# Population, habitat use pattern and feeding behaviour of Irrawaddy squirrel (*Callosciurus pygerythrus* Geoffroy, 1831) in Jahangirnagar University campus

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**Abstract**

The study was conducted to know the population, habitat use pattern and feeding behaviour of Irrawaddy Squirrel (*Callosciurus pygerythrus*) in Jahangirnagar University Campus from October 2016 to September 2017. The population density had slightly varied in different months; it was the highest in May (997.58/km$^2$) and the lowest in January (612.98/km$^2$). The mean population density was 841.34/km$^2$ (SD= 135.98). The visibility was the highest at 0900h (15.71%) and the lowest at 1100h (7.07%). The monthly variation was the highest in May (9.88%) and the lowest in January (6.07%), which was probably due to the change of temperature. In total 15 plant species were preferably occupied by the squirrels in Jahangirnagar University Campus. The most preferable tree species was Koroi (*Albizia procera*) and the frequency was the highest for it as 16.71% of the total sightings of squirrel were in and around Koroi tree. The middle canopy was mostly used (48%) by Irrawaddy Squirrel, followed by lower canopy (29%), upper canopy (10%) and ground (13%). In case of diurnal variation in feeding the highest rate of feeding was recorded in afternoon (at 1700h, 18.46%) and morning (at 0800h, 17.06%). Maximum time spent in feeding was in May 2017(17.40%) and minimum in January 2017 (2.52%). The major items of their diet included fruits and seeds for which they spent 39.4% and 25.4% time, respectively. According to the study, squirrels of Jahangirnagar University Campus were not distributed uniformly, but concentrated in some areas due to vegetation type, food availability and human presence. The study also revealed that the squirrels of Jahangirnagar University campus showed variation in their food choice, feeding behavior and habitat preference.

**Key words:** Population, Irrawaddy Squirrel, Habitat use, Feeding.

## INTRODUCTION

Squirrels are spectacular creatures of nature. They are small or medium-size rodents belonging to the order Rodentia of the class Mammalia. This order containing about 1650 species; is the largest group of living mammals , comprising some 40 percent of all present day mammal species. Much of the success of rodents can be attributed to their generalized body plan, grinding cheek teeth and very efficient gnawing front teeth. Indeed the very name rodent is derived from the Latin "rodere" which means "to gnaw". Rodents also breed fast and slow an ability to adapt quickly to changing surroundings and to colonize new habitats. The first rodents may well have been forest living squirrel like animals; they appeared in the fossil record some 50 million years ago in North America and soon after that in Eurasia (Black, 1972). Since that time the rodents have spread widely. Now they are found in all countries and a wide variety of life styles (Eisenberg, 1981).

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Bangladesh is a country of varieties species of amphibians, reptiles, birds and mammals. Bangladesh is the home land of 9 species of squirrels under the family Sciuridae of the order Rodentia (IUCN, Bangladesh 2015).

The study of population, habitat use pattern and feeding behaviour of squirrels is very important as they play significant role in the ecosystem of an area to know the present condition of the species and recommend the appropriate conservation measures if they are at risk. Due to habitat destruction, over-exploitation of forest resources, etc. the number of squirrels is decreasing day by day. Though some studies were conducted on ecology, behaviour, food habit and habitat use pattern of some species of squirrel in different regions of Bangladesh but in case of Irrawaddy Squirrel (*Callosciurus pygerythrus*) information about population density is rarely reflected in Bangladesh. Therefore, this study was aimed to know the population, habitat use pattern and feeding behaviour of Irrawaddy Squirrel (*Callosciurus pygerythrus*) that may help in the conservation of this species.

**MATERIALS AND METHOD**

**Study Period and Study Area:** The Irrawaddy Squirrel or Hoary-bellied Himalayan Squirrel (*Callosciurus pygerythrus*) have been studied in their habitat, Jahangirnagar University Campus from October 2016 to September 2017. Data were collected from 6 am to 12 pm and 3 pm to 7 pm. However, data collection period was adjusted in accordance with the seasonal changes and day length. A total 67 days were spent in the field. Weather has great influence upon the distribution and activity of wild animal fauna. However, during the study period, the twelve month prolonged weather was quite suitable for the observation of this species, except the extreme cold temperature during the whole month of December and January. It was observed that, the most suitable sunny temperature was found in prime condition representing 52.66% of the total study period, followed by shady weather 23%. In contrast, 16.01% was covered by cold weather and only 8.33% by the cloudy weather.

The study was conducted in Jahangirnagar University Campus which is an undeclared sanctuary of many wild animals. Geographically this university is situated between 90º47'50" N to 90º48'10" N and 23º4'0" E to 23º4'15" E, 32 km North-West capital Dhaka. Bangladesh Public Administration Training Center (BPATC) and Radio Bangladesh Broadcasting Center are situated on the South of the university the North-East part of the university is surrounded on by Savar Cantonment and on the north by Jatiya Smritishoudha (National Monument), on the East by Dhaka-Aricha highway which is used to communicate with northern area and southern part of Bangladesh. An open land of human settlement is situated on the west the University. The total area of University is now 697.56 acres. The University campus is elongated by north south direction with 2 miles.

**Data sampling and analysis:** Strip transect sampling method was the most suitable method to estimate the population density of the squirrels of Jahangirnagar University Campus because of the habitat and vegetation type. In this method depending on the

visibility on the study area the observation range may vary. Usually 20 meters are used on both side of the center line. The initial location of the objects should be considered because the objects might move away after watching. If any object is sighted beyond their pre-decided observation ranges, or if the object is coming from the back, the observation is not recorded. This method assumes that all objects in the strip are recorded. Even then, some of the objects have might been missed in the strip, but if it is not more than 5% of the total objects recorded, the error is statistically negligible. The more areas covered in strip transects, the less error in the result will be. During the study period 9 transects were selected for studying their population. Transects were located in areas which are suitable in terms of accessibility and observation in each study site. Even if any centerline of transect was slightly undulated, the observation strip was maintained straight (roughly) by manipulating the observation distance to that particular area. The squirrels were observed and identified properly and carefully. Opportunistic survey and scan sampling methods were used for the study of habitat and food preference. In case of scan sampling method the activity of all visible individuals was recorded at 5 minute interval based on Altman (1974) and Martin & Bateson (1993). A total of 651 scans were recorded for feeding behaviour. Squirrels are diurnally active hence, data were mainly collected through direct observation by walking through transects and other study sites, preferred plant species were identified by the aid of books, wildlife experts and botany experts. Population densities were calculated by dividing the total number of individuals in transects with the total area surveyed. Feeding rates were estimated by time-count method. Significance of diurnal and monthly variation of population density and feeding behavior were assessed with Chi-Square test (Grassman *et al*., 2005 and McCoy 1986).

**Table 1. Strip transects used in population estimation**

| Transects | Starting point (Geographical location) | Ending point (Geographical location) | Length ($L$) | Width ($2W$) | Repetition (times) |
|---|---|---|---|---|---|
| 1 | 23º53′ 03.2″N 90º16′16.6″E | 23º52′52.9″N 90º16′16.6″E | 200m | 20m | 48 |
| 2 | 23º52′52.0″N 90º16′16.6″E | 23º52′52.1″N 90º16′12.2″E | 100m | 20m | 48 |
| 3 | 23º52′51.8″N 90º16′11.4″E | 23º52′47.7″N 90º16′11.5″E | 100m | 20m | 48 |
| 4 | 23º52′47.1″N 90º16′11.1″E | 23º52′47.1″N 90º16′08.0″E | 80m | 20m | 48 |
| 5 | 23º52′42.2″N 90º16′13.4″E | 23º52′34.4″N 90º16′15.0″E | 200m | 20m | 48 |
| 6 | 23º52′28.8″N 90º16′04.2″E | 23º52′21.2″N 90º16′04.1″E | 150m | 20m | 48 |
| 7 | 23º52′52.1″N 90º15′55.1E | 23º52′59.5″N 90º15′54.9″E | 200m | 20m | 48 |
| 8 | 23º52′54.4″N 90º15′54.9″E | 23º52′54.4″N 90º15′49.8″E | 130m | 20m | 48 |
| 9 | 23º53′02.6″N 90º15′59.6″E | 23º53′02.6″N 90º15′55.0″E | 80m | 20m | 48 |

**RESULTS AND DISCUSSION**

**Population status of Irrawaddy Squirrel:** The study was conducted in the squirrel occupied areas of the campus. The squirrels of Jahangirnagar University Campus were not distributed uniformly but concentrated in some areas so the density was little bit high. They were found mainly in the 'Chatri Hall Lane', 'Somaj Biggan-Porisonkhan Bonuvumi', 'Central Masjid Bonuvumi', 'Shahid Minar Lane', 'MMH Hall Road', Botanical Garden', 'Dipu Memorial' and near the 'Al Beruni Hall (extension)'.
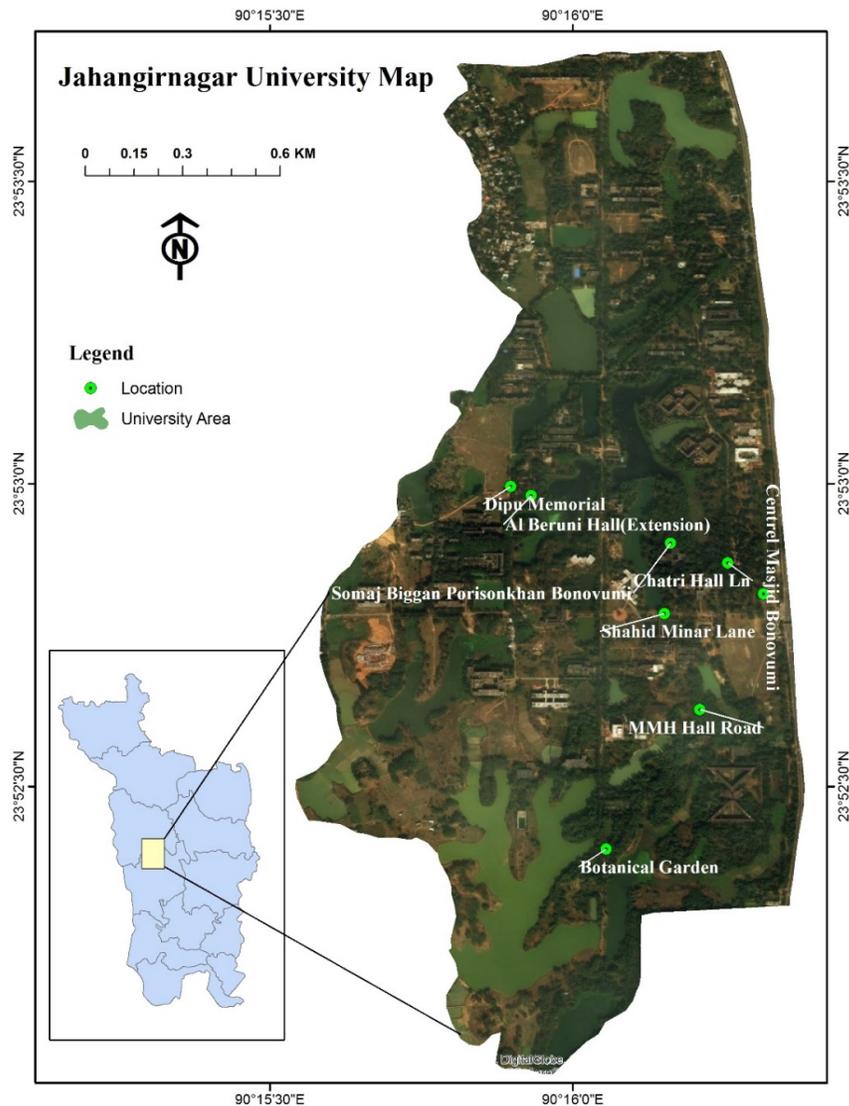
**Fig. 1. Squirrel occupied areas in Jahangirnagar University Campus**

In the study it was found that the Irrawaddy Squirrel remained active whole day and displayed different activities but they were frequently visible during the morning (0070h-1000h) and afternoon (1600h-1800h). In morning visibility was the highest at 0900h, 15.71%, and at evening 1800h it was 14.76%. It was the lowest at 1100h (7.07%). The diurnal variation in occurrence was significant $(\chi^2 = 54.91, df=8, P<.00001)$.

The study covered both the winter (November to January) as well as summer (March to August). The most preferable temperature for Irrawaddy Squirrel was found in between 29°C-32°C, as their visibility and activity was found peak in these temperature. Following this, the second preferable temperature was recorded in between 33°C-34°C followed by 21°C-24°C. It was also found that in the temperature of below 20°C, they were rarely seen. From the present study it was found that, the Irrawaddy Squirrel was most frequently observed during the late spring and the summer period in the month of February (9.52%), March (9.64%), April (9.76%) and May (9.88%). It slightly lowered in frequency of occurrence in the month of June (7.86%), July (6.66%), and August (7.38%) during the rainy season. The least was found in January (6.07%) during the extreme cold. The monthly variation in occurrence was significant $(\chi^2 = 20.11, df=11, P= 0.0438)$.

It was found that population density had slightly varied with the month, it was the highest in May (997.58/km$^2$), followed by April (985.57/km$^2$), March (973.55/km$^2$), February (961.54/km$^2$) October (937.5/km$^2$), September (901.44/km$^2$) and it was the lowest in January (612.98/km$^2$) (Figure 2A) . The mean population density is 841.34±135.98/km$^2$. Monthly occurrence of Irrawaddy Squirrel in different transects has been given in figure 2B.



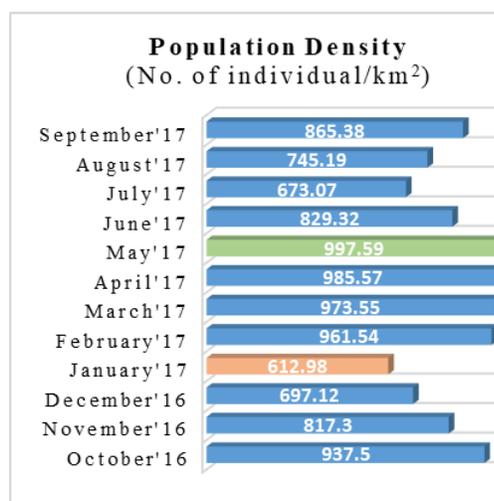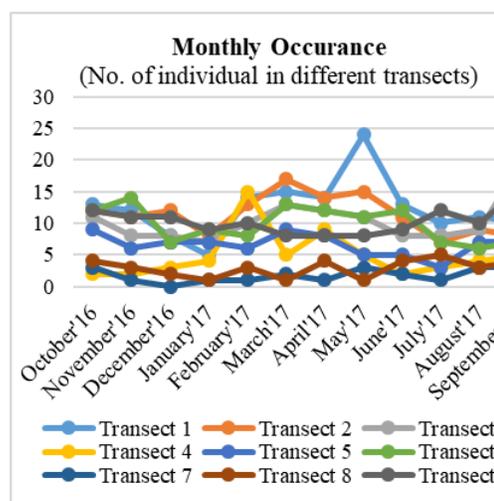Fig. 2A                                                                                     Fig. 2B

**Fig. 2A & 2B. Population density (no. of individual/km$^2$) of Irrawaddy Squirrel in different months, 2B. Monthly occurrence of Irrawaddy Squirrel (from October 2016-September 2017) in   different transects**

Irrawaddy Squirrel is a diurnal species occurs in evergreen and semi-evergreen forests and edge and degraded areas derived from them, including gardens, shifting cultivation fallows and plantations; densities are higher in heavily degraded habitats than in little-encroached ones. The species is common in India, in Nepal, Bangladesh and Myanmar. In north-east India, measured 'relative abundance' ranged from 0.11 to 1.58 per $km^2$, with density higher in plantations (10.14 individuals per $km^2$) and in heavily logged forests (23.4 per $km^2$) than in lightly logged forest (1.85 per $km^2$) and in unlogged primary forests (2.72 per $km^2$) (Datta & Nandini 2014).

In Jahangirnagar University the density was little bit high in these areas as the woodland ecosystem didn't provide continuous breeding and feeding ground for them. Vegetation type, various infrastructures, water bodies and moreover human movement had made them confined in some areas. Population density varied monthly because of the visibility rate which was related to condition of the weather, vegetation and food resources.

**Habitat use pattern:** Jahangirnagar University Campus is enriched with diverse ecological habitat and vegetation type to support a large number of wildlife species. The woodland ecosystem provided good habitat for Irrawaddy Squirrel. Trees and bushes which provide particular type of shelter and sufficient food resources are mainly preferred by Irrawaddy Squirrel. During the present study it was observed that wooden trees were mainly chosen by Irrawaddy Squirrel. Various tree species were used by Irrawaddy Squirrel but mainly the occupied 15 plant species in Jahangirnagar University Campus are Kathhal (*Artocarpus heterophylus*), Aam (*Mangifera indica*), Bot (*Ficus* sp), Bel (*Aegle paniculata*), Peyara (*Psidium guajava*), Jam (*Syzygium cumini*), Kamranga (*Averrhoa carambola*), Jamrul (*Syzygium* samarangense*)*, Pink Cassia (*Cassaia javanica*), Palash (*Butea monosperma*), Shegun (*Tectona grandis*), Kathhbadam (*Termialia catappa*), Koroi (*Albizia procera*), Arjun (*Terminalia arjuna*), Mahagony (*Swietenia mahagoni*) Irrawaddy Squirrel mostly used Koroi (*Albizia procera*), 16.71% of total Squirrel were found at Koroi tree. They also used Kathhal (*Artocarpus heterophylus*), Shegun (*Tectona grandis*), Mahagony (*Swietenia mahagoni*) and Aam about 13.72%, 13.25%, 10.76%, 10.28%, respectively (Table 2).

**Table 2. Plant species used by Irrawaddy Squirrel for Habitat and Feeding**

| Local name | Scientific name | Percentage of preference | Eaten plant parts |
| --- | --- | --- | --- |
| Kathhal | *Artocarpus heterophylus* | 13.72% | Fruit, Seed |
| Aam | *Mangifera indica* | 10.28% | Fruit |
| Bot | *Ficus* sp. | 2.01% | Fruit |
| Bel | *Aegle paniculata* | 1.32% | Fruit |
| Peyara | *Psidium guajava* | 4.32% | Fruit |
| Jam | *Syzygium cumini* | 1.24% | Fruit |
| Kamranga | *Averrhoa carambola* | 2.16% | Fruit |
| Golapjam | *Syzygium jambos* | 1.01% | Fruit, Seed |
| Pink Cassia | *Cassaia javanica* | 4.10% | Flower |
| Palash | *Butea monosperma* | 5.43% | Flower |
| Shegun | *Tectona grandis* | 13.25% | Seed, Leaves |
| Kathhbadam | *Termialia catappa* | 11.64% | Seed, Leaves |
| Koroy | *Albizia procera* | 16.71% | _ |
| Arjun | *Terminalia arjuna* | 2.04% | _ |
| Mahagony | *Swietenia mahagoni* | 10.76% | _ |

According to (Prodhan 2015), Irrawaddy Squirrel occupied total 16 species in Rema-Kalenga Wildlife Sanctuary which are *Artocarpus heterophullus, Terminalia arjuna, Tectona grandis, Dillenia pentagyna, Acacia* sp., *Ziziphus jujube, Carica papaya, Musa paradisiaca, Mangifera indica, Bambusa* sp., *Artocarpus chaplasa, Albizia procera, Psidium guajava, Ficus* sp., *Callicarpa arborea, Lagerstroemia* sp. etc. On the other hand in Kaptai National Park they Occupied 11 plant species which are *Ziziphus mauritiana, Terminalia bellirica, Tectona grandis, Melia azadirachta, Pterospermum acerifolium, Alstonia scholaris, Ficus* sp, *Bauhinia scandens, Artocarpus heterophyllus, Bursera serrate, Pterospermum semisagittatum*. Among these, the dominantly occupied the *Artocarpus heterophyllus* in both site.

Different types of wild animal uses different strata of suitable habitats for their food and shelter. It increases the foraging efficacy and also decreases competition. They basically prefer those strata where foods are available. Another important factor behind strata selection is for the movement activity. From the present study it was found that middle canopy was mostly used (48%) by Irrawaddy Squirrel, followed by lower canopy (29%), upper canopy (10%) and only 13% of soil floor used by them. So it can be said that, middle canopy was the best stratum and on the other hand, soil floor was the least preferable for Irrawaddy Squirrel of Jahangirnagar University Campus.

In Rema-Kalenga Wildlife Sanctuary and Kaptai National Park they used the forest stratum as ground (3%), low (57%), middle (30%) and high (10%) and ground (13%), low (56%), middle (21%) and high (10%), respectively (Prodhan 2015).

There were some similarities in habitat use pattern with the previous work and also some dissimilarities because of vegetation type, food abundance and human occurrence.

**Feeding behaviour of Irrawaddy Squirrel:** Though Irrawaddy Squirrel usually foraged for food all day long, it was found to forage actively in the morning and at afternoon. During adverse weather condition like heavy rainfall or bright sunny weather or cold winter they remained inactive. Diurnal variation in feeding peak depended on sunrise, sunset, sleeping time, rainfall, fog, etc. There were two feeding peaks in day, one in the morning at 0800h, 17.06% after beginning their daily activities and the other was in the afternoon before their retirement at 1700h, 18.46%. In the midday and before the sun set the feeding was less. The variation was significant $(\chi^2= 16.38, df=8, P=0.03725)$. Overall diurnal variation in feeding is presented in Figure 3A.

Feeding varied within month due to availability of food. Irrawaddy squirrel spent the maximum time in feeding in May 2017 (17.40%) and minimum in January 2017 (2.52%).The variation was significant $(\chi^2= 19.74, df=11, P= 0.0490)$. Monthly variation in feeding is presented in Figure 3B.
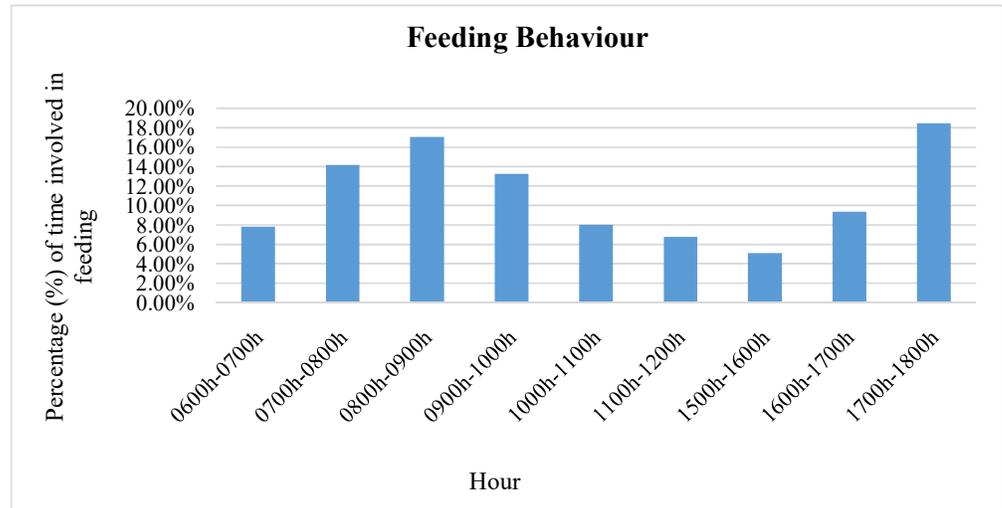
**Feeding Behaviour**



**Fig. 3A. Diurnal variation in feeding, $(\chi^2 = 16.38, df=8, P=0.03725)$**
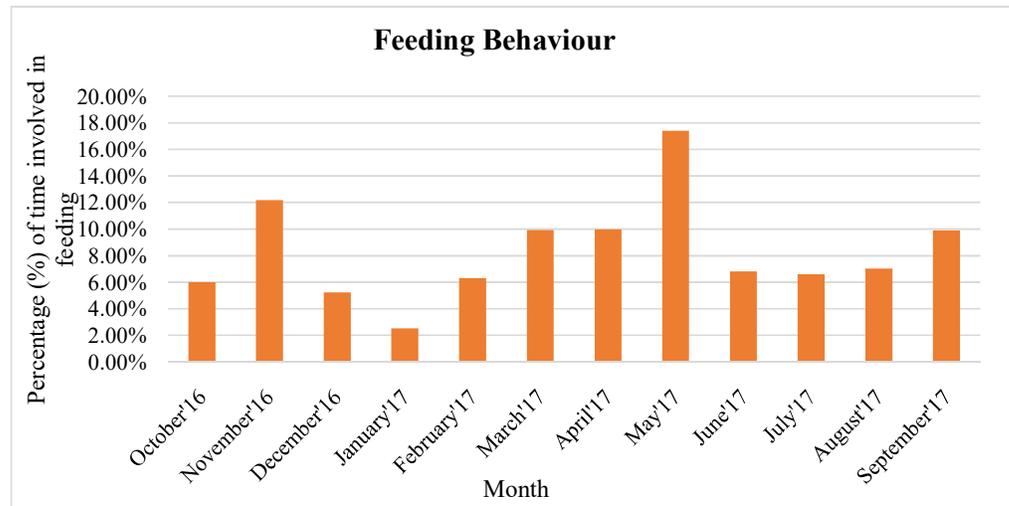
**Feeding Behaviour**



**Fig. 3B. Monthly variation in feeding, $(\chi^2 = 19.74, df=11, P= 0.0490)$**

According to Islam (2008) study on Hoary- bellied Himalayan Squirrel the highest amount of food 19.0% manipulated in the September and the lowest 6.0% in the November. The differences among the studies were due to vegetation type and food availability. In case of Jahangirnagar University in the Month of May a lot of seasonal fruits remained available, perhaps it was the reason of spending maximum time in feeding in this month.

Irrawaddy Squirrel can take a wide variety of food items based on their availability and this varies according to the habitat and the time of the year. Thus they can be said opportunists and generalists. The fruits, barks, buds and seeds are mainly preferable food for squirrel. The Irrawaddy Squirrel takes different types of food. The present study noted different types of food that is listed here.

**Fruits:** The proportion of time spent in fruit eating varied seasonally which was dependent on the availability of fruit found. They spent 39.4% of their total feeding time for eating fruits. *Mangifera indica, Zizyphus mauritiana, Syzygium cuminii, Psidium guajava, Artocarpus heterophylus* were the preferred food of Squirrel. **Seeds:** Seed formed a significant part of their diet. Seeds were the main food of squirrels and were eaten throughout the year. *Tectona grandis, Termialia catappa* was the main seed item during study period. However, they spent 25.4% of their time in taking for seeds. **Flowers:** Flower was not available throughout the year. So it was not preferred food item. However, they spent 8.8% of their time in taking for flowers. **Bark:** They spent 5.9% of their time for feeding bark of trees. **Termite:** Termite was the only insect feed by the squirrel during study time. They spent 14.6% time for feeding termite. Irrawaddy Squirrel used both ground and trees for their activities. It came to ground occasionally. Within the 34 observations during study period they spent 93.1% of their feeding time on the ground and 6.9% time on trees.
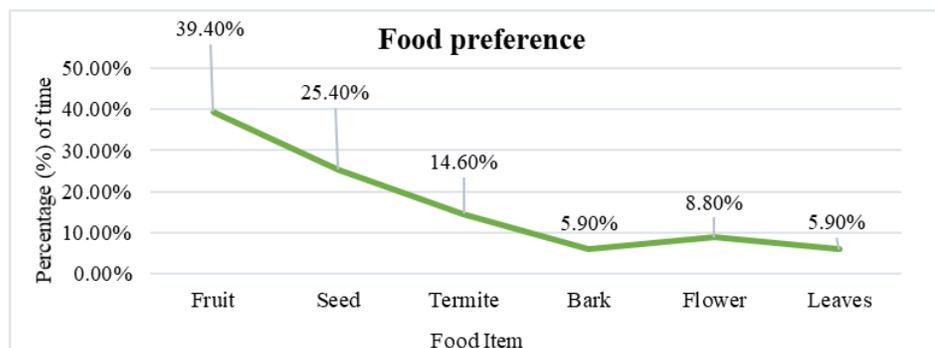


**Fig. 4. Different food particles eaten (in percentage) by Irrawaddy Squirrel**

Seasonally Irrawaddy Squirrels prefer fruit, seed, termite, leaves mainly. During winter they feed Segun seed most. Feeding type also varies with ages where young feeds termite most. Islam (2008) studied the activity pattern and feeding behavior of the Hoary-bellied Himalayan Squirrel *Callosciurus pygerythurs* in Madhupur National Park. The squirrels of Madhupur National Park spent 19% of their time on feeding, the highest amount of food consumed in September (19%). They fed on fruit (30%), barks (17%), buds (7%), insects (29%), fungi (5%) and seeds (7%) which varied in properties in different months. Irrawaddy Squirrel mostly preferred fruits, but the percentage of eating fruits was higher in Kaptai National Park than in Rema-Kalenga Wildlife Sanctuary. The percentages (time) in Rema-Kalenga Wildlife Sanctuary were fruit (24%), seed (8%), bud (22%), flower (4%), bark (28%), leaf (0%) and insect (14%); whereas in KNP were fruit (32%),

seed (4%), bud (14%), flower (9%), bark (23%), leaf (0%) and insect (18%) (Prodhan 2015). In Jahangirnagar University the Irrawaddy Squirrel took different types of food. The proportion of time spent in fruit eating varied seasonally which depended on the availability of fruit found.

The Irrawaddy Squirrel needs to fight with birds which feed on seeds, fruits and others. They are preyed upon by several species such as eagle, kite which preys on arboreal mammals. As they live in the upper canopy, it helps them to avoid many ground predators. The Irrawaddy Squirrel feeds on mostly different types of fruits and seeds which are also consumed by human and conflict with human also occurs because of causing damage to their feeding sources and properties.

In conclusion, the population of squirrels of Jahangirnagar University Campus though is not at higher risk but the rapidly growing construction along with habitat destruction and fragmentation, disturbance by local people, over exploitation of the land for cultivation, unplanned excavation or renewal of the lake, increasing sound pollution can affect their existence. As they mostly depend on large timber yielding and fruit bearing trees, so any type of imbalance of the ecosystem can be harmful for their survivability.

For the management of Irrawaddy Squirrel priorities should be given in those constraints and threats that impede the growth of Irrawaddy Squirrel population. Thus, for the better management and conservation of Irrawaddy Squirrel, special attention should be given to their feeding and breeding grounds and finally to prepare an effective conservation and management plan to save them from extinction and from the increasing human population.

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