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Eco-Ethological Study on *Semnopithecus Entellus* in Chitrakoot (Satna), Madhya Pradesh

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Abstract: AN Eco-ethological aspect of the Hanuman langurs were studied from September 2012 to December 2013 at the various troop's sites in Chitrakoot. For this study, four bisexual troops were monitored to study the group size, age-sex composition, and other ecological behavior patterns. In present investigations, it was recorded that they feed on natural and provisioned food. around thirty plant species were identified as food which ratifies their folivorous nature. Major circadian activities of Hanuman langur such as resting, walking, sleeping, feeding, grooming, mating and playing were also recorded. In spite of a round the year breeding, observations on decreased birth rate in the Semnopithecus entellus envisage bad indicator for future of this endangered species was also discussed.

Keywords: Troop, Florivorous, Langur, Circadian, Juvenile.

INTRODUCTION

The study of non-human primates is a fascinating and rewarding endeavor contributing in many ways to our knowledge of human history, behavior and development. Gray langur groups are extremely variable in both their size and composition, especially between different habitats and between years (Mohnot & Rajpurohit 1992). Due to rapid deforestation and urbanization the natural habitat of Hanuman langurs was destroyed while they are settled in human settlements, industrial complexes and agricultural plots. In recent years humans have viewed the Hanuman langur as an agricultural pest due to their folivorous nature of feeding. In Chitrakoot there are 30 plant species used by Hanuman langurs in their diet with some of the provisioned food like Chana, Lai, Biscuits, Laddu, Chapati, Banana, Guava, and Mango are frequently fed by people. The availability of food is also affect the home range of troops, if the food is available in its home range, they did not travel a long distance to search for food, thus their home range is decreased(Mishra &Chaturvedi,2015). Hanuman langurs live in three main types of troops uni-male bisexual troops (one adult male, females, Juveniles), multi-male bisexual troops (males and females of all age/sex classes), and all male band. The relationship within a troop, between the adults, may vary by sex. Among themselves, males may be peaceful, cooperative or agonistic, while males and females are usually calm and cooperative with each other. Female-female relationships are typically positive and they will feed, move, rest, groom one another, embrace and greet each other (Ahsan& Khan 2006). Males usually breed at the age of six or seven years and mature males prevent any of the males below this age from mating, though they may be sexually mature. Females come into estrous at about three and a half year of age (R.A. Minhas*et al*.2010).Breeding season also varies with location and gestation from 190-210 days (Roonwal and Mohnot 1977).Hanuman langurs are listed as the least concern species in IUCN red list categories, CITES Appendix I and Schedule II in wildlife protection act 1972 (India).The international union for the conservation of Nature and Natural Resources in 2007 again classified *Semnopithecus* as Lower Risk. In Chitrakoot the over-exploitation of the forest woodlots, especially species of *Diospyrosmelanoxylon* (Tendu), *Madhucalongifolia* (Mahua), *Holopteliantegrifolia* (Chilla), *Acacia indicia* (Babool), *Azadirachtaindica* (Neem), *Mangiferaindica* (Aam) and a lot of other plants species are used as fuel for hotels and Brickfield, threatens the Hanuman survival in this area. The crop-raiding habit of the Hanuman langurs is also harmful to their own survival, this situation may arise in the future to tranquilize and migrated out of Chitrakoot and to rehabilitate them in another forested area of the country, another problem of this species in Chitrakoot–Satna road these animals die due to the road accident, this is because the troops cross the road frequently. Some juvenile langurs kill and eaten by the natural predator such as dog, wolf, and fox. In conservation point of view cutting the forest land for wood and to build houses is one of the major problems for the

survival of langurs. Thus in Chitrakoot, the natural habitat of the langurs decreasing an alarming rate and this leads to increase conflicts between monkey and humans.

METHODS AND MATERIALS

Study area

Chitrakoot is known as the religious cultural capital of India which situated on the border of U.P. and M.P. According to the Imperial Gazetteer of India, the geographical of Chitrakoot is Hill and places of pilgrimage in the Karvi Tehsil (now Chitrakoot District) at Banda district. Chitrakoot is the most historical and religious Hindus place of India and surrounded by lush green hills of legendary Vindhyachal range. The study area of Chitrakoot is located between 80°44' 48.042" to 80°54' 51.53" E latitude and 25°12' 13.0823" to 25°2' 19.952" N longitude. Topography factors were concerned with the physical geography of the earth in the area. The general topography of Chitrakoot is hilly and undulating cut off by numerous rivers and rivulets. Chitrakoot is situated in the close vicinity of the tropic of cancer is landlocked, so in this places, a typical tropical climate condition occurs.

STUDY METHODS

The present study on socio-behavioral aspects and particularly of *Semnopithecus entellus* in Chitrakoot forest range area was carried out for 1years. The study was initiated in April 2012 and terminated in April 2013. Approximately 4000 hours, devoted to this study for present field work. To study the social and reproductive behavior of the *Semnopithecus*entellus investigate or identified the 4 focal troops in the study area and assigned name such as S1 to S4. We apply different methods, to study the different types of socio-behavior.

Total count Methods

In total count method, the entire study area was searched and all animals seen were tallied. It does not follow that the entire number of animals was seen, although this often assumed. With the help of this method total count census of all troops was completed. Each identified troops were visited and by visual inspection counts, the total population of any particular troops was covered. During counts, efforts were made to identify sexes of all the age categories. This work was done an early morning at 5 am to 7 am and from 6 pm to 7 pm in the evening. This method was repeated for three times and calculates the mean value.

To study the different activities of *Semnopithecus entellus* such as feeding, locomotion, Agonistic, playing, sexual and grooming scan and Ad-libitum sampling method was used as describe by Altamann (1974). In this method, observer walks silently along with visitors and recorded the different activities. The data from these activities was collected from dawn to dusk, for three days in each troop in each season.

Ad –libitum sampling method

This is a sampling technique that has no systematic constraints on what is recorded or when is considered relevant at the time. The observer notes what behavior is observed and what is considered relevant at the time. In this sampling method, there is a longhand note and it has all details were recorded. The process of acquiring residency and the process of multi-male to uni-male troop formation are recorded as a part of Ad-libitum sampling. This method is revealed rare but significant behavioral events. It is generally not a good technique for the scientific study of behaviour.

Scan-Sampling

In scan sampling, the behavior of all the individuals in a group of animals is recorded at predetermined time intervals. When we observe a group of animals and record the behaviour of each individual in the group at one-minute intervals for a twelve hour time period. Sometimes during the course of observing animal behavior, certain behaviour are performed by several of the animals at the same time, usually, one animal start behaviour, and then the other animals began to perform the behavior. This is called social facilitation.

In this types of sampling method, there are all the individuals were scanned.With the help of this method newborn baby, social changes in the troops, individuals disappear from groups, etc. were recorded.

Focal-Animal Sampling

In this sampling method, all of the actions of one animal are recorded for a specific time period. For example when we select one Hanuman langur and observed its five minutes, during this five-minute period, all of the activities that this animal performs are recorded, while the activities of the other animals in the area not recorded. When the time period is up, we observe and record the activities of another Hanuman langur. This is focal –animal sampling method. This continues until all of the animals in the group have been observed for the specified time period.

Continuous Sampling

The continuous sampling method is another sampling method that is frequently used to observe behavior. With the help of this method, we recorded the all of the activity that occurs while the animals are being watched. This method is very useful in recording the social interaction between two or more animals in a group. In present investigation recorded chases, fights, Feeding bouts, nursing bouts etc. during the period of observation.

On the basis of the morphological differences, the Hanuman langurs are classified into following age categories.

Category	Description
Adult male	In the adult male stage, the individuals sexually and socially mature with well-developed secondary sexual character
Adult female	From 4 years onwards the female reaches the age of the adult female. In females secondary sexual character is well developed, the skin was pink in colour.
Sub-adult	Members of the group those are sexually but not socially mature. In females above two years of age, mammary nipples are visible. In males 4-6 years of age,
Juvenile	Sexually immature, weaned members of the group are juvenile. The juvenile period differs in male and female.
Infants	From 4-5 months to 7-8 months babies considered as infants. In this period the fur colour is slowly changing from black to brown

RESULT AND DISCUSSION

The study troops were named such as S1(Hanuman Dhara lower), S2 (Hanuman Dhara Upper), S3(Sati-Anusuiya outer) and S4(Sati-Anusuiya temple). There were also other troops living in the neighboring these troops but during study period only four troops focused for analysis

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Population status of the common langur

In summer 2012 there were 159 Hanuman langurs are observed during the period. The average group size was 39.75 individuals per troop. The largest troop was S2 (47 individuals) and the smallest was the S4 (31 individuals).Table no. 01

On the other hand in summer 2013 there were 168 individuals were observed and the average troop size was 42 langurs per troops, the largest troop size was S1 (52 individuals) and the smallest was the S4 (35 individuals). Table no.2

Table no.1 Troop size, structure, composition and the age-sex classes and ratio of four troops of Hanuman langus in summer 2012. S1= Hanumandhara lower; S2= Hanumandhara upper; S3= Sati Anusuiya Temple outer; S4 Sati Anusuiya Temple

Troop Names	Troop Size	Adult		Young					
		Males	Females	SAM	SAF	JM	JF	INF	NB
S1	42	1	12	1	3	4	11	7	3
S2	47	2	9	2	6	3	9	11	5
S3	39	3	13	1	2	4	3	6	4
S4	31	5	6	1	3	3	5	5	3
Total	**159**	**11**	**40**	**5**	**14**	**14**	**28**	**32**	**15**
Mean	39.75	2.75	10	1.25	3.50	3.50	7	8	3.75
Mean%		7.61	25.09	3.10	8.67	8.67	17.28	19.81	9.42

SAM= Sub-adult-male, SAF= Sub-adult female, JM= Juvenile male, JF= Juvenile female, INF= Infant, NB= Newborn

Age-Class Composition

In summer 2012 the average percentage of different age classes were 7.61% adult male, 25.09% adult female,3.10% sub-adult male,8.67% sub-adult female,8.95% juvenile male, 17.28% juvenile female, 19.81% infants and 9.42% newborn babies.(Table No.1). while this data for summer 2013 were 9.31% adult male, 28.08% adult female,5.06% sub-adult male,8.61% sub-adult female,7.52% juvenile male, 13.61% juvenile female, 23.33% infants and 4.42% newborn babies.(Table No.2). This data strongly showed that the troops of Hanuman langurs average 65% population belong to the sexually immature individuals.

Sex-Ratio of the Hanuman Langur

Of the four troops were observed for the analysis only S1 troop (summer 2012) was a uni-male bisexual troop and the rest of three were multi-male bisexual troops. The present study showed that 19.66% of the population is male and 51.04% of the population is female, while 29.23% population is sexual un-identified mainly belong to infants and newborn groups. On the other hand in summer 2013 all troops were multi-male bi-sexual troops and the 21.89% of the population is male, 50.30% female and 27.75% population sexually unidentified. The average number of male per troop was 8.25 and female 21. These results are significantly more female than males in this population because of the percentage of adult female twice that of males in the population.

Table no.2 Troop size, structure, composition, and age-sex classes and the ratio of four troops of Hanuman langurs in summer 2013. S1= Hanumandhara lower; S2= Hanumandhara upper; S3= Sati Anusuiya Temple outer; S4 Sati Anusuiya Temple

Troop Names	Troop Size	Adult		Young					
		Males	Females	SAM	SAF	JM	JF	INF	NB
S1	52	3	18	4	6	2	7	11	1
S2	42	4	10	3	4	3	8	9	1
S3	39	3	11	1	3	3	3	12	3
S4	35	5	9	1	2	4	5	7	2
Total	**168**	**15**	**48**	**9**	**15**	**12**	**23**	**39**	**7**
Mean	42	3.75	12	2.25	3.75	3.00	5.75	9.75	1.75
Mean%		9.31	28.08	5.06	8.61	7.52	13.61	23.33	4.42

SAM= Sub-adult-male, SAF= Sub-adult female, JM= Juvenile male, JF= Juvenile female, INF= Infant, NB= Newborn

Table no.3 showing birth rate & age sex ratio of various troops during -2012

Troop Names	**Troop size**	**No. of males**	**No. of adult female**	**No. of births**	**Birth rate**
S1	42	1	12	3	0.25
S2	47	2	9	5	0.55
S3	39	3	13	4	0.30
S4	35	5	9	3	0.33
Average Birth Rate					**0.35**
Age-sex class ratios	AM: AF	AF: INF	AM:INF	INF:JU	AF:NB
	1:3.63	1:0.8	1:2.90	1:1.31	1:0.37

Table no.4 Showing birth rate & age sex ratio of various troops during -2013

Troop Names	**Troop size**	**No. of males**	**No. of adult female**	**No. of births**	**Birth rate**
S1	52	3	18	1	0.05
S2	42	4	10	1	0.10
S3	39	3	11	3	0.27
S4	35	5	9	2	0.22
Average Birth Rate					**0.16**
Age-sex class ratios	AM: AF	AF: INF	AM:INF	INF:JU	AF:NB
	1:3.20	1:0.81	1:2.60	1:0.89	1:0.14

Birth rate and age sex ratio

The study reveals that births in general varied from troop to troop during the study period. The average birth rate in the whole population for the year 2012 was 0.35 infants/female/troop/year Maximum birth rate was recorded in the focal troop S2 (0.55 infants/female /year) and minimum birth rate in the troop S2 (0.25) Table no.4) while the average birth rate in the whole population for the year 213 was 0.16 infants/female/troop/year Maximum birth rate was recorded in the focal troop S3 (0.27 infants/female /year) and minimum birth rate in the troop S1 (0.05)Table no. 5. It was observed and local people also reported that female langurs delivered their child at safer sites, which are very difficult to explore. Mating occurred in the month of September to November. In the troop's dominant hierarchy clearly, show that if more than one adult female estrous at the same time the high-rank female mated first with the male and these female live three days within the male. In a uni-male bisexual troop, only one resident male mate with all the females of the troop. During the mating time, the male langur has very aggressive to rest of all members. Age sex class ratio of Hanuman langurs was constant but birth rate is flatulated.

Social behavior

The different behavior patterns of the troops were recorded through focal and scan sampling methods (Altmann 1974). In which the activities of visible animals were recorded throughout the day from dawn to dusk. Data were collected for 60 hours per month for each of the focal troops, for three consecutive days in a month. Langurs are social animals these animals lives in generally two types of groups, bisexual troops, and the all-male bands. They live in groups, numbering 10-100 individuals result in larger defensive coalitions and higher numbers of females per groups. Bisexual troops are generally matrilineal and females remain for life in their natal troops while males emigrate, usually as juveniles, to join all-male bands. In uni-male troops, the resident male is under constant pressure from other males attempting to take over the troop. When a group of female takes over a troop they will kill the infants and

mate with the females. The secondary sexual characters are developed in males at the age of six or seven years. Females come into estrous at the age of three or four years. Ecological conditions, food availability and physical condition influence the timing of reproductive events in females. Breeding season varies with location and gestation from 200-210 days. Young are born between January and March until June, with most births around the energetically worst period of the year. Langurs normally give single birth but rare cases some researcher two or three birth also recorded.

Diurnal activities

Hanuman langurs started our daily activities from early morning with morning" Whoops". After descending from the roosting sites and before moving to foraging ground the troop usually stayed in the vicinity of their roosting site for some time and then started our daily activities e.g. feeding , grooming, monitoring dozing and movement. A brief description of each activity is below.

Feeding

In present investigation observed that the all-male bands spent more time in feeding than the bisexual troops. The Hanuman picked up, held and then ate the food from the hands or directly from the trees. For instance, the mature leaves of Mahua (*Madhucalongifolia*) were plucked and they ate only the petiole, but they ate young leaves directly from trees or they detached shoot with young leaves either with hands or mouth from the branch and then ate. In the case of jackfruits (*Artocarpusheterophyllus*) were eaten directly from trees.

Dozing

This is a solitary behavior in this activity the focal animal slept, rested or motionless with closed eyes with slight body movements did occur.

Movements

This activity includes all locomotory activities such as climbing, jumping, leaping, running and walking between arboreal supports.

Monitoring

This activity was also a solitary behavior in which an animal was neither feeding nor sleeping not engaged in social behavior but it was observing around, watching and remaining vigilant.

Grooming

This activity includes all types of grooming behavior such as allogrooming, auto-grooming or self-grooming. Allogrooming may be between female-female, female-male or adult female-juvenile female or adult individual with the young ones. In this activity picking up parasites, debris or fur of another one or itself being groomed by other individuals.

Seasonal behavior variation in various troops of Hanuman langurs

Hanuman langurs are more active during morning and evening time and they relaxed more In the mid-day and afternoon.They are extremely relaxed generally about an hour siesta in the afternoon. They rested both places trees and ground, but on the ground they preferred moist and shady places for mid-day resting. In present observation found that during the year 2012 and 213 the Hanuman langurs spend most of the time on feeding (29.18%) and (29.25%) respectively 2012 and 2013 and less time spent on sexual & other behavior (4.63%) and (4.58%) during 2012 and 2013(Table No.6 &7). During summer season more Hanuman langurs were engaged in dozing.

Table No.6 Annual time spent in different activities during study period-2012-13

Activities	Percentage of total activity (%)
Movement	11.35
Feeding	29.21
Grooming	10.34
Monitoring	21.63
Dozing	22.71
Sexual & others	4.60

Seasonal Variation

During study period it is observed that the Hanuman langurs engaged in three most prominent diurnal activities, these are feeding, dozing and monitoring. Altogether these activities account for about 74% of the total diurnal activities. In summer season or hot day, monitoring takes more time (22.18%) to compare the winter season (21.01%). Likewise, hanuman langurs spend more time in dozing (23.14%) during summer season comparison to winter season (19.35%). A reverse situation exists feeding in summer season (27.34%) compared to winter season (31.81%) same situation exists for monitoring activity during summer season (11.25%) compared to winter season (12.95%). These differences are statistically significant. Sexual and other activity does not fluctuate in different season as in table no.7

Table No.7 Seasonal variation of activities in the different focal troop of Hanuman langurs during 2012&13

Activity	During summer season (Mar-Sept.)	During winter season (Oct.-Feb.)
Movement	11.25	12.95
Feeding	27.34	31.18
Grooming	10.01	8.41
Monitoring	22.18	21.01
Dozing	23.14	19.35
Sexual &Others	4.55	4.47

DISCUSSION

The earlier studies of langur populations from different habitats show differences in age sex ratio, birth rate, troop's size and breeding seasons. Minhas*et al* (2010) our study found that the average birth rate of 0.3 infants/ female/year and maximum birth occurred in months of March to June. Rajpurohit*et al.* (1994) observation show that in Jodhpur langurs the birth rate is 0.63 infants/female/year and maximum birth recorded in the month of March and April. Wesley Sunderraj (2001) reported the seasonality of birth in Nilgirilangurs (8 groups observed from 1985 to 1988) showed two distinct peaks. The primary peak was in May when 17 brown infants were recorded and the second peak occurred in November with the birth of11 more infant. These 28 infants formed 45% of the 63 infants born during three years. Nevertheless, some brown infants were recorded round the year, except during February and August. This seasonality could be related to the seasonality of food availability. In our study, the average birth rate is 0.25 infants/female/year and it varied from troop to troop, because in some places provisioning and crop raiding together may provide better opportunities. In Chitrakoot, the maximum birth occurred between March to July. In Chitrakoot, the birth rate is decreased because in langurs troop's more than 65% population belong to sexually immature classes. Another region due to deforestation the natural food is available in scanty and they spent more time in search of food if provide them provisioning food in sufficient quantity then may be increased their mating time.

Divya Vasudev (2006) studies the Group size and composition in the common langurs *(Semnopithecus entellus)* at Mudumalai Wildlife Sanctuary Bandipur Tiger Reserve and Nagarahole National Park, the average group size was 18.61individuals / troops. Ahsan and Khan (2006) studied the troop size composition and the age-sex ratio of the *Semnonpithecusentellus*in Bangladesh. In his study, they found that the average group size of the troops was 13.67 with 7.32% adult males, 60.68% adult females, 13.87%juveniles and 19.51%infants in July 2006. In September 2006 it was 14.67% with 9.09% adult males, 54.55% adult females, 9.09% juveniles, and 27.27% infants. In the present study, the average group size was 40.87 individual per troop. Majumder*et al.*(2010) our study observed that 50 plant species were utilized by Hanuman langurs in Pench Tiger Reserve Madhya Pradesh, while the Haldi*et al.* found that Presbytispotenziani utilized 118 plant species as food. Ahsan and Khan (2006) observed the Hanuman langurs of Keshabpur (Bangladesh) consumed food from 60 plant species. Mishra and Chaturvedi (2015) study in Chitrakoot and concluded mostly 30 plant species are utilized by langurs in this area; this article is published in International journal of scientific research. In Chitrakoot, the langurs in forested environments spent 30 to 60 % of their diurnal activity in feeding (Yoshiba, 1967) and at Shimla, they spent 40% time in feeding (Sugiyama, 1976). In present study at Chitrakoot, they spent 29.21% time in feeding.

CONCLUSION

The study of not- human primates is very interesting and it contributed the understanding of social behavior, biologically evolutionary, cultural and lifestyle of human societies. The relationship within a group between the adults varies by sex. Among themselves, males may be peaceful, cooperative or agonistic, while males and females are usually calm and cooperative with each other Births are usually singletons and the majority of births occur at night.

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