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FIELD OBSERVATIONS ON THE MALAYAN GIANT SQUIRREL, *RATUFA BICOLOR GIGANTEA* (M'CLELLAND) AND SOME OTHER DIURNAL SQUIRRELS OF JALPAIGURI DISTRICT, WEST BENGAL

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INTRODUCTION

The giant squirrels *(Ratufa)* are most distinctive. From a review of the ecology, feeding habits and distribution of the giant squirrels, Thorington and Cifelli (in press) concluded that they exhibit a number of characteristics which make them of considerable interest and potential use as indicator species and that authentic study on the ecology of *Ratufa* will not only provide a picture of the habitat quality but also guidelines for the formulation of strategies of conservation. Within the Indian limit, three species of giant squirrels, viz., the Indian Giant Squirrel, *Ratufa indica* (Erxleben), the Grizzled Indian Giant Squirrel, *R. macroura* (Pennant) and the Malayan Giant Squirrel, *R. bicolor* (Sparrmann) occur. The first two are restricted to the Peninsular India and the third to the northeastern India. Studies on the habits, ecology, and distribution of *R. indica* were made by Hutton (1949), Abdulali and Daniel (1952), Khajuria (1955), Moore and Tate (1965) and Krishnan (1972). Phillips (1935) revealed some ecological aspects of *R. macroura* in Sri Lanka. Detailed investigations on the ecology of *R. bicolor* and some other species of giant squirrels were carried out in Malaya and Vietnam (Tien 1972, Mackinnon 1978, Payne 1979a, 1979b, 1980). No detailed information about the habit and ecology of *R. bicolor* occurring in the Indian range are available. Only one subspecies, *R. b. gigantea* (M'clelland) occurs within the Indian range.

In connection with the study of species-composition of rodents in West Bengal a faunistic survey tour to Jalpaiguri district, was undertaken by the authors from 2nd to 23rd September, 1983. During the survey, authors could get some opportunity of direct observations on the activity pattern and population of *R. b. gigantea* in different forest ranges of Jalpaiguri district. These findings are reported in the present paper along with notes on the other two species of diurnal squirrels, *viz.*, *Callosciurus pygerythrus* (Geoffroy) and *Funambulus pennanti* Wroughton occurring in the district. The report is mainly based on 69 sighting records of *R. b. gigantea* and 36 sighting records of other two species.

STUDY AREA

Three forest ranges, *viz.*, Diana, Khuntimari and Chilapata of the Jalpaiguri district have been surveyed. In all the forest ranges of the district, plantation and forest exploitation are regular processes. At Diana, forest is of mixed primary type and mainly composed of plants like *Dalbergia sisso, Acacia catechu, Salmalia malabarica, Albizzia lebbek, Duabanga sonneratiodes, Wrightia tomentosa, Trewia nudiflora,* etc., with creepers and thick under-

growth. At Khuntimari, forest is quite rich and moist tropical type, consisting of *D. sisso, A. catechu, Sterculia villosa, Dillenia pentagyna, Eugenia jambolana, Phyllanthus emblica, Elaeocarpus ganitrus*, etc. Undergrowth is very thick and interspersed with various species of grasses. Patches of dry mixed forest, predominated by *Shorea robusta, Tectona grandis, Gmelina arborea and Terminalia belerica* are also met with. Forest at Chilapata is largely secondary mixed deciduous, consisting chiefly of various planted trees and thick undergrowth. Trees are mostly common to that of Khuntimari. All the three ranges have considerable area of riverine grass jungle particularly at Chilapata. Forest villages with some cultivated land are found in each range. 'Pucca' and 'Kacha' roads of nearly 2-4 metre wide, pass through the forest ranges, thus dividing them into a number of blocks, each ranging 100 to 200 hectares in area.

METHOD

The authors and other three party members along with the Forest department people surveyed the forests from about 6.00 hours to about 13.30 hours and again from 15.00 hours to about 23.00 hours. Survey was done on foot along the jungle roads, but occasional entry was made deep inside the forest to follow or chase the animals. During the survey work, in addition to making collections of zoological specimens by trapping, netting and shooting, field observations were made on the habits and activity of different species of mammals. Survey was conducted from 4th to 6th at Diana, 8th to 14th at Khuntimari and 16th to 21st at Chilapata during the month of September. However, about 32 hours of survey work distributed in different days were wasted due to heavy rain. To have an idea about the relative abundance of different species of diurnal squirrels specific survey along the jungle roads (a total of about 7 km.) covering nearly 300 hectares of Chilapata forest range was made in the morning and evening of 17th and 18th September.

Date and timing of each sighting of the diurnal squirrels together with the name of the species, type of activity, location of the animal on the plant were recorded. As far as possible scientific or local names of the plants were noted. The range of activity of the animal in the canopy was estimated by eye to the nearest two meters. The records relate to the animal at the moment of first sighting. However, observation on the undisturbed animal was continued so long it could be followed. Most of the plants and food items were identified by the authors in the field with the help of the State Forest Department people and rest were collected and identified with the help of the scientists of the Botanical Survey of India, Calcutta.

Five specimens of *R. b. gigantea* (2 Male, 3 Female) were collected and their reproductive condition, stomach-contents studied.

Two dreys of *R. b. gigantea* and in same number of *F. pennanti* were collected for detailed examination.

OBSERVATIONS

Sighting frequency :

Specimens of *R. b. gigantea* were recorded in all the three forest ranges throughout the study period. Out of a total of 69 sighting records, five were made at Diana, 40 at Khuntimari and 24 at Chilapata. For *C. pygerythrus*, 19 sighting records were made at the Chilapata range. Out of 17 sighting records of *F. pennanti*, four were made at Diana and 13 at Chilapata range. First two species of squirrels were recorded in the forest proper, and the last one near hamlets.

Activity hours :

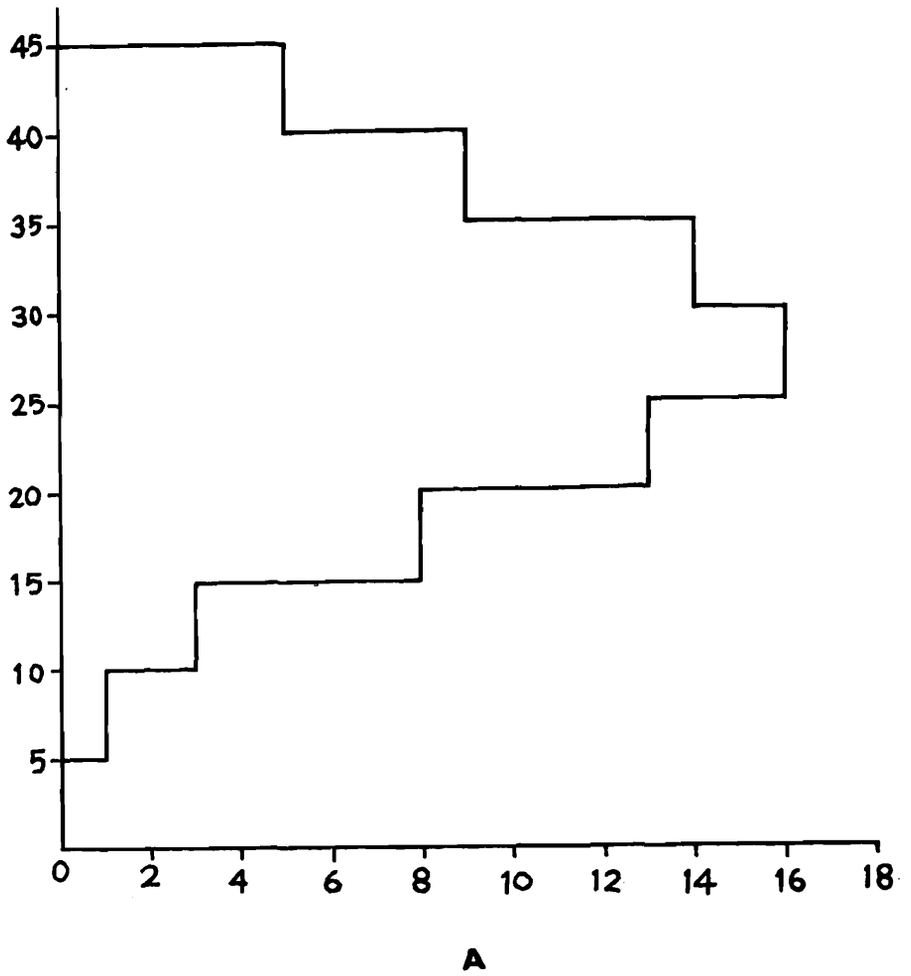
Sightings of *R. b. gigantea* were recorded during the day, from 7.00 hours to 18.10 hours except between 12.05 hours and 15.15 hours. However, no survey was conducted inside the forest from 13.30 hours to 15.30 hours and only casual observations were made from the camp itself. From the frequency of hourly sighting records (Table 1), it appears that peak of activity is reached late in the morning from 8.00 to 9.00 hours and in the afternoon 16.00 to 17.00 hours. Activity hours of *F. pennanti* almost tally with that of *R. b. gigantea*. However, for *C. pygerythrus*, activity reached at its peak just before dusk, *i.e.*, between 17.00 and 18.00 hours. Frequency of hourly sighting records revealed that all the three species of squirrels remain active from about an hour after the sunrise to dusk, with a lean period at noon. At the time of heavy or moderate rains no specimens of *R. b. gigantea* could be noticed, but during drizzles it could be seen feeding.

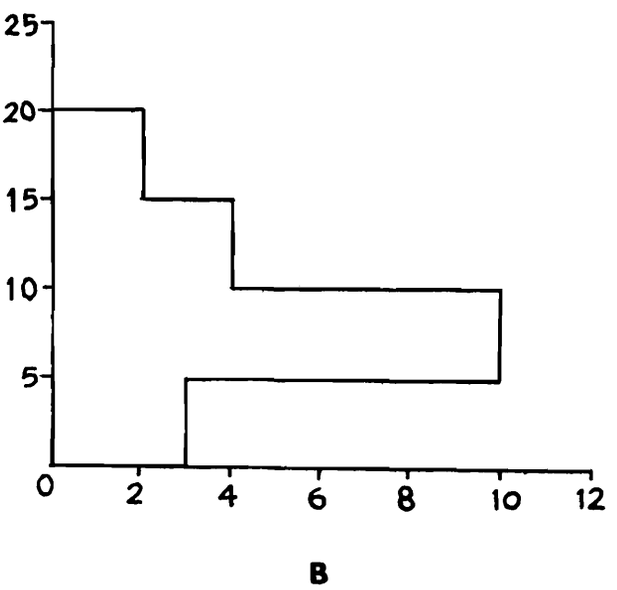
Vertical distribution :

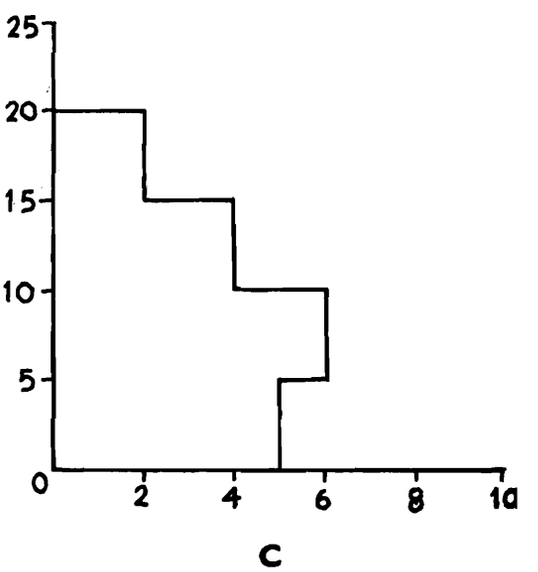
Based on the location of the squirrels in the tree at the time of first sighting, vertical distributions of three species are graphically represented in Text-fig. 1. The graph shows that *R. b. gigantea* is strictly arboreal. It does not descend below 5 metre and mostly found above 15 metre. Maximum sightings were recorded at a height of 20-25 metre. The other two species were found below 18 metre. Both of them, particularly *F. pennanti*, often came down to the ground for feeding, ascending other trees or some man-made structures. Maximum sightings of both species were recorded at a height of 5-10 metre. The Malayan Giant Squirrel totally avoids the ground and passes from one tree to another with powerful horizontal and descending leaps or through some connecting branches.

Drey :

While moving through all the three forest ranges, a good number of dreys of *R. b. gigantea* were observed. These dreys can easily be located by their large, globular structure and being situated in a somewhat open area of the plant particularly at the beginning of slimmer branch or twig. Both the dreys collected were brown in colour, made up of leaves, twigs and tendrils. Single circular opening of the drey is situated on one side of the upper surface. The diameter of the dreys varied widely being 25 cm. and 52 cm. No padding material or stored food articles were found inside. Young ones were absent from both the dreys. None of the dreys were observed below 18 metre. Only one drey could be seen in a tree. There was no plant specificity for the construction of drey, but they were mostly located on *S. robusta* and *D. sisso*.







Text-fig. 1. Graphic representation of the vertical distribution of three species of squirrels based on sighting records.
Vertical axis = Height in meters ; Horizontal axis = Number of sightings ; A. *R. b. gigantea*, B. *C. pygerythrus*, C. *F. pennanti*

Dreys of *F. pennanti* were observed on trees as well as on the roof of huts. Dreys collected were globular in structure, 10 and 12 cm. in diamerer, with a somewhat triangular opening on the upper side. Varieties of material such as, leaves, cotton, jute, grass, paper and even wire were used in the construction of drey. Out of two dreys examined, floor was padded with cotton in one. However, no stored food material was found.

Dreys of *C. pygerythrus* could not be noticed.

Home range :

Since the individual specimen of squirrel could not be marked, it is not possible to state authentically the home range of each species. Most of the dreys of *R. b. gigantea* were located in the central region of a forest block, but animals were often seen foraging in the region where the forest opens particularly along the jungle roads. It was also observed that Malayan Giant Squirrel was passing from one block of the forest to the other by crossing the jungle roads through canopy. This suggests that at least for feeding, *R. b. gigantea* moves round a quite large area covering one or more blocks of the forest, each ranging from 100 to 200 hectares.

From direct observations, it appears that the home range of *F. pennanti* is relatively less, being restricted within one or two trees or to the neighbouring huts of the village.

No estimate about the home range of *C. pygerythrus* could be made as this animal is very wary and hides in the thick foliage as soon as an intruder is observed. Moreover, no drey of this species in the forest could be located.

Population :

From the frequency of the sighting records it appears that forest at Khuntimari supports a good population of *R. b. gigantea*, but the other two species of diurnal squirrels are apparently absent. The secondary mixed forest of Chilapata sustains three species of diurnal squirrels and from sighting records it appears that the population of *R. b. gigantea* is the highest followed by *C. pygerythrus*. In the mixed primary forest of Diana, population of diurnal squirrels appears to be less than in the other two forest ranges surveyed. However, at Diana, *R. b. gigantea* and *F. pennanti* occur. The latter species was apparently scarce and restricted to the outskirts of the forest range.

A specific survey was conducted in about 300 hectares of Chilapata forest range. It gives an idea about the relative population density of three species of squirrels (Table 2). The number of dreys were also counted during specific survey. As many as 38 dreys of *R. b. gigantea* and 3 dreys of *F. pennanti* were observed. Findings of the present survey indicate the higher population density of *R. b. gigantea* as compared with that of other two species of squirrels. However, it was also felt that in the forest, *R. b. gigantea* is very conspicuous by its large size, loud harsh cackle, deep black-light buff coloration, and habit of dropping seeds, fruits or even twigs during feeding. Tilting of the finer branches of the trees due to their movement often draws attention from far distance. On the other hand, *C. pygerythrus* is often overlooked owing to their relatively small size, wary habit and agouti coloration

which matches with the colour of the bark. Thus, the estimate of relative population density from sighting is inevitably rough. However, taking all the three species of diurnal squirrels into account, the overall squirrel density at the Chilapata forest range appears to be very low, being about 0.05 animal per hectare.

Food habit :

Most of the sighting records of *R. b. gigantea* were made during their feeding. When undisturbed, it was found to feed on a single tree for even up to 40 minutes. However, about 50 per cent of this time was spent on actual feeding and the rest in search of food or observation. A particular animal could be seen feeding on a particular fruiting tree daily in the morning or afternoon, following a definite track from its drey. Fruiting trees at the outskirts of the forest or along the jungle roads were most preferred for foraging. However, it was never seen to feed on the trees of the forest village.

During feeding, *R. b. gigantea* regularly drops seeds, fruits, leaves, twigs from the canopy and also makes sound. It was observed to feed on a variety of plant species, consuming leaves, flowers, bark and fruits. Depending on the type and condition of the fruit, it may consume the entire fruit, only the soft part or seed. In table 3, food items taken by *R. b. gigantea* along with the number of feeding occasion have been shown. From the frequency, *D. sisso* appeared to be the most preferred plant, followed by *S. robusta.* However, this may be a seasonal feature. None of the records showed feeding on insects or other animals. Analysis of the stomach contents of five specimens revealed only vegetable matter.

Feeding of *C. pygerythrus* was recorded only on three occasions and never on the species of plants selected by *R. b. gigantea.* Once it was observed to feed on the bark of *Acacia catechu* and on two occassions on seeds of *S. villosa.*

Funambulus pennanti apparently feeds only on the trees of forest villages. Of the five feeding records of this species, three involve fruits of *Ficus bengalensis* and one each on the seeds of *Areca catechu* and fruits of *Psidium guava.*

Reproduction :

No sign of breeding activity was observed in any of the three species. In all the three females specimens of *R. b. gigantea* vaginal orifice was perforated and mammae were prominent. However, none of them was lactating or contained foetuses or visible embryos.

DISCUSSION

Hourly sighting records of all the three species revealed that they remain active in the morning and afternoon and take rest during mid day as has been mentioned by Prater (1980).

Earlier records about the vertical distribution of squirrel species, assigned them to arboreal, terrestrial and scansorial categories (Harrison 1962). All the three species in the present study are principally arboreal and may occur in the same forest range. However, there is a clear line of demarcation in the utilisation of the forest strata by each of them.

Table 1. Hourly sighting records of three species of diurnal squirrels in the forest of Jalpaiguri district, West Bengal.

Species	Frequency of sighting records									
	7.00-8.00 hours	8.00-9.00 hours	9.00-10.00 hours	10.00-11.00 hours	11.00-12.00 hours	12.00-13.00 hours	15.00-16.00 hours	16.00-17.00 hours	1700-18.00 hours	18.00-19.00 hours
R. b. gigantea	6	20	9	4	3	1	5	16	4	1
C. pygerythrus		2	3	1	1	1		1	8	2
F. pennanti	1	5	3	1	1		1	2	2	

Table 2. Sighting records of the three species of diurnal squirrels during the specific Survey at Chilapata.

Species	Number of sighting records	
	On 17.9.1983	On 18.9.1983
R. b. gigantea	7	8
C. pygerythrus	6	4
F. pennanti	4	4

Table 3. Food items taken by the diurnal squirrels in the forest of Jalpaiguri District, West Bengal

Species of squirrels	Species of plant on which feed	Part of plant consumed	Feeding occasion
R. b. gigantea	*Dalbergia sisso*	Flower	3
		Leaves	6
		Bark	2
		Fruit	6
	Shorea robusta	Fruit	8
		Leaves	4
		Bark	5
	Careya arborea	Fruit	2
	Gmelina arborea	Bark	1
	Schima wallichii	Seed	2
		Leaves	1
	Phyllanthus emblica	Leaves	1
	Ficus bengalensis	Fruit	2
		Bark	1
	Trewia nudiflora	Fruit	2
	Putranjiba roxbergii	Fruit	2
	Elaeocarpus ganitrus	Fruit	2
	Michelia champaca	Seed	1
		Leaves	1
	Terminalia belerica	Fruit	1
		Bark	1
C. pygerythrus	*Acacia catechu*	Bark	1
	Sterculia villosa	Seed	2
F. pennanti	*Ficus bengalensis*	Fruit	3
	Psidium guava	Fruit	1
	Areca catechu	Seed	1

Although *C. pygerythrus* and *F. pennanti* have considerable overlapping vertical distribution, practically no competition exists between the two. Former is restricted to the forest proper, while the latter is almost confined to the villages. Mackinnon (1978) also found differential use of the various strata of the same forest structure by the seven species of diurnal squirrels.

From the food habits, it appears that squirrels are mostly dependant on the fruits. Howeve, many of the plant species of the present survey area have irregular fruiting cycles. Some species fruit once in every two, three or even five years, so that fruiting patterns of no two successive years are exactly the same. Thus, it is difficult for the frugivorous animals to locate the food in a routine way in every year. Again, different plant species have different chemical and physical defences against herbivore predators. The predators have to evolve way of breaking down the defence. Thus, any given plant predator is able to utilise only a small percentage of the forest flora. As a result to locate the suitable feeding plants, an animal has to move a lot within the forest. This may be one of the factors for the larger home range of the Giant Squirrel.

Number of the dreys of the Giant Squirrel observed in a particular region of Chilapata forest range were more than the number of animals visible in that area. It suggests that the same individual may build a number of dreys within its home range as it is reported for *R. indica* (Krishnan 1972). However, it could not be ascertained whether a particular individual was using more than one drey simultaneously or rotationally or only one drey discarding the older ones.

It has been noted that dreys of *R. b. gigantea* are constructed on the comparatively slimmer branches. This is obviously to provide additional protection to young ones and even the adults during rest against heavier predators.

All the three species of the present study have been observed to feed only on plants. However, records of their omnivorous habit are not uncommon. According to Tickell (in Blanford 1891, p. 374) Malayan Giant Squirrel takes insects and eggs of birds. Ghosh (1981) reported an incidence of flesh eating by *C. pygerythrus*. Agrawal (1965), McCann (in Moore and Tate 1965, p. 74), Sood and Dilber (1977) referred to the omnivorous habit of *F. pennanti*. In fact, rodents, though principally herbivorous, also feed on insects, eggs and flesh (Jameson 1952, Prasad 1954, Harrison 1954, Prakash 1962, Fall *et. al.*, 1971, Chakraborty 1977). It has also been established by the above studies that consumption of a wide variety of food items is to select the best possible balanced diet from the available food resources. Thus, in the present study though all the three species were observed to consume only plant material, they can probably take other food items, if required.

Food habit, and foraging regions of the three species of squirrels indicate that inspite of their occurrence in the same geographical area, there is apparently no competition among them for food. The Malayan Giant Squirrel does not appear to feed on the trees of forest villages. The authors had, however, opportunity of observing a specimen of *R. indica*

feeding on a ripe papaya *(Carica papaya)* at a height of only three meters in a garden of Kumli, a village adjacent to the Periyar Sanctuary, Idduki district, Kerala.

From the food habits of three species it may be concluded that, though *F. pennanti* shares some amount of human food, none of them appears to be pest at least in the present study area.

Based on the trapping data, Harrison (1969) stated that spuirrel-abundance ranges from 0.6 to 1.9 per hectare in different forest areas of Malaysia. At Krau Game Reserve, Pahang, Malaysia, at least seven species of squirrels occur and their density is about two animals per hectare (Mackinnon 1970). Thus, diversity as well as density of diurnal squirrel species appeared to be much less in the area of our study than in other regions. In the forest of Jalpaiguri, legal as well as illegal felling of trees is a regular feature which destroy a good number of dreys along with the young ones. Well established populations of various species of frugivorous birds, Rhesus Macaque, *Macaca mulatta* (Zimmermann), and Langur, *Presbytis entellus* (Dufresne) share considerable amount of forest flora with the squirrels. Extensive grass jungle within the forest are of no use to squirrels for food or shelter. Moreover, squirrels particularly *R. b. gigantea*, are often killed for flesh and skin by the local people. All the above factors may contribute to the relatively low population density of diurnal squirrels in the forests of Jalpaiguri district.

SUMMARY

Peak activity of the three species of diurnal squirrels of Jalpaiguri district is attained during morning and the afternoon. There is clear cut demarcation about the utilisation of canopy among the three species. Dreys of *R. b. gigantea* and *F. pennanti* revealed no stored food material or young ones. All the three species feed on the fruits, seeds, bark of the different available plant but there is apparently no competition among them for food. Population of *R. b. gigantea* in the jungle of Jalpaiguri is more than other two species of squirrels. In the study area, density of diurnal squirrels was about 0.05 animal per hectare. No sign of breeding in any of the three species was observed during the survey.

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