

Differences in home ranges of rhesus monkey (*Macaca mulatta*) groups living in three ecological habitats

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Abstract. Field observations were carried out on rhesus monkeys living in Asarori Forest, Chakia Forest, and temples. Data on group size, group composition and socionomic sex-ratios were obtained. An average home range size in these three habitats was found to be 5.18 km², 1.52 km² and 0.017 km² respectively. A positive correlation was found between group size and home range size in the Asarori Forest. Core areas were absent inside the home ranges in Chakia Forest. The average core area in other 2 habitats was 0.48 km² and 0.009 km² in Asarori Forest and temples respectively. The variability in home ranges and core areas is analysed in terms of differences in ecological conditions.

Keywords. Home range ; phylogenetic adaptation ; adaptive modification ; rhesus monkey.

1. Introduction

In our earlier studies (Pirta and Singh 1978, 1980) we have emphasised the phylogenetic adaptiveness of home ranges in rhesus monkeys. The nature of a phylogenetically adaptive behavioural system varies from an extremely environmentally labile to a highly environmentally stable one (Lorenz 1965). The reviews by Clutton-Brock and Harvey (1977) and Southwick and Siddiqi (1974) indicate that home range size is an environmentally labile behavioural system and varies greatly both within and between the species of non-human primates. Although the home ranges of Hanuman langur (Vogel 1977) and bonnet monkey (Rahman and Parthasarthy 1978) have been studied in various ecological habitats in India, such comparative data on rhesus monkey are lacking. Such information helps in understanding the adaptive modifications going on in the behaviour of a species. They result from the interaction of phylogenetically acquired blueprints and the environment. In the present study our observations on the home ranges of rhesus monkey inhabiting 3 natural environmental conditions are reported.

2. Method

During the exploratory phase we became thoroughly acquainted with the geographical features of all 3 habitats. Our main emphasis was to record the loca-

tion of a monkey group as accurately as possible on a map, whenever and wherever it was encountered. A group was followed from a few minutes to several hours at a stretch on an observation day. Occasionally, a group was followed from dawn to dusk and during late evening and early morning hours. The period of study and time devoted to observations in different habitats are given in table 1. Behavioural observations were started after the monkeys became acquainted with the observer. We observed the monkeys by standing at the periphery of the group. All recordings were made on notebooks and maps *ad lib*. The main variables measured are given in table 2. However, qualitative notes of the ecological characteristics of a habitat and behaviour of monkeys were also taken.

3. Study areas

3.1. Asarori forest

The study site (32 km²) included blocks of Laldhang, Chandrabani, Asarori, Mahobawala and Mohamadpur (compartments 1, 2 and 3 only), which form a major portion of Asarori forest range in the Western division of Dehra Dun forest (figure 1). The Asarori forest is on the northern slope of the Siwalik Hills, with elevations ranging from 425 m at the valley floor to 950 m at the Siwalik crest. Detailed description of the Asarori forest has been reported by Lindburg (1971). The major area of the forest part studied was covered by *Shorea robusta* which was interspersed with other tree species, grassland and eroded stream beds or raos.

Table 1. Period of study and groups observed in different habitats.

Habitat	Area explored	Year	Days	Groups
Asarori Forest	32 km ²	Jan. 1974 to Dec. 75	400	13
Chakia Forest	24 km ²	Aug. 1977 to July 78	70	3
Urban area	40 km ²	do	150	2

Table 2. Sampling variables and their measures

Variables	Measures
1. Group size	Number of individuals which regularly associate together and share a common home range.
2. Group composition	Number of individuals in each age-sex class, i.e. adult males, adult females, juveniles and infants.
3. Home range size	Total area (km ²) over which the group was seen moving and foraging during one year period.
4. Core area size	Area (km ²) within the home range most frequently used for night resting.

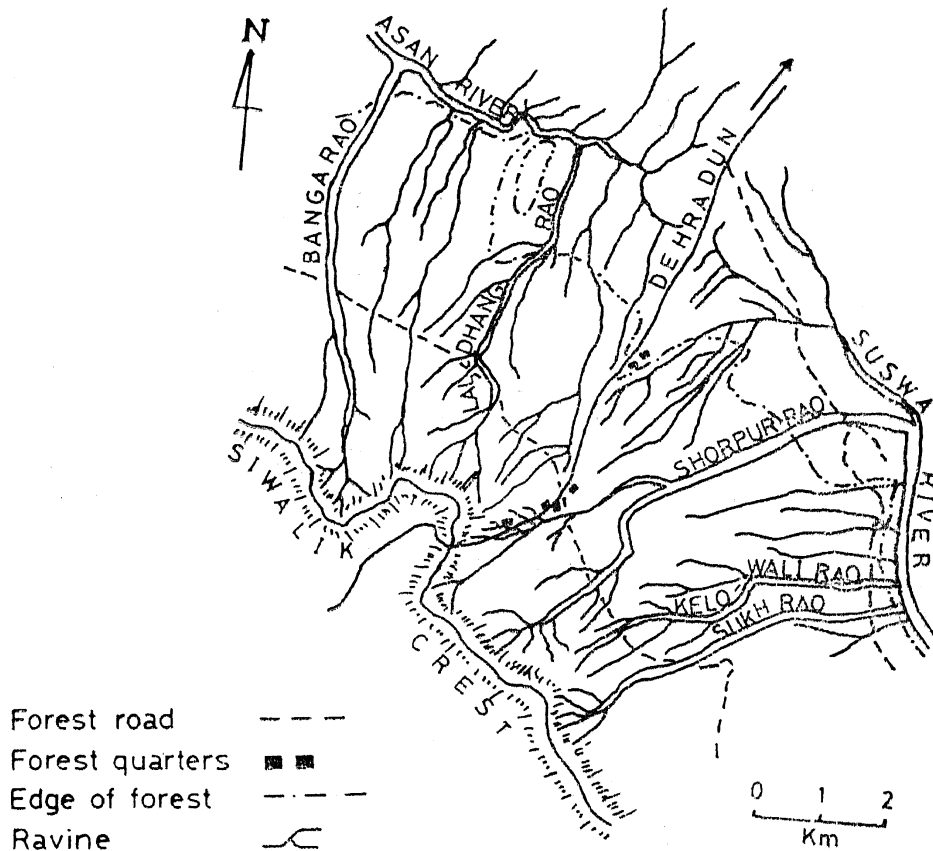


Figure 1. Map showing the principal features of forest habitat in Asarori.

3.2. Chakia forest

The study site (24 km²) was an isolated part of Chakia forest range of Varanasi division, and included four blocks : Sapahi, Sherpur, Amlahwa and Garhar (figure 2). It was mainly a scrub forest covered by interspersed trees of *Tamarindus indica*, *Azadirachta indica*, *Mangifera indica*, *Syzygium cumini*, *Semicarpus anacardium*, *Tectona grandis*, *Bombax malabaricum*, *Butea monosperma* and young plantations of bamboo and acacia. Shrubs of *Smilax indica*, *Carissa spinarum*, *Abrus precatorius* and *Ziziphus mauritiana* formed a thick vegetation along the ravines. The whole area was surrounded by cultivated land. In the southern part were 2 hillocks while the remaining area was plain but interspersed with deep ravines. The river Karamanasha flows in the middle of this forest part from south to north, accompanied by its 2 canals.

3.3. Urban area

The Varanasi city and its surrounding area, covering approximately 40 km², was explored for urban monkey population. Finally, two temples inside the city, each with a resident monkey group were selected for long term observations.

3.3a. *Sankat Mochan temple* : This temple was surrounded by a boundary wall and covered approximately 1.2 hectares. On both sides of the main temple

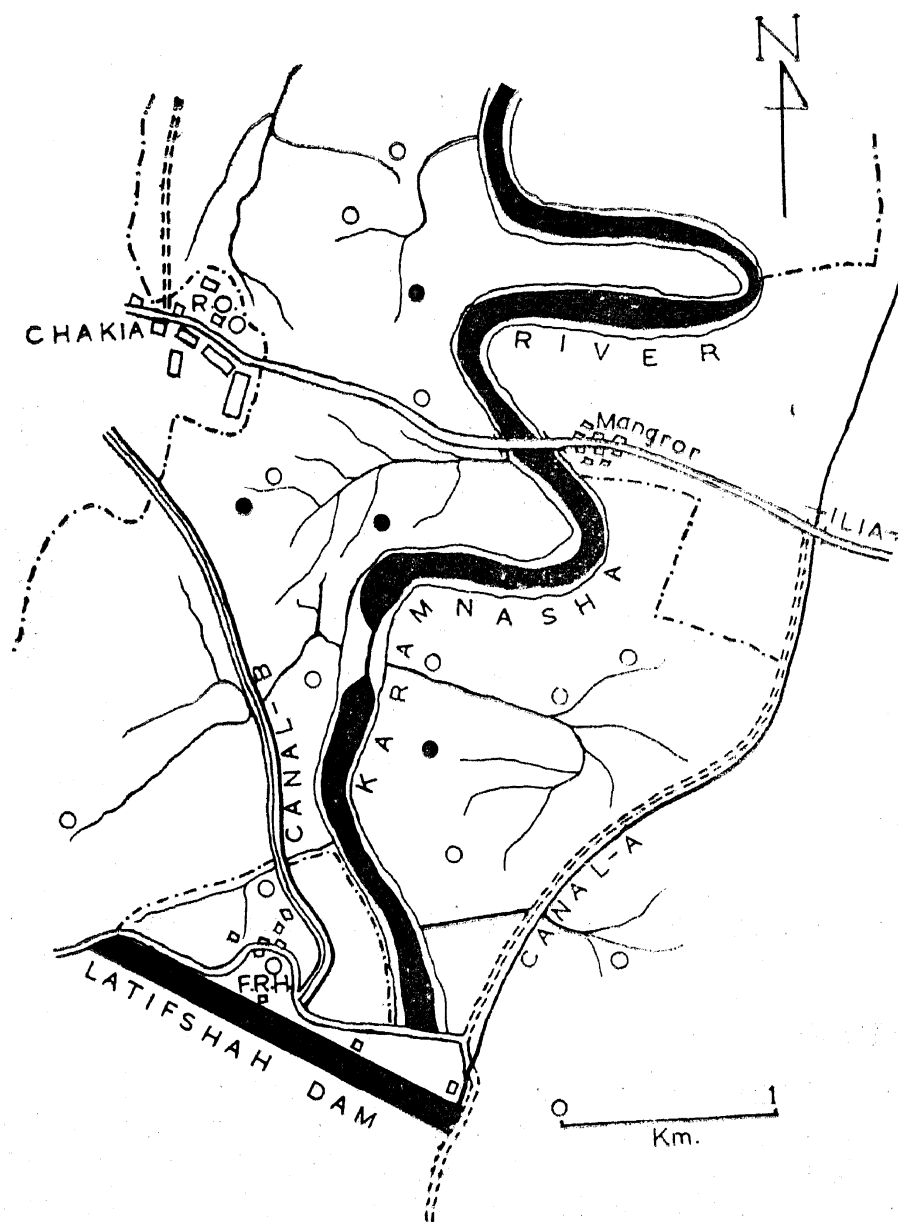


Figure 2. Map showing the principal features of forest habitat at Chakia. Black circles show rhesus groups and empty circles langur groups.

building was a thick vegetation of trees and shrubs. The tree species in this temple included *Ficus religiosa*, *Ficus bengalensis*, *Azadirachta indica*, *Phyllanthus emblica*, *Semecarpus anacardium* etc. There were shrubs of *Carissa spinarum*, *Smilax indica* and *Ziziphus mauritiana*. Various kinds of vegetables and grasses were also grown in the temple and its adjacent gardens. The Sankat Mochan temple is the temple of the monkey god Hanuman. People visited this temple specifically on Tuesdays and Saturdays to feed the monkeys. Other features of the temple are shown in figure 3.

3.3b. *Durga temple* : This temple was in the midst of buildings and covered approximately 0.6 hectares. On one side of it was a big pond. Except for a few trees in the compounds of adjacent buildings there was no vegetation in

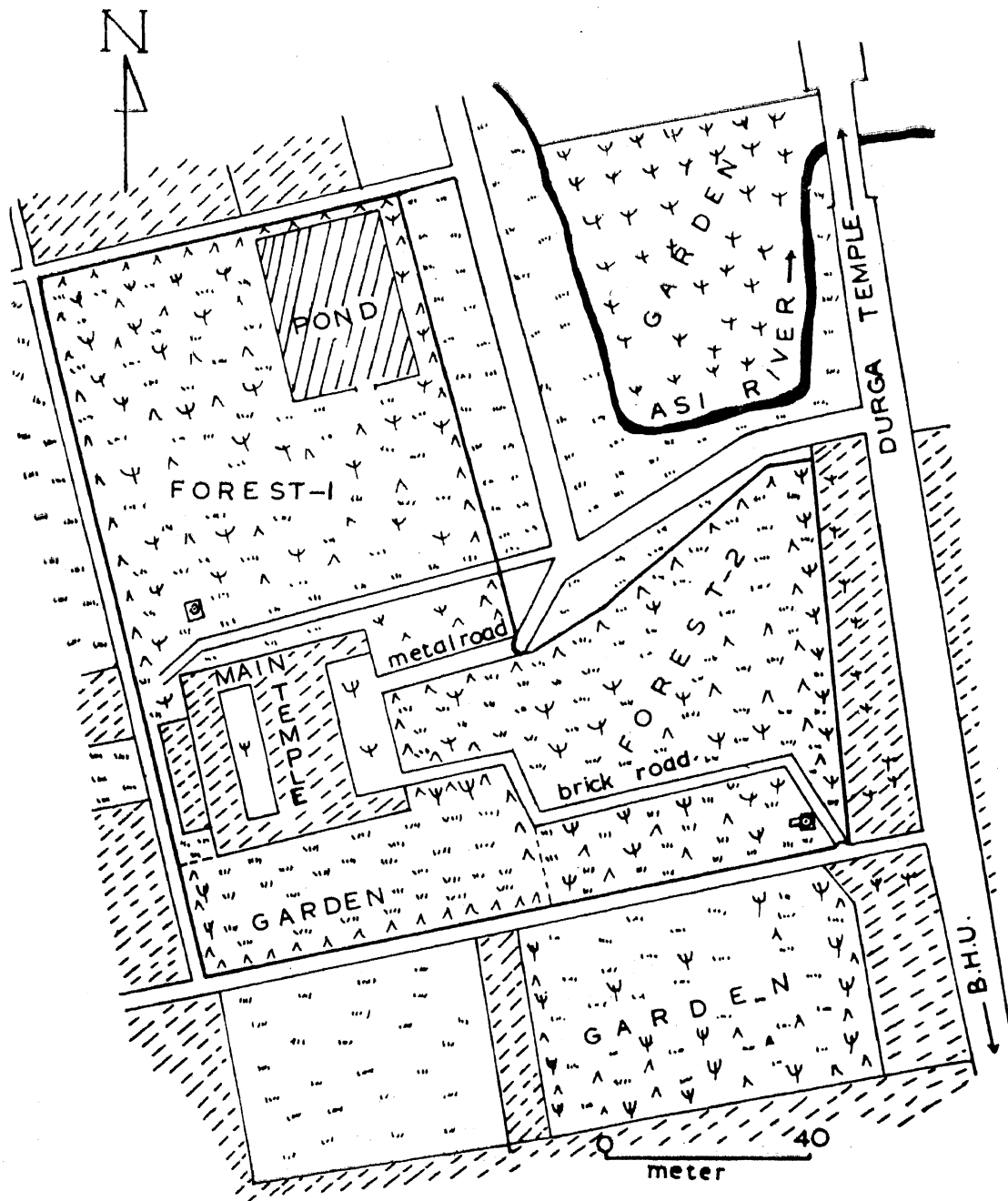


Figure 3. Principal features of Sankat Mochan temple.

Durga temple. There was less open space for monkeys in this temple in comparison to the Sankat Mochan temple. Because the Durga temple was located just on the side of the main road, the monkeys of this temple had more contact with human beings than those of the Sankat Mochan temple. Other habitat features of Durga temple are shown in figure 4.

A comparison of Asarori forest, Chakia forest and temple habitats is given in table 3.

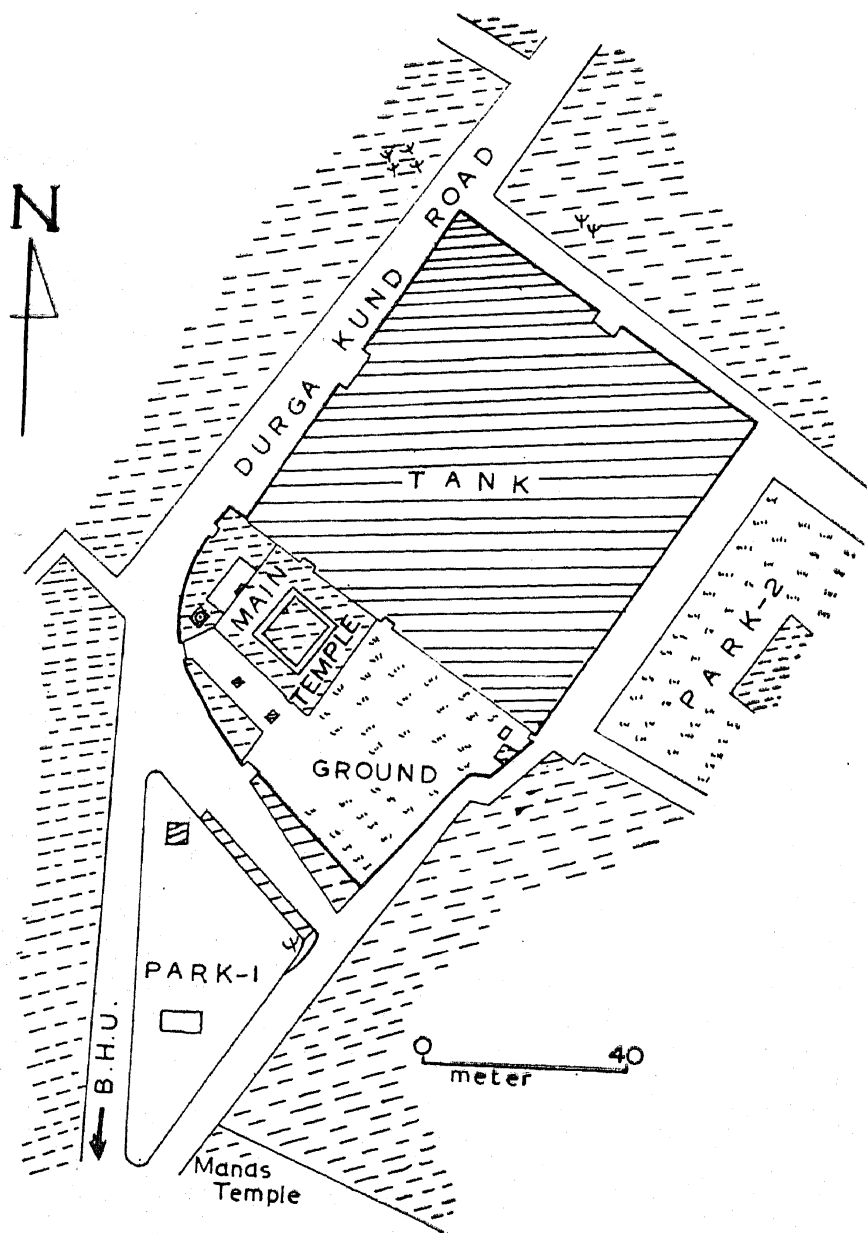


Figure 4. Principal feature of Durga temple.

4. Observations

Rhesus monkeys live in groups which comprise of adult males, adult females, juveniles and infants. A group occupies a circumscribed area of a particular niche, the home range.

4.1. Group size

In all 13 bisexual groups, 3 temporary all-male associations and 2 solitary males were observed in Asarori forest. A total of 598 monkeys lived in an area of 32 km². The number of monkeys in bisexual groups varied from 11 to 127 with an average group size of 45 (table 4).

Table 3. Comparison of the three habitats.

Characteristics	Temples, Varanasi	Chakia forest, Varanasi	Aśarori forest, Dehra Dun
Temperature	7° C–41° C	7° C–41° C	0° C–40° C
Annual rainfall	1088 mm	1088 mm	1600 mm
Vegetation	A few trees in Sankat Mochan temple	Scrub forest	Moist Deciduous forest
Human influence	High	Medium	Very less
Other wild mammals	Jackal (in Sankat Mochan temple)	Jackal, pig, leopard (?)	Jackal, pig, deer species, antelopes, elephants, leopard
Sleeping trees	Roof (Durga temple) and trees (Sankat Mochan temple)	Few trees	Numerous trees
Water sources	Many	Many	Few
Food sources	Good, localised	Poor, scattered	Good, scattered
Predators	Man, dog, hawk	Man, dog, hawk, leopard (?)	Man, dog, weasel, hawk, leopard
Other primates	None	Langur	Langur

Table 4. Numerical data on group size, group composition, home range size and core area of rhesus groups in Aśarori forest.

Group	Group size	Group composition *				Home range (km ²)	Core area (km ²)	Socionomic sex-ratio (MM : FF)
		MM	FF	JJ	II			
G 1	30	3	8	12	7	5.06	0.56	1:2.66
G 2	127	11	35	61	20	14.06	1.81	1:3.18
G 3	11	1	3	4	3	1.12	0.04	1:3.00
G 4	77	8	25	29	15	9.56	0.88	1:3.12
G 5	70	6	21	33	10	11.25	1.13	1:3.50
G 6	37	2	10	19	6	1.75	0.07	1:5.00
G 7	33	2	9	15	7	2.75	0.14	1:4.50
G 8	37	3	9	18	7	3.93	0.32	1:3.00
G 9	28	3	9	12	4	3.93	0.22	1:3.00
G 10	32	4	10	12	6	2.25	0.11	1:2.50
G 11	37	3	9	18	7	5.06	0.56	1:3.00
G 12	37	3	10	17	7	3.93	0.32	1:3.33
G 13	28	2	7	13	6	2.81	0.14	1:3.50
Mean	44.92	3.92	12.69	20.23	8.07	5.18	0.48	1:3.33
S.E.M.	± 8.36	± 0.78	± 2.45	± 3.97	± 1.28	± 1.09	± 0.20	

* Based on census in June-July 1974 ; MM—adult males ; FF—adult females ; JJ—juveniles ; II—infants.

In the Chakia forest, 5 bisexual groups and 1 isolated male lived in an area of 24 km². Three groups counted ranged from 27 to 38; an average group had 31.6 individuals (table 5).

In the city of Varanasi 9 bisexual groups were located in an area of 40 km² approximately. Two temple groups were counted, providing an average group size of 98.5 (table 6).

Table 5. Numerical data on group size, group composition and home range size of rhesus groups in Chakia forest.

Group	Group size	Group Composition *				Home range km ²	Socionomic sex-ratio (MM : FF)
		MM	FF	JJ	II		
Group 1	38	3	17	12	6	3.00	1:5.66
Group 2	27	2	11	7	7	0.56	1:5.50
Group 3	30	3	17	5	5	1.00	1:5.66
Mean	31.66	2.66	15.00	8.00	6.00	1.52	1:5.60
S.E.M.	± 3.31	± 0.35	± 2.00	± 2.08	± 0.57	± 0.75	

* Based on census in December 1977; MM—adult males; FF—adult females; JJ—juveniles; II—infants.

Table 6. Numerical data on group size, group composition, home range size and core area of temple monkeys.

Group	Group size	Group composition *				Home range km ²	Core area km ²	Socionomic sex-ratio (MM:FF)
		MM	FF	JJ	II			
Sankat Mochan temple group	129	13	40	46	30	0.020	0.012	1:3.07
Durga temple group	68	7	20	28	13	0.015	0.006	1:2.85
Mean	98.50	10.00	30.00	37.00	21.50	0.017	0.009	1:2.96
S.E.M.	± 30.50	± 3.00	± 10.00	± 9.00	± 8.50	0	0	

* Based on census in December 1977; MM—adult males; FF—adult females; JJ—juveniles; II—infants.

4.2. Group composition

An average group in Asarori comprised of 3.9 adult males, 12.7 adult females, 20.2 juveniles and 8 infants. In Chakia forest an average group size comprised of 2.6 adult males, 15 adult females, 8 juveniles and 6 infants. There were 10 adult males, 30 adult females, 37 juveniles and 21.5 infants in an average temple group. Socioeconomic sex-ratios (adult males : adult females) in Asarori, Chakia forest and temples were 1 : 3, 1 : 5 and 1 : 3 respectively.

4.3. Home range size

An average home range size of 13 bisexual groups in Asarori forest was 5.18 km². The home range remained the same for 2 years except for some minor changes in the case of some groups. There was extensive overlapping of home ranges among 13 groups of Asarori forest. A group shared its home range with at least 4 other groups (figure 5). The largest group (G2) shared the home range of 10 groups. A relationship was found between the group size and home range size. As the number of individuals increased the size of the home range also increased (product-moment coefficient of correlation, $r = 0.934$; $df = 11$; $p < .01$).

In Chakia forest the average home range size was 1.52 km² for the 3 rhesus groups. The overlapping of home ranges was less in the Chakia forest when compared to the Asarori forest. The home ranges in Chakia forest were also smaller in size (figure 6).

The temple group lived in an average home range of 0.017 km². There was no overlapping among the home ranges of Durga temple group and Sankas Mochan temple group (figures 7 and 8). Whenever another group was seen on the periphery of Durga temple group home range, the latter group immediately chased the former group away.

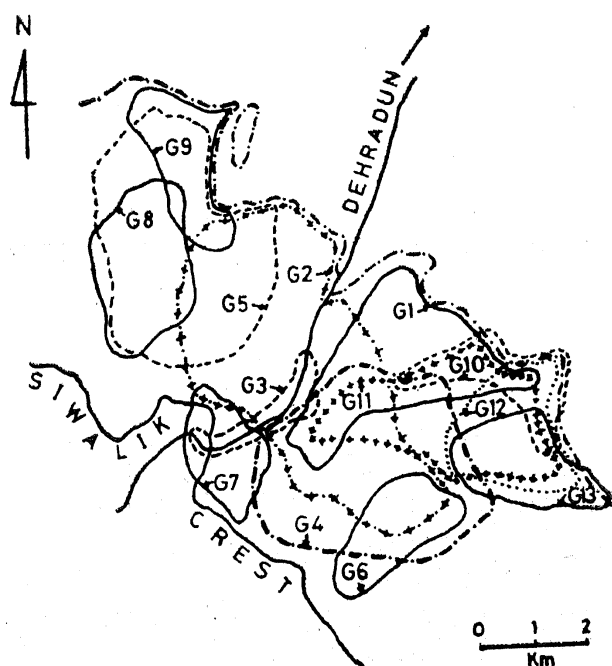


Figure 5. Home ranges of rhesus monkeys occupying the Asarori forest.

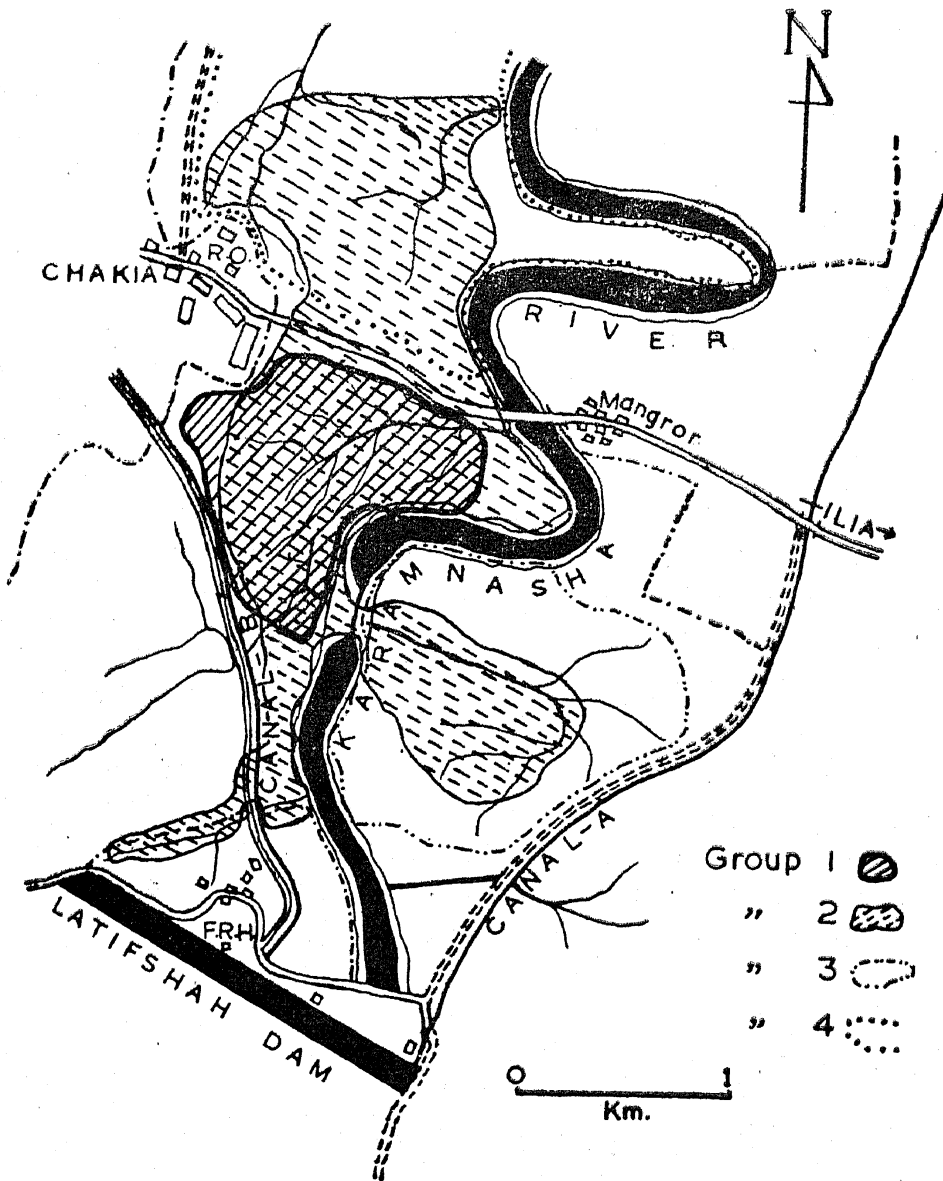


Figure 6. Home ranges of rhesus monkey groups occupying the Chakia forest.

4.4. Core area size

In Asarori forest, each group had one or two core areas, which were preferred to other parts of its home range. More than 60% of the sleeping sites converged in this area (*s*). The size of core areas varied from 0.04 km² to 1.81 km² with a mean of 0.48 km². There was no overlapping among core areas of different groups (figure 9). Deep ravines, high ridges, dense shrubs, tall trees of *Shorea robusta* and *Terminalia tomentosa* and presence of water were characteristic features of these core areas. The size of the core areas increased with the size of group in Asarori forest (product-moment coefficient of correlation, $r = 0.942$; $df = 11$; $p < 0.01$).

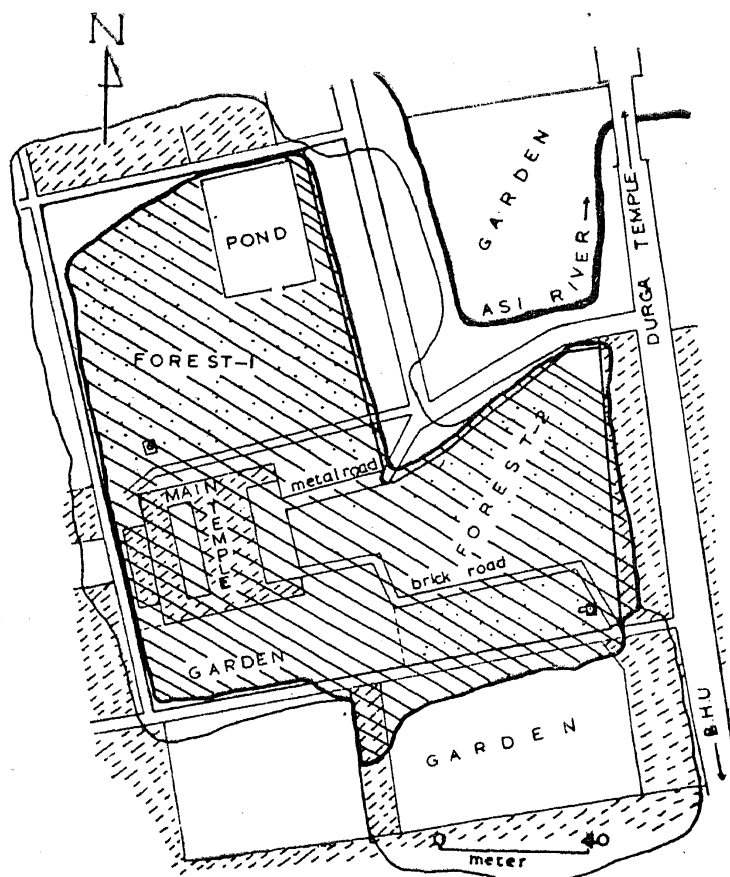


Figure 7. Home range (thin line) and core area (thick line) of the Sankat Mochan temple group.

Core areas were not discernible in the home ranges of Chakia forest monkeys. The temple monkey had permanent places to sleep during nights. The average size of the core area was 0.009 km^2 . The Sankat Mochan temple monkeys slept on the trees during nights while Durga temple monkeys slept on the temple roof.

5. Discussion

We found variability in home ranges of rhesus monkeys in different habitats. This variability can be understood partially in terms of some conclusions drawn by Clutton-Brock and Harvey (1977) for primates in general.

(i) "Populations living in areas of low food availability tend to have larger home ranges than those living in areas where food is more abundant." The Asarori forest groups lived in larger home ranges (mean 5.18 km^2) than those of temple groups (mean 0.017 km^2). Southwick and Siddiqi (1974) have also reported similar differences in the home ranges of forest and temple rhesus groups. However, conditions in Chakia forest are different due to scarce food resources, few night lodging trees and restricted space. These conditions are almost similar to those reported by Lindburg (1971) for the 4 rhesus groups living in Forest Research Institute, Dehra Dun. Although the rhesus groups at Chakia forest

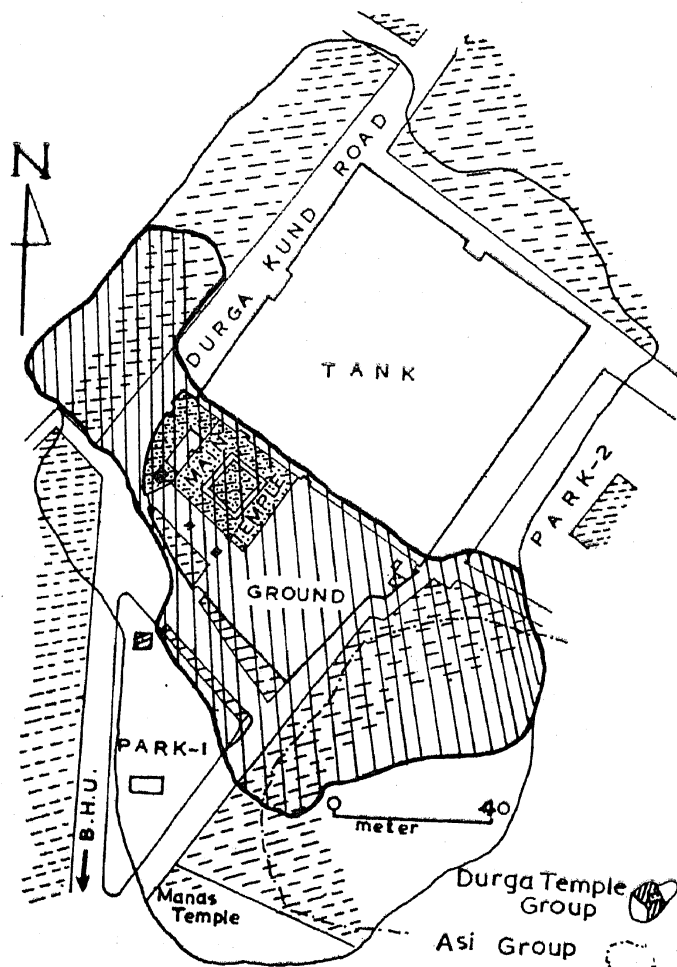


Figure 8. Home range (thin line) and core area (thick line) of the Durga temple group.

lived in home ranges, the core areas were absent. The 4 groups at Forest Research Institute lacked in both, they neither had specific home ranges nor the core areas.

(ii) "Within populations, groups whose ranges include a large proportion of preferred habitat tend to have the smallest ranges." Among the urban population of rhesus monkeys, the home ranges of temple groups were much smaller than the home ranges of groups living in other city niches. In the 2 temples plenty of food was offered to monkeys but the other 7 groups living in other parts of the Varanasi city procured their food by pilferaging from houses and shops. The latter groups were observed to roam over large areas of the city.

(iii) "Large groups may occupy bigger ranges than smaller groups though this is not always the case." We found that in Asarori forest, the size of the home range was closely correlated with the group size; the smaller the group size the smaller the home range, and *vice versa*. In a follow-up study, Makwana (1978) also observed a similar relationship between group size and home range size. Field data from other sources are not adequate to make comparisons.

(iv) "Home ranges tend to be largest at those times of the year when food is least available. When food and water were scarce in the Asarori forest during the hot dry season (March-June), the group covered the largest area of home

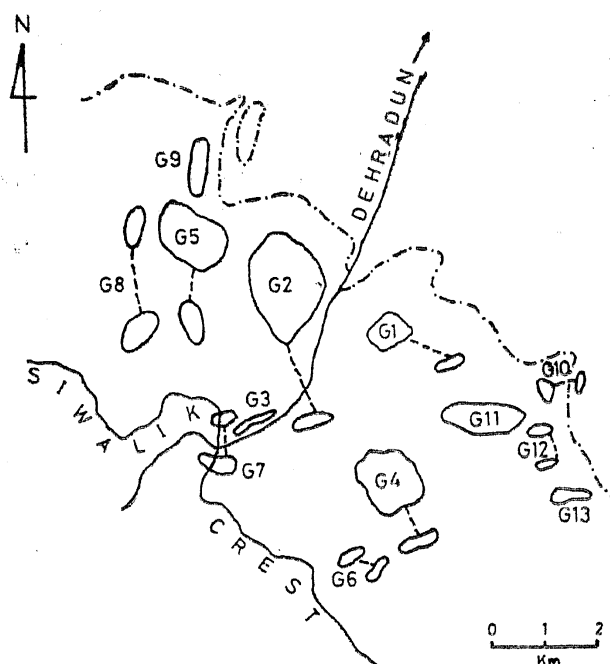


Figure 9. Core areas of rhesus monkey groups occupying the Asarori forest.

range (Lindburg 1971). Our observations also support this, however, it seems true only for those groups whose home ranges are fairly large, approximately above 5 km².

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