed eating is apparently due to high availability of seeds and low abundance of young leaves in dry seasons (Oates 1988). Seeds are high-quality food items and their nutrient content and digestibility are usually relatively high (Waterman *et al*. 1988) and reported as a significant proportion of diet of colobines (McKey *et al*. 1981, Maisels *et al.* 1994). During dry season when leaves are inadequate, langur sustain themselves on flowers, fruits and seeds (Solanki *et al*. 2008b).

The purpose of this study was to understand the composition of diet, food choice and plant species used by *T. pileatus*. This baseline information will help in habitat management and conservation of this species in natural forest.

5.2 METHODS

5.2.1 Study plan

Data on food plants and diet of Capped Langur were collected during January 2016 to December 2017. The observation was started from sunrise and end at evening when the Capped Langur entered into night halt (sleeping) tree. The observation time was classified into four time blocks, i.e., early morning (0500 - 0830 hr), late morning (0831 - 1200 hr), early afternoon (1201 - 1530 hr) and late afternoon (1531 - 1900 hr). The observation starting time was fluctuated depending on the seasonal variation.

5.2.2 Data collection

Data on feeding behavior were collected using scan sampling techniques in which the activities of visible animals were recorded throughout the day from dawn to dusk followed Altmann (1974). Scan sampling data sheet was prepared (Annexure 1) to collect data from the field. Plant species and plant parts eaten by the Capped Langurs were also noted while scanning the feeding activities. Food items were classified into (1) mature leaves, including leaf petiole, (2) young leaves, (3) tender leaves, (4) buds, (5) flowers, (6) fruit (immature and mature fruits), (7) seeds, (8) shoot and very

unusually (9) bark during food lean period. Sometimes other feeding activities (drinking water and termite soil trails as their food) were also recorded.

The local name of the food plant species were identified by local field guide. Both known and unknown food plant species were photographed and representative samples (leaves, flowers and fruits) of each food plant species were collected for herbarium specimens. The specimens collected were processed through pressing inside newspapers, sun dried and then pasted on herbarium sheets for long time preservation. Later the photographs and herbarium sheets were used for plant identification with the help of plant taxonomist.

5.2.3 Feeding height

Feeding activities at different height of the tree were recorded through visual estimation and these heights were categorized as upper canopy (above 20 m), middle canopy (10-20 m) and lower canopy (up to 10 m), followed by Solanki *et al.* (2008a) and Martin and Bateson (1986).

5.2.4 Material used

A Nikon DSLR (Nikon D3200, Lens Nikkor 55 - 300 mm) camera was used to take photographs of food and feeding behavior and also food plants, food parts or representative sample for plant identification. A Bushnell binocular (Bushnell 10 x 42 NatureView) was used to observe feeding behavior, food and food plants from a long distance. A weather station (Acurite: 5-in1 weather sensor, model: 06004) was used to collect humidity, rainfall and maximum-minimum temperature of the study area.

5.2.5 Data analysis

Percentage of feeding time on different food items was calculated as described by Gupta and Kumar (1994). Food diversity and food preferences were calculated on the basis of feeding time on a plant species and part of the particular plant eaten as per procedure given by Sussman (1987) and Barlett (1999). The Shannon-Weaver diversity Index was used to examine seasonal variation in dietary diversity. Pearson correlation coefficient test was used to test the relationship between mean temperature, rainfall and dietary percentage variable. Pie charts, bar diagrams were presented using Microsoft Excel 2010.

5.3 RESULTS

5.3.1 Food habit and food preferences

The Capped Langur used plant parts as their food item. Among the plant parts it used leaf (tender leaf, young leaf and mature leaf), fruit, bud, flower, seed and shoot (Plate 5.1 to Plate 5.3). It was also observed that, sub-adult male took tree bark (Plate 5.4) and the adult-male ate termite soil trails. Leaves were highly preferred (63.55%) food items, followed by fruits (22.44%), flowers (6.54%), seeds (4.68%) and others (flower buds, shoots, bark) were equally selected (0.93% each). From this study it was also observed that the Capped Langur drink accumulated rain water from the tree trunk (Plate 5.4) in the forest and also from available water sources (ditches and cratch) (Plate 5.4) from human habitation.

5.3.2 Monthly variation of food item

The feeding activity of the Capped Langur varied in different months of the year (Fig. 5.1, 5.2). The highest number of plant species was recorded as food items in February (33.7%) during 2016 and the lowest in July (20.59%) during 2017. Among the feeding activity leaves were highly preferred in August (19.12%) during 2016 and lowest in March (1.47%) during 2016. Highest fruit preference was recorded in April (26.32%) during 2017 and least (4.17%) in February, July and December during 2016. Fruit was not eaten by the Capped Langur in March, September and October. The highest flower was taken in April (40%) during 2017. The consumption of different food items in different months was significantly varied ($H = 30.21$, $df = 11$, $n = 60$, $p < 0.05$). During this study only one record was observed to take flower bud and bamboo shoot in November during 2016 and bark in August during 2016. In May 2017 adult-male was observed to take termite's soil trail from the tree bark (*Litsia glutinosa*).

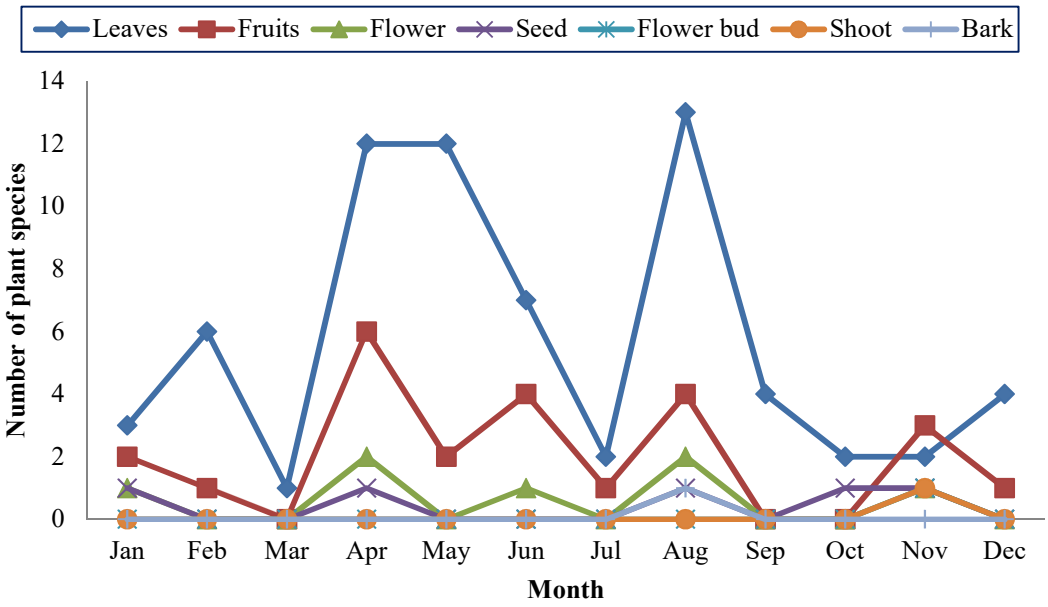


Fig. 5.1. Monthly variation of different food items consumed by Capped Langur in 2016.

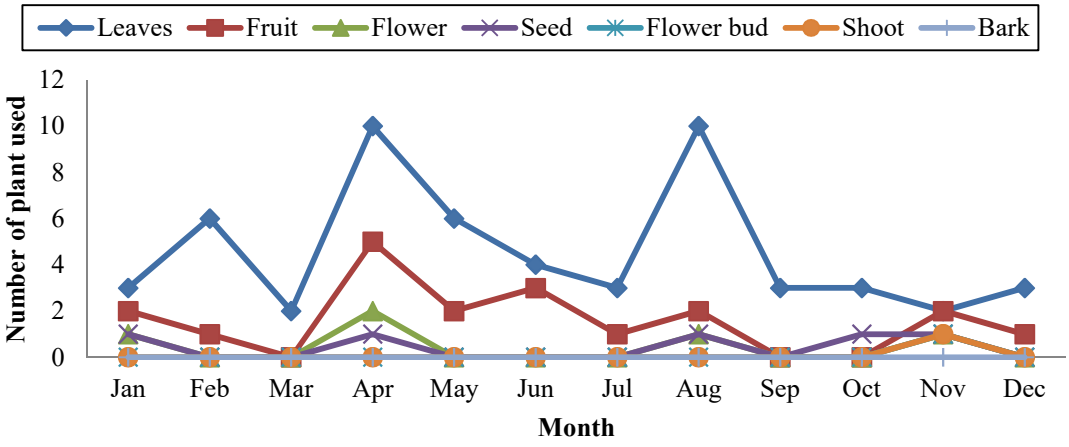


Fig. 5.2. Monthly variation of different food items consumed by Capped Langur in 2017.

5.3.3 Seasonal variation of the food item

Leaves were consumed more in summer (47.07%) and less in winter (22.05%) season (Fig. 5.3, 5.4) during 2016. The highest proportions of fruits were taken in summer (52.63%) but least in monsoon (15.79%) during 2017. Flowers were highly preferred in summer (42.86%) during 2016 but the least in monsoon (20%) during 2017. On the other hand the lowest preferences of seeds (20%) were recorded in summer during both of the year. The consumption of different food items were not significantly varied in different seasons (χ^2 = 0.5471, df = 12, p>0.05). During the study period flower bud and bamboo shoots were recorded to eat only in winter season and tree bark in monsoon. The Shannon-Wiener Index (H) ranged from 1.06 – 1.11, the lowest in winter and the highest in summer.

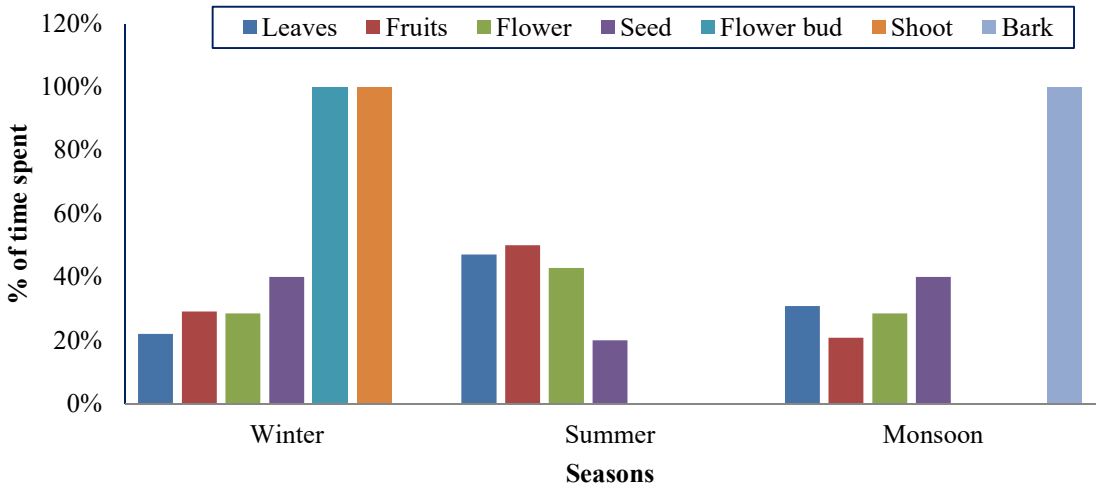


Fig. 5.3. Seasonal variation of food items consumed by Capped langur in 2016.

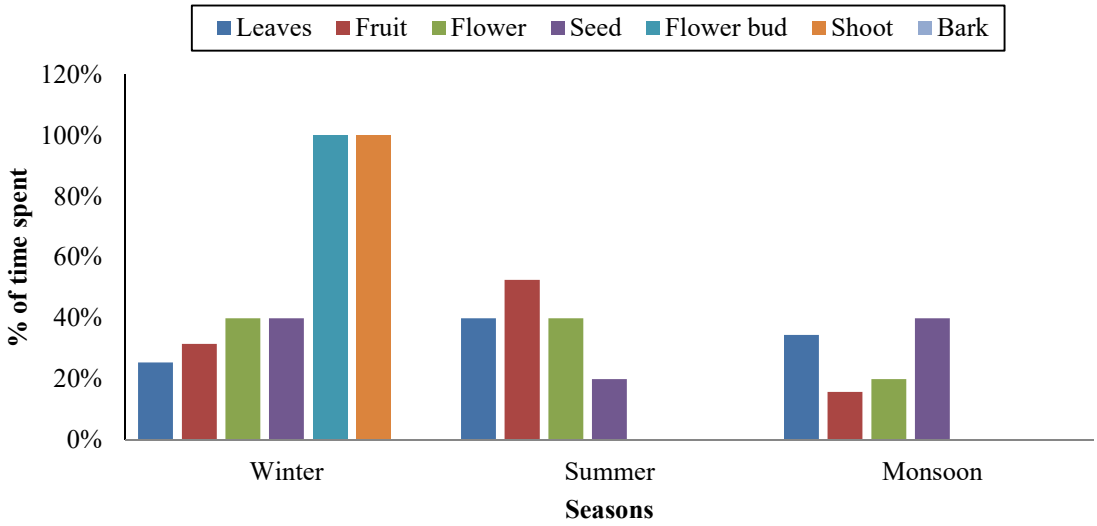


Fig. 5.4. Seasonal variation of food items consumed by Capped langur in 2017.

5.3.4 Number of food plant species used as food

During the study period large number of plant species was used by the Capped Langur. A total of 82 plant species (include 7 unidentified species) belonging to 39 identified and 3 unidentified families were utilized as diet. Among the total food plants, 58 trees, shrubs 5, climbers 18 and 1 parasitic plant (Table 5.1). Capped Langur consumed the highest amount of food from trees (70.7%) than the others (Fig. 5.5). It obtained only leaves from 48 plant species, only fruit from 19 species, only flower 1 species, only seed from 3 species, shoot from 1 species, flower moreover seed from 1 species, leave as well as flower from 4 species, leave, flower and flower bud from 1 species, leave and fruit from 2 species, leave and additionally bark from 1 species and leaves along with seed from 1 species. Trees provide the food round the year, shrubs for 6 months, climber 8 months and parasitic plant was taken only in January and June. Trees, shrubs and climbers provided food for every season except parasitic plant which produced food for Capped Langur in summer and winter.

Throughout the year, it was seen that most of the food plant species (85.5%) provided the food for only one month, but the rest of the plants (14.5%) provided for two months.

Table 5.1. Plant species utilized as food by Capped Langur in the Madhupur National Park.

SL. No.	Scientific Name	Local name	Family	Habit	Month*
1	*Thunbergia fragrans* Roxb.	-	Acanthaceae	Climber	A
2	*Thunbergia grandiflora* Roxb.	Nillata	Acanthaceae	Climber	Ju
3	*Annona reticulata* L.	Nonaata	Annonaceae	Tree	Mr
4	*Miliusa velutina* (Dunal) Hook. f. & Thom.	Gandigajari	Annonaceae	Tree	M
5	*Uvaria hamiltonii* Hook. f. & Thom.	Banarkala	Annonaceae	Shrub	A, Au
6	*Wrightia* sp.	Dudh-koraiya	Apocynaceae	Tree	M
7	*Rhaphidorpha peepla* (Roxb.)	-	Araceae	Climber	A, M
8	*Areca catechu* L.	Supari	Arecaceae	Tree	Au
9	*Mikania cordata* (Burm. f.) Robinson	Assamlata	Asteraceae	Climber	A, M
10	*Oroxylum indicum* (L.) Kurz	Nasona	Bignoniaceae	Tree	M
11	*Bombax ceiba* L.	Tula	Bombacaceae	Tree	S
12	*Bursera serrata* Wall. Ex Colebr.	Chitrika	Burseraceae	Tree	A
13	*Trema orientalis* (L.) Blume	Jiban	Cannabaceae	Tree	J, Au
14	*Capparis zeylanica* L.	Asarilata	Capparaceae	Climber	A
15	*Carica papaya* L.	Pepe	Caricaceae	shrub	D
16	*Terminalia bellirica* (Gaertn.) Roxb.	Bohera	Combretaceae	Tree	A
17	*Merremia umbellata* (L.) Hallier f.	Sadakalmi	Convolvulaceae	Climber	F
18	*Coccinea grandis* (L.) Voigt	Telakucha	Cucurbitaceae	Climber	N
19	*Dillenia pentagyna* Roxb.	Ajuli	Dillenaceae	Tree	M, Ju
20	*Dioscorea bulbifera* L.	Pagla-alu	Dioscoreaceae	Climber	N
21	*Dioscorea pentaphylla* L.	Jhumalu	Dioscoreaceae	Climber	Ju
22	*Dioscorea* sp. 1	Gas alu	Dioscoreaceae	Climber	Au
23	*Dioscorea* sp. 2	Gas alu	Dioscoreaceae	Climber	M
24	*Dioscorea* sp. 3	-	Dioscoreaceae	Climber	Au
25	*Shorea robusta* Roxb. ex Gaertn.	Gajari/Sal	Dipterocarpaceae	Tree	M
26	*Elaeocarpus robustus* Roxb.	Jalpai	Elaeocarpaceae	Tree	F
27	*Aporosa dioica* (Roxb.) Muell.-Arg.	Patakharulla	Euphorbiaceae	Tree	M, Ju
28	*Gelonium multiflorum* A. Juss.	-	Euphorbiaceae	tree	F
29	*Manihot esculenta* Crantz.	Kasava/ Simul Alu	Euphorbiaceae	Shrub	M
30	*Albizia* sp.	-	Fabaceae	Tree	Au
31	*Dalbergia*	-	Fabaceae	Tree	D
32	*Mucuna* sp.	-	Fabaceae	Tree	S
33	*Bambusa tulda* Roxb.	Talla bans	Gramineae	Tree	N
34	*Litsia glutinosa* (Lour.) Robinson	Kukurchita	Lauraceae	Tree	Au
35	*Litsea monopetala* (Roxb.) Pers.	Kharajora	Lauraceae	Tree	A
36	*Acacia auriculiformis* A.Cunn. ex Benth. & Hook	Akashmoni	Leguminosae	Tree	N
37	*Albizia lebbeck* (L.) Benth. & Hook.	Kalo-koroi	Leguminosae	Tree	Au
38	*Albizia procera* (Roxb.) Benth.	Koroi	Leguminosae	Tree	N
39	*Bauhinia malabarica* Roxb.	Karmai	Leguminosae	Tree	M, Ju
40	*Dalbergia lanceolaria* L. f.	-	Leguminosae	Tree	A
41	*Erythrina ovalifolia* Roxb.	Kantamandar	Leguminosae	Tree	Au

SL. No.	Scientific Name	Local name	Family	Habit	Month*
42	*Leucaena leucocephala* (Lamk.) de Wit.	Ipil-Ipil	Leguminosae	Tree	J, O
43	*Samanea saman* (Jacq.) Merr.	Rendikoroi	Leguminosae	Tree	Au
44	*Spatholobus* sp.	-	Leguminosae	Climber	S
45	*Tamarindus indica* L.	Tetul	Leguminosae	Tree	J
46	*Loranthus falcatus* L.f.	Pargacha	Loranthaceae	Parasitic	J, Ju
47	*Aphanamixis polystachya* (Wall.) R N. Parker.	Pitraj	Meliaceae	Tree	N
48	*Chickrassia tabularis* (A. Juss.) Wight & Arn.	Chickrass	Meliaceae	Tree	Au
49	*Melia sempervirens* (L.) Sw.	Goranim	Meliaceae	Tree	Au
50	*Toona ciliata* M. Roem.	Pia	Meliaceae	Tree	J
51	*Acacia pennata* (L.) Willd.	Kuchi lot	Mimosaceae	Climber	F
52	*Artocarpus lacucha* Buch.-Ham.	Dewa	Moraceae	Tree	A
53	*Streblus asper* Lour.	Shaora	Moraceae	Tree	A
54	*Ficus hispida* L. f.	Kakdumur	Moraceae	Tree	A
55	*Ficus racemosa* L.	Jagga dumur	Moraceae	Tree	A
56	*Ficus retusa* L.	Jir Bat	Moraceae	Tree	Ju
57	*Ficus rumphii* Blume	Hijulia	Moraceae	Tree	A
58	*Morus alba* L.	Tunt	Moraceae	Tree	F
59	*Musa paradisiaca* L.	Aittakola	Musaceae	shrub	N
60	*Syzygium samarangense* (Blume) Merr. & Perry	Jamrul	Myrtaceae	Tree	J
61	*Bridelia tomentosa* Blume	Khoi	Phyllanthaceae	Tree	D
62	*Ziziphus mauritiana* Lamk.	Baroi	Rhamnaceae	Tree	N
63	*Anthocephalus chinensis* (Lamk.) A. Rich.ex Walp.	Kadam	Rubiaceae	Tree	Au
64	*Haldina cordifolia* (Roxb.) Ridsdale	Kaika	Rubiaceae	Tree	A, Au
65	*Randia* sp.	Mankata	Rubiaceae	Tree	Jl, Au
66	*Citrus aurantifolia* (Christm. & Panzer) Swingle	Lebu	Rutaceae	shrub	J
67	*Citrus grandis* (L.) Osbeck	Jambura	Rutaceae	Tree	F
68	*Erioglossum edule* Blume	Baraharina	Sapindaceae	Tree	Ju
69	*Schleichera oleosa* (Lour.) Oken.	Joyna	Sapindaceae	Tree	M
70	*Pterospermum acerifolium* (L.) Willd.	Kanak champa	Sterculiaceae	Tree	A
71	*Gmelina arborea* Roxb.	Gamari	Verbenaceae	Tree	Au
72	*Tectona grandis* L. f.	Segun	Verbenaceae	Tree	Au
73	*Vitex* sp. 1	-	Verbenaceae	Tree	M
74	*Vitex* sp. 2	-	Verbenaceae	Tree	O
75	*Vitis* sp.	-	Vitaceae	Climber	Ju
76	Unidentified species 1	-	Meliaceae	Tree	A
77	Unidentified species 2	-	Meliaceae	Tree	Ju
78	Unidentified species 3	-	-	Tree	S
79	Unidentified species 4	-	-	Tree	M
80	Unidentified species 5	-	Asclepiadaceae	Climber	Ju
81	Unidentified species 6	-	Vitaceae	Climber	S
82	Unidentified species 7	-	-	Climber	D

*Note : J – January, F – February, Mr – March, A – April, M – May, Ju – June, Jl – July, Au – August, S – September, O – October, N – November, D – December

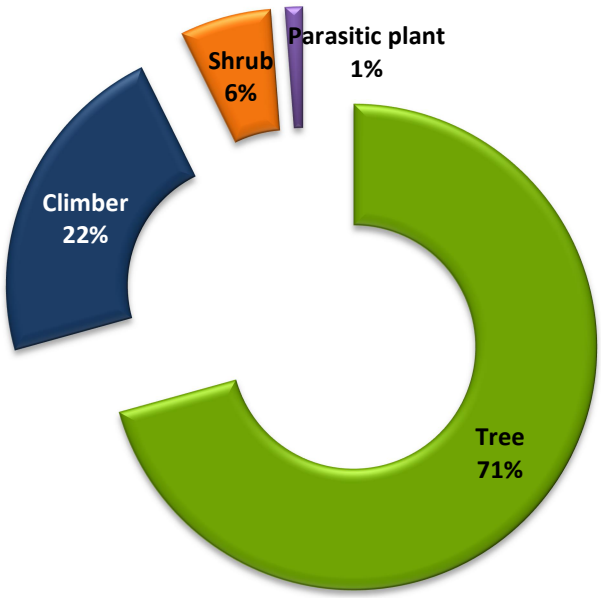


Fig. 5. 5. Percentage of food consumed from different plants.

5.3.5 Preferred food plant families

Leguminosae provided the highest (12.5%) food plant species during this study. The Moraceae provided the second highest (10%) food plant species in a year. Dioscoreaceae was the third most used (6.25%) plant family by the Capped Langur (Fig. 5.6).

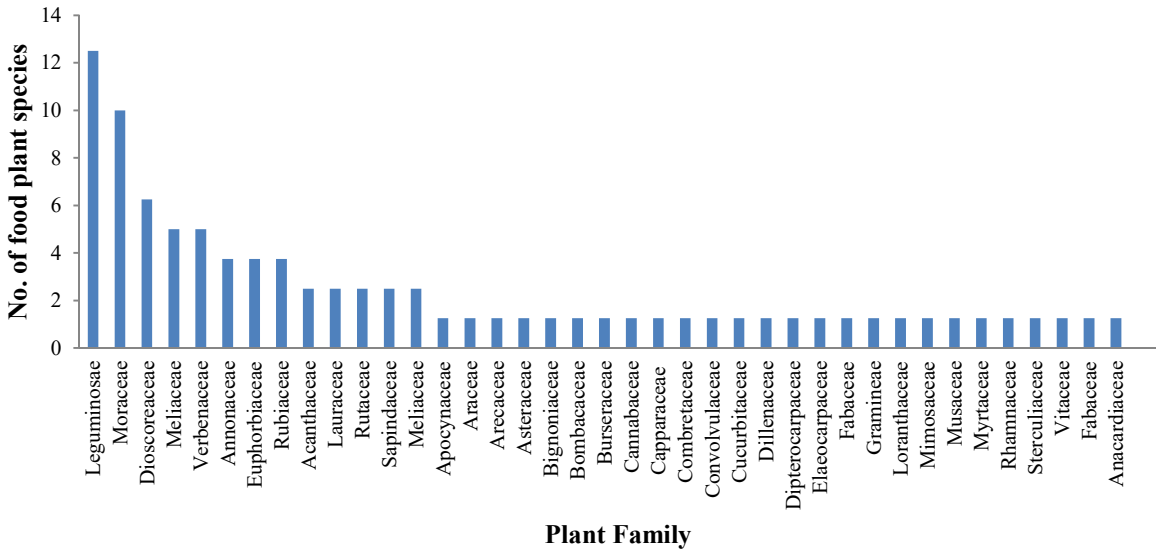


Fig. 5.6. Preferred food plant families by the Capped Langur.

5.3.6 Monthly variation of food plant species

The number of food plant species in different months ranged from 2 to 22 (mean = 11.08 ± 6.78). During the study period the highest number food plants was consumed in May (n=22, 26.51%) and the lowest in March (n=2, 2.41%) (Fig. 5.7). The number of food plant species was not significantly varied (t = 0.001704, p = 0.998671) in different months. One sub-adult male was seen to take bark for once in August 2016 and adult male was taken in May 2017 soil from termite trail.

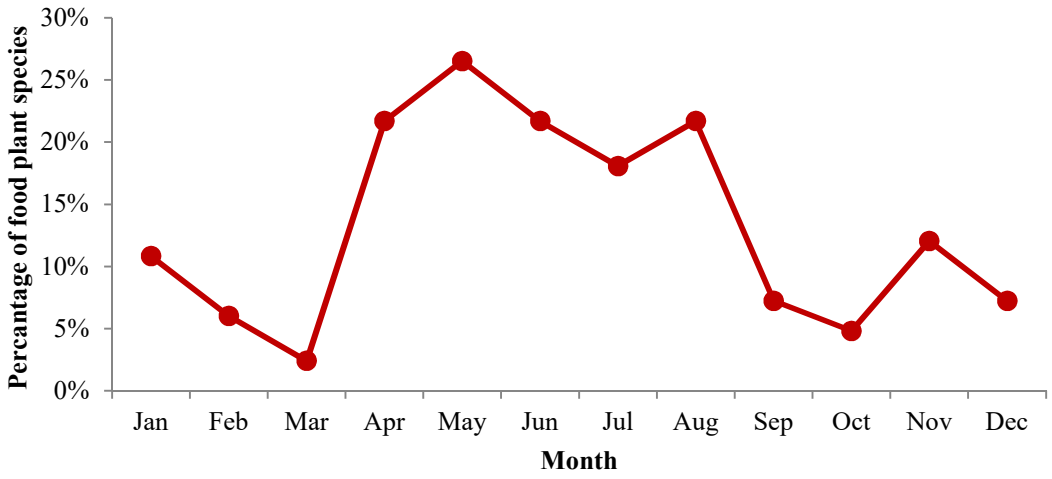


Fig. 5.7. Monthly variation of food plant species.

5.3.7 Seasonal variation of food plant species

The highest number of food plant species was recorded in summer (45%) than the other two seasons (Fig. 5.8). The number of food plant species was not significantly varied (t = 0.27205, p = 0.78837) in different season. The diet in summer was more because during this season all plants grow up with new leaves in this forest and as a folivore species Capped Langur utilized this scope. The Shannon-Wiener Index (H) ranged from 1.06 – 1.11 the lowest in winter and the highest in summer. Dietary diversity increased when available food items were found in the area.

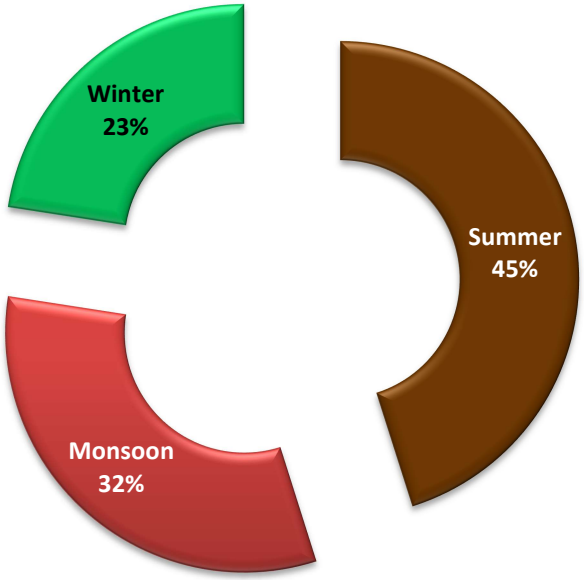


Fig. 5.8. Seasonal variation of the food plant.

5.3.8 Preferred feeding height

Capped Langur spent their highest time in the middle canopy (48%) for feeding than the other canopies (Fig. 5.9). Sometimes (1%) it was also recorded to get down on forest floor to eat available food (fruits of *Citrus aurantifolia*).

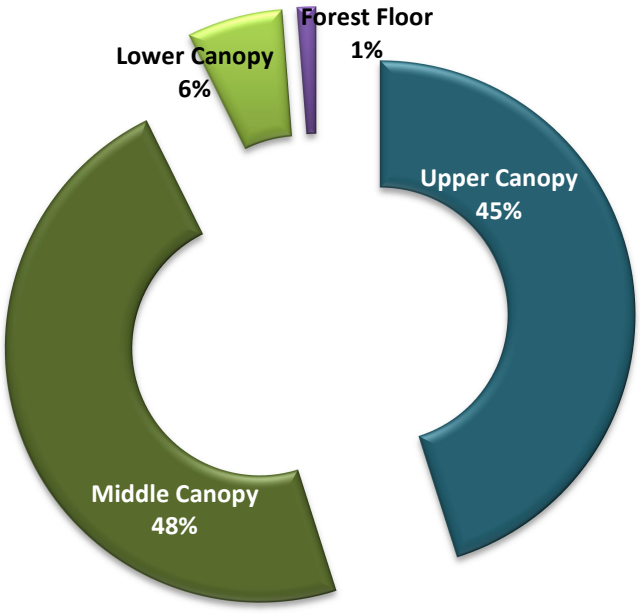


Fig. 5.9. Canopy preference by the Capped Langur.

5.3.9 Diet preference in relation to temperature and rainfall

Capped Langurs spent their highest time feeding in the sunny weather and the lowest during heavy rain. Leaves were highly preferable food items of the Capped Langur and the highest consumption (19.12%) was recorded when the temperature was high (31.6^{o} C). There was no significant relationship between food choice with temperature and rainfall (Table 5.2), so it reveals that the food choice of Capped Langur depends on available food items.

Table 5.2. Pearson correlation coefficient between the monthly average temperature and rainfall with dietary food item.

Dietary diversity	Average Temperature (^{o}c)		Average Rainfall (mm)	
	r	p	r	p
Leaves	0.2237	0.484604	0.3427	0.275504
Fruit	0.2203	0 .49144	0.1028	0 .750547
Flower	0.2007	0.531673	0.0007	0.998277
Seed	-0.0659	0.840937	-0.2836	0.372765
Flower bud	0.1616	0 .615838	-0.3148	0 .320251
Shoot	0.1616	0 .615838	-0.3148	0 .320251
Bark	0.2967	0.350224	0.2411	0.450315

5.4 DISCUSSION

Capped Langur is typically selective folivorous in their food habits and the diet was dominated by leaves (especially young leaves) in compare with other plant parts (fruit, bud, flower, seed, shoot and tree bark). Tender and young leaves were the most consumed food items, followed by fruits and flowers, which was also similar to earlier studies (Islam and Husain 1982, Stanford 1991b, Hasan 2017). Kabir (2002) stated that Capped Langur generally choose young leaves, shoots, flowers and fruits than mature leaves. Capped Langur spent the highest time for feeding leaves to acquire more energy (Hasan 2017). Primates select foods for the sake of proteins and soluble carbohydrate, plant parts with low level of nutrients are ignored (Hladik 1977, Milton 1979, McKey *et al.* 1981). The proportions of food items consumed by Capped Langur were almost similar with other colobines in different places in different time (Table 5.3).

Table 5.3. Proportion of time spent in feeding and percentage of different food items consumed by other colobines in Bangladesh.

Species	Feeding	Leaves	Flowers	Fruits and seeds	Shoots	Bud	Bark	Study area	Source
T. pileatus	28.51	63.55	6.54	27.12	0.93	0.93	0.93	Madhupur National Park	This study
T. pileatus	32	68	3.6	26.5	2	-	-	Madhupur National Park	Islam and Husain 1982
T. pileatus	35	66.8	7.0	33.7	-	-	-	Madhupur National Park	Stanford 1991b
T. pileatus	39.4	40.5	18	37.5	-	-	-	Rema Kalenga Wildlife Sanctuary	Kabir 2002
T. Phayrei	-	51	16	14	19	-	-	Lawachara National Park	Aziz and Feeroz 2009
T. Phayrei	34.1	46.6	17.5	34.3	-	-	-	Rema Kalenga Wildlife Sanctuary	Kabir 2002
S. entellus	39.1	42.3	2.4	53.2	-	-	-	Keshabpur	Khatun *et al*. 2012

Food availability in different months and seasons influences the diet of Capped Langur. As new leaves appear in summer, Capped Langur spent most of their feeding time to consume. The consumption rate of young leaves increased in summer when the food diversity was very low at Satchari National Park (Hasan 2017). The proportion rate of the consumption of leaves depended on the availability of sources. Trees provided the food for the year round, shrubs for six months, climbers for eight months but the parasitic plants supported the diet only for two months. Primates perform to regulate their diets in response to seasonal shortage of preferred foods (Bennet 1983, Davies 1984). The dietary diversity was the highest in summer at Madhupur National Park due to availability of food items. But at Satchari National Park the highest feeding diversity was recorded in winter (Hasan 2017). In winter, Capped Langur used maximum number of plant in February and the least in November (Solanki *et al.* 2008a).

During this study the recorded food plants (82 species) were the highest than the earlier studies in the same area; Islam and Husain (1982) recorded 26 and Stanford (1991b) noted 35 food plant species. This may be due to the present study covered two habitats, one was the natural forest and another was the human habitation area. While at the Satchari National Park 52 plant species were recorded as food resources of Capped Langur (Hasan 2017). Kabir (2002) recorded 80 and 70 food species for *Trachypithecus phayrei* and *T. pileatus* respectively at the Rema Kalenga Wildlife Sanctuary. But in case of *Semnopithecus entellus* at Keshabpur 43 and 91 food species were identified by Ahsan and Khan (2006) and Khatun *et al.* (2012) respectively. Aziz and Feeroz (2009) documented 29 food plant species for *Trachypithecus phayrei* at Lawachara National Park. In Pakhui Wildlife Sanctuary, India, 52 food plant species provided wide dietary spectrum for *T. pileatus* (Solanki *et al*. 2008a). *T. pileatus* utilized maximum number of plant species (48 species) in the study area to obtain leaves. The preference of food trees was not influenced by the number and density of that tree (present study, Solanki *et al.* 2008b, Hasan 2017). Food plant species diversity of langurs influences by the floristic composition of the habitat (Mohnot 1971, Hladik 1977, Gupta and Kumar 1994, Solanki *et al*. 2008a).

Plant species under the Family Leguminosae provided a significant amount of young leaves and dominated the diet of Capped Langur in the study area. Davies (1984) also reported that Leguminosae was the preferred food for *Presbytis rubicunda*. The Moraceae were the second preferred and Dioscoreaceae was the third

adopted plant families in the Madhupur National Park. But Hasan (2017) stated that Moraceae conquered the diet of *Trachypthecus pileatus* in Satchari National Park. Kool (1989) and Fashing (2001) noted that trees of the family Moraceae controlled food of *Colobus guereza* at Kakamega forest, Kenya and *Trachypithecus auratus* at Pagandaran, Indonesia.

This study reveals that the type of food choice depended on the availability of the food items. Remarkable amount of young leaves, flowers and fruits are eaten at early morning to fulfill the protein and energy demand after overnight fasting, on the other hand, mature leaves at the mid-day. Hasan (2017) also recorded the same at the Satchari National Park. Raemaekers (1978) and Vasey (2005) said that sugar in fruit is rich in energy, which replace the penurious sugar level in blood. Flowers contain higher percentage of water, nitrogen and copper (Oftedal 1991, Waterman and Kool 1994, Behie and Pavelka 2012) to reimburse the water and mineral deficiency (Hasan 2017). Seeds and shoots were recorded to consume at mid-day.

The Capped Langur spent the highest time in middle canopy during feeding to take maximum number of food and also to protect themselves from direct sunlight and rain. Usually Capped Langur group members used the same feeding height (this study, Kabir 2002, Hasan 2017). But Stanford (1991a) documented that the most preferred feeding height varied from 10 – 14 meters. Sometimes they also came to lower canopy for feeding and other activities (this study, Kabir 2002). In the evergreen and semi-deciduous forest of Gombe National Park, East Africa *Cercopithecus mitis* and *Cercopithecus ascanius* feed in all heights from ground to top of the canopy (Clutton-Brock 1973). Moreover *Cercopithecus thoesti* observed on the ground in the Kibale forest, Uganda (Clutton-Brock 1973).

Temperature and rainfall had no direct impact on food choice of Capped Langur. But consumption rate of leaves were positively correlated with temperature due to fulfill their water requirement during hot weather. Whereas, temperature and rainfall both were negatively correlated with time spent in feeding flowers (Hasan 2017).

PLATE 5.1

Rhaphidorpha peepla (Roxb.)

Mikania cordata (Burm. f.) Robinson

Haldina cordifolia (Roxb.) Ridsdale

Dalbergia lanceolaria L. f.

Dioscorea sp.

Vitex sp.

Loranthus falcatus L.f.

Coccinea grandis (L.)Voigt.

Plate 5.1. Some leaves food of *Trachypithecus pileatus*.

PLATE 5.2

Erioglossum edule Blume

Ficus hispida L. f.

Bursera serrata Wall. Ex Colebr.

Dillenia pentagyna Roxb.

Litsea monopetala (Roxb.) Pers.

Aporosa dioica (Roxb.) Muell.-Arg.

Randia sp.

Citrus aurantifolia (Christ.) Swingle

Plate 5.2. Some fruit items of *Trachypithecus pileatus*.

PLATE 5.3

Flower: *Pterospermum acerifolium* (L.) Willd.

Flower: *Thunbergia grandiflora* Roxb.

Flower: *Anthocephalus chinensis* (Lamk.) A. Rich. ex Walp.

Flower: *Syzygium samarangense* (Bl.) Merr.

Seed: *Leucaena leucocephala* (Lamk.) de Wit.

Seed: *Pterospermum acerifolium* (L.) Willd.

Shoot: *Bambusa tulda* Roxb. Wit.

Bark: *Litsia glutinosa* (Lour.) Rob.

Plate 5.3. Some other food items of *Trachypithecus pileatus*.

PLATE 5.4

(a)

(b)

(c)

Plate 5.4. (a) took tree bark and
(b, c) drinking accumulated rain water from tree trunk and cratch.

CHAPTER 6 : HUMAN-CAPPED LANGUR CONFLICT AND CONSERVATION THREATS

6.1. INTRODUCTION

Habitat destruction and extensive deforestation continue at alarming rates throughout the world and the existence of forest species is in danger of extinction (Marsh and Mittermeier 1987). Most of the protected areas are under tremendous pressure of human population growth (Srivastava 2006a). Human population pressure on natural habitats, combined with hunting and live capture, has driven numerous species to the brink of extinction (Srivastava 2006a). The clear cutting of the forest for settlement, agriculture and selectively logged for fuelwood, construction material and exploited for natural product result in habitat loss (Srivastava 2006a). Habitat loss is the principal threat to wild primate population (Srivastava 2006a). In many areas the damage is substantial and locally threatening to the survival of the primates (Srivastava 2006a). The population of the Capped Langur has been decreasing due to habitat loss and degradation (Srivastava *et al.* 2001a, 2001b) and hunting (for food, medicinal purposes and artifacts for socio-cultural practices and religious and cult ceremonies [Solanki 2002, Kumar and Solanki 2004a]). Unlawful hunting and reduction of most important food plants for the collection of non-timber forest produce were to be most serious threats for the Capped Langur (Kumar and Solanki 2008). Habitat destruction for agricultural activities, permanent settlement, fuel and fodder are also major threats for the Capped Langur (Kumar and Solanki 2008).

Over the two millennia human agricultural activity and hunting have been affected the primate populations (Cowlishaw and Dunbar 2000). The main issue for human-primates' conflict and conservation of primates is crop raiding (Miah *et al*. 2001, Aziz and Feeroz 2007, Ahsan and Uddin 2014, Naher *et al*. 2017). The conversion of agricultural lands to human settlements which were invaded by primate for food resulting human primates' conflicts (Uddin and Ahsan 2018). Crop damage (palatable and unpalatable) depends on the scarcity of food of primates in the areas (Uddin and Ahsan 2018) and aggressive human behaviour also influences the primates to damage unpalatable crops (Khatun *et al*. 2013). Increased human population and coexist by primates with human settlement areas also influence conflict between human and primates in Bangladesh (Uddin and Ahsan 2018). High human population pressure, smaller terrestrial area, limited resources and mismanagement are the principal causes

of forest destruction in Bangladesh, which will ultimately declining the primate species (Kabir 2002). Demand of forest lands for human settlement and forest product for building materials, fuelwoods, foods and non-timber forest products are shrinking the natural habitats of wildlife causing some of them become endangered and even extinct (Hasan 2017). So, without proper protection of natural forest all forest dependent animals' especially arboreal species will continue to decline in near future. For the preparation of the conservation action plan of primate species like Capped Langur, specific data on various aspects of the species and its threats are important. That is why this plan was taken to find out the major conservation threats and human-Capped-langur conflict in the Madhupur National Park.

The aim of this study was to document the major conservation threats of the Capped Langur and also report on human impacts on this langur habitats as well as human-langur conflict in and around the national park, so that effective conservation measures could be taken in future for this species in this area.

6.2 METHODS

6.2.1 Study plan and data collection

A questionnaire (Appendix 2) was designed to collect data on human-langur conflicts and major threats in the study area during July 2017 to June 2018. Three hundred forty seven people were randomly interviewed by the researcher and sometimes with two trained field assistants who were familiar with the local people and their language. Respondent were heads of household, their wives and others who were eager to answer the questions. The questionnaire was arranged with both closed and open-ended questions.

For the convenience of the analyses the data were categorized into homestead yards and cultivated areas on the basis of crop damage. The data were categorized as 1. small household, and 2. large household. The family those who had ≤ 4 family members were categorised as small household and those who had > 4 members were categorized as large household. The family those who had < 0.1 acres land were classified as small land-holding, who had 0.1 - 0.5 acres land were classified as medium land-holding and the family who had > 0.5 acres land were categorized as large land-holding status. To find out the human-Capped Langur conflict the questionnaires survey was done in eleven villages (Baliapara, Bijoypur, Chanpur,

Charipara, Dhonra, Harinatala, Kathalia, Kathbawla, Rajabari, Rasulpur and Telki) surrounding the national park.

6.2.2 Data analysis

Microsoft Excel 2010 was used to compile and analysed the data and also to prepare pie charts, bar diagrams. Chi-square test was used to evaluate differences in the answers of respondents and $p<0.05$ was considered to be statistically significant.

6.3 RESULTS

6.3.1 Crop damage caused by the Capped Langur

Among the total respondents (347), 99.42% complained against Capped Langur for crop damage. Crop damage in the homestead areas were the highest than in the cultivated areas (Fig. 6.1). From the surveyed data it revealed that the highest raiding activities was reported in the yard (Fig. 6.2).

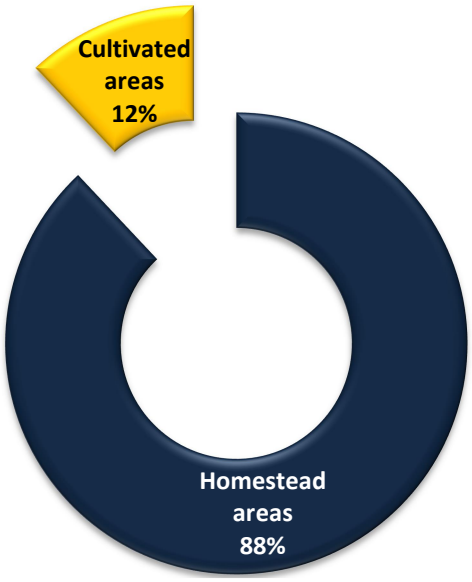


Fig. 6.1. Crop damaged caused by the Capped Langur.

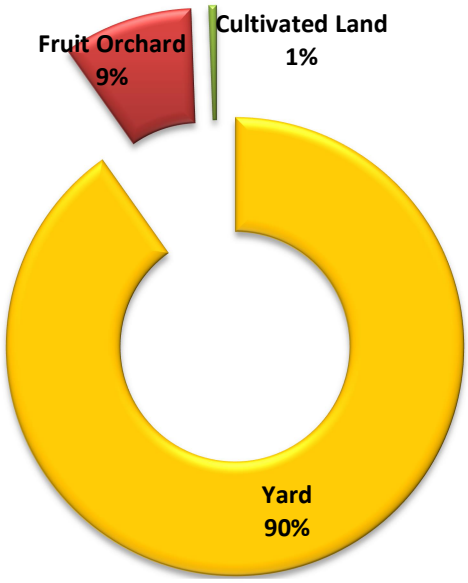


Fig. 6.2. Percentage of crop raiding site of the Capped Langur.

6.3.2 Human-Capped Langur conflict

On the basis of religious status of the respondents, 90.5% Muslims reported that the occurrence of human-Capped Langur conflict followed by 2.6% Hinduism and 6.6% Christian. The highest percentage of conflict was recorded in the Harinatala village and the lowest in the Charipara (Fig. 6.3). This is because the Harinatala village is very near (about 0.5 km) to the Madhupur National Park and people in this village are habituated with the Capped Langur and it is also dense with diversified homestead plant species. On the other hand, Charipara village is far away (about 3 km east from the Rasulpur Mazar) from the national park. The highest conflicts were recorded from the Mymensingh district side than that of the Tangail side of the NP (Fig. 6.4).

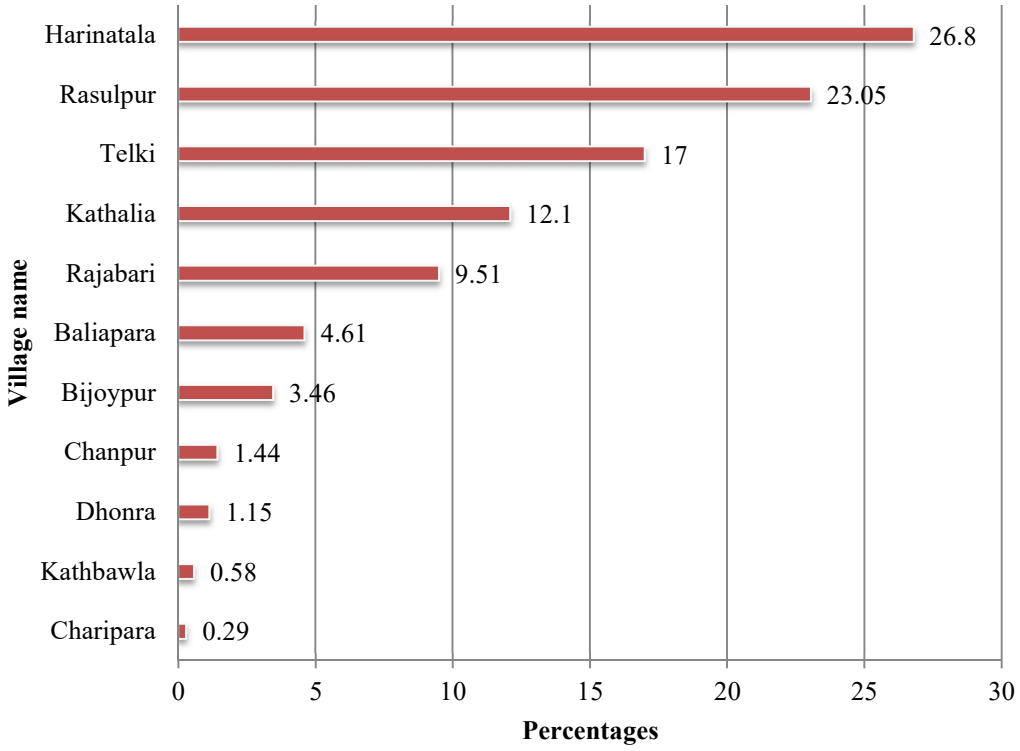


Fig. 6.3. Human-Capped Langur conflicts in different villages.

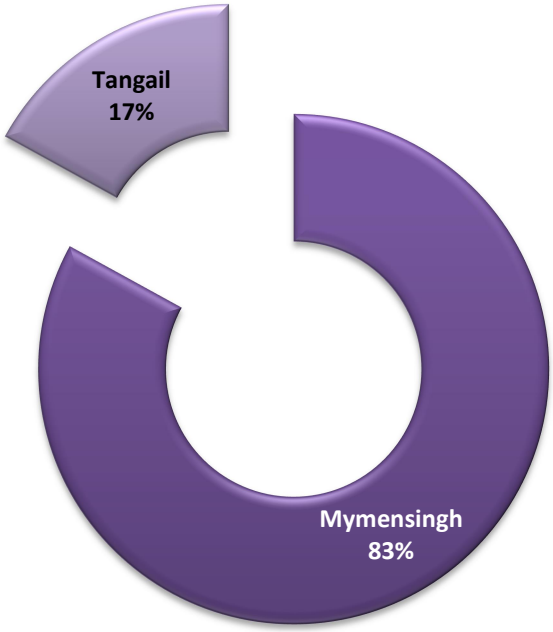


Fig. 6.4. Human-Capped Langur conflicts in two districts.

From the analysis of the questionnaires, it was revealed that large household family (Fig. 6.5) and medium land-holding members were more acquainted with human-Capped Langur conflict (Fig. 6.6). Most of the respondents stated that the crop damage rate was severe by the Capped Langur (Fig. 6.7).

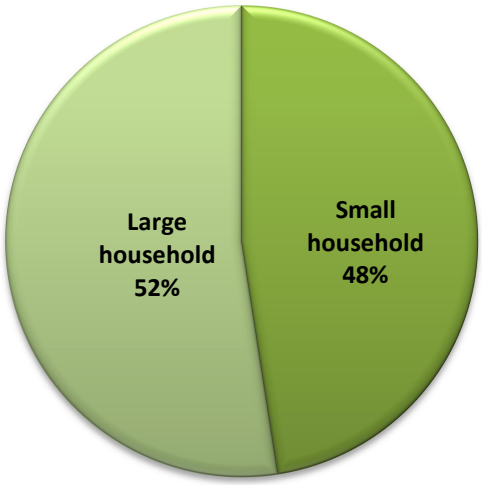


Fig. 6.5. Human-Capped Langur conflict with different house-holding status.

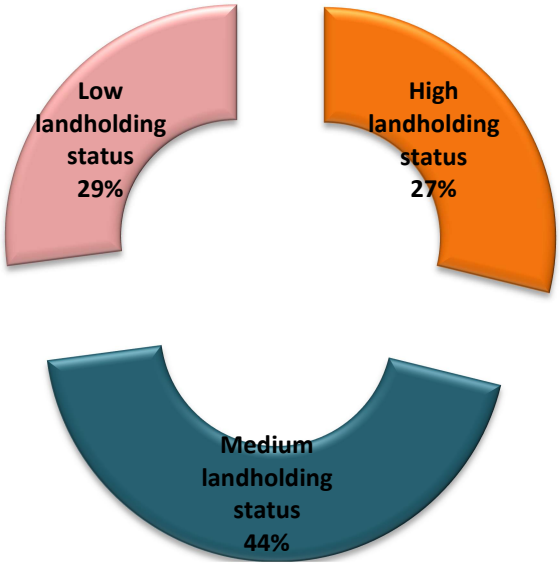


Fig. 6.6. Human-Capped Langur conflict with different land-holding status.

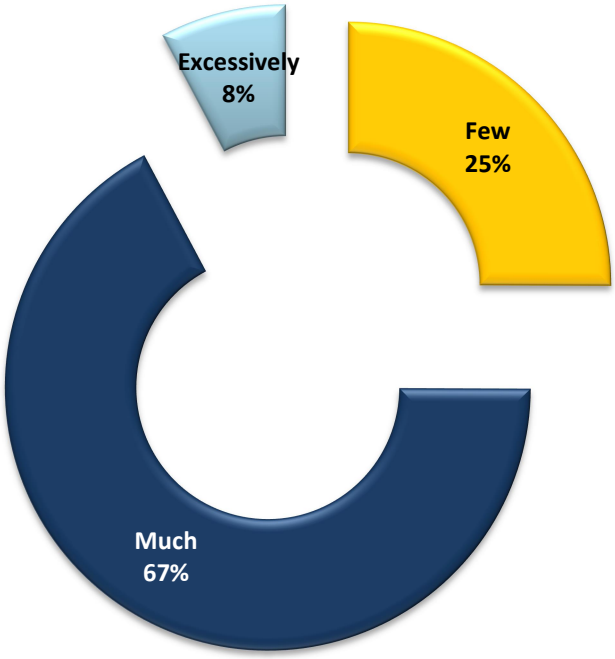


Fig. 6.7. People's opinion regarding crop damage rate by the Capped Langur.

6.3.3 Crop-raiding period by the Capped Langur

The highest proportion of the respondents reported that the Capped Langur raid human habitation area occasionally (Fig. 6.8) and in a day it was the highest during afternoon (Fig. 6.9).

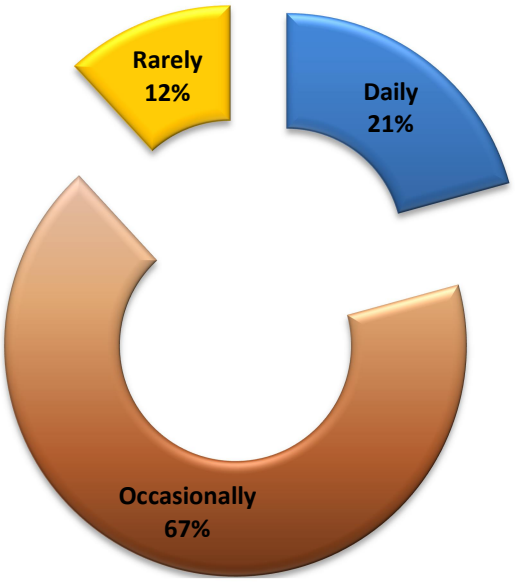


Fig. 6.8. Crop-raiding period by the Capped Langur.

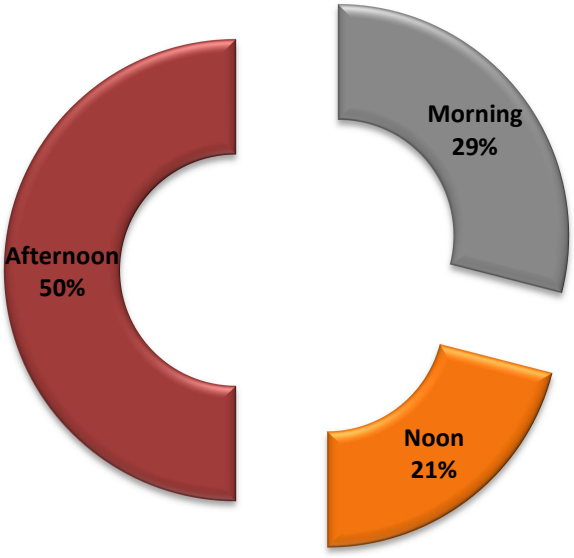


Fig. 6.9. Crop-raiding time in a day.

6.3.4 Seasonal variation of crop-raiding activities by the Capped Langur

The crop-raiding activities by the Capped Langur varied across the seasons. The highest (69%) raiding activities were recorded during winter (Fig. 6.10). This is because the Madhupur National park is a deciduous forest, during winter due to shortage of food (usually leaves) Capped Langurs move from forest to human habitation.

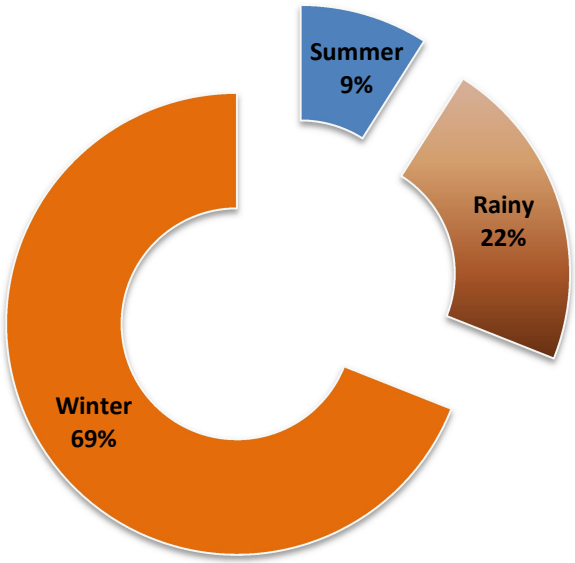


Fig. 6.10. Seasonal variation of the crop damage caused by the Capped Langur.

6.3.5 Crop raiding items

The Capped Langur raid different types of food item, i.e., crop, leaves, flowers, fruits, shoots and vegetables (Plate 6.1, 6.2). The percentage of crop raiding activities depends on the availability and food preference. Fruits were highly raided (Fig. 6.11) by the Capped Langur in the homestead area. The raiding of different types of food were significantly differed between Mymensingh and Tangail districts (χ^2 = 9.864, df = 4, p = 0.0428). In fact, Capped Langur damaged more crops than they actually consume.

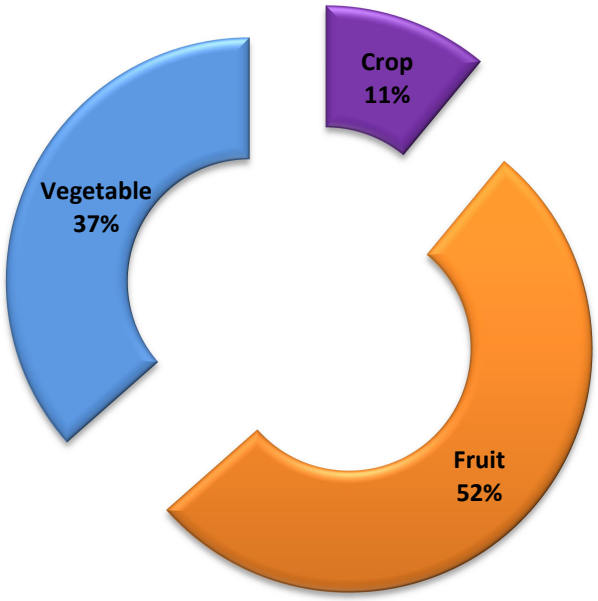


Fig. 6.11. Raiding of different type of food items.

6.3.6 Methods used to deter Capped Langur

Local people implement some traditional methods to deter Capped Langur from their crop land, vegetable and fruit gardens. They use bow-arrow, bamboo, catapult, stick, earthen stone (Plate 6.3, 6.4) and sometimes make harsh sound to drive away the Capped Langur and it is more effective than the others (Fig. 6.12).

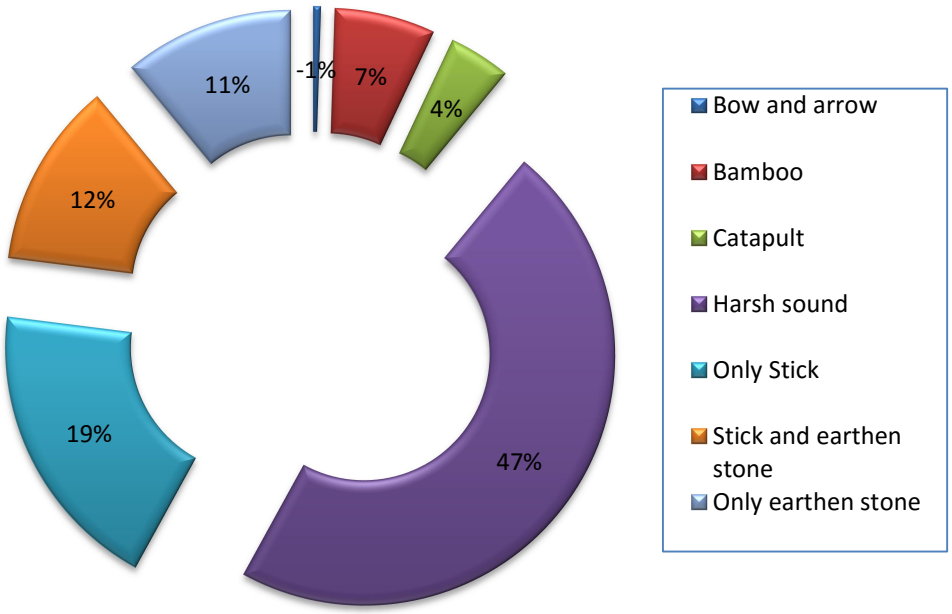


Fig. 6.12. Traditional method used to deter Capped Langur.

6.3.7 People's attitude towards the conservation of Capped Langur

Majority of the respondents (Fig. 6.13) had a positive attitude towards the conservation of the Capped Langur. But 4% people disagreed to conserve Capped Langur. Because they think that Capped Langur is not helpful animal for them, rather they cause crop damage, destroy their house roof, etc.

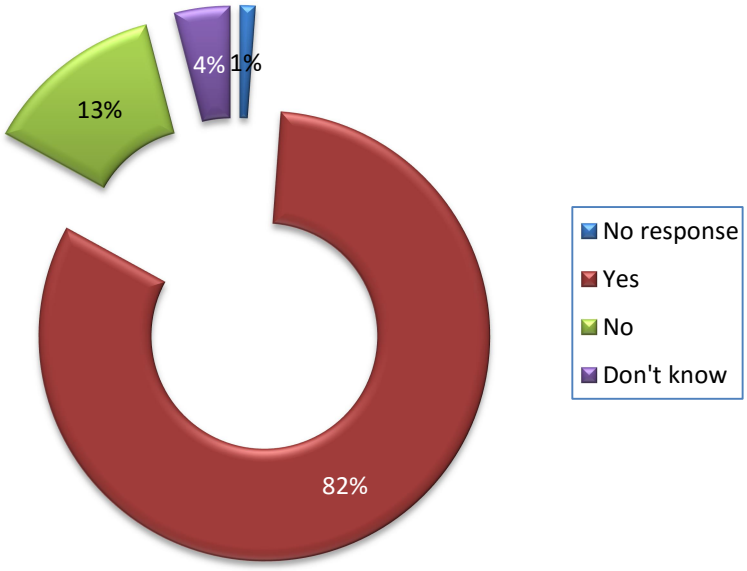


Fig. 6.13. Attitudes towards conservation of Capped Langur.

6.3.8 Public recommendation to reduce human-Capped Langur conflict

Most of the people (70.61%) suggested that establish a zoo would enhance to reduce the human-Capped Langur conflict. Because they think by establishing a zoo government can take care of all individuals in a captivity, which may decrease the encounter with human and Capped Langur, as well as government also can earn revenue from the zoo. Some people think that conservation of habitat for langur may reduce conflict (Fig. 6.14). Besides these, several suggestions (i.e.; food supply, public awareness, translocation, fencing, reduce deforestation activities, creating monitoring cell, increase plantation, need government initiative, etc.) were came from the local people to reduce the human Capped-Langur conflict (Fig. 6.14).

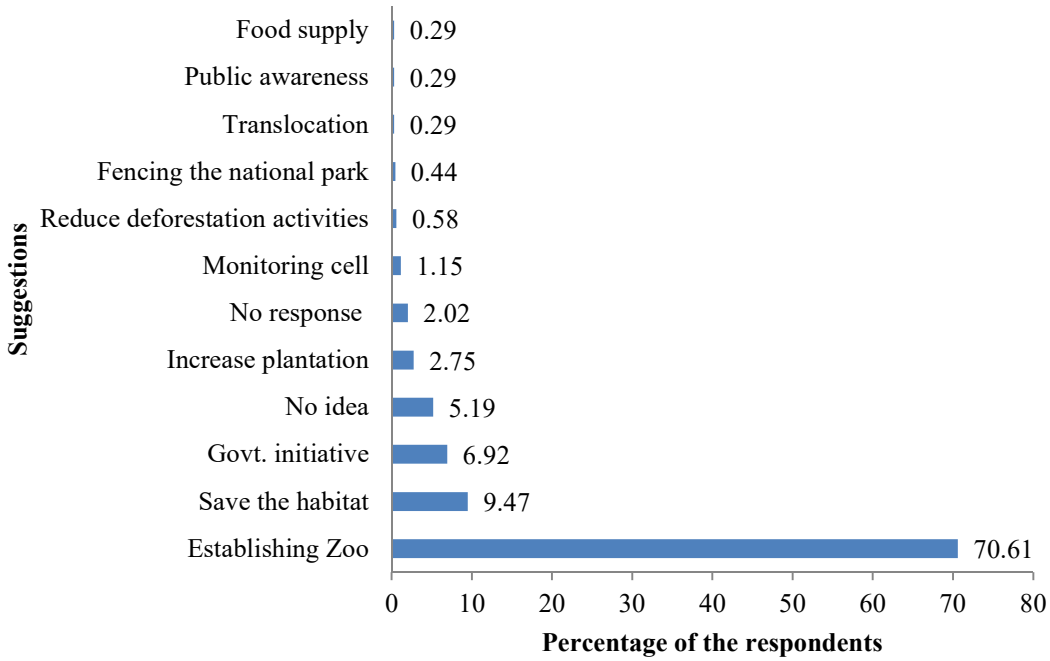


Fig. 6.14. Public opinion regarding to Capped Langur conservation.

6.3.9 Conservation threats

From the observation and questionnaire survey it was recorded that several threats were responsible for the conservation of Capped Langur in MNP area. Though the effects of the threats were not seen leading extinction immediately but had confirmed the estimated population narrowing rapidly which seems to be resulted out by permanent number of population destruction. The major threats are described below:

6.3.9.1 Habitat degradation

During this study it was recorded that habitat degradation was a common scenario in the Madhupur National Park (Plate 6.5). Due to increase of human population and their daily needs, encroachment of natural forest are expanding at an alarming rate. Therefore, local and ethnic people are expeditiously infringing and destroying the habitat (Plate 6.6) of the wild animals especially arboreal animal like Capped Langur. Forest resource occlusion due to human activities Capped Langur is now facing serious threats in the study area. Moreover monoculture practice (Plate 6.7a) by the Bangladesh Forest Department also enhances to rapid degradation of the forest. As a result of these activities human beings are directly or indirectly responsible for the destruction of Capped Langurs' habitat in the Madhupur National Park.

6.3.9.2 Encroachment of forest land

In the study area local people are regularly expanding their cultivated land at the fringe area of the Madhupur National Park. Local communities commercially cultivate different types of crops, fruits like; *Ananas sativus, Citrus aurantifolia, Curcuma longa, Musa* sp., *Oryza* sp. *Zingiber officinale* and vegetables by clearing the forest land (Plate 6.7b). Sometimes inside the deep forest local and ethnic communities take lease large areas of natural forest for commercial crop production (Plates 6.8 and 6.9) which lead the rapid encroachment of the forest habitat resulting fragmented habitat and cause annoying situation for the movement of arboreal animal especially the Capped Langur in the area.

6.3.9.3 Collection of timber and fuelwood

Timber and firewood collection are common scenario inside the Madhupur National Park. Daily household needs, year-long large numbers of local people enter into the forest for timber and fuelwood collection but it is the highest in winter. They collect all types of plant material (thin and thick twigs, dry leaf litter) (Plates 6.10, 6.11, 6.12a), sometimes they also break and cut down fresh plants and let them dry on the forest floor, later to collect when dried up. Needs of increased human population expedite illegal logging (Plate 6.13) for furniture and other household demands caused the destruction of both undergrowth and all forest canopies. From the questionnaires survey it was revealed that in a day 30 to 35 collectors enter into the different parts of the Madhupur National Park and one person collecte about 40 to 50 kg fuel wood and someone sold in the local market about 10 – 15 Tk./kg. Local people reported that several groups are involved with illegal logging in the study area. The maximum proportion of timber and fuel wood collected from *Shorea robusta*, *Lannea coromandelica* and *Mellotus philippensis.*

6.3.9.4 Forest fire

Forest fire is the serious conservation threat for the wildlife especially plant depended animals in the Madhupur National Park. During the study period it was observed that in dry season (winter) some wicked people intentionally make forest fire to clear up wood land for cultivation (Plate 6.12b). This fire burns the whole area from undergrowth to large tree, which lead to fragment forest and cause destruction of habitat for wildlife especially plant depended animals.

6.3.9.5 Poaching

Among the non-human primates in MNP, Capped Langurs are under high hunting pressure due to their group size, limited home range and less aggressive behaviour than the other primates. An important fact is that, the foraging area of Capped Langur was most confined in the study area. Capped Langurs prefer comparatively undisturbed dense forests which creates opportunity for hunters because dense forest was less guarded and less visited by forest guards or other local people or visitors than the periphery. Hunting is less reported in forest edges or even other human dominated areas. It is also known that the hunter preferred adult Capped Langur to hunt comparatively which supplied more meat than others.

Capped Langur is opportunistically hunted by the ethnic communities or even in special day (Christmas day). Among the ethnic groups, young's (15 – 30 years) are the active hunters in the area.

6.3.9.5.1 Hunting techniques

In the Madhupur National Park ethnic communities use several methods to hunt Capped Langurs. The techniques used by the hunters are described below.

a) **By Pet Dogs:** Hunting by dog is a most common practice of ethnic people in the study area. During hunting a group hunter (7-20 persons) enters into the forest with their pet dogs (2-3 dogs) and try to find the Capped Langur's group. When the dogs spot out a group of Capped Langur start barking, then all individuals of the langur group dispersedly run away and try to hide in the forest. If any Langur is isolated from the group, the hunters then target that individual and hunt easily by throwing pieces of brick to Langur's head. Finally, it fall down and the hunters then collect it. The hunters generally use hand-made tools like sling to throw hard particles. Usually the slings are of 18-25 cm in length. Sometimes the hunters climb up the tree with long bamboo sticks to chase the Langur. If there are no canopy bridges to jump other tree then the scared Langur jumps down on the forest floor. After that the trained dogs catch it and handover to the master. Hunters later put it in a plastic bag and bit them until death.

b) Trap: Fruits bait trap is another popular method to hunt Capped Langur. Fruits like banana, pineapples, jackfruits are put in a large, transparent plastic bags. The opening of the bag is tied up by a metal line or wire, when the Capped Langur distinguishes the bag and enters into the bag to eat fruits then the hunter pull the wire to tie out the opening of the bag. Fruits bait traps used during availability of seasonal fruits in the study area.

c) Net: Local people reported that net trap was the primordial methods and it was used till last decade. It might be set in a particular place on trees where langurs frequently traveled for food and resting. The net was set up by the one end of a long rope and the other end of the rope was tied up with tree trunk or hold by the hunter in hiding condition. When Capped Langur moved under the net the hunter released the net to capture it.

d) Arch: This is another primitive technique. From the questionnaires survey it was reported that arch hunters were seen in 20th century and in the previous decades too. Hunters from tribal community might take these as opportunistic food rather than deer, pig, civets, etc.

e) Gun: Guns are not known to use now a days, but it was used in previous century.

6.3.9.6 Road killing

The Tangail–Mymensingh highway (Plate 6.14) has fragmented the habitat of the Capped Langur in the Madhupur National Park. All types of motorized vehicle use this road and lead to road accident of wild animals especially the Capped Langur in the area. The construction of road has caused direct loss of habitat and the threat of easy access by poachers, farmers and illegal harvesters of plants and animals. The construction of road inside the forest creates a long canopy gap which force the Capped Langurs to use road cause fatal road accident. Moreover, Tangail–Mymensingh highway with numerous bends in different areas has split the potential habitat of the Capped Langur in MNP area.

During the study period, 4 accidents were reported, causing 3 spot dead and 1 injured. All these accidents happened during crossing the road except Monar Baid

beat while one adult male jumped over the road to cross the canopy and fell down on the running bus and injured severely.

6.3.9.7 Electrocution

In the Madhupur National Park uninsulated electric wires pass through the forest approaching Tangail–Mymensingh highway and sub-roads inside the forest which causes threats to primates, especially the Capped Langur. During the study period two incidents of mortality due to electrocution of Capped Langurs were recorded. One was adult-female while jumped to cross canopy but unfortunately died because of short-circuiting of two electric parallel power lines connected by long tail and the another one was juvenile during playing slipped on to the electric power line caused fatal accident and finally died.

6.4 Recommendations

- To minimize the conservation threats of the Capped Langurs, natural habitat should be maintained with proper plantation.
- Monoculture practice should be avoided for habitat restoration and re-establishment of the fragmented habitat.
- Laws should be strongly implemented to stop logging for timber and other forest products inside the habitat of Capped Langur.
- Community participation should be the best way for forest protection.
- Avoid construction of roads inside the forest to control easy access of poachers and hunters.
- Speed limit of vehicles on Tangail–Mymensingh highway should be controlled by creating speed breakers after each one kilometre.
- Use insulated electric power line inside the forest to stop accidents from electrocution.
- To reduce the road accidents of primates, should maintain natural canopy bridges and establish artificial canopy bridges over the highway and electric power lines.
- Inside the forest hyper-enthusiastic tourist activities should be controlled and use of loud speakers, screaming, gossiping and laughing in high volume must be prohibited.
- Arrange mass education and awareness program for the conservation of nature and wildlife.

6.5 DISCUSSION

Due to shortage of food and food lean period Capped Langurs move from their forest habitats and enter into the human orchard or vegetable gardens and thus human-langur conflicts occurred in the study area. Raided of home gardens and paddy fields by primates initiated the human primate conflicts in the Madhupur National Park (Naher *et al*. 2017). For less energy loss Capped Langur usually raid peripheral villages of the Madhupur National Park. As a result of highest and diverse vegetable and fruit production in winter the highest raiding activities were recorded in winter and fruits were highly raided in the homestead area. The availability of edible foods in home gardens and cultivated fields increases the crop-damaging habit of hon-human primates (Khatun *et al.* 2012). When Capped Langurs forage ruin more foods than they actually eat. This was also supported by Naher *et al.* (2017). To save their crop local people use bow-arrow, bamboo, catapult, stick, earthen stone, tin-box and sometimes make sound orally to show scare the Capped Langur in the study area. But Naher *et al*. (2017) stated that, patrolling and chasing the primates by stick and catapult was the major crop protection strategies. For the protection of nature and natural habitat majority of the people had positive attitude towards the conservation of the Capped Langur.

Clearing of forest land for commercially cultivation of *Ananas sativus, Citrus aurantifolia, Curcuma longa, Musa* sp. and *Zingibe rofficinale* is a major threat for Capped Langur as well as other primates. Forest encroachment for human settlement, illegal logging, fuel wood collection, grazing and hunting are also leading rapid destruction wildlife habitat especially the arboreal mammals in the study area. Habitat destruction for agricultural activities, permanent settlement, fuel and fodder is also a threat to the sanctuary (Kumar and Solanki 2008). Hunting, poaching and habitat destruction is frequent in the adjacent forest areas of Pakke Wildlife Sanctuary, Arunachal Pradesh, India (Choudhury 1996, Kumar and Solanki 2004a, Kushwaha and Hazarika 2004). Clearing of natural canopy bridges forces the Capped Langurs to use the road and uninsulated power supply line cause fatal accidents. Set up of picnic spots inside the forest and uncontrolled or hyper-enthusiastic tourist activities interrupt the normal activities of the Capped Langur in the area. Population of the Capped Langur has been declining mainly due to habitat loss and degradation (Srivastava *et al.* 2001a, 2001b) and hunting for food, medicinal purposes and

artifacts for socio-cultural practices and religious and cult ceremonies (Solanki 2002, Kumar and Solanki 2004a). Kumar and Solanki (2008) reported that illegal hunting and depletion of food plants were to be most serious threats for Capped Langur. In northeast India Capped Langur is declining due to habitat loss, fragmentation and hunting (Srivastava *et al.* 2001a, 2001b, Kumar and Solanki 2004a). Srivastava (2006b) also stated that habitat loss is the principal threat to wild primate populations and it results from clear cutting for human settlements and agriculture and forests are also selectively logged for fuelwood and construction material and exploited for natural products. The hunting of primates in Northeast India takes place for food and also be killed when they raid and damage crops (Srivastava 2006b).

PLATE 6.1

(a)

(b)

Plate 6.1. Fruit and vegetable raided by the Capped Langur in homestead area (a) *Musa paradisiaca*, (b) *Dioscorea* sp.

PLATE 6.2

(a)

(b)

Plate 6.2. Capped Langur raided on (a) *Citrus grandis* and (b) *Citrus aurantifolia.*

PLATE 6.3

(a)

(b)

Plate 6.3. Langur deterring methods used by the local people (a) bamboo, (b) bow and arrow.

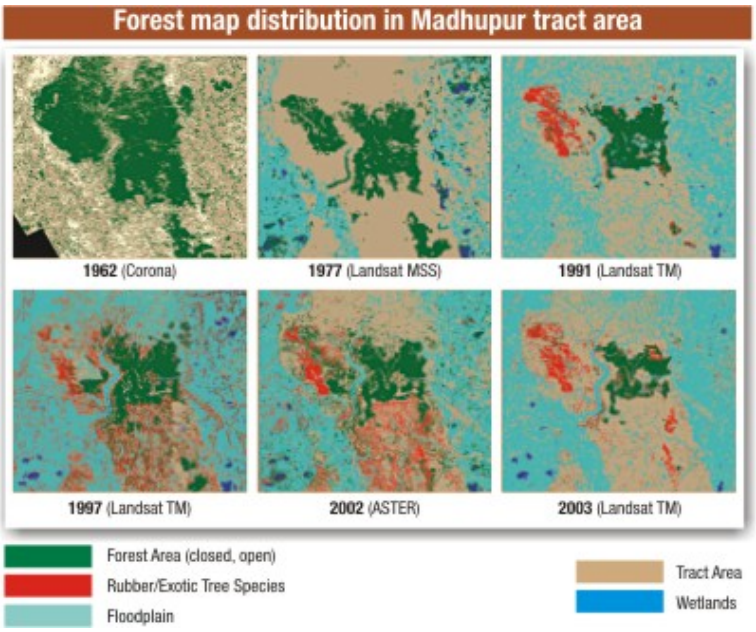
PLATE 6.4

(c)

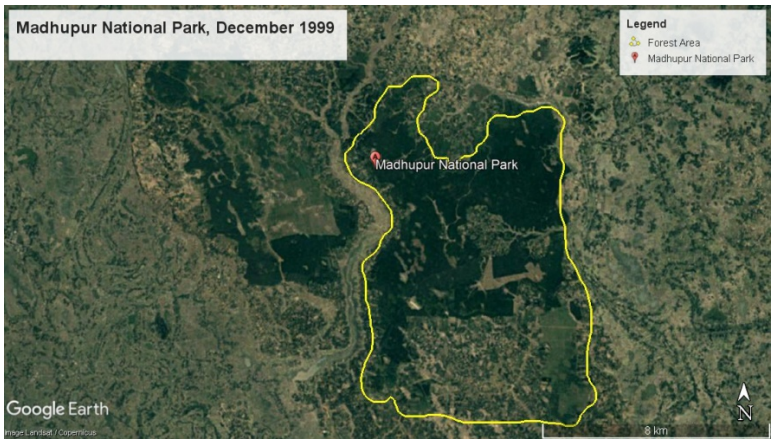
(d)

Plate 6.4. Langur deterring methods used by the local people (c) catapult, (d) earthen stone.

PLATE 6.5



(a)



(b)

(c)

Plate 6.5. Scenario of forest encroachment in Madhupur forest during 1962 to 2016 [source: (a) The Daily Star, 22 August 2009 and (b,c) Google Earth].

PLATE 6.6

(a)

(b)

Plate 6.6. Forest destruction is an endless activity in the study area.

PLATE 6.7

(a)

(b)

Plate 6.7. a) Monoculture plantation in the Madhupur National Park.
b) Clearing up the forest floor for vegetable and other crop production.

PLATE 6.8

(a)

(b)

Plate 6.8. Forest land lease system practices for commercially crop production. a) *Ananas sativus*, b) *Citrus aurantifolia.*

PLATE 6.9

(a)

(b)

Plate 6.9. Forest land lease system practices for commercially crop production. a) *Musa* sp., b) *Colocasia* sp.

PLATE 6.10

(a)

(b)

Plate 6.10. Collection of fuel wood.

PLATE 6.11

(a)

(b)

Plate 6.11. Collection of twigs and forest litters for fuel wood.

PLATE 6.12

(a)

(b)

Plate 6.12. a) Collection of dry leaves.
b) Forest fire caused by the local people for cultivation.

PLATE 6.13

(a)

(b)

Plate 6.13. Illegal logging activities for furniture and household demands.

PLATE 6.14

Plate 6.14. Tangail–Mymensingh highway fragmented the Capped Langur habitat.

CHAPTER 7 : SUMMARY

A study was carried out on 'Behavioral patterns and conservation of Capped Langur (*Trachypithecus pileatus*) at Madhupur National Park in Tangail of Bangladesh'. The population census did during April 2015 to March 2016, data on behavioral patterns were collected from January 2016 to December 2017 conservation threats during July 2017 to June 2018.

7.1. Group number and group size

A total of 154 individuals in 18 troops and one isolated adult male (AM) of Capped Langur (CL) were recorded. Probably due to safe habitat and availability of food plant species the highest number (53.55%) of Capped Langur was recorded in Beribaid Forest Beat. The group size ranged from 3 to 14 (8.6 ± 3.4, n=18) individuals.

7.2 Group composition and sex ratio

Among the 155 individuals (including isolated AM), 51% were adults and 49% were immatures (sub-adult, juvenile and infant). The females were the highest (58.1%) in the total population of Capped Langur in the study area. The ratio of adult males and adult females was 1:2.8, adults and young 1:0.9, adult females and infants 1:0.3, adult males and sub-adults 1:1.5, and adult females and young 1:1.3 in March 2016.

7.3 Group structure

Four types of group structures (i.e., one-male, uni-male uni-female, uni-male multi-female and multi-male multi-female) were recorded during this study. Except four (21.1%), all troops were recorded from the national park area. During lean period food availability (especially in winter season) Capped Langur moved from natural forest to human habitation area (Harinatala and Kathalia village; under the Muktagacha upazilla, Mymensingh district), near the eastern boundary of the national park. Ten (55.6%) troops were recorded along the Tangail–Mymensingh highway (which passes near the southern boundary line of the national park) in Beribaid Forest Beat area.

7.4 Activities start, end time and diurnal active period

The Capped Langur started their daily activities before sunrise except in May and June in 2016. Starting time of the diurnal activities ranged from 27 min. before to 19 min. after (- 4.22 ± 11.61 min., n=18) sunrise but it stopped the activities always after sunset, which ranged from 8 to 26 min. (16.33 ± 5.5 min., n=18). Langurs started activities early during short daylight period (winter) and late during long daylight period (summer).

The duration of the diurnal total active period ranged from 665 min. (11 hrs. 5 min.) to 795 min. (13 hrs. 15 min.) (716.67 ± 41.41 min., n=12) in a day and the day length varied from 639 to 814 min. (729.67±65.21 min., n=12). It was the highest (795 min.) in August and the lowest (665 min.) in December.

7.5 Diurnal activity budget

Capped Langur spent the highest time in resting (32.68%), followed by foraging and feeding (28.51%), sleeping (18.15%), traveling (11.11%), playing (7.57%), mating (1%), grooming (0.98%) and other activities (0.97%). In a day, the adult-male spent its maximum time (29.44%) in resting. The adult-female, sub-adult (male and female) and juvenile (male and female) spent the highest time for feeding. Infant was observed to be spend its maximum time (28.46%) for sleeping in a day.

7.6 Monthly variation of activity budget

The highest resting time recorded in October (42.69%) and the lowest in June (25.03%). Time spent in foraging and feeding was the highest in February (33.70%) and the lowest in July (20.59%). Sleeping time was the highest in April (30.02%) and the lowest in July (4.03%). The traveling time was the highest in July (27.98%) and the lowest in April (4.73%). The time spent in playing was the highest in February (15.32%) but the least in July (1.96%).

7.7 Seasonal variation of activity budget

The Capped Langur spent more time (35.78%) in resting during monsoon and the least (28.55%) in summer. Foraging and feeding was the highest in winter (29.96%) but the lowest during monsoon (27.73%). Time spent in traveling was the highest in monsoon (15.05%) and the lowest in summer (8.23%). The highest sleeping was

recorded in summer (25.44%) but the minimum in monsoon (11.54%). The highest playing time was recorded in winter (8.39%) and the lowest in monsoon (6.55%).

7.8 Activity budget in relation to weather and different day period

There was a significant relationship between resting and traveling with average temperature and rainfall but insignificant in other activities. Resting and sleeping was the highest in mid-day. The highest feeding time was recorded in late afternoon period. The highest traveling time was recorded during early morning.

7.9 Mating behavior

The highest mating behaviour was recorded (68.18%) in morning (0600 hr to 0930 hr) but the lowest (31.82%) in afternoon (1400 hr to 1900 hr). The duration of mating time ranged from 5 second to 25 second (mean 14.82±6.01 second, n=22). Seasonally it was peak in winter (85.28%) but low in summer (1.53%).

7.10 Substrate height used during different activities

The Capped Langur used 0 - 18 m (9.14 ± 4.5 m, n=288) height during feeding. For traveling, the substrate height ranged from 0 - 27 m. (16.03 ± 7.9 m, n=35). They preferred to use canopy bridge for traveling but also used forest floor in long canopy gap. In a day the daily path length varied from 102.76 to 1054.62 m. (388.46 ± 271.41 m., n=74) The daily path length size depended on the availability of the food plants in the study area.

7.11 Food habits and food preference

The Capped Langur used leaf (tender leaf, young leaf and mature leaf), fruit, bud, flower, seed and shoot as their food items. Leaves were highly preferred (63.55%) than others.

7.12 Food preference in different months

Leaves were highly preferred in August (19.12%) and lowest in March (1.47%). The highest fruit preference was recorded in April (25%) and the least (4.17%) in February, July and December. The highest flower was taken in April and August (28.57%).

7.13 Food preference in different seasons

Leaves were consumed more in summer (47.07%) and less in winter (22.05%) season. The highest proportions of fruits were taken in summer (50%) but least in monsoon (20.84%). Flowers had equal preference (28.57%) during winter and monsoon but it was highest in summer (42.86%). On the other hand lowest preferences of seeds (20%) were recorded during summer but in winter and monsoon it had equal preference (40%). During the study period flower bud and bamboo shoots were recorded to take only in winter season and tree bark in monsoon.

7.14 Number of plant species used as food

A total of 82 plant species (include 7 unidentified species) belonging to 39 identified and 3 unidentified families were utilized as diet. Among the total food plants, 58 (70.7%) were trees, 5 (6.1%) shrubs, 18 (22%) climbers and 1 (1.2%) was parasitic plant. Different types of trees provided the food round the year, shrubs for 6 months, climber 8 months and parasitic plant was taken only in January and June. The highest number of food plant species was recorded in summer (45%) than the other two seasons.

7.15 Preferred food plant families

Leguminosae provided the highest (12.5%) food plant species during this study. The Moraceae provided the second highest (10%) and Dioscoreaceae was the third most used (6.25%) plant family by the Capped Langur.

7.16 Preferred feeding height, diet preference in relation to temperature and rainfall

Capped Langur spent the highest time in the middle canopy for feeding than the other canopies. The highest consumption (19.12%) of leaves were recorded when the temperature was high (31.6^{o} C). There was no significant relationship between food choice with temperature and rainfall. The food choice of the Capped Langur depends on available food items.

7.17 Crop damage caused by the Capped Langur

Crop damaged by the Capped Langur in the homestead areas were the highest (88%) than in the cultivated areas. The highest percentage of human-Capped Langur conflict was recorded in the Harinatala village (26.8%) and the lowest in the Charipara (0.29%) of the study area. In a day the highest crop-raiding activities was reported in afternoon (50%) and in a season it was peak in winter (69%). Fruits were highly raided (52%) by the Capped Langur than the other food items (i.e., crop, leaves, flower, shoots and vegetable).

7.18 Capped Langur deterring methods

Local people used bow-arrow, bamboo, catapult, stick, earthen stone and sometimes orally made harsh sound to deter the Capped Langur and it was more effective (47%) than the others.

7.19 Public recommendation regarding to reduce human-Capped Langur conflict

Regarding the public opinion in the study area establish a zoo, habitat conservation, supply provisioned food, public awareness, translocation, fencing, reduce deforestation activities, creating monitoring cell, increase plantation and government initiative could be the best ways to reduce the human Capped-Langur conflict in the Madhupur National Park area.

7.20 Threats of Capped Langur in the Madhupur National Park

Habitat destruction, encroachment in forest area, illegal logging for timber and fuelwood, forest fire, hunting, road accident, electrocution and hyper-enthusiastic tourist activities are the major conservation threats of the Capped Langur in the Madhupur National Park area.

7.21 Recommendation

Avoiding monoculture practice, enforcement of laws to reduce illegal logging, avoiding construction of roads inside the forest, using insulated electric power line inside the forest, creating speed breakers on the highway, establishing artificial canopy bridges over the highway and electric power lines, and by controlling hyper-enthusiastic tourists activities may reduce the threats and mortality rate of primates especially the Capped Langur in the Madhupur National Park.

CHAPTER 8 : CONCLUSION

Behavioral activities, diet, human-langur conflict and conservation threats was studied in Madhupur National Park. The Capped Langur started their activities early in the morning, during winter (short day length) it was started earlier than summer (long day length). The food plants diversity influenced the population of Capped langur in the forest. This study recognized 82 food plant species as their diet. The daily path length size depended on the availability of the food plants. The length of the day, food availability and seasonality affected the time budget of different activities. Capped Langur spent the highest time in resting followed by foraging and feeding. The fragmented and long canopy gap forced this animal to use forest floor for traveling, which initiated human-conflict in the forest. They inhabit in the natural forest, but during food lean period (especially in winter), they raid in human cultivated areas near the fringe area of the park, which leads to human-langur conflicts. Habitat destruction, forest encroachment, illegal logging for timber and fuel wood, forest fire, hunting, road accident, electrocution and hyper-enthusiastic tourist activities were the major conservation threats for this species. Avoiding monoculture practices, avoiding construction of roads inside the forest, using insulated electric power line inside the forest, creating speed breakers on the highway, establishing artificial canopy bridges over the highway, by controlling hyper-enthusiastic tourists activities and strict enforcement of Bangladesh Wildlife (Conservation and Security) Act, 2012 may reduce the threats and mortality rate of primates especially the Capped Langur in the Madhupur National Park.

CHAPTER 9 : REFERENCES

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CHAPTER 10 : APPENDICES

Appendix 1. Data Sheet on behaviour of Capped Langur. **Survey Form No.** ☐

Date: 2. Area : Forest beat : Forest range:
Start time: End time: GPS:

Group Name	Scan No.	Sex	Behaviour									
			Re	For & Fd	Tra	Pl	Gr	Ag	Sub	Vig	Ma	Sl
		A. Male										
		A. Female										
		Sub-A. Male										
		Sub-A. Female										
		Ju. Male										
		Ju. Female										
		Infant										

NOTE: Re – Resting, For & Fd – Foraging and Feeding, Tra - Traveling, Pl – Playing, Gr – Grooming, Ag – Aggression, Sub – Submission, Vig – Vigilance, Ma – Mating, Sl – Sleeping

Appendix 2. Human-Capped Langur (*Trachypithecus pileatus*) conflicts and probable conservation measures in Madhupur National Park Area.

ক. জরিপে তথ্য প্রদানকারী ব্যক্তির আর্থসামাজিক অবস্থা:

১. জরিপ নং ২. তারিখ:

৩. উত্তর দাতার নাম : ৪. পুরুষ/মহিলা

৫. গ্রাম : ৬. ডাকঘর : ৭. থানা : ৮. জেলা :

৯. ধর্ম : ১০. বয়স : ১১. শিক্ষা :

১২. আপনি কত বছর ধরে গ্রামে বসবাস করেন?

১৩. পরিবারের সদস্য সংখ্যা: ..... ১) পুরুষ .....২) মহিলা .....

১৪. আপনার প্রধান পেশা কি?

পেশা	টিক দিন (√)
১) ছাত্র	.....
২) কৃষি	.....
৩) চাকুরি	.....
৪) ব্যবসা	.....
৫) শ্রমিক	.....
৬) গৃহীনি	.....
৭) অন্যান্য	.....

১৫. আপনার কত একর জমি আছে?

১৬. আপনি কিভাবে এ জমির মালিক হয়েছেন?

	হ্যাঁ	না
১) জন্মসূত্রে	.....	.....
২) ক্রয়সূত্রে	.....	.....
৩) দান সূত্রে	.....	.....
৪) খাস জমি	.....	.....
৫) বর্গা	.....	.....

১৭. এ বছর আপনি কত একর জমি চাষ করেছেন?

খ. হনুমান কর্তৃক মানুষের ক্ষতির পরিমাণ ও জরিপকারীর মতামত:

১৮. আপনার গ্রামে কি মুখপোড়া হনুমান দেখা যায়? হ্যাঁ ..... না .....

১৯. আপনার গ্রামে কোথায় মুখপোড়া হনুমান দেখা যায়?

১) বাড়ির আঙ্গিনায় ☐ ২) ফল গাছের বাগানে ☐ ৩) বনে ☐ ৪) বাজারে ☐

৫) ফসলের মাঠে ☐ ৬) নদীর পাশে ☐ ৭) অন্যান্য ☐

২০. আপনার বাড়িতে কতবার মুখপোড়া হনুমান আসে?

১) প্রতিদিন ☐ ২) মাঝে মাঝে ☐ ৩) হঠাৎ ☐ ৪) খুবই কম ☐

২১. বছরের কোন সময় হনুমান আপনার গ্রামে আসে?

গ্রীষ্মকাল ☐ বর্ষাকাল ☐ শীতকাল ☐ সারা বছর ☐

২২. দিনের কোনসময় আপনার গ্রামে হনুমান দেখা যায়?

ক) সকাল ☐ খ) দুপুর ☐ গ) বিকাল ☐

২৩. মুখপোড়া হনুমান কি মানুষের ফসলের ক্ষতি করে থাকে? হ্যাঁ ☐ না ☐

২৪. উত্তর হ্যাঁ হলে কি পরিমাণ ক্ষতি? কম ☐ বেশি ☐ খুব বেশি ☐

২৫. কোন সময়ে হনুমান ফসলের বেশি ক্ষতি করে থাকে?

গ্রীষ্মকাল ☐ বর্ষাকাল ☐ শীতকাল ☐ সারা বছর ☐

২৬. হনুমান কি কি ফসলের ক্ষতি করে থাকে?

২৭. আপনি হনুমানের হাত থেকে ফসল রক্ষা করার জন্য কোন পদ্ধতি ব্যবহার করেন? হ্যাঁ ☐ না ☐

২৮. সাধারণত কোন পদ্ধতি ব্যবহার করে থাকেন?

২৯. আপনার গ্রামে মানুষ-হনুমান সংঘর্ষ বিষয়ে আপনার অভিমত কি?

বাড়ছে ☐ কমছে ☐ একই রকম আছে ☐

গ. হনুমান, হনুমানের আবাসস্থল ও গ্রামের জনগনের মতামত:

৩০. গত ১০ বছরে গ্রামে হনুমানের সংখ্যার কোন পরিবর্তন লক্ষ্য করা যাচ্ছে?

হ্যাঁ ☐ না ☐ আগে দেখা যেত না এখন দেখা যাচ্ছে ☐

৩১. উত্তর হ্যাঁ হলে: বাড়ছে ☐ কমছে ☐ পরিবর্তন নেই ☐

৩২. মধুপুর বনাঞ্চল থেকে আপনি কি ধরনের সুবিধা ভোগ করে থাকেন?

জ্বালানী কাঠ ☐ আসবাবপত্রের কাঠ ☐

৩৩. মধুপুর বন থেকে আপনি কত দিন পর পর কাঠ সংগ্রহ করে থাকেন?

প্রতিদিন ☐ সপ্তাহিক ☐ মাসিক ☐ বাৎসরিক ☐

৩৪. মধুপুর বন কোন প্রজাতির কাঠ বেশি আহরণ করে থাকেন?

গাছের নাম	সংখ্যা

ঘ. হনুমান সংরক্ষণ বিষয়ে মতামত:

৩৫. হনুমান কি পরিবেশের জন্য উপকারি? হ্যাঁ ☐ না ☐ জানিনা ☐

৩৬. আপনার ভবিষ্যত বংশধরদের জন্য হনুমান সংরক্ষণ কি উপকারী?

হ্যাঁ ☐ না ☐ জানিনা ☐

৩৭. পরিবেশ সংরক্ষণ আপনার ভবিষ্যত বংশধরদের জন্য উপকারী, এ বিষয়ে আপনার মতামত কি?

হ্যাঁ ☐ না ☐ জানিনা ☐

৩৮. সরকারিভাবে হনুমান সংরক্ষণের ব্যবস্থা গ্রহণ করলে আপনি কি হনুমান সংরক্ষণে অংশগ্রহন করতে আগ্রহী?

হ্যাঁ ☐ না ☐ জানিনা ☐

৩৯. কি করলে হনুমান সংরক্ষণের ক্ষেত্রে সহায়ক হবে বলে আপনি মনে করেন?

৪০. এলাকায় সরকারি কোন খাস জমি আছে? হ্যাঁ ☐ না ☐ জানিনা ☐

৪১. হনুমানের আবাসস্থল সংরক্ষণে মধুপুর বন থেকে কাঠ আহরণ সহনশীল পর্যায়ে হওয়া উচিত কি?

হ্যাঁ ☐ না ☐ জানিনা ☐

৪২. আপনার গ্রামে বা এলাকায় মানুষ-হনুমান সংঘর্ষ কমাতে আপনার পরামর্শ কি:

ধন্যবাদ