

## Establishment of home range, intraspecific and interspecific relations in rhesus monkeys (*Macaca mulatta*) under infant-infant rearing conditions

RAGHUBIR SINGH PIRTA\* and MEWA SINGH\*\*

Department of Psychology, Meerut University, Meerut 250 001

\*Present address: Department of Psychology, Kashi Vidyapith, Varanasi 221 001

\*\*Present address: Department of Psychology, University of Mysore, Mysore 570 006

**Abstract.** Twelve rhesus infants, reared in two groups in a forest habitat, were observed for more than one year to study their reactions to conspecifics and the effect on home range size. The infants exhibited behaviours characteristic of wild rhesus monkeys in the absence of any prior physical exposure to their conspecifics. Both peer groups established intra- and intergroup dominance hierarchies. They remained aloof from wild rhesus monkeys and showed xenophobia to stranger infants. Their home ranges increased with age and rearing experience. No change was observed in home ranges after adding more individuals.

**Keywords.** Rhesus; conspecifics; xenophobia; home range; dominance hierarchy; interspecific; cling.

### 1. Introduction

Carpenter (1942) released 350 rhesus monkeys, gathered from random sources in India, on a small island of Cayo Santiago. Within a year, the whole monkey community divided itself into social groups 'each holding and defending a territory'. Another population of 165 rhesus monkeys imported from India in 1961-62 was also settled on another island La Paraguera. They also formed social groups and established home ranges which remained unchanged in later years (Vessey 1968). Numerous studies conducted subsequently on these colonies suggest that rhesus monkeys unknown to each other organise themselves into social groups, establish their own home ranges and develop stable intra- and intergroup relationships.

The rhesus monkeys released on these islands were adults when caught in India and therefore had lived for several years in their native groups. The question raised was whether the monkeys separated from their mothers at an early age will be able to organise themselves into groups if given an opportunity to do so. Several laboratory studies have demonstrated that infants separated from mothers soon after birth and reared with their age mates develop strong emotional attachments and develop into 'normals' (Harlow 1962; Rosenblum and Harlow 1963). However, Dolhinov and Bishop (1970) felt 'it is unlikely that the laboratory "normals", with their limited experiences, could survive in the wild... Harlow's rhesus had much less to learn than the rhesus living in a North Indian Forest.' (p. 175).

In the present investigation, two groups of infant rhesus monkeys were raised in a forest area near Dehra Dun, Northern India. These peer groups were observed for

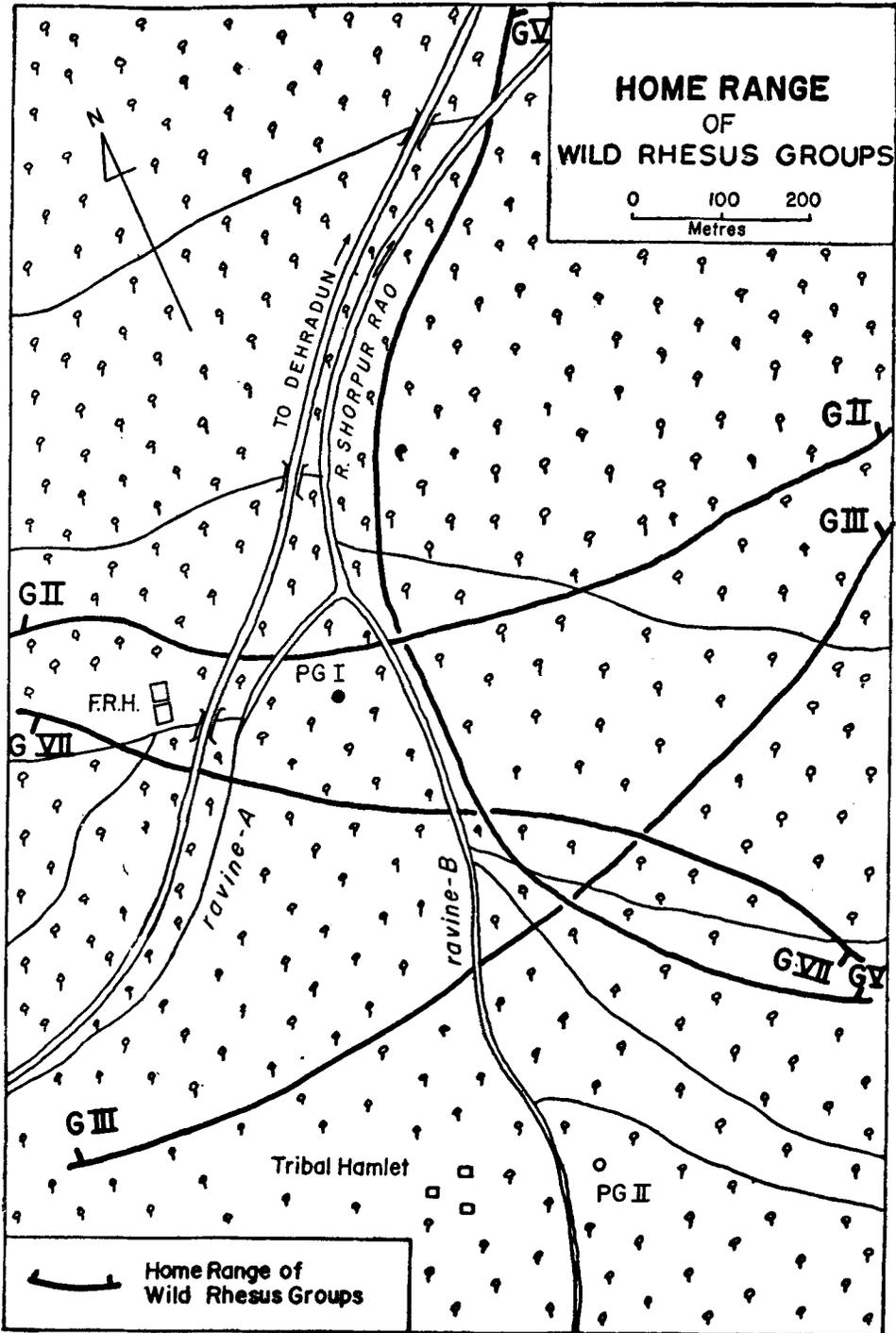


Fig. 1

more than one year to see the development of behaviour patterns characteristic of wild rhesus groups and their survival value for the species.

## 2. Study area

The infants were reared in an area of Asarori Forest (for details, see Lindburg 1971) located about 12 km from the city of Dehra Dun, on the northern slope of the Sivalik Hills. The ravines of Shorpur Rao (erosion bed) transverse this forest (figure 1). Along the fringes of ravines are open areas from a few to 100 m wide, covered with grass and scattered shrubs of *Carissa spinarum* and *Zizyphus jujuba*. On both sides of the ravines the land rises up to 150 m, forming steep ridges covered mainly with trees of *Dulburgia sissoo* and interspersed by *Mallotus philipinensis* and *Terminalia tomentosa*. Water was available in the ravines for most part of the year. Rhesus monkeys, langurs and domestic animals were very common but other large mammals were occasionally seen. However, several species of birds inhabited this part of the forest and as this area was near the main highway, it was daily visited by herdsmen, woodcutters and forestry men.

## 3. Subjects and methods

(a) Two areas were selected on the side of Ravine A of Shorpur Rao. Two metal sheet cages (approximately 45×30×30 cm), with wiremesh on three sides and fitted with a sliding door, were fixed in a *M. philipinensis* tree in each area. The cages were approximately at 5 m from ground level. The first batch of 6 infants, forming Peer Group I (PG I) was introduced to its parent tree in the last week of June 1973. In the middle of July 1973, two batches of three infants each, were

Table 1. Numerical data for peer group I and peer group II social composition and home range size

Rearing Peer Group	1973								1974				
	Aug. (I-Stage)	Sept.	Oct.	Nov.	Dec.	Jan. (II-Stage)	Feb.	Mar.	Apr.	May	June	July	1-15 Aug
I	3	3	3	3	3+4	7	5	5	3	3	3	3	3
Male	3	2	2	2	1+3	4	2	2	2	2	2	2	1
Female	5	5	5	6	11	11	7	7	5	5	5	5	4
Total	0.02 Km <sup>2</sup>			0.08 Km <sup>2</sup>			0.20 Km <sup>2</sup>						
Home Range	2	2	2	2	2+1	3	3	3	2	2	2	2	1
II	4	4	4	4	3	3	3	3	3	3	3	3	0
Male	6	6	6	6	6	6	6	6	5	5	5	5	1
Female	0.01 Km <sup>2</sup>			0.06 Km <sup>2</sup>			0.17 Km <sup>2</sup>						
Total	0.01 Km <sup>2</sup>			0.06 Km <sup>2</sup>			0.17 Km <sup>2</sup>						
Home Range													

Identifications: Peer Group I 7F, 10F, 11F, 15M, 19M, 29M.

Peer Group II 23F, 26F, 27M, 28M, 33F, 35F.

Strangers 41M, 43-F 50F, 52F, 58M, 60M, 61M, 62M (62M was not used as stranger)

introduced to the parent tree of Peer Group II (PG II) at two week interval. These infants were separated from their mothers at 20 to 60 days of age. Mothers were captured from different parts of North India. Their mean age was about 2.5 months on 1 August 1973. The composition of these groups for each month of study period is given in table 1. Seven strangers were also employed in this study (peer's age group). They were introduced to each peer group one by one and kept for a few days and later removed. All these strangers were then released in PG I. A new infant was added to PG II.

(b) During the first few months of their release, the infants in both groups were totally dependent on artificial feeding. Once they started foraging on plant species surrounding their parent tree, their diet was slowly decreased to reinforce natural feeding. A few months before the end of the study, their artificial feeding was totally stopped. Human protection was also decreased once they became familiar with their surroundings at approximately two months of their plantation on trees. Care was however taken against human interference or illness of any individual.

(c) The infants were adapted to their natural surroundings for about 20 days. The observations were started on 1 August 1973, and continued till 31 July 1974, a few days after which the infants of both groups were removed from the study area. During this period at least one of the present authors watched them everyday. The observations were made any time of the day ranging from a few minutes to several hours. Occasionally, the peer groups were observed from dawn to dusk as well as at night. Group movements, intra- and intergroup relations, interactions with wild rhesus groups and relations with other animal species were systematically recorded.

#### **4. Observations**

##### *4.1. Group structure*

During the first few months of their release a dominance hierarchy emerged in each group, which persisted throughout the study period (Singh and Pirta 1977). No. 15M dominated PG I and No. 28M dominated PG II. Both groups lacked one characteristic of wild rhesus groups—the peripheral male. All the males acquired a place in the hierarchy. Although PG I alpha male was most dominant among the two peer groups and had more males than females in his group, no male was out-casted from the group.

During day time resting, mostly two subgroups were formed in each peer group. But at nights, infants of each peer group slept together. Alpha male led the group on occasions like external threat, returning to parent tree or while moving towards resting and sleeping sites.

##### *4.2. Home range*

During the early stages of observations, the movements of the infants were only restricted to their parent tree and covered an area of approximately 10 sq m around their trees. During the end of the study period, the movements of the PG I and PG II were 0.2 km<sup>2</sup> and 0.17 km<sup>2</sup> respectively. It is interesting to note that the size of their

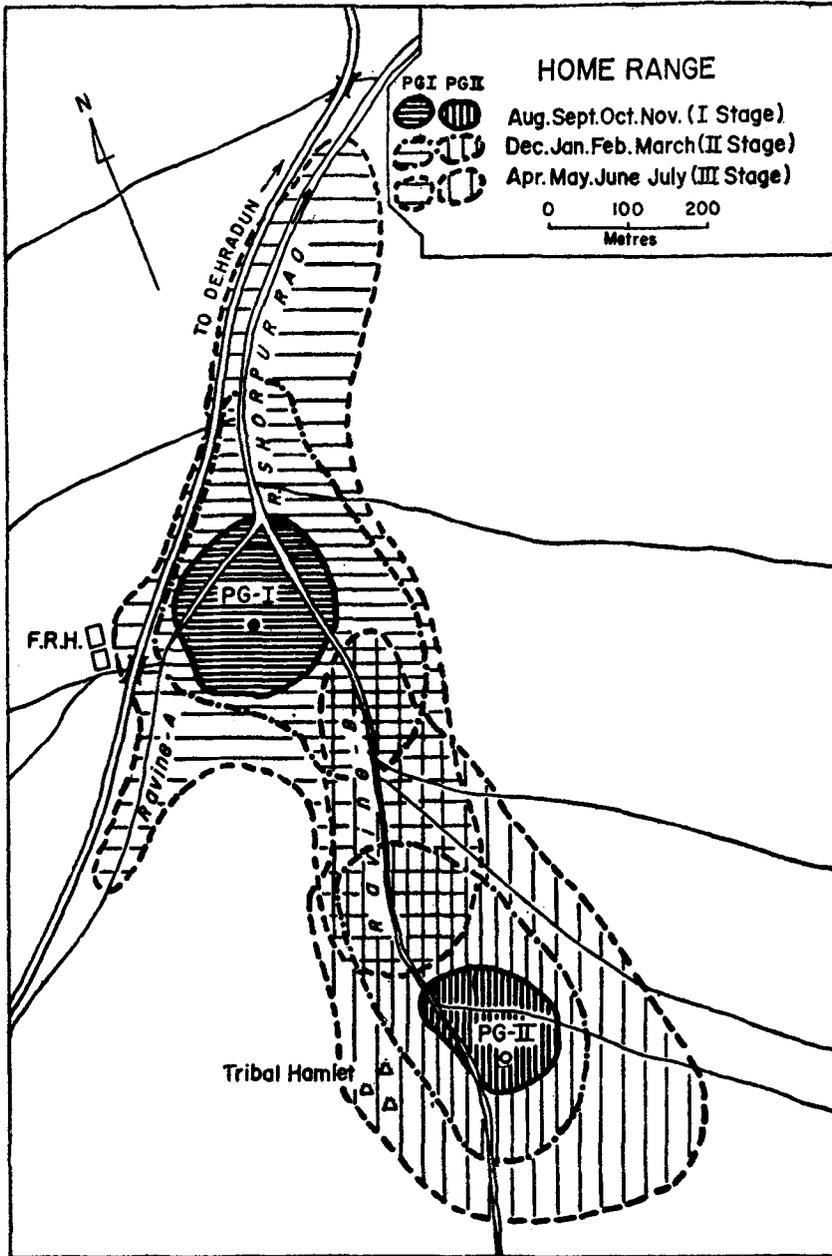


Fig. 2

home range was more than that observed for urban groups which ranged from  $0.1 \text{ km}^2$  to  $0.15 \text{ km}^2$  (Southwick *et al* 1965). The ranging patterns of PG I and PG II resembled the urban and forest group ranging patterns. The infants of each peer group returned to their parent tree at night and for resting during day time (an urban pattern). During foraging, they did not scatter like urban monkeys in their home ranges, but moved

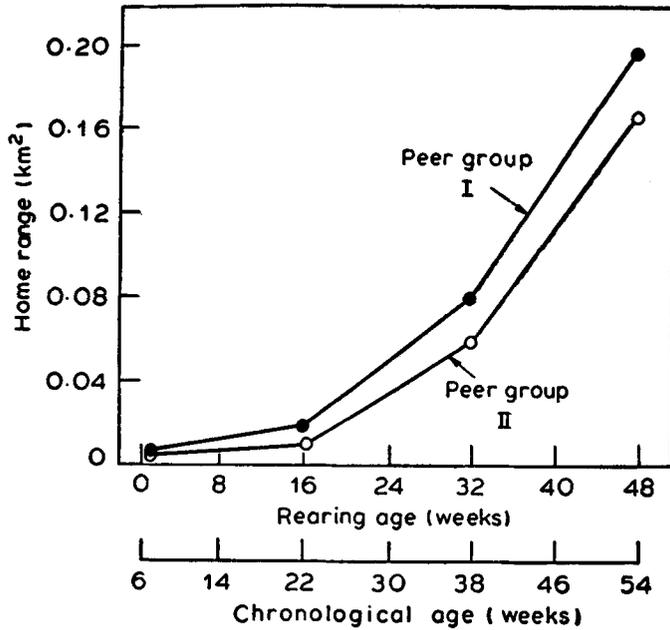


Fig. 3

as single units like forest monkeys. Whenever any member of the group left the place in search of food the others followed him.

To analyse the development of home ranges for each peer group, the total study period was divided into three stages of four months each (figure 2). It was found that the size of home range increased with rearing experience and growing age (figure 3). Activities of both peer groups in their home ranges during the three stages are discussed in the following paragraphs:

*I stage:* From August to November, the home ranges of PG I and PG II increased from a few square metres to 0.02 km<sup>2</sup> and 0.01 km<sup>2</sup> respectively. The first excursions of infants from tree to ground were either for food droppings or for play. While playing on ground, they explored the area around their trees and moved a few metres away on shrubs in search of food. But these excursions were for very short periods. Any slight disturbance made them to rush back to their parent tree. They always rested and slept in the parent tree. During the end of this stage an important event took place in PG II. We changed cages of PG II to a nearby tree, and from that day onwards the infants of this group slept at night on adjacent trees. However, during day time, they used to rest in their cages. In October and November, strangers were introduced to each peer group for short periods. No change in dominance relations and in home ranges occurred due to the introduction of strangers.

*II stage:* From December to March, the home range increased from 0.02 km<sup>2</sup> to 0.06 km<sup>2</sup> in PG II. Both groups spent most of their time in parent tree. But slowly the area visited and the time spent for foraging excursions increased. Any disturbance caused them to take refuge in any nearby tree.

#### 4.3. Effects of adding members in peer groups

Lindburg (1971) observed in Asarori rhesus monkeys that larger the group size, larger was the home range. We also expected an increased in PG I home range after adding seven infants in it. But there occurred no sudden change or increase in the home range. Furthermore, contrary to our belief, it was found that the home range of PG II increased 4 to 6 times to PG I's home range, during this stage. Only one infant (62M) was added to PG II. Thus it became clear that the home ranges increased as usual; the addition of infants produced no change.

*III stage:* During the last period of the study from April to July, the home range of PG I increased from 0.08 km<sup>2</sup> to 0.20 km<sup>2</sup>, and 0.06 km<sup>2</sup> to 0.17 km<sup>2</sup> in the case of PG II. The number of infants during this stage in each peer group was 5. An important trend observed during this period was that the infants in both groups spent less time in their parent trees. Their foraging excursions increased both in time and space. Sometimes it was difficult to find them in their home ranges. They played, rested and slept in any tree in the home range wherever they stopped foraging. During the last months of the study they had started sleeping in different parts of their home ranges though they used to come to their parent tree at night. They always slept on highest branches and away from the main stem, which is a characteristic of wild rhesus monkeys. Their cages were removed in June 1974, when the artificial feeding was totally stopped. After that, the peer groups visited their parent tree daily but for very short periods.

Another important change observed during this stage was the overlapping home ranges, which resulted in intergroup dominance hierarchy. PG I always dominated PG II despite the equal number of individuals in both groups. It was the personality of PG I alpha male (15M) which played an important role.

#### 4.4. Feeding habits

In the beginning, the infants were dependent on artificial food but it was gradually decreased and totally stopped in the last months of the study. These naive infants developed strong preferences for a number of plant species from the very beginning. It was remarkable that their choice included the plant species eaten by wild rhesus monkeys in this area and also reported by Lindburg (1971). One of their preferred food item was ripe and unripe fruits of *spinarum* which was scattered in the home ranges of both groups. They also foraged on tender grasses predominantly the *Cynodon dactylon*, fruits of a shrub *Zyzyphus jujuba*, flowers and buds of *Shorea robusta*, fruits of *Eugenia jambolana*, leaves of *M. philippinensis* and several species of climbers. Their delicacies also included plant parasites of Lorantheaceae family, small insects and soil of ravines. It was very amusing to see PG I infants, with their mouths bright red after eating buds of cactus which grew near their parent tree.

#### 4.5. Mortality

In both peer groups, there was no instance of death due to disease, except among the strangers. Among the 6 individuals in each group, 2 females were lost in PG I and 1 female in PG II, while one male in PG II died by falling from tree during night.

Among the 8 new added infants, 6 died because of diseases. But at the end of the study and a few days after it (from 17 July to 15 August), the rate of mortality was alarming. Some predator started attacking these infants. Four infants of PG II were found missing one by one (17 July-33F; 20 July-62M; 7 August-28M; and 9 August-26F). Only one infant (35F) remained which joined the PG I. Then the predator started attacking PG I. A female (No. 10) was found missing from this group on August 13. The remaining 5 infants were then captured on 15 August 1974. This indicates that not only infants but juveniles also require protection.

#### 4.6. *Relations with wild rhesus monkeys*

Four Wild rhesus monkey groups (figure 1), ranging in group size from 11 to 127 individuals, visited the home ranges of the PG I and PG II. During the first stages of rearing, the intrusion by wild groups in the study area was partially checked. During the later two stages, the wild groups were free to move and they visited the area around the parent tree. The members of both peer groups remained aloof from the wild groups. In all encounters with the wild groups, the infants either rushed to the parent tree or flew away in any direction. During the later situation the peer groups sometimes went out of their home ranges. All the members followed the alpha male. They remained clung to each other on trees until the intruding monkeys left the area. Mostly they remained quiet and tried to be least conspicuous during such occasions. Sometimes it was difficult to locate and bring back these sacred young ones.

#### 4.7. *Relations with conspecific strangers*

During the last month of I-stage, seven strangers of the same age group (3 normals, 4 frontally operated) were introduced to PG I and PG II, one at each time. Each stranger was released near the parent tree of each group in the presence of group members. The stranger was kept in group for four days and then removed. All the strangers received aggressive encounters from group members (xenophobic reactions). Two strangers ran away from the peer group soon after their release. The strangers avoided any encounter with group members, but followed them at distance in bushes. The xenophobic reactions of infants temporarily subsided when the stranger withdrew. No matter how submissively the stranger approached the group members, it was attacked even by the lowest ranking animal of the group. Strangers never dared to reach the milk bottles or food items placed in cages in the presence of group members. The strangers had to be fed separately to keep them alive. The xenophobic reactions toward strangers reached a climax in the evening, when all members in each peer group clung to each other. During these months (October, November, December) the temperature goes below 0°C on the Sivalik range. The shivering stranger would make numerous submissive attempts to contact the peer group members, but he was pushed away, chased, threatened and bitten severely. The stranger had to go for shelter to the second cage, or huddle on a nearby branch until he was brought back to the camp. We found that after several days the stranger was adjusted in the peer group and received a lowest place in the hierarchy. It is to be noted that without our interference for the first one or two days of release, it would not have been possible for a stranger to survive.

#### 4.8. Relations between the peer groups

The home ranges of the peer groups started increasing along the Ravine A during II stage of rearing. There was considerable overlap of home range during III stage and as a result several encounters took place between PG I and PG II. Most of them were peaceful in which PG II withdrew when it saw PG I. In a few cases the dominant male of PG I (15M) chased the members of PG II who ran away screeching, fear grimacing and cooing. No fight was observed. Occasionally after seeing the animals of PG II, 15(M) climbed on trees, moved actively on branches and shook them at intervals. On these occasions his tail remained fully arched over his back ('crook-tail' position). Sometimes two other males (19M and 29M) accompanied him, with aggressive posturing and barking at PG II members. The females (10F and 50F) mostly remained passive but followed them.

### 5. Interspecific relations

#### 5.1. Peaceful relations

Several species of mammals inhabited the study area. Commonly available species were langurs (*Presbytis entellus*), chital (*Axis axis*), sambar (*Cervus unicolor*), barking deer (*Muntiacus muntjack*) and Indian wild boar (*Sus scrofa*). The infants of both groups withdrew when langurs jumped near their trees during foraging. Mostly they roamed about peacefully near the langur groups. A passive stare by a langur aroused fear in the infants which was expressed by high pitched screech vocalizations. Whenever chitals and sambars came for grazing in their area, all the group members slowly moved away from the ground and climbed on trees and bushes or shrubs and explored the activities of these animals. They were seen frequently startled by the loud alarm calls of peacocks. Domestic animals roamed mostly beneath their trees. The infants of both peer groups foraged in their proximity and sometimes threatened or barked at these animals.

#### 5.2. Predator-prey relations

The potential predators of the infants were hawks and weasels. The encounters with weasels were not observed in the case of peer group infants, but they killed two isolated infants near the study area even in the presence of the animal caretakers.

Encounters with hawks were observed everyday. One of us witnessed a hawk killing one peer group infant and three isolated infants. Any low level flight of these birds produced a sudden crouching and clinging response accompanied by vocalizations. The hawk attacked while the infants were moving, playing or resting on the top of a tree. The infant was picked up in strong talons and carried to a nearby place under shrubs. The method of killing the animals was always the same i.e. the skin over left side of the chest was torn up, rib cage broken, and the heart and lungs eaten. When the infant (a stranger) in PG II was killed, the other members were found clinging to each other like a ball on a bush, and the hawk was eating their companion under the same bush. They moved from the bush only when the hawk flew away as one of us approached the site.

The infants of both peer groups responded to humans by a sudden flight on ground or climbed on a tree or a bush. Domestic dogs occasionally ran towards these infants but they were never successful. The infants gave alarm calls seeing a dog and all infants climbed the trees and remained there till the dog was out of sight.

## 6. Discussion

The present study while lacking experimental control and statistical designs is a first hand account in which the existence of some species specific behaviour patterns are reported in infants raised in peer groups. These infants were not exposed to any social experience of the adult members of their species. In the following paragraphs the survival value of these behaviour patterns is discussed.

### 6.1. Use of space

The use of ecological resources in order to satisfy the biological needs require the animals to space out (Kummer 1970). Several field studies on free ranging rhesus monkeys (Southwick *et al* 1965; Vessey 1968; Lindburg 1971) clearly indicate that these macaques have developed two types of mechanisms to handle space:

6.1.1. *Handling of intergroup space*: Rhesus groups establish home ranges in order to restrict their activities to a particular area. As this area is not defended from movements of other groups, there are overlapping home ranges. The problem of priority in using overlapping areas depends upon intergroup dominance hierarchy. The infants raised in both peer groups not only established their home ranges but an intergroup dominance hierarchy also emerged.

6.1.2. *Handling of space within a group*: Biological as well as social needs press the individuals of a group to space out. This is done through expressions of submissive and aggressive behaviour which results in a stable dominance hierarchy, a familiar characteristic of rhesus monkeys. Each of the peer group formed a stable hierarchy soon after their release in the study area (Singh and Pirta 1977).

### 6.2. Maintenance of social integrity of groups

Two mechanisms were used by these peer groups to maintain their groups as cohesive units:

(a) Xenophobia guarantees the integrity of the social group and the least chance of disruptions. This trait is very common in rhesus monkeys and other primates (Holloway 1974). It was manifested clearly by members of PG I and PG II when strangers were introduced to these groups.

(b) Another important behaviour was first observed by Lorenz (1952) in his flock of jackdaws bred in complete social isolation. One day, a huge flock of migrating jackdaws settled in an adjoining meadow, and soon, all of his younger birds joined it but high ranking older birds stayed aloof. Lorenz was astonished to see that the older ones flew away, selected one by one their young fellows out of hundreds in the meadow, and by sweeping induced a following response and led them home. We

also were afraid of the future of our peer infants, as we saw that wild rhesus groups of more than hundred monkeys visited the study area. But we never lost our infants during the visits of these groups. It was interesting to note that there were no old companions among the peer group infants (like the old jackdaws of Lorenz), but the alpha male partially played the same role. All members of the group followed him. Avoidance of other groups and following members of one's own group prevent the social group from losing its integrity.

### 6.3. *Response to predator*

At this stage, we are not sure how the infants of PG I and PG II learnt to react in different ways to different species. Whether they learnt it by experience or it was already in their repertoire is a controversial issue. Any hawk or vulture flying closely over the infants aroused an alarm call and crouching response in them. This response resembled the response of birds in 'hawk-goose' silhouette experiments of Tinbergen (1951). The crouching or clinging to any object makes it difficult for a dashing predator (hawk) to pick up its prey easily. In one case we saw a hawk attempting and failing to lift a baby who clung to the tree branches at the top, and only sustained cuts in three places on its body. The wild rhesus monkeys respond to the hawk in the same way. The response to ground predators was flight to trees.

### 6.4. *Infant-infant clinging*

A very common pattern during social contacts among each peer group infants was social clinging. Harlow (1969) and Chamove *et al* (1973) observed this pattern in a number of experiments on peer-raised infants. These investigators considered it as a symptom of abnormality which retards development of complex behaviours. Rearing infants in free ranging conditions left no doubt in our minds for its survival value for these infants. Social clinging in PG I and PG II was observed in several patterns viz. dorsal-ventral, ventral-ventral or a mixture of both. These patterns were commonly seen during resting, sleeping and stress conditions. An infant sleeping alone on a branch is more likely to fall than an infant sleeping in ventral-ventral clinging to another infant. Any imbalance in the position of one infant causes the other to hold more tightly and prevent it from falling. Several cases were observed in which infants fell down from trees while asleep, and in two such cases they died. In the wild, the first year and second year monkeys always sleep with the mother. In the winter season, when temperature falls below zero degree in this forest, infants were observed shivering soon after sunset. The social clinging is the only mechanism to generate heat by close body contact and to stop heat loss by minimum exposure of the body surface. During external threats, the infants cling to each other so tightly that it is difficult for a predator to remove any of them. The clinging was also observed when low ranking infants showed 'temper-tantrums' due to frustrating situations. On such occasions, the high ranking infant approached this infant and both clung to each other and provided reassurance to the low ranking one. We hypothesise that ventral-ventral cling in the age mate rhesus monkeys is a prototype of 'embrace' which is very common in langurs, apes and human beings.

At the end of the study when our peer raised monkeys were about 15 months old, they were unable to protect themselves even from small predators—hawks and

weasels. Although, they had developed appropriate behaviour patterns to combat these animals, yet they needed protection as they were physically immature and one can say that it will be impossible for Harlow's peers-only-raised 'normals' to survive in a North Indian forest if released below two years of age.

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### References

- Carpenter C R (1942) Societies of monkeys and apes; *Biol. Symp.* **8** 177-204
- Chamove A S, Rosenblum L A and Harlow H F 1973 Monkeys (*Macaca mulatta*) raised only with peers-A pilot study; *Anim. Behav.* **21** 316-325
- Dolhinow P J and Bishop N 1979 The development of motor skills and social relationships among primates through play; in *Minnesota Symposia on Child Psychology* ed J P Hill (University of Minnesota Press Minneapolis) **4** 141-198
- Harlow H F 1962 The heterosexual affectional system in monkeys; *Am. Psychol.* **17** 1-9
- Harlow H F 1969 Age-mate or peer affectional system, in *Advances in the study of behaviour* eds D S Lehrman, R A Hind and E Shaw (New York: Academic Press)
- Holloway R L 1974 *Primate Aggression, Territoriality and Xenophobia* (London: Academic Press)
- Kummer H 1970 Spacing mechanism in social behaviour *Soc. Sci. Inform* **9** 109-122
- Lindburg D G 1971 The rhesus monkey in north India: An ecological and behavioural study; in *Primate Behavior* ed. L A Rosenblum (New York: Academic Press) Vol. **2** 1-106
- Lindburg D G 1976 Dietary habits of rhesus monkeys (*Macaca mulatta Zimmerman*) in Indian forests *J. Bombay, Nat. Hist. Soc.* **72** 261-269
- Lorenz K Z 1952 *King Solomon's Ring* (New York: Crowell)
- Rosenblum L A and Harlow H F 1963 Generalisation of affectional response in rhesus monkeys; *J. Percept. Motor Skills* **16** 561-564
- Singh M and Pirta R S 1977 Hierarchical behaviour in 'peers-only' raised rhesus monkey (*Macaca mulatta*) infants: A qualitative observational study *Indian J. Behav.* **1** 43-47
- Southwick C H, Beg M A and Siddiqi M R 1965 Rhesus monkeys in North India; in *Primate Behavior: Field Studies on Monkeys and Apes* ed. I Devore (New York: Holt Rinehart and Winston) pp. 111-159
- Tinbergen N 1951 *The Study of Instincts* (Oxford: Clarendon Press)
- Vessey S H 1968 Interactions between free-ranging groups of rhesus monkeys; *Folia Primatol.* **8** 228-239