**POPULATION, TIME ACTIVITY BUDGET AND HABITAT UTILIZATION OF NILGIRI LANGUR (*Semnopithecus johnii)* IN NILGIRI FOREST DIVISION, TAMIL NADU, SOUTHERN INDIA**

**Abstract**

The aim of the study was to understand population, time activity budget and habitat utilization of Nilgiri langur (*semnopithecus johnii*) in Nilgiri Forest Division from June to October 2018. Totally 57 Nilgiri langur troops comprising 535 individuals with an average group size of 9.38±3.65 individuals were recorded from six forest ranges altogether. The sex ratio between an adult male and an adult female of Nilgiri langur was 1:1.09. Similarly, the sex ratio between sub adult male and sub adult female was 1:1. An adult female and young one sex ratio was 1:2.9. Out of 153 hours of observation, it was found the Nilgiri langurs utilized six different habitat types for its various ecological purposes. Among them, the shola forest was effectively utilized by them to fulfill their all ecological requirements including feeding, resting and moving, etc. The Nilgiri langurs fed eighteen plant species of which, five of them were highly preferred food plants. It is very important and management point of view to note that except *Syzigium cumini* others are exotic plant species namely *Acacia mearnsii, Acacia melanoxylon, Pinus wallichiana* and *Cupperssus macrocorpus.* The fruiting phenology of *Syzigium cumini* occurs in stipulated period of time in the year unlike other exotic plants and its availability also comparatively lesser than other exotic plants. Most of the exotic plant species’ parts are edible to Nilgiri langurs which minimized the movement of the animals to get their nutritional requirements. Therefore, this study suggests eradication of exotic species is highly needed of the hour. Because the effects of secondary components on Nilgiri langurs is not known if the animals are forced to feed such exotic plant parts continuously.

**Keywords**: Nilgiri langur; Population; Activity budge**;** Habitat utilization; Feeding ecology.

**Introduction**

The primate is one of the most different groups of mammals having 300 or more species and 600 or more sup-species. The Asian primates have 13 genera and 176 species and more subspecies (Solanki, 2015). India has a long history of being recognized as one of the world's richest primate regions, both in terms of species richness and population abundance. In India, 24 species of primates are found in the Western Ghats is home to six species of primates and 16 are found in the northeastern states (Singh et al. 2020). Of which, Lion tailed macaque (*Macaca silenus*), Bonnet macaque (*Macaca radiata*), Nilgiri langur (*Semnopihtecus johnii*), Black-footed gray langur (S*emnopithecus hypoleucos),* Tufted gray langur (*Semnopithecus priam*) and Slender loris (*Loris lydekkerianus*) ~~(~~Kumara *et al*. 2023).

*Semnopithecus johnii*, often known as the Nilgiri langur, is an endangered species that is only found in the Western Ghats of Tamil Nadu, Kerala, and the hills of Coorg in Karnataka (Tanaka, 1965; Sunderraj, 2001; Kumara & Singh, 2004; Ryley & Shortridge, 1913).The Nilgiri Langurs are usually found in tropical evergreen forests at elevations over 500m above Mean Sea Level (MSL), however, in the habitats of the Kalakad-Mundanthurai Tiger Reserve (KMTR) in Tirunelveli Hills of Tamil Nadu, they are found even at an elevation of 180-200m MSL (Hohmann, 1989; Sunderraj, 2001). The Nilgiri langurs are group living, typically uni-male, multi male, all male and all female groups (Sunderraj, 2001, Roonwal & Mohnot, 1977). The group size of Nilgiri langurs are very shy although its lives in groups up to 3 to 25 animals (Srivastava *et al.*, 1996) and an average of 8 to 9 animals (Prater, 1980). The group size consists of one adult male and five adult females and the rest of them are infants and juveniles (Srivastava *et al.,* 1996). Group size is influenced by environmental conditions such as season, habitat openness, food, and food availability (Southwell, 1984). Nilgiri langurs are strictly arboreal in habit and they are mainly found in sholas which are narrow tracts of forests with streams running through it (Poirier, 1968; Parthasarathy, 1995). They are not confined to the forest and may invade gardens and belts of cultivated woodlands. The Nilgiri langur is confined to evergreen forests, it commonly occurs in dry deciduous forests and moist deciduous forests of Western Ghats, also adapted to live in anthropogenic habitats such as eucalyptus and teak plantations (Roy *et al*., 2012).

Activity patterns in many primates were studied by many authors (Barbhuriya *et al*., 2022; Vanaraj and Pragasan, 2021; Jaman and Huffman, 2013; Bravo and Sallenave, 2003; Clutton-Brock, 1977b; Ding and Zhao, 2004; Doran, 1997; Huang *et al.,* 2003; Passamani, 1998), and found that many primates spent their time by increasing feeding time and/or changing pattern of other activities like rest, travel, etc. (Chapman, 1988a & Overdorff, 1996). Important physiological and environmental aspects, including energy balance, body size, and food availability, are all related to activity budgets (Clutton-Brock, 1974). Some groups increase their time spent in feeding, increase dietary diversity, and/or increase the number of food patches visited per day relative to nearby populations inhabiting more intact forest areas (Onderdonk and Chapman, 2000; Wong *et al.,* 2006; Milich *et al.,* 2014).

In feeding ecology is the central component of species biology, relating to its survival, reproduction, production dynamics, habitat requirement and pattern of sociality (Hohmann *et al.,*2012)……………… The diet includes flowers, buds, seeds, bark, stem, insects and soil (Poirier, 1969b; Roomwal & Mohnot, 1977; Malviya *et al.,*2011). The study of diet can help to understand the role of a species in an ecosystem's energy and nutrient cycles. It also sets a foundation for the understanding of foraging behavior, population dynamics, habitat use and social organization of the species (Mills,1992). The IUCN has classified the Nilgiri langur as vulnerable, and it is listed on the Schedule I part I of Indian Wildlife and CITES appendix II (Protection) Act, 1972 (Singh *et al*., 2008; Molur *et al*.,2003; Singh et al., 2020). The population of Nilgiri langur shows a declining trend (Singh *et al.,* 2008) and large-scale habitat destruction for plantation and agriculture and poaching have affected the species (Ramachandran & Joseph, 2001). The objectives of this study were to determine the distribution pattern and population status of the Nilgiri langur as no long-term study has been attempted so far. The aim of the study is to identify any difference in activity budget between adults and subadults along with examining habitat utilization and feeding ecology of Nilgiri langur to understand the effective conservation and strategies in the Nilgiri Forest Division.

**Study Area**

The Nilgiris is a major part of the Nilgiri Biosphere Reserve and is situated (11, 12' and 11, 43' North and 76, 14 and 0 77, 1' East) in the North-Western corner of Tamil Nadu in Southern India. They are bounded on the North by the State of Karnataka and in the West and southwest by Kerala and East and South by the Coimbatore district of Tamil Nadu. The Nilgiris inhabited a total area of 2542.49 sq. km and the elevation of the Nilgiris range from 300 to about 2,700 meters. The district is located between 11°12' to 11°37' North latitude and between 76°30' to 76°55' East longitude. As the state's most forested district, Nilgiris represents an important section of the Western Ghats in Tamil Nadu and stands as the intersection of the Western and Eastern Ghats. The peak of Doddabetta is the highest elevation in Nilgiris with an altitude of 2637 meters. The study was carried out in six forest ranges of the newly merged Nilgiris Forest Division. There are Nilgiri South, Korakundha, Pykara, Governorshola, Parsons Valley and Naduvattam. Temperature range of mean maximum and minimum annual temperatures are 18.9º C -19.6ºC and 9.9ºC-11.3ºC respectively, with a mean of 13.9º-15.40ºC. The vegetation of the Upper Nilgiris can be broadly classified into the Southern montane wet forest (Shola and grasslands) and plantations. Presently, most of the forested areas in the Upper Nilgiris are under plantation, with very little shola cover left (Fig. 1).

**Methods**

The study was conducted from June to October 2018 in the newly merged Nilgiris Forest Division (NFD), Tamil Nadu.

The distribution of Nilgiri langur was estimated by the total count sampling method to cover in the study area (NRC,1981; Whitesides *et al.,*1988). The langur was classified into three age categories, viz., According to Sunderraj's (2001) description of their structural differences, male, female, and newborn. Repeated surveys were conducted to estimate the group size and demography. All locations were recorded using GPS to prepare the distribution map of this species in the Nilgiris Forest Division using Arc GIS 10.4.1 version computer software. The focal animal sampling method was deployed to observe the feeding ecology of Nilgiri langur (Altmann, 1974). Feeding on insects/fruits/flowers/leaves/social and self-directed activities, plant species (when the individual feed on plant materials), plant parts were eaten, and its phenophase, etc. were collected. Time activity budget data was collected through an Instantaneous or scan sampling method to gather information on group/individual activity (Altmann, 1974). In the case of primates, group scanning was taken on all visible members of the group for 5 minutes at every 15 minutes interval. The activities of Nilgiri langur were categorized into feeding, movement, playing, fighting, scratching, grooming, courtship, display and mating.

**Results**

**Population status**

Based on the pilot survey in the Nilgiris division the population status of Nilgiri langur were carried out in six forest ranges of Nilgiri forest division from June to October 2018. Totally 57 troops were identified with 535 individuals of Nilgiri langur of which 175 were adult male, 192 were adult female, 51 were both of sub adult male and female 51 sub adult male, 51 sub adult female and 66 were young ones within an average group size of 9.38±3.65individuals. Among the maximum numbers of individuals were sighted in Naduvattam forest range (n=153) within an average group size of 8.5±3.45 individuals and minimum numbers of individuals 28 were sighted in Governorshola forest range within an average group size of 9.33±3.78 in the Nilgiris (Table 1, Fig. 2). The Nilgiri langur sex ratio between an adult male and adult female in the Nilgiris Forest Division was 1:1.09. Similarly, the sex ratio between sub adult male and sub adult female was 1:1. An adult female and young ones sex ratio was 1:2.9.

**Time Activity Budget**

The time activity budget of nilgiri langur were spent their time in carried out different activities like Feeding, Movement, Scratching, Grooming, Courtship, Display, Mating, Resting. A total of 153 hrs spent to observe time activity budget of Nilgiri langur troops (n=57). Nilgiri langur spent most of its time for feeding (32 hrs) followed by resting (32 hrs) than other activities. Adult male individuals spent most of their time for feeding activity (54%) followed by resting (19%), movement (12%) and other social activities (15%). While adult female individuals spent most of their time for feeding (53%) activity followed by resting (18%), movement (10%) and other social activities (19%) as like adult male. There is no significant differences was observed between time spent for different activities by adult male and adult female individuals of Nilgiri langur (χ2 = 6.2674, df = 8, p = 0.61729). It was quite interesting to note that unlike Adult male and adult female, the sub adults spent most of their time for feeding activity (58%) followed by Movement (17%), grooming (17%). Then resting activity was not found in sub adults. Playing (17%) and fighting (8%) behaviour only observed by sub adults and young onces. There is no significant differences was observed between time spent for the activities of adults and sub adults (χ2 = 0.4134, df = 8, p = 0.99994). Young onces were observed to spent most of their time carried out feeding (50%) followed by Movement (15 %), Playing (14%), Grooming (14%) and resting (7%) and there is no significant differences was observed in time spent adults and young ones in different activities (χ2 = 12.608, df =8, p = 0.12607) in the Nilgiris Forest Division irrespective of the forest ranges (Fig. 3).

**Habitat utilization of Nilgiri langur**

Habitat utilization of Nilgiri langur results shows that 35 troops were recorded in shola forest habitat (61%) which was followed by 9 troops in wattle plantation (16%). Only a few amounts of utilization were seen in other plantation like 7 troops in pine plantation (12%), 3 troops in tea plantation (5%), two troops in agricultural plantation (4%) and one troop in cupperssus plantation (2%) respectively (Fig. 4). Figure 5 shows that there were six habitat types have been utilized by the Nilgiri langurs in the Nilgiris Forest Division irrespective age and sex classes during the study period. Totally 153 hours observations of Nilgiri langur were effectively utilized in shola forest for all activities (n=86 hrs.) which was followed by pine plantation (n=27), wattle plantation (n=23), each six hours in Agriculture and in *Cupperssus* plantations and just five hours in Tea plantation.

**Food preference of Nilgiri langurs**

Totally 83 hrs were spent to find out the plant-feeding preference of Nilgiri langurs. A total of eighteen plant species were eaten by Nilgiri langurs in the Nilgiris Forest Division. Of which *Acacia mearnsii* was most preferably eaten by them followed by *Cupperssus macrocorpus, Acacia melanixylon* and *Syzigium cumini* on the other hand, species such as *Actinodaphne, Dhalia imparialis, Eleagnus kolaga* was consumed least quantity irrespective of sexes. It was quite interesting to note that all the sexes were highly fed on exotic invasive alien species than endemic plant species (Table 2). Among them adult male predominantly feeding each four hours on *Pinus wallichiana* and *Cupperssus macrocorpus* and every three hours on *Acacia mearnsii,* and *Syzigium cumini.* The adult female predominantly feeding viz. three hours each on *Acacia mearnsii, Acacia melanoxylon* and *Pinus wallichiana.* It was quite interesting to note that the native plant species named *Syzigium cumini* was equally preferred (n=2 hrs.) by sub adult male, sub adult female and young ones. The study has found that among five predominantly preferred plant species by the Nilgiri langurs in the Nilgiris Forest Division, just only one plant species named *Syzigium cumini* was in the list of native plants rest of them were invasive alien species such as *Acacia mearnsii, Acacia melanoxylon, Pinus wallichiana* and *Cupperssus macrocorpus* (Fig. 6). Among the plant parts eaten by the Nilgiri langurs, young leaves were found as most dominant (76%) in the diet followed by seeds (11%), stem (6%), flower (5%) and cone (2%) irrespective of sexes.

**Discussion**

The present study has recorded 1-23 individuals an average of 9.38±3.65 of Nilgiri langurs in a group in the Nilgiris Forest Division. Daniel and Kannan (1967) recorded that the range of troop size differed from 1 to 30 individuals in South India. According to Poirier (1969a) an average group size of Nilgiri langur was 8.9 individuals more accurately monitored troops in the sholas. Among the current studies of (Kumara *et al*., 2023), 2 -27 individuals with a mean group size of 9.10±5.54 langurs were recorded in the Western Ghats. The present study has recorded the sex ratio between an adult male and adult female in the Nilgiris Forest Division was 1:1.09. Similarly, the sex ratio between sub adult male and sub adult female was 1:1. An adult females and young ones sex ratio was 1:2.9. This is considerably equal sex ratio with Ramakrishnan and Samson (2012), when it was 1:2.4 in the Nilgiris North Forest Division. Singh *et al*. (2016) studied the adult female and immature ratio was 1:0.33 in the Western Ghats. It was also found that the present study area sex ratio between an adult male and adult female was a skewed sex ratio when compared with Sunderraj (2001). He found the sex ratio between an adult male and adult female was 1:2.5 in the Mundanthurai Plateau and Ramachandran and Joseph (2001) recorded 1:2 in Silent Valley National Park. This is rather a highly skewed sex ratio when compared with Poirier (1969b) study 100 females, 83 males. Singh et al., (2016) studied the adult female and immature ratio was 1:0.33 in the western ghats.

Totally 535 individuals were sighted belonged to 57 troops from all six forest ranges of Nilgiris Forest Division altogether. Of which Naduvattam Forest Range (n=153) recorded highest number of individuals. On the contrary, Governor Shola Forest Range (n= 28) recorded lowest number. This was mainly because of the occurrences of more shola forest patches in the Naduvattam Forest Range. On the other hand, Governor shola Forest Range attributed more agricultural lands than natural forests. Being an arboreal in nature the Nilgiri langurs tends to live in dense forests than in agricultural lands. Carpenter (1964) and Poirier (1968b) has stated that the Nilgiri langur population density and troop size varied considerably in the numerous and isolated in sholas of south India. They also concluded that the less number of Nilgiri langur troops were observed in the agricultural plantation. Horwich (1972) has stated that most of the Nilgiri langurs were found in the evergreen forests between 600m to 1800m and although they appear thriving in deciduous habitat.

The present study found that the adult male and adult female Nilgiri langurs have spent most of their time feeding followed by resting and movement than other activities such as scratching, grooming, courtship, mating and display. According to Srivasthava *et al.* (1996) the Nilgiri langurs spent an average of 36% of its total activity time for feeding. Parthasarathy (1995) has stated that the adult female was found to groom more than adult males and similarly sub-adult females also rarely groom juveniles and infants. According to Roonwal and Mohnot (1977) the adult females rarely play with their young ones. Similarly, the studies have been reported that the foraging and feeding activity is predominant for many colobines (Leen et al. 2019; Khan 2020; Naher et al. (2022).

The time-activity budget of sub-adult male Nilgiri langur was noticed playing and fighting with adults and young ones. But the sub-adult female had spent most of their time for feeding followed by social behavior of grooming and no fighting was recorded. The Young ones were recorded playing more time followed by resting and grooming with both sexes. Parthasarathy (1995) has observed social play behaviour in the Nilgiri langur occurs amongst infants, juveniles, and sub-adults, rarely adults. He also further stated that the adult females were found to groom more than adult males and sub-adult males and they rarely groom juveniles and infants. However, the other primate species were observed to have minimal activity of playing found in the adult females and sub-adults and juveniles (Zain and Ch’ng, 2011; Akhter 2021)

The present study has recorded six types of habitats that were utilized by the Nilgiri langurs in the Nilgiris forest division. Of which shola forest was effectively utilized by them for all activities such as feeding, resting, movement, and other social activities. This study has recorded 18 plant species were listed in the diet of Nilgiri langurs. Of which five of them were dominant preferred food plants to Nilgiri langurs in the Nilgiris Forest Division. Except *Syzigium cumini* others were exotic plant species namely *Acacia mearnsii, Acacia melanoxylon, Pinus wallichiana* and *Cupperssus macrocorpus.* This was mainly because of their availability in vast areas as well as fruiting phenology of *Syzigium cumini*as occurs only in stipulated period in the year. Most of the plant parts are considered to be the edible parts to Nilgiri langurs in the case of exotic plant species. *Acacia* leaves, flowers, seeds provided year-round as food source to Nilgiri langurs minimized the need for an extensive movement to complete their nutritional requirements. Ramachandran (1995) has reported 13 food plants from the Shendurney Wildlife Sanctuary. Srivastava *et al.* (1996) has recorded 29 food plants in Periyar Tiger Reserve. Sunderraj and Johnsingh (1993) were reported 54 food species in Servalar gallery forests in Mundanthurai Wildlife Sanctuary. Among the observations of primates prefer the food plant species, Vanaraj and Pragasan (2020) recorded 95 species of food plants in Kalakkad Mundanthurai Tiger Reserve. Similarly, Borah et al. (2021) recorded 41 food plants, Assam, while Thakur et al. (2022) recently reported 20 plant species in Himachal Pradesh.

 They had observed the Nilgiri langurs were mainly feeding on leaves and other parts of the plants in the study area. Nilgiri langur consumed food containing more protein than carbohydrate and lipid. Curtin (1980) has mentioned that the Asian columbines' are successfully adaptive to their digestion of a sacculated stomach which digests cellulose by bacterial fermentation and thereby allows the exploitation of vegetation parts. The large amount of leaves devoted by the Nilgiri langurs is due to several physiological and behavioral adaptations. Rajpurohit (2005) found that this helps them to survive on their relatively un-nutritional diet through most of the day and gain energy by steady foraging for long periods that involves little movement. Poirier (1968c) studied the concentration and type of food plant in the home range played a major role in determining its size. Troops inhabiting sholas lacking a food source such as *Acacia melanoxylon* tree had larger home ranges than troops in areas where was abundant.

**Conclusion**

The study highlights the habitat preferences of Nilgiri langurs in the Nilgiris Forest Division, emphasizing their strong reliance on shola forest habitats. The majority of recorded troops were found in shola forests, indicating their crucial role in providing suitable resources for the species. Wattle and pine plantations also supported a considerable number of troops, though to a lesser extent. Other plantations, including tea, agricultural, and Cupperssus, were utilized minimally. Observation time further reinforces this trend, with 153 hours of monitoring revealing that Nilgiri langurs spent the highest proportion of their time in shola forests, followed by pine and wattle plantations. Hence, this study suggests eradication of exotic species is highly needed, as the long-term effects of secondary components on Nilgiri langurs are not known if the animals are forced to feed on such exotic plant parts continuously. The minimal time spent in other plantation types suggests they may not provide sufficient resources or suitable conditions for the species. Overall, the findings indicate that conservation efforts should prioritize shola forests to ensure the continued survival of Nilgiri langurs. Additionally, habitat restoration and management strategies should consider improving the ecological value of other plantation areas to support the species habitat.

Disclaimer (Artificial intelligence)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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**Table 1 Population status and Demographical structure of Nilgiri langur recorded in the Nilgiris Forest Division**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.No.** | **Name of the** **forest ranges** | **Total number** **of** **troops sighted** | **Total number** **of** **individuals sighted** | **Average number** **of troops sighted****M ± SD** | **Demography** |
| **AM** | **AF** | **SAM** | **SAF** | **Y** |
| 1 | Nilgiri South | 11 | 106 | 9.63±2.73 | 34 | 34 | 9 | 12 | 17 |
| 2 | Korakundha | 9 | 107 | 11.8±4.67 | 34 | 35 | 12 | 12 | 14 |
| 3 | Pykara | 10 | 95 | 9.5±4.2 | 27 | 31 | 15 | 13 | 9 |
| 4 | Governorshola | 3 | 28 | 9.33±3.78 | 7 | 10 | 2 | 3 | 6 |
| 5 | Parsons valley | 6 | 46 | 7.66±1.86 | 17 | 20 | 4 | 2 | 3 |
| 6 | Naduvattam | 18 | 153 | 8.5±3.45 | 56 | 62 | 9 | 9 | 17 |
|  | **Total** | **57** | **535** | **9.38±3.65** | **175** | **192** | **51** | **51** | **66** |

 AM – Adult Male, AF– Adult Female, SAM – Sub adult male, SAF – Sub adult female, Y- young ones

**Table 2 Food plant preference by the Nilgiri langurs in the Nilgiris Forest Division (n=83 hours)**

|  |  |  |
| --- | --- | --- |
| **S.No.** | **Name of the plant species** | **Feeding plants preference** |
| **AM** | **AF** | **SAM** | **SAF** | **Y** |
| 1 | *Acacia mearnsii* | + + + | + + + | + | + + | + |
| 2 | *Acacia melanoxylon* | + + | + + + | + | + | + |
| 3 | *Syzigium cumini* | + + + | + + | + + | + + | + + |
| 4 | *Syzigium grandis* | + + | + |  |  |  |
| 5 | *Syzigium arnotiana* | + + | + + |  |  |  |
| 6 | *Eleagnus kolaga* | + | + + |  |  |  |
| 7 | *Actinodaphne* | + | + |  |  |  |
| 8 | *Symplocose foliosa* | + | + + |  |  |  |
| 9 | *Cryptocarya* | + | + |  |  | + |
| 10 | *Cupperssus macrocorpus* | + + + | + + | + | + | + |
| 11 | *Mangifera indica* | + | + |  |  |  |
| 12 | *Grevillea robusta* | + | + |  |  |  |
| 13 | *Solanum mouritianum* | + | + |  |  |  |
| 14 | *Dhalia imparialis* | + | + |  |  |  |
| 15 | *Pinus wallichiana* | + + + | + + + | + | + | + |
| 16 | *Daucuscarota* | + | + | + |  |  |
| 17 | *Elaeocarpusoblongus* | + + | + + |  |  |  |
| 18 | *Alnus nepalensis* | + | + |  |  |  |



**Figure 1 Focused study area**



**Figure 2 Range wise the Nilgiri langur distribution in Nilgiri Forest Division**

**Figure 3 Proportionate of time activity budget of Nilgiri langur in Nilgiri Forest Division**

 **Figure 4 The percentage of habitat utilization of Nilgiri langur in Nilgiri Forest Division**

**Figure 5 Habitat utilization of Nilgiri langur in Nilgiri Forest Division irrespective of the age and sex classes (n=153 hours of observation)**

**Figure 6 Percentage of food plants preferred by Nilgiri langur in Nilgiri Forest Division (n=83 hours observation) irrespective of the age and sex classes.**