

# On the Social Change of Hanuman Langurs (*Presbytis entellus*) in Their Natural Condition<sup>1, 2)</sup>

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## INTRODUCTION

I have already reported some of the socio-ecological studies of hanuman langurs (*Presbytis entellus*) conducted by the Japan-India Joint Project in Primates Investigation over a period of two years from April, 1961. Its main research area was a tropical dry deciduous forest lying to the west of Dharwar in Mysore State, India (SUGIYAMA 1964).

The first step of the project was the study of general ecology of langur troops living on and by the road running westwards from Dharwar to Haliyal (SUGIYAMA 1964). It was made clear that there are two types of groups: the bisexual troop that comprises 16 animals on the average usually including only one adult male and the male group that consists of male langurs only.

Moreover, another close investigation was made into seven troops and one male group inhabiting around the spot of 21 km from Dharwar.<sup>3)</sup> It became clear by that investigation that each of these troops settles down in a home range of about 17 hectares, while the male group is always moving by choice where any troop does not exist, and that there is strong antagonism between the troop-males and the male group (SUGIYAMA *et al.* 1965).

The infant langur has many chances to be held by the females of the troop other than the mother (infant transferring) and grows up to be a member of the troop that has little social differentiation. Moreover, the infant langur is allowed to behave freely in the troop by every member. If it is a male infant, no antagonism arises between the infant and the leader even when he grows up into a mature male (SUGIYAMA 1965).

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- 1) This is the fourth report of the Japan-India Joint Project in Primates Investigation.
  - 2) The field work on which this report is based was financed by a Rockefeller Foundation grant for the behavioral study of Indian monkeys (RF 60229).
  - 3) Henceforth 'km' used in this paper to show a spot is a distance from Dharwar on the Dharwar-Haliyal road.

What process does this social organization of hanuman langurs go through to maintain the 'one-male-troop'? What relation lies between the troop and the male group, both the component parts of langur society? What change has each langur troop undergone and what development has langur society made in many years? In order to reveal the inner organization of langur society, an attempt to pursue the process of a social change was made.

This is a report of the whole process of a social change that took place not from an artificial cause, but in natural conditions in the 30th troop. Social changes occurred not only in this troop but in the 1st, the 5th, and the 7th troops, which are to be reported in the near future. I brought about an artificial social change in the 2nd troop for experiment (SUGIYAMA 1966). A social organization theory of hanuman langurs on the basis of these observations is to be developed in the serial reports.

As mentioned in the preceding paper (1964), I am indebted to many persons who helped me to carry out this long term survey for two years. Special mention should be made of Dr. Harold Trapido, the Virus Research Centre of Rockefeller Foundation, Poona,<sup>4)</sup> and Professor Dr. Denzaburo Miyadi, Kyoto University,<sup>5)</sup> who made their best to realize and achieve this project. I owe much to my colleagues Dr. Syunzo Kawamura, Dr. M.D. Parthasarathy and Mr. Kenji Yoshiba who spent two years with me in the study and investigation of langurs. I wish, also, to acknowledge such extensive help from Dr. Junichiro Itani, Laboratory of Physical Anthropology, Kyoto University, who gave his comments and suggestions to the preliminary drafts and material improvements. A number of colleagues and friends at Laboratory of Physical Anthropology, Laboratory of Animal Ecology, Kyoto University and Japan Monkey Centre have helped by reading and criticizing the drafts of this report.

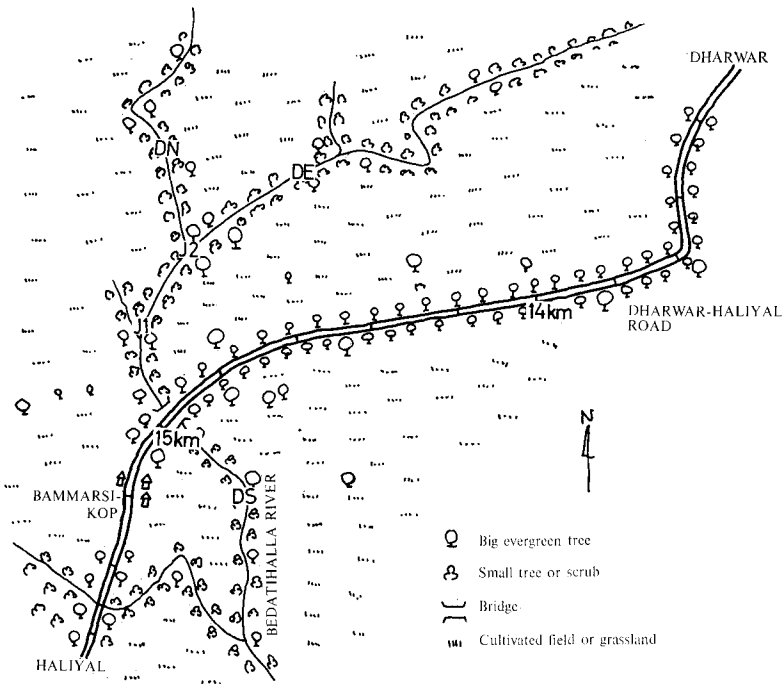
## *I. AN OUTLINE OF THE 30TH TROOP AND ITS CIRCUMSTANCES*

### *A. The Habitat*

The home range of this troop had a vertical and a horizontal axis: the one is the roadside trees growing along the Dharwar-Haliyal road between 13.8 km and 15.1 km, and the other is the riverine forest spreading along the Bedati-halla river, the road and the river crossing each other at the spot of 15 km from Dharwar (Fig. 1). The neighborhood is either a cultivated field or a grass land that is dotted with mangoes, nial trees, and neems except in the environs of these axes (Fig. 2). Farm products are grain such as wheat, maize, and rice, but during the dry season except May to October when people plow a land, the cultivated field completely turns into a grass land or a waste land. The roadside trees and the riverine forest consist of the following kinds

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**Fig. 1** Schematic map of the habitat of the 30th troop and its vicinity



**Fig. 2** Vegetation of the range of the 30th troop  
 A: Bedati-halla river covered with riverine forest, mainly of small trees  
 B: Grassland and cultivated field with scattered trees

of trees and shrubbery, of which the leaves, buds, and nuts are staple food for hanuman langurs living in this neighborhood: flame of the forest (*Butea monosperma*), java plum (*Syzygium cumini*), neem (*Azadirachta indica*), teak (*Tectona grandis*), tamarind (*Tamarindus indica*), pongam (*Pongamia glabra*), fig tree (*Ficus sp.*), lantana (*Lantana aculeata*), acacia (*Acacia farneciana*), dalbergia (*Dalbergia latifolia*), and caesalpinia (*Caesalpinia coriaria*).

The Bedati-halla river 3-5 meters in width becomes full of muddy water

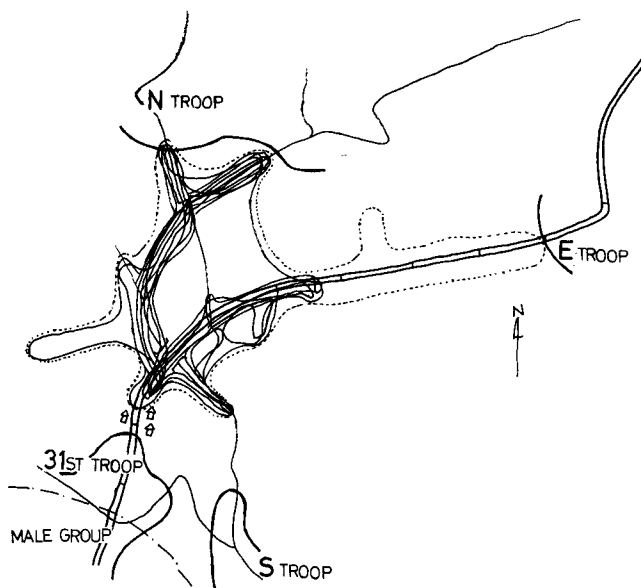
to overflowing during the rainy season, but it nearly dries up during the dry season, its flux lowering to 2-3 liters a minute. Most of the roadside trees are evergreens that provide langurs with green leaves and leafy shades during the dry season on the roadside and on the riverside.

These environmental conditions are very different from those in the forest part where all the trees become bare of leaves during the dry season. The lay of the land is such a gently-sloping hill as we can overlook the whole view of the home range if we stand on the tree.

Unlike langur troops living in the forest part that was stated in SUGIYAMA *et al* (1965), the 30th troop that had the home range in the roadsides and the environs of the cultivated field was little effected by my field observation from the beginning of the survey. The 30th troop did not differ from those of the forest part in the social organization and behavior.

### B. The Home Range

Figure 3 shows the traces of the 30th troop for 21 days during a period from March 18 to May 9, 1962 and the whole home range of it confirmed by the preceding survey. The whole home range is 38 hectares, but hardly used parts such as a grass land and a waste land excepted, the rest is 30 hectares. In the survey of the seven troops living in the vicinity of 21 km from Dharwar



**Fig. 3** The daily movement of the 30th troop was traced for 21 days between March 18 and May 9, 1962, and the home range limit recognized before that period is shown by the break line. Home range limit of adjacent groups, N troop, E troop, S troop, 31st troop (thicker solid line), and male group (chain) are also shown.

(that was reported in SUGIYAMA *et al.*, 1965), the home range was from 10.3 to 31.5 hectares, 16.8 hectares on average.

Though the home range of the 30th troop is about two times as large as the average home range of the troops living in the forest part, the real home range used by the troop is almost as large as that of the 1st troop, the biggest of the above-mentioned seven troops in the forest. The riverine forest and the roadside trees are available for the troop all through the year as a source of food-supply, and they are of higher value than the forest part containing mostly deciduous trees. But more than half of the frequently used part is utilized by the troop as a mere passage like the road and the grass land.

The 30th troop was surrounded by four langur troops, whose territories were never lapped over that of the 30th troop. Though there was some inter-troop relationship between them through a demonstration like display jumping (SUGIYAMA *et al.* 1965), direct clashes hardly happened between them. Table 1 shows the social composition of the troops adjacent to the 30th troop.

**Table 1** Composition of the 30th troop and its adjacent troops

|                 | Adult ♂  | Adult ♀  | Subadult ♂ | Subadult ♀ | Juvenile ♂ | Juvenile ♀ | Infant   | Total     |
|-----------------|----------|----------|------------|------------|------------|------------|----------|-----------|
| <b>30th Tr.</b> | <b>1</b> | <b>9</b> | <b>1</b>   | <b>0</b>   | <b>5</b>   | <b>3</b>   | <b>5</b> | <b>24</b> |
| S Tr.           | 1        | 4        | 0          | 0          | 0          | 2          | 0        | 7         |
| 31st Tr.        | 1        | 4        | 0          | 1          | 0          | 1          | 3        | 10        |
| E Tr.           | 1        | 14       | 0          | 0          | 3          |            | 3        | 21        |
| N Tr.           | 1        | 9        | 0          | 0          | 1          |            | 8        | 19        |

### C. Social Composition

The social composition of the 30th troop as of April 20, 1962 is shown in Table 2. The mother-infant or the mother-juvenile relationship was judged from their characteristic behavior such as embracement while resting, and sucking or suckling, and also from the frequency of these kinds of behavior. The birthmonths of infants born from 1961 to the beginning of the next year were all guessed, referring to the data of the roadside survey reported by SUGIYAMA (1964).

This large-sized troop comprized 24 langurs—one adult male, one male of four years old, two males of three years old, two males of two years old, one male of one year old, three infant males, nine adult females, three females of one year old, and two infant females (Fig. 4). It is comparatively a rare case among langur troops in Dharwar that a subadult male of four years old exists in the bisexual troop, which has relation to the multiplication of the troop members. There were nine adult females in the troop, but the mother females of one-yearold juveniles did not participate in child-bearing during a period from 1961 to the beginning of 1962. All the other females that had no yearling



Childbirths from 1961 to the beginning of 1962 took place intermittently over a six-month period. This is very similar to the case of the 4th troop in Dharwar I have already stated in the 2nd report. It follows from this that the mating season, if it may be called so, continued over a period of six months.

Individual langurs have different social positions according to their social relationship, sexes, and ages, but there is not a great social difference among individual langurs that are nearly of the same age and of the same sex. Aggressive behavior and suggestive behavior of ranking orders could hardly be seen among the nine adult females. There was no differentiation in spatial distribution among troop members. They were already stated in SUGIYAMA's report (1965).

## II. THE SOCIAL CHANGE

As it was already mentioned, the four langur troops, N, E, the 31st, and S inhabited the neighborhood of the home range of the 30th troop. Besides them one male-group existed, whose home range was lapped over that of the 31st troop and they had another large home range to the south of the troop (Fig. 3). The male group consisted of 7 langurs; six full grown adult males and one young adult male. When the male group approached the 31st troop, the leader male of the 31st troop became strained to the extreme and drove it away for himself. The male group ran away without showing any resistance against the leader male. This group could never be observed to enter the home range of the 30th troop until an incident happened on May 31, 1962.

### A. The First Day: the Occurrence of an Incident

At 14:00 on May 31 the male group that was usually in the neighborhood of the home range of the 31st troop moved toward the road in a hurry from the direction of the spot J1 and stopped at a roadside tree 14.8 km away from Dharwar. Four langurs of the 30th troop,  $B \text{♀}$ ,  $Bi$ ,<sup>6)</sup>  $D \text{♀}$ , and  $E \text{♀}$  were found to join the male group. Every male langur got excited excessively. Particularly  $L \text{♂}$  of large build violently repeated teeth grinding and convulsive threat<sup>7)</sup> toward the north. All the male langurs in excitement surrounded these females of the 30th troop at a distance. Though they made an attack on them alternately, they were forced to retreat by a violent counterattack of  $B \text{♀}$  and  $E \text{♀}$ . No cooperation could be seen among the male langurs in this conflict. A single attack was made on the females. Sometimes troubles occurred among these males.

Around 16:00  $D \text{♀}$  began to show a sign of sexual excitement shuddering

6)  $Bi$  is  $B \text{♀}$ 's female infant under one year of age.

7) It is a kind of threatening behavior often seen in an intertroop strife (see SUGIYAMA *et al.* 1965).

her head, and at last presented herself to the surrounding males turning the buttocks on them. But  $B\varphi$  drove away any male whenever he tried to approach  $D\varphi$ .

At 17:30 the rest members of the 30th troop were found to be at rest midway between DN and J1 about 450 meters distant from the male group. The leader male,  $Z\delta$  had a long cut from side to side on the calf of the right hind leg. It seemed to have been given by a male langur with the canine teeth within a few hours before, for it had not coagulated yet from excessive bleeding. Though he continued teeth grinding and convulsive threat toward the male group, he appeared to be much exhausted from the severe wound. Night came while the troop remained at the place.

The male group moved about 50 meters along the road by 18:00. The three females and the infant did not run away from the group, or rather followed it at some distance.  $D\varphi$ 's oestrus heightened and began to behave violently in sexual excitement. Though it could not be observed directly, it seemed that around 13:00-14:00 when the male group invaded the home range of the 30th troop, it clashed against the troop midway between J1 and J2, and that the leader male was given the serious wound by an attack of the males in the group. Though the male group retreated, then a part of the troop members must have followed it.

#### B. The Second Day: An Attack of the Male Group and the Confusion of the 30th Troop

At 9 : 50 on June 1, the male group was discovered at the spot DE, but the 30th troop was not to be seen around there. There seemed to have been a clash between the male group and the 30th troop early in the morning. Some males had a blood stain on the body. The 30th troop seemed to disperse in all directions around the spot J2.

At 12:50 the male group moved to the spot DN and went down the river through the riverine forest, uttering an aggressive sound. At 14:00 the male group made an attack on several troop members between J2 and J1.  $E\varphi$ ,  $B\varphi$  and  $Bj^{(8)}$  ran away toward the Dhonk-halla bridge at the spot J1 along the river. Some members of the male group chased them persistently. The other males attacked  $E\varphi$ ,  $Ej^{(9)}$  and  $Ej$ . The 30th troop was scattered over a range of 500 meters, but the male group did not cease the attack. In the repeated attacks on the 30th troop members between the bridge and the spot J2, the most aggressive of the seven males were  $L\delta$ ,  $M\delta$ , and  $N\delta$ , and the rest were only their followers. Although the attack of the male group led the troop into confusion and dispersion, the leader male did not appear to the last.

$D\varphi$  showed a sign of oestrus on that day, too. At 15 : 48 she came near to the male group, squealing as if she attracted their attention, and began to

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8) & 9)  $Bj$  is a juvenile male of  $B\varphi$ 's and  $Ej$  is a juvenile female 1-3 years old of  $E\varphi$ 's.



present herself to them. No copulation could be observed.

A clash between the male group and the 30th troop continued till the evening in this way. Night came, but the troop remained scattered over a range of 500 meters around the spot J2.

### C. The Third Day: The Disorganization of the 30th Troop

On the morning of June 2, most members of the 30th troop including the leader male  $Z\delta$  remained in the neighborhood of J1, still scattered over a wide range, while the male group stayed on a mango tree to the south-east of J2.

Around 12 : 50  $Z\delta$  began grinding his teeth toward the male group, standing on the tree.

At 13 : 25  $Z\delta$  of the 30th troop started fighting against  $L\delta$  of the male group that came from J2. Staring at each other on the trees at a distance of about five meters, both the langurs threatened each other, repeating teeth-grinding and convulsive threat. A few minutes later  $L\delta$  climbed down the tree and ran up on the other tree.  $Z\delta$  ran away. Chasing him for one or two minutes,  $L\delta$  returned to his tree and repeated threatening gestures. That fight continued until 13:50 when  $Z\delta$  ran away completely towards the north-west across the grassland. All the while the other members of the male group remained quiet in the neighborhood of J2, and the members of the 30th troop dispersed in all directions over a range of 60 -70 meters around J1. They were all watching the fight between the two males.

$L\delta$  approached the females of the 30th troop, producing a low sound <gwé, gwé>. The females ran off, giving a scream, and gradually lost the way back. At last they stopped running and remained still. At 14:28  $L\delta$  uttered an alarm bark <gék> and made an attack on a dog from the tree that came near to the troop on a sudden. After the dog went away,  $L\delta$  occupied the center of the troop, surrounded with the troop members. The other members of the male group were staying at a distance of about 20 meters.

Around 15:30  $L\delta$  and  $M\delta$  started a violent attack on the females, especially on  $H\varphi$  and  $B\varphi$ . Alternating the attack of  $L\delta$  with the counterattack of  $B\varphi$  and other females, they moved in the riverine forest as a whole. Being still in oestrus,  $D\varphi$  approached the males, shuddering her head, and presented herself to them.

At 17:20 the male group crossed the road and went to the south through the riverine forest. The 30th troop members stopped there for a while, but five minutes later the oestrous female, started after the group. The other members followed her at once.

At 17:30 the male group and the 30th troop members reached the spot DS on the south of the home range of the 30th troop. The langurs I observed at that time were all the seven male langurs of the male group and  $A\varphi$ ,  $AI$ ,  $C\varphi$ ,  $CI$ ,  $D\varphi$ ,  $G\varphi$ ,  $Gj$ ,  $H\varphi$ ,  $Hj$ ,  $I\varphi$  and  $Ii$  of the 30th troop, 18 langurs in all.

This group passed the night at the spot DS.  $B♀$  and  $Bi$  remained away from the troop at the spot J1, and the rest members of the 30th troop—the leader male  $Z♂$ , a subadult male, all the infants,  $E♀$ ,  $Ej$ ,  $F♀$ ,  $FI$ —remained scattered around J2.

#### D. The Fourth Day: Separation of the Male Group from the New Troop

On June 3 the male group and a part of the 30th troop that stayed overnight at DS started moving to the north early in the morning. At 9:40 they got to the bridge.  $L♂$  made an attack against the fellows of the male group which led them into confusion. At 9:50 they went to the east along the roadside trees. The participants and the procession order of them are as follows:  $A♀$ ,  $AI$ ,  $H♀$ ,  $C♀$ ,  $Ci$ ,  $D♀$ ,  $Gj$ ,  $Hj$ ,  $G♀$ , and  $L♂$ .

On the other hand, the other six langurs of the male group except  $L♂$  ran to the east across the grass land, but  $I♀$  and  $Ii$  stayed there.

Not only when they started moving, but while moving,  $L♂$  followed after the females, sometimes in the middle and sometimes in the last of the procession. Like the leader male of the ordinary bisexual troop,  $L♂$  made threatening behavior and display jumping<sup>10)</sup> against a dog.

At 11:30 when  $L♂$  and the females reached the spot of 14.5 km together with their infants, the six males of the male group came rushing on them from the spot J2. Giving a low sound <gweee>, the males joined them. Five minutes later  $N♂$ ,  $O♂$ ,  $P♂$ , and  $Q♂$  moved further 150 meters to the south-east, and took a rest on a large tamarind tree. The females tried to go after them. At once  $L♂$  passed the females ahead at full speed and drove them back, giving a violent threatening bark.

At 13:30  $B♀$  and  $BI$  joined this troop that had been at the spot J1 since the previous night. From the morning of that day the rest members of the 30th troop including  $Z♂$  were staying between J2 and DN. Though  $Z♂$  was watching to the south all the time on the top of a tall tree, at 13:40 he began threatening, uttering a voiceless sound <ahát, ahát>. Five minutes later he approached the troop by himself, but stopped 100 meters distant from  $L♂$  and his troop.  $Xj$ ,  $Ej$ ,  $Dj$ , these male juveniles followed him squeaking. Adult and juvenile females remained midway between J2 and DN. On seeing him,  $L♂$  started threatening bark and teeth-grinding at the roadside. At 13:50  $Z♂$  returned to the spot DN together with the juvenile males without coming to grips with  $L♂$ . The rest members of the 30th troop were eight langurs— $Z♂$ ,  $Ej$ ,  $Fj$ ,  $Dj$ ,  $E♀$ ,  $Ej$ ,  $I♀$ , and  $Ii$ . However,  $Y♂$ ,  $Hj$ ,  $Ij$ ,  $F♀$ , and  $FI$  could not be found in either group.

The troop with  $L♂$  as the leader—hereafter it is called the new 30th troop or the new troop—settled down in the neighborhood of 14.5 km. The male group that was on the tamarind tree 150 meters distant came near to the

10) It is a kind of demonstration displayed to a general object (see SUGIYAMA *et al.* 1965).

new troop and remained at a distance of 20-30 meters as if they surrounded it. At 18:50 when it got dark, the male langurs began grinding their teeth. By and by they were driven away by  $L\delta$  toward the south. The new troop moved to 14.3 km. The new troop kept a far distance from the male group.

#### E. The Fifth Day: The Stability of the New Troop and the Beginning of Sexual Activity

On June 4  $G\varphi$  disappeared from the new troop, but  $E\varphi$ ,  $Ej$ ,  $F\varphi$ ,  $FI$ ,  $I\varphi$ , and  $Ii$  joined it instead. All the females and male infants of the 30th troop except  $G\delta$  became members of the new troop. The rest members of the 30th troop and the male group except  $L\delta$  could not be seen at least within the home range of the 30th troop all the day. Accordingly there was no clash between the new troop and them. The new troop moved from 14.4 km to 15 km by 17:30.

At 11:25 the first copulation could be observed between  $L\delta$  and  $D\varphi$  that had come presenting to him. Then  $L\delta$ 's ejaculation was observed.

While resting or feeding himself,  $L\delta$  lay in the middle of the dispersed troop. He made a vocal attack on the dog or the other enemies as well as a troop male usually does. His status as the new leader seemed to have become stable in the new 30th troop, while the females were still very sensitive to any behavior of  $L\delta$ , expressing strain and fear, and sometimes ran away squealing when he approached them. The females and juveniles were rarely observed to be seated or moving within 2 m from  $L\delta$ , or to offer a grooming to him keeping their composure.

#### F. The Seventh Day: Infant Biting of $L\delta$

At 9:20 on June 6 the new troop was found dispersing around a nial tree at the spot of 15.1 km. In the troop was  $G\varphi$  that had been missing since the previous day. Now  $Bi$  disappeared instead.  $B\varphi$ ,  $F\varphi$ ,  $Fj$ ,  $FI$ ,  $I\varphi$ , and  $Ii$  remained 200 meters distant from them between the bridge and J1.  $AI$  had a cut 10 cm long and 2 cm deep on the left buttock. It was so serious a wound that he could not walk for himself. Therefore, he was clinging to the mother. It could be judged from the severe cut that he must have been bitten by an adult langur male with his canines.

$L\delta$  made a severe attack against the mother  $A\varphi$ , and she made a violent counterattack on him, though she had never fought with him before. At the same time,  $L\delta$  made a vocal attack on  $B\varphi$  and the others that deserted him as violently as he did it on the dog, and then he rushed on them.  $L\delta$  drove them back to the south along the riverine forest, and reached the bridge at 14:50. The rest members joined him. There all the adult females, juvenile females, and infants except missing  $Bi$  of the 30th troop gathered together. However, the attack of  $L\delta$  and the squeal of the females continued until sunset.  $D\varphi$  showed a sign of sexual excitement on that day, too.

There occurred no clash between the new troop and the male group, or between the new troop and the ex-leader and juvenile males of the 30th troop.

It was judged from the concentrative attacks of  $L\delta$  on  $A\varphi$  and the severe resistance of  $A\varphi$  that the cut on  $AI$  must have been given by  $L\delta$ . Supposedly  $Bi$  must have been also bitten to death by  $L\delta$  and that  $B\varphi$  and the other females must have left the new troop after offering resistance against him. But the dead body of  $Bi$  could not be found between the spot of 15 km and J1 or in the vicinity.

#### G. The Eighth Day: The Aggression of $Z\delta$ and His Return to the Troop

At 12 : 20 on June 7  $Z\delta$  moved alone to the spot J2 and attacked  $L\delta$ . After a severe fight  $L\delta$  ran away from the troop.  $Z\delta$  returned to the center of the females, and all the troop members gathered on a neem tree. In that fight  $Z\delta$  was bitten by  $L\delta$  on the right side of the head, so that the upper part of his right ear lobe was cut off from the head and hung down. He seemed to be seriously wounded with profuse bleeding.  $L\delta$  received a bite 10-15 cm long on the right fore arm, though not a serious wound. During the fight juvenile females remained quiet, watching the two males. Not a single juvenile male returned to the troop all the while.

Until 13 : 20  $L\delta$  was looking for a chance to approach the troop at a distance of 20 meters from the 30th troop. At last he ran away to the Dhonkhalla bridge without making any resistance against  $Z\delta$ . Although  $Z\delta$  seemed to get excited and tired very much, his return to the troop restored the stability of it and cleared away much confusion. Of course, neither an attack on the females nor infant biting by  $Z\delta$  took place.

#### H. The Ninth Day: The Reaggression of $L\delta$

On the morning of June 8  $L\delta$  came from the direction of DS with the male group of six langurs, and clashed the 30th troop at between J1 and J2. A severe fight broke out between  $L\delta$  and  $Z\delta$ . At 10:00  $Z\delta$  ran away to the direction of DE, and the new troop was reorganized.  $Z\delta$  was followed by  $C\varphi$ ,  $CI$ ,  $F\varphi$ ,  $FI$ ,  $I\varphi$ , and  $Ii$ . The females that remained in the troop with  $L\delta$  and the others were those who had no infant of their own and  $A\varphi$  and  $B\varphi$  whose infants got hurt.

At 10:15 the male group of six langurs was attacked by  $L\delta$ , and driven away to the direction of DN. The females followed them. Therefore,  $L\delta$  went after the females.

Around 15:00  $L\delta$  began to show threatening gestures including teeth-grinding to the other males. At first he directed threat towards indefinite males, but around 16:00 he came to concentrate his aggression on  $M\delta$  and  $N\delta$ . At 16:36  $N\delta$  was driven away by  $L\delta$  and moved to a tree 30 meters distant from the others. Though  $D\varphi$  got sexually excited on that day, too,  $L\delta$  took no interest in her.

#### I. The Tenth Day: An Attack on the New Troop of the Six-Male Group

At 9:30 on June 9, the new troop was found on a fig tree at the spot J2

and the male group of six langurs on a nial tree at a distance of about 50 m. They were almost at the same places where they spent the previous night.

At 10:20 as soon as  $H^{\text{♀}}$  moved toward the nial tree, the other females followed her.  $L^{\text{♂}}$  which chased them clashed against the male group. It was driven away in a moment and ran away across the Dhonk-halla river. The new troop moved along the riverine forest toward J1. While they were traveling,  $F^{\text{♀}}$ ,  $FI$ ,  $C^{\text{♀}}$ , and  $CI$  joined them. By the time the new troop got to the bridge, all the females and the infants except  $I^{\text{♀}}$  and  $Ii$  had entered the new troop. The attack of  $L^{\text{♂}}$  on the females gradually decreased, and they ceased from running away with scream even if  $L^{\text{♂}}$  approached them.

#### J. The Eleventh Day: Retaliation of $Z^{\text{♂}}$

On the morning of June 10 the new troop was moving to the north along the riverine forest. At 9:30 when it reached the spot J1, the new troop encountered  $Z^{\text{♂}}$  that came alone near the troop to attack it. A severe fight broke out between  $L^{\text{♂}}$  and  $Z^{\text{♂}}$ . The adult females and juveniles of the new troop went on moving and got to the spot J2 at 10:00. The fight between them continued until 10:15 when  $L^{\text{♂}}$  started for J2 to join the females.  $Z^{\text{♂}}$  was left alone at J1. There were all the females and the infants of the 30th troop including  $I^{\text{♀}}$  and  $Ii$  in the new troop at J2 (except  $Bi$  that was supposed to have been killed).

At 11:00  $Z^{\text{♂}}$  came near to J2 from J1 step by step. He and  $L^{\text{♂}}$  began to threaten each other, grinding their teeth. Two minutes later they started biting each other on a tree.  $L^{\text{♂}}$  bit  $Z^{\text{♂}}$  on the calf of the right hind leg, namely, the same part that he had given the serious wound before. He swung his head biting the calf. They fell from the tree and parted.  $Z^{\text{♂}}$  ran away. He seemed to be tired from excessive bleeding.  $Z^{\text{♂}}$  came back and clashed against  $L^{\text{♂}}$  at 11:09 again. After a grappling,  $Z^{\text{♂}}$  ran away to the north. He joined the juvenile males— $Y^{\text{♂}}$ ,  $X^{\text{♂}}$ ,  $F^{\text{♂}}$ ,  $I^{\text{♂}}$ ,  $B^{\text{♂}}$  and  $D^{\text{♂}}$ —between J2 and DN. The juvenile males made a vocal attack against  $L^{\text{♂}}$ , uttering <chii...> in high pitch.

At 11:35  $L^{\text{♂}}$  rushed on the group of  $Z^{\text{♂}}$  and the juvenile males, and drove them away. The group was then about 100 meters apart from the new troop at J2, at a distance of which it was yet possible for all the members of the group and the troop to discern one another from either side. Not only  $I^{\text{♀}}$ ,  $F^{\text{♀}}$ ,  $B^{\text{♀}}$  but  $D^{\text{♀}}$  that got separated from her one-year-old infant  $D^{\text{♂}}$  did not try to approach and help their sons. The juvenile males did not move toward their mothers, either.  $D^{\text{♂}}$  retreated to DN together with  $Z^{\text{♂}}$  and the other juvenile males.

Though  $Z^{\text{♂}}$  ran away beyond the home range of the 30th troop, the juvenile males remained at DN. Then  $L^{\text{♂}}$  attacked and bit them that ran from place to place to escape from him. At last he drove them away. The new troop consisted of all the females and infants of the old 30th troop.

K. The Twelfth and the Thirteenth Day: The Abandonment of Infants and the Oestrus of Mothers

On June 11  $Z\delta$  and the juvenile males left to the north, and the male group left to the south. The new troop peacefully passed the day on the roadside without a clash.

At 15 : 50 when the new troop began moving,  $A\delta$  started alone leaving her  $AI$  behind on a tree.  $AI$  hesitated to go through the open land together with the troop members, because he could not behave so actively and freely as the others owing to the wound. Although  $AI$  whined <hyii, hyii> in high pitch for a while, the new troop went forward without paying any attention to him. By and by he climbed down the tree and chased the troop and the mother limpingly at full speed as if he rolled on the ground. Though the mother  $A\varphi$  could hear her infant crying, she did not go back to take the infant in her arms nor to walk side by side with him.

At 9 : 30 on June 12 when the troop was found on the roadside 50 meters distant from the place where the troop had been in the previous evening,  $AI$  had already disappeared from the troop. Having sought for him thoroughly in the vicinity,  $AI$  could not be found whether dead or alive. He had no ability yet to lead a solitary life independently of the mother, because he was only 7.5 months of age. Simultaneously with the disappearance of  $AI$ ,  $A\varphi$  began to show a sign of oestrus, presenting and shuddering her head always beside  $L\delta$ .  $B\varphi$  also showed a sign of oestrus in the afternoon.

As  $L\delta$  got a stable position in the new troop, he hardly attacked the females. Accordingly they became fearless of the male.

For forty minutes from 16:00,  $Z\delta$  and the juvenile males of the 30th troop that had come down the riverine forest to the south from the north kept on watching toward the new troop from J1. Sometimes  $Z\delta$  made a vocal threat, but they at last left toward DN by way of J2. There was no clash between the new troop and them.

At 17 : 45 the new troop moved to the east along the road. When the troop got to 14.5 km, the leader male of troop E rushed on it that had a home range to the north-east of 13.5 km along the road. Instantly the leader male came into the new troop,  $L\delta$  moved back away from the troop. The leader male of troop E threatened him at the center of the females for about two minutes, and withdrew from the troop quietly.

L. The Fourteenth and the Fifteenth Day: The Last Attack of the Male Group

On June 13 the status of  $L\delta$  became stable in the new troop, and he took the lead in the movement of the troop on most occasions. At 11:00 all the members of the new troop moved more than fifty meters except  $L\delta$  and the oestrous  $A\varphi$  and  $B\varphi$  beside him. But the troop stopped because he did not join them.

A copulation could be observed between  $L\delta$  and  $B\varphi$ . He ejaculated. After 16:50 a part of the male group could be seen at J2, but there was no clash against the new troop.

At 11:00 on June 14 the new troop reached J2. The male group was near the bridge.  $M\delta$  advanced to J1 all alone, and exchanged an aggressive threat with  $L\delta$ . At 13:30  $L\delta$  approached  $M\delta$  and came to J1. After prolonged exchange of an aggressive threat  $L\delta$  and  $M\delta$  started a fight.  $M\delta$  retreated to the bridge after a violent grappling and biting each other, and joined the male group. They went away down the Bedati-halla river to the south.  $L\delta$  returned to J1. The new troop moved slowly to the bridge till the evening came.

The male group and  $Z\delta$ , the ex-leader of the 30th troop, completely ceased from resistance against the new troop on June 14. They could never be observed to enter the home range of the 30th troop since then. The male group, now six male langurs, returned to the home range of the 31st troop after that. On the other hand,  $Z\delta$  and his six juvenile males formed another male group to the north of the old home range after they had been driven out of the 30th troop.

The contact of the new troop with adjacent troops could be observed three times. But generally the home ranges of the troops hardly overlapped each other and there was not so rigid territoriality as seen in the densely populated habitat in the vicinity of 21 km that was shown in the 2nd report (SUGIYAMA *et al.* 1965). Therefore, these adjacent troops had hardly a direct effect on the formation of the new troop. Figure 5 is the schema of the social change of the 30th troop that began on May 31, 1962.

#### M. Infant Biting and Sexual Activity

The females showed a sign of oestrus one by one since. Some of them succeeded in copulations with  $L\delta$ . All the infants and one juvenile female in the troop were bitten by him in turn like  $AI$  and  $Bi$ . Their mothers got sexually excited after they had abandoned their children. These phenomena are all shown in Table 3.

The oestrous females were judged by the characteristic behavior such as presenting and head-shuddering, not to speak of their dangling after the male. There were not many which showed a sign of oestrus from July to the middle of September. This period being the rainy season, the daily activities of langurs became dull and the sexual activity also could be little observed.

As is shown in the Table 3, the mothers of  $Bi$ ,  $AI$ ,  $FI$ , and  $Ii$  grew sexually excited within ten days after these infants had been bitten by  $L\delta$  and disappeared from the troop.

$FI$ ,  $CI$ , and  $Fj$  had been very active and in good health until the day before an incident happened as in the case of  $Bi$ . However, they had already disappeared from the troop when the incident was recognized. Though their dead

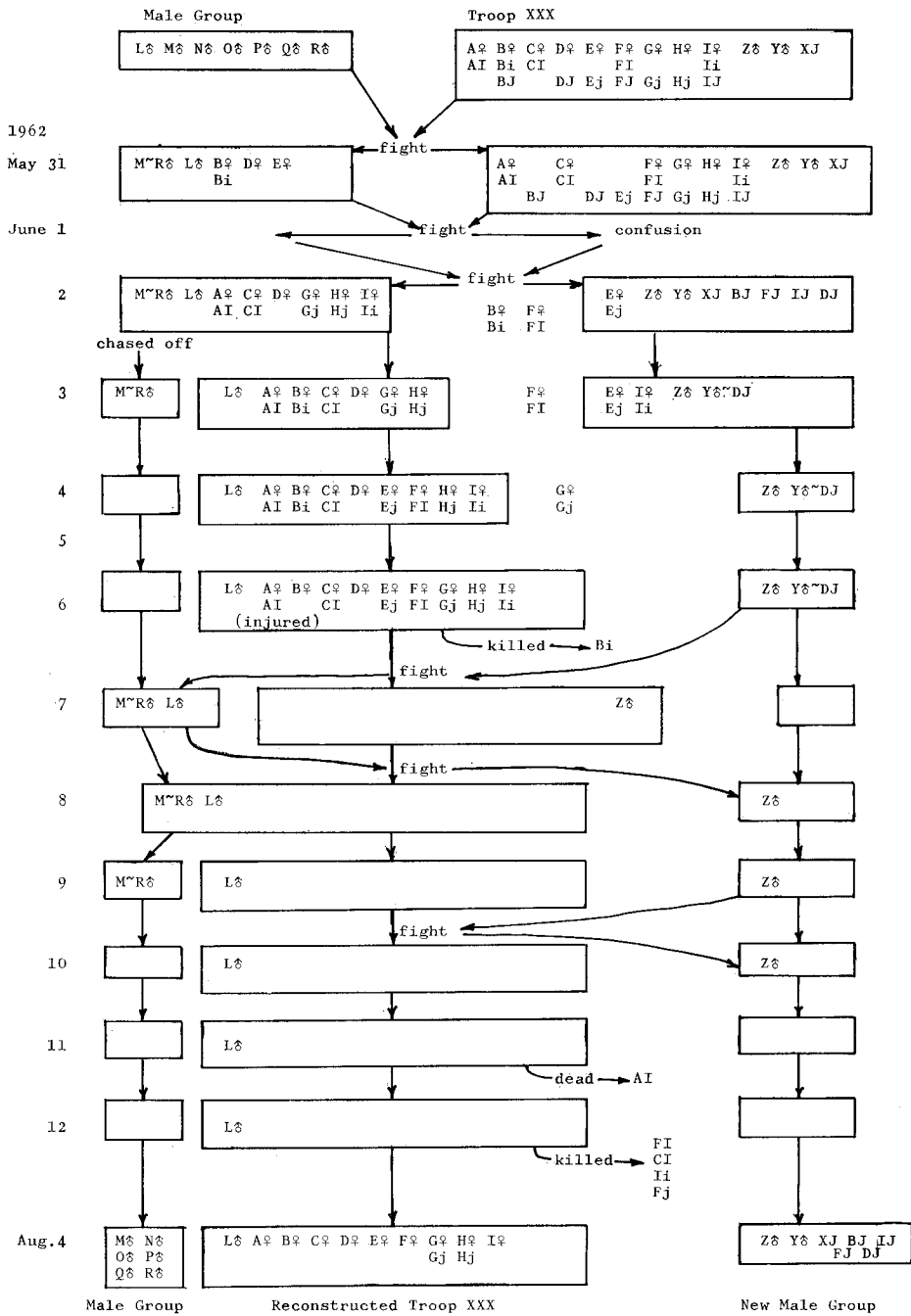


Fig. 5 Schema of the social change of the 30th troop.



**Table 3** Oestrus of mother and child missing. Oestrous time of the female shows only the period which is recognized by the fervent presenting behavior with shuddering. Bracketed occasions show the observation of only light presenting. Plus mark shows the recognition of copulation (COP.) and seminal emission of the male (S.E.).

| Female       | Oestrous time   | COP. | S. E. | child     | bitten       | missed       |
|--------------|-----------------|------|-------|-----------|--------------|--------------|
| <i>D</i> ♀   | May 31 ~ Jun. 8 | +    | +     | none      |              |              |
| <i>A</i> ♀   | Jun. 12 ~ 16    |      |       | <i>AI</i> | Jun. 6       | Jun. 11      |
| <i>B</i> ♀   | Jun. 12 ~ 13    | +    | +     | <i>Bi</i> | Jun. 6       | Jun. 6       |
| ( <i>E</i> ♀ | Jun. 23 ~ )     |      |       | none      |              |              |
| <i>F</i> ♀   | Jun. 23 ~ 25    |      |       | <i>FI</i> | Jun. 17~18   | Jun. 17~18   |
| <i>H</i> ♀   | Jun. 25 ~ 29    | +    | +     | <i>Hj</i> |              |              |
| ( <i>H</i> ♀ | Jun. 19 ~ 25)   |      |       |           |              |              |
| <i>I</i> ♀   | Jun. 14 ~ 25    |      |       | <i>Ii</i> | Jul. 5       | Jul. 6~8     |
| ( <i>B</i> ♀ | Aug. 8 )        | +    | +     |           |              |              |
| <i>E</i> ♀   | Sep. 6 ~        |      |       | <i>Ej</i> | Aug. 4       | Aug. 4       |
| <i>B</i> ♀   | Sep. 23 ~ 28    | +    | +     |           |              |              |
| <i>G</i> ♀   | Sep. 24 ~ 29    | +    | +     | <i>Gj</i> |              |              |
| <i>A</i> ♀   | Sep. 24 ~ 29    | +    |       |           |              |              |
| <i>I</i> ♀   | Sep. 24 ~ 29    |      |       |           |              |              |
| <i>F</i> ♀   | Sep. 24 ~       |      |       |           |              |              |
| <i>H</i> ♀   | Sep. 24 ~ 29    |      |       |           |              |              |
| <i>C</i> ♀   | Sep. 24 ~ 28    |      |       | <i>CI</i> | Jun.29~Jul.2 | Jun.29~Jul.2 |
| <i>E</i> ♀   | Sep. 25 ~ 29    |      |       |           |              |              |
| <i>D</i> ♀   | Sep. 25 ~ 27    |      |       |           |              |              |

bodies were thoroughly sought, none of them could be found out. The attack of *L* ♂ on the mothers who lost their infants and their resistance to the male could be observed. The following is the case of *E* ♀.

*Example 1.*

On August 4, 1963 *L* ♂ was in excitement from the morning, and made a severe attack on *E* ♀. At 9:30 when the troop was found, *Ej* had already disappeared from it, and the mother *E* ♀ had a slight wound 5 cm long on the left upper arm. As *L* ♂ kept on attacking *E* ♀ all day long, she moved at a distance of 10-30 m from the other members of the troop to keep clear of him. This state continued for several days. At last on August 9 she came to move separately from the troop. On August 10, she returned to the troop, and the relationship between *L* ♂ and her recovered a normal state by degrees after that.

In the case of *Ii* the following process was observed: an attack of *L* ♂ on *Ii*, the infant's serious wound, her disappearance from the troop, and the mother's oestrus.

*Example 2.*

On July 3, 1962 it was found in the morning that *CI* disappeared from the troop.  $L\delta$  had been attacking the rest infants very severely for several days. He ceased from hard offence for a while in the morning but resumed it around 15:00. The females in confusion fled this way or that to make their escape and dispersed in a wide range.  $L\delta$ 's attack was concentrated on  $I\varphi$  with *Ii* in her bosom. As  $I\varphi$  who took her infant in her arms could not run fast,  $L\delta$  caught up with her in a moment. Every time he tried to catch her,  $I\varphi$  made a severe counterattack on him, giving a violent cry <gyaaa...>. However,  $L\delta$  touched her haunch with his hands two times, but she narrowly escaped from him.

On July 4  $L\delta$  resumed his attack on  $I\varphi$ . At 15:30  $L\delta$  at last caught her from behind, and bit the buttock of *Ii* stuck out from between her thighs.  $I\varphi$  tried to run away, giving a noisy cry <gyaaa...>, while *Ii* clung to the mother tightly without uttering a scream. All the while the other females surrounded him uttering a noisy cry to divert his attack on her. About 20 seconds later  $L\delta$  parted from her, and  $I\varphi$  ran away with her infant *Ii* in the arms.

At 9 : 30 on July 5, it was recognized that *Ii* had been bitten on tail root by  $L\delta$ . The muscle of the tail seemed to have been cut, for it was dangling on the buttock. Though *Ii* was walking slowly on a tree, her jumping could never be seen. She seemed to be considerably enfeebled by the wound. The mother had no wound on her body.  $L\delta$ 's attack was continued, though not so severely as before.

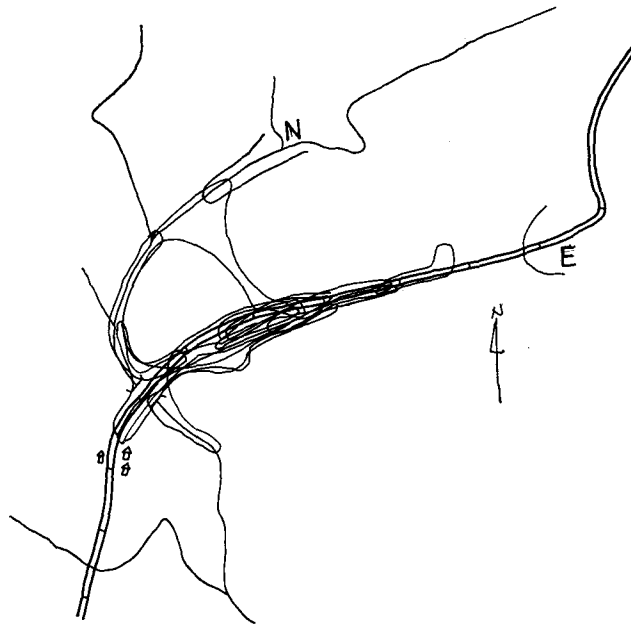
*Ii* had left the troop by the next observation day, July 9. Ten days later, namely, on July 18 the mother  $I\varphi$  showed a sign of oestrus.

In a series of incidents that happened on May 31, the wounds the adult females were given by  $L\delta$  were a slight scratch of  $B\varphi$  on the first day and a slight cut of  $E\varphi$  that was inflicted on her when she lost her infant *Ej*. The other seven adult females did not get even a scratch, though four adult females of them had their infants injured by  $L\delta$ .

### III. THE SOCIAL LIFE OF THE NEW TROOP

#### A. Home Range

The new leader male of the new troop did nothing but to follow the other members on the occasion of movement in the early stage of the troop life after the social organization had been changed by a series of incidents, but later on he came to lead a procession by himself. However, the home range of the new troop was that of the 30th troop as before. The new troop did not expand another new range in the least. Figure 6 shows the traces of the new troop for 25 days during a period to August 10 from June 11 when a change of the social organization came to an end and a new stable period began. The new troop succeeded to the home range of the 30th troop with the road as an axis. The new leader,  $L\delta$  never attempted to advance into the roadside and the vicinity between 15.2 and 16 km that had been the center of his movement in the time of the male group.



**Fig. 6** Movement of the reconstructed troop. Trace of the daily movement of new 30th troop; 25 days from June 11 to August 10, 1962.

**Table 4** List of infants born during late 1962 — early 1963

| Mother       | Sex of new baby | Estimated birth month  |
|--------------|-----------------|------------------------|
| A ♀          |                 |                        |
| B ♀          | ♀               | late Dec. ~ mid Jan.   |
| C ♀          | ♀               | mid Jan. ~ early Feb.  |
| D ♀          | ♀               | late Jan. ~ mid Feb.   |
| E ♀          | ♂               | late Dec. ~ mid Jan.   |
| F ♀          | ♂               | late Jan. ~ mid Feb.   |
| G ♀          |                 |                        |
| H ♀          | ♀               | late Jan. ~ mid Feb.   |
| I ♀          | ♀               | early Jan. ~ late Jan. |
| <i>total</i> | ♂ 2 + ♀ 5 = 7   |                        |

**B. Social Behavior**

No remarkable change could be observed in the social behavior of the new troop members except a decrease of juveniles' playing time after a change of the leader male. It is said that playing time increases proportionately with the number of playfellows (SUGIYAMA 1965). Therefore it is natural that playing time should decrease in the new troop that contains only *Gj* and *Hj* as juveniles.

$G\text{♀}$  disappeared from the troop between December 20, 1962 and March 13, 1963, the reason of which is unknown.

### C. Delivery of the Next Season

As  $G\text{♀}$  had already left the troop, it is unknown whether she gave birth to an infant. Seven out of the other eight adult females were concentrically delivered of their infants during two months from the end of December, 1962 to the middle of February, 1963. Table 4 shows the newborn infants and their estimated birthdays confirmed on March 14, 1963. Supposing the period of their fertilization was June and July, the first half of the period when their sexual activity suddenly heightened (see Tab. 3), the duration of their pregnancy would be for six to seven months. This does not contradict Hill's data (1936-37).

## IV. A SUMMARY OF INCIDENTS AND THE PROBLEMS TO BE DISCUSSED

Now the incidents in the 30th troop are to be summarized and I am going to arrange the problems to be treated before a discussion is begun about them.

### A. Summary

Though there was no overlapping part between the moving range of the seven-male group and the home range of the 30th troop, the male group suddenly invaded the home range of it on May 31, 1962. It made an attack on the leader male  $Z\text{♂}$  and inflicted a severe wound on him. Though the male group went far off from the troop for a time, three adult females followed the group taking an infant with them.

On the following day, June 1, the male group made a severe attack on the 30th troop again and led it into utter confusion. The attack was daily repeated. Most of the females deserted  $Z\text{♂}$  and followed after the male group. Six subadult and juvenile males of the 30th troop were all attacked and driven away from the troop by  $L\text{♂}$  and other male langurs. Therefore, they went away with  $Z\text{♂}$  from the troop.  $L\text{♂}$ , the most aggressive male in the repeated attacks on the troop on June 2 and 3 expelled the other six fellows of the male group from the 30th troop. They had taken by force. Consequently three new groups were formed: the new troop with  $L\text{♂}$  as the leader; the male group of now six male langurs; and another new male group comprising  $Z\text{♂}$  and other males driven away from the 30th troop.

On June 7  $Z\text{♂}$  made a counterattack against the new troop of  $L\text{♂}$ . He overpowered  $L\text{♂}$  and recaptured the troop. But the next day he was expelled again by  $L\text{♂}$ . On June 10  $Z\text{♂}$  tried the last attack on  $L\text{♂}$  only to fail, and completely disappeared from the home range of the 30th troop.

On June 8 when  $L\text{♂}$  returned to the new troop, the male group of six langurs joined the troop together with him. On that day they were driven

out of the troop.  $M\delta$  and  $N\delta$  of the male group that had been active aggressors after  $L\delta$  in the first attack showed persistent resistance to  $L\delta$ . However, they could not successfully join the new troop. At last the male group but  $L\delta$  returned to its moving range.

Among the females that followed  $L\delta$ ,  $D\varphi$  that had no infant of her own began to show a sign of oestrus just after the first attack, and succeeded in a copulation with  $L\delta$  for the first time on June 4.

On June 6,  $L\delta$  bit two infants and inflicted the wound on them. One infant disappeared from the troop immediately after that. The other one left the troop on June 11. The mother grew sexually excited on the following day, June 12. The rest three infants and one juvenile female one year old were bitten by  $L\delta$  one by one. They had left the troop by August 4. All the adult females including these mother langurs showed a sign of oestrus by the end of September, and most of them were observed to copulate with  $L\delta$ .

The members of the new troop did not readily obey  $L\delta$  at first, but gradually his status as the leader became secure with the oestrus of females and the height of sexual activity as a turning period. The new troop came to take united action as a stable troop. It inherited the whole home range of the 30th troop.

Instead of 24 langurs in the old 30th troop [one adult male, three males of 3-4 years old, three males of 1-2 years old, nine adult females, three females of one year old and five infants], the social composition of the new troop consisted of 12 langurs [one adult male, nine adult females, and two females of one year old]. The social organization of the old 30th troop that had nearly developed into a multi-male-troop was rejuvenated as a one-male-troop without having juvenile males or infant males.

## B. The Problems at Issue

Now I must make clear the relationship between the bisexual troop and the male group that has been repeatedly discussed in a series of reports. An elucidation of the relationship between them is nothing but to make clear the mechanism that enables langurs to maintain the social organization of 'one-male-troop.' Many novel phenomena shown in the social change are parts of the mechanism to maintain the social organization of 'one-male-troop,' and they have close relation to it; an attack of the male group against the bisexual troop, the exclusion of all the male langurs from the troop by the new leader male, infant biting, the desertion of injured infants by their mothers, and so on.

What factor has an effect on the rejuvenating processes of the social organization, and what prevents a troop from developing into a multi-male-troop? Is it related to local differences in the social organization? These problems should be analyzed and examined to foster a better understanding of the social organization of primates.

## V. DISCUSSION

### A. A Mechanism to Maintain the Social Organization of One-Male-Troop

As was already reported (SUGIYAMA 1964), two different types of langur troops could be observed in a field study of 44 groups living in the vicinity of the Dharwar-Haliyal road in the early stages of our survey for a period of two years. Thirty-eight of the 44 groups were bisexual troops including both males and females, and the rest were male groups including only male langurs. As 28 out of the 38 bisexual troops had only one full grown adult male in each troop, it was supposed that the male langurs born and brought up in a troop might move from the troop into a male group through some process.

As stated in chapter 3 of the above-mentioned report (SUGIYAMA 1964), fragmental observations of langur troops in the early stage of this project suggested to us that in order to maintain a characteristic social organization, that is, 'one-male-troop,' the troop must go through a severe conflict with the male group and a sudden social change. It was thought necessary to make clear the actual process of it so as to understand the social organization of hanuman langur completely and deeply.

As SUGIYAMA *et al.* (1965) reported, a conflict between adjacent troops is not so severe. It is nothing but a kind of demonstration. The troop male shows extreme aggressiveness against the male group and expels it very nervously. As far as observations in the above-mentioned report are concerned, the male group did not offer any resistance against the troop male at any time, and as was already stated in this report, even the seven-male-group that attacked the 30th troop ran away without offering any resistance when it encountered the 31st troop, though their moving range and home range usually overlapped. However, the case of the 30th troop shows that once the male group begins attacking the troop actively, the troop male gets into a serious crisis. This is the reason that the troop male nervously attacks and expels the male group, though it is always running away without offering any resistance to the troop male.

Moreover, this case reveals that a new male group is composed of the male langurs driven out of their troop by the new leader.

Before the incident of the 30th troop was observed, some suppositions had been made about the cause of the phenomenon that most troops have only one full-grown adult male and that as stated by SUGIYAMA *et al.* (1965), they have very few juvenile and subadult males. The first supposition we made was what I have substantiated in this paper: the exclusion of the male langurs including juveniles from the bisexual troop is caused by the severe attack of the male group; one male langur of the male group deprives the troop male of his status; the males driven out of the troop form a new male group; thus the

repeated attacks of the male group help the troop to maintain the one-male-troop pattern.

The second supposition was the arbitrary desertion of the troop life by the male langurs. Many cases of solitarization have been known to us of the natural troops of Japanese monkeys. If a Japanese monkey becomes a solitary, it is not only because the monkey is driven out of the troop by the attack of the other troop members, but also because the monkey deserts the troop life by himself in many cases (MIZUHARA 1957; IMANISHI 1961; ITANI *et al.* 1963). In the preliminary stages of solitarization a male Japanese monkey moves into the peripheral part from the center of the troop, while in the case of male langurs these phenomena including the arbitrary desertion of the troop life could never be seen (SUGIYAMA 1965). Even if these phenomena occurred in langurs, they would be rare cases.

The third supposition was the secession of males from the troop because of antagonism between the leader male and them. The fact is, however, that even subadult males hardly existed in the troop. Moreover, in each troop there was little antagonism, for example, between the leader and the 2nd, the 3rd ♂ of the 1st troop (young adults of 5-6 years old), or the 2nd ♂ of the 5th troop (about 5 years old), or *Y*♂, *XJ*, *BJ*, of the 30th troop. Especially the 2nd and the 3rd ♂ of the 1st troop attained to maturity during the period of our survey, and they were observed to copulate with adult females of the troop. But no antagonism was engendered between the leader and them. Moreover, they always lived in the center of the troop with other members, and instead of the leader, they made such a display and threatening behavior as the leader usually does on the occasion of a contact with an adjacent troop or other enemies (to be reported by KAWAMURA concerning the social organization of the 1st troop). Various kinds of play and a friendly relationship between the leader male and juvenile or subadult males of the 30th troop were already stated (SUGIYAMA 1965, chapter 2-F). The relationship between the 2nd ♂ and the leader male of the 5th troop was also a friendly one (YOSHIBA, in preparation). Therefore, it is hardly possible to infer from these facts that male langurs in Dharwar leave the troop because of antagonism between the leader male and them.

Now in conclusion, the phenomenon that there is only one full-grown adult male among the members of the bisexual langur troop and that even juvenile and subadult males are hardly included among them may result from the fact that the male group sweeps away all the males from the troop by a severe and direct attack. According to my observation on June 10, the juvenile males of the 30th troop showed a slight inclination to leave the troop of their own free will, following the ex-leader, but clearly the leader of the new troop tried to expel them from the troop by a severe attack on them.

CARPENTER (1940) says that the troop of gibbons consists of a few members; one male, one female, and one or two infants, and that when their infants grow

up, they are driven out of the troop, if they are young males, by the adult male, and if young females, by the adult female of the troop, because of their jealousy or competitive activity against their children

IMANISHI (1961) is sceptical of the phenomenon itself that the expulsion of children from the troop is caused by the jealousy or the competitive activity of their parents against them, for such a fact cannot be found in the recent abundant data of the social life of nonhuman primates.

The society of hanuman langurs in Dharwar I surveyed is of 'one-male-troop' with only one adult male in it, and the desertion of the males from the troop is caused by an attack from the outside of the troop in all cases.

There are many species of monkey that compose 'one-male-troop' or a similar social organization. Though few studies have been made to make clear why the other males except the predominant one do not exist in the troop, presumably in many cases it is owing to the expulsion of males from the troop by the attack of outside males as is often the case with langurs, or to the secession of males from the troop by themselves as seen in many examples of the solitarization of Japanese monkeys.

#### B. The Frequency of Social Changes and the Period of the Leader's Reign

If the above-mentioned conclusion is generalized, another new hypothesis becomes possible. Suppose some adult male became the new leader of a troop after expelling all the males and got his own infant six months later. It follows that the period of his reign as the new leader in the troop is now equal to the age of his eldest son plus six months, the period of pregnancy.

For example, except one leader male, the leaders of the 2nd, the 4th, the 6th, and the 8th troop that had no other males than infants under one year of age in their troops as of May, 1962 (SUGIYAMA *et al.* 1965) may be thought to have become the leaders by force probably about one year before. Furthermore, it may be presumed that the leader of the 30th troop that had a four-year-old male as the eldest in the troop swayed the troop for the past four years and a half, and that the leader of the 1st troop including a six-year-old male as of March, 1963, did so for the past six years and a half.

Of course, there may be some exceptions that the infants born in the first year of the new leader's rule are all females, or that all the males have been driven out, though infants have not been bitten to death as in a social change of the 7th troop. But it may be possible to estimate roughly the duration of a career as the leader of his present troop.

The langur troops into which we carried on a close investigation for more than one year are the 1st, the 2nd, the 3rd, the 4th, the 6th, the 7th and the 8th that have already been reported by SUGIYAMA *et al.* (1965) and the 5th and the 30th troop, that is, nine in all. Social changes similar to the incident of the 30th troop occurred in four troops of them from April, 1962 to



March, 1963 except an artificial social change for experiment in the 2nd troop and chain-reacting ones in nearby troops (SUGIYAMA 1966).

After the incident of the 30th troop as the first case, another new troop was formed in July, 1962 as a result of an attack of a male group against the 5th troop and its nearby troops (YOSHIBA, in preparation). In October, 1962 a part of the male group that failed to become the members of that new troop attacked the 7th troop and expelled the leader male from it (SUGIYAMA and YOSHIBA, in preparation). Moreover, the males that could not enter the 7th troop made another attack on the 1st troop, and the leader male disappeared from the troop together with two young adult males in March, 1963 (KAWAMURA, to be reported).

In short, social changes occurred in four out of nine troops in the course of one year, that is, at the rate of two years and one or two months a troop. However, when the 1st, the 5th, and the 30th troop were chosen as the objects of a close investigation, the large-sized troop that comprizes langurs of various ages was taken into account. Consequently we had to select these troops that were liable to a social change.

Table 5 shows the estimated period of the leader's reign in the above-mentioned nine troops ending with the rejuvenescence of the social organization caused by a social change. In the other troops that did not undergo any social change, the period is until March, 1963 when the whole survey was over.

According to the Table 5, the period of the leader's reign is for about three years on the average. But in the case of the leader of the 2nd troop, it came to an end in a year owing to an artificial social change (SUGIYAMA 1966). The leaders of the 3rd, the 4th, the 5th, the 6th, and the 8th troop were still dominating over their troops when our survey was over, so that the average period of the leader's reign may be much longer than three years.

4.5-5 years is the average period of the leader's reign in the four troops that underwent a social change caused by an attack of the male group. It follows that the more highly developed troop it is, the more social crises it has been exposed to. In short, it is very hard for a male to remain in the troop where he was born until he has attained full maturity.

The social changes observed during three months from June to September, 1961 in the roadside survey stated in the 1st report (SUGIYAMA 1964) were the case of the 34th troop (Chapter 3-B), the case of the division of the 40th troop (Chapter 3-C), and the case of the 39th troop (Chapter 3-D) in the report. As the number of the observed bisexual troops was thirty-eight, it follows that a social change occurred three years or three years and one month a troop, though there may have been some changes that escaped my observation. In conclusion, the frequency of social changes, that is, the period of the leader male's reign in one and the same troop may be supposed to be 4.5-5 years per troop. In this way, most troops have undergone the rejuvenation of social organiza-

**Table 5** The reigning period of the troop leader

| Troop No. | Oldest age of ♂ except leader | Period of reign. (yrs.) | Time of social change | Time reigning period calculated. | Remarks   |
|-----------|-------------------------------|-------------------------|-----------------------|----------------------------------|---|
| 1st Tr.   | ca. 6                         | ca. 6.5                 | Mar. 1963             | Mar. 1963                        | KAWAMURA  |
| 2 Tr.     | 0.5                           | 1                       | Jun. 1962             | Jun. 1962                        | artificial social change<br>SUGIYAMA (1965)   |
| 3 Tr.     | 2                             | 2.5*                    |                       | Mar. 1963                        | KAWAMURA  |
| 4 Tr.     | 1                             | 1.5*                    |                       | Mar. 1963                        | PARTHASARATHY   |
| 5 Tr.     | Ca. 5                         | ca. 5.5*                | Jul. 1962             | Mar. 1963                        | leader lost some ♀ and a part of home range but did not lose his status<br>YOSHIBA (1965) |
| 6 Tr.     | 1                             | 1.5*                    |                       | Mar. 1963                        | SUGIYAMA <i>et al.</i> (1965)   |
| 7 Tr.     | 0.5~1                         | 1~1.5                   | Oct. 1962             | Oct. 1962                        | infants were not killed by the new leader<br>SUGIYAMA <i>et al.</i> (1965)                |
| 8 Tr.     | 1                             | 1.5*                    |                       | Mar. 1963                        | SUGIYAMA <i>et al.</i>  |
| 30 Tr.    | Ca. 4                         | ca. 4.5                 | May. 1962             | May. 1962                        | SUGIYAMA  |
| Mean      |                               |                         |                       | ca. 3                            |   |

The leaders with \* marks were still reigning their troop in March, 1963.

tion owing to an attack of the male group before they develop into a multi-male-troop including more than one adult males. Thus the troops can maintain the organization of 'one-male-troop.'

If no other kind of social change than the above-mentioned ones took place, a large-sized one-male-troop could be formed including twenty or thirty adult females. The fact is, according to my survey in Dharwar the largest number of adult females in one troop was fourteen.

Such a kind of social change as seen in the 5th troop may bring about the rejuvenescence of social organization before the extreme increase of adult females in one troop. For example, in July, 1962 when a male group attacked the 5th troop, the leader of the troop ran away without offering any resistance against the group, and then some adult females followed the male group. Consequently the 5th troop became of a small size, and another new troop was formed in the neighborhood (YOSHIBA, in preparation).

### C. Local Differences in the Social Organization and the Population Density of Hanuman Langurs

It has already been stated in the 1st report (SUGIYAMA 1964) that among 19 groups of hanuman langurs observed by us in a short survey near Raipur in central India, there were 16 troops of which 7 troops had more than one full-grown adult males, and that the troop size was 29.1 animals including 2.8 adult males on average.

Though it was left undiscussed in the same report how the langur troops in Dharwar and Jaipur in north India (PRAKASH 1962) with one-male-troop as a normal type differ from those in other districts in the social organization, if there were few male groups and few social changes of such a kind as stated in this report, a large-sized troop with more than one adult males in it like the 1st troop would inevitably increase in number. JAY who made an intensive survey into langurs near Raipur has not reported yet such social changes as those observed by us. The fact that nine out of the sixteen troops we observed near Raipur were one-male-troops suggests to us that there is no basic difference in the social organization between hanuman langurs in Dharwar and those near Raipur.

But what causes local differences remains unsettled. It was reported by SUGIYAMA (1964) and by SUGIYAMA *et al.* (1965) on the basis of a close investigation that the population density of hanuman langurs in the forest part of Dharwar is from 85 to 135 animals/km<sup>2</sup>. We have not a right and satisfactory standard to judge whether this population density is either best fit or too high for the life of langurs and for the maintenance of their normal social relationship. Moreover, we have no other correct data of it worthy of comparison. But the forest in Dharwar made an impression on us that it has too large a population, partly because all the part of it is occupied by langur troops at the rate of 500 meters a troop, though their home ranges overlap one another, and

partly because male groups are compelled to live and move either in the home ranges of the bisexual troops only in their absence, or in the parkland of low ecological value where no troop lives.

This high population density may force the male groups to live in bad environmental conditions and cause them to attack the bisexual troops more actively and more frequently than in other districts. Consequently frequent troop-reorganizations compel most langur troops to keep their one-male-troop within the limit of about sixteen members and prevent them from developing into large-sized multi-male-troops. In other words, with an increase of male group members, the attacks of the male group against the bisexual troop will be more and more frequent.

On the contrary, if the males driven out of the troop in less populated area can live peacefully without an attack of the troop male in a land that provides abundant food and easily accessible safety from a possible enemy, the frequency of social changes will decrease.

The fact that the troops of hanuman langurs near Raipur in central India and in Ceylon (RIPLEY, in press) are larger in size than those in Dharwar and that there are more multi-male-troops and fewer males in the male group seems to have relation to the low population density of hanuman langurs. Though JAY (1963) says that there exist some male langurs not belonging to any troop, she does not refer to the number of them. It is possible to think that the high population density in Dharwar makes the troop males and the males of the male group unfriendly and that it makes the one-male-troop pattern more prevalent than in other districts.

#### D. Relationship between the Bisexual Troop and the Male Group

The process of a social change in the 30th troop is to be examined in this chapter.

*The motive of an attack of the male group against the bisexual troop:* The male group members are at least in such circumstances as cannot gratify their sexual desire. In so densely-populated areas as Dharwar all the places rich in food and safe from the enemy are occupied by bisexual troops, so that the male group cannot get a place to live in safely and composedly. In this sense, the members of the male group are insecure beings.

Accordingly they must try to take the status in the bisexual troop by force to get females to satisfy their sexual urges and to have a living place abundant in food and safe from the enemy. Supposedly, the stronger is their desire, the more actively and frequently do they make an attack on the bisexual troops. The existence of so powerful a male in the male group as to overcome the troop male is a prerequisite for the attack on the bisexual troop.

The sexual activity of langurs could be observed all through the year, though during a certain period of the year this activity became dull. But no definite mating season could be seen in langurs unlike Japanese monkeys

(SUGIYAMA *et al.* 1965). Delivery, though seen through the year, was clearly concentrated from December to April. As mentioned above, if the period of pregnancy is for six or seven months, delivery from December to April shows that copulations were made from May to October in most cases. May to October may be thought to be the most active mating peak.

As far as my observation is concerned, there was no sexual activity in the male group before the attack on the bisexual troop, but their sexual urges may be supposed to have heightened before it. This may have been the direct motive of the attack of the male group against the 30th troop.

Judging from oestrus and soliciting behavior shown by  $D\text{♀}$  two or three hours after the first attack and from her real sexual activity that reached the peak rapidly, we may suppose that such a stimulus as an attack of the male group or contact with new males led her to sudden sexual activity.

In a study of rhesus monkeys (*Macaca mulatta*) in Cayo Santiago Island, Puerto Rico, CARPENTER (1942) insisted that some external stimulus given by a sort of behavior has an effect on the physiology of oestrus.

In natural troops of Japanese monkeys well-known to us, there are few social changes of such a kind as seen in langur troops, so that we have no data of the influence of social incidents on sexual activity.

In what state is the troop that the male group chooses as the object of an attack? The male group that attacked the 30th troop daily used most parts of the home range of the 31st troop as a large part of its moving range. But the male group attacked not the small 31st troop of 10 langurs (see Tab. 1) but the large 30th troop of 24 langurs. As mentioned in the previous section, all the troops that the male group attacked during the period of our survey were large-sized ones including langurs of many generations. 4.5-5 years on average seemed to have passed since the leaders began to rule the troops.

This fact shows that the highly-developed social organization of langurs under many years' reign of one leader male is liable to be attacked by the male group. But the reason is still unknown to us. The males of the male group may know that the leader male of such a troop is less active than the male langur that has a career of one or two years as the leader.

*Conflict between males:* As it has been already mentioned, the severe social change is caused by an attack of the male group members placed in unstable circumstances, especially by a male langur powerful enough to overcome the troop male in order to deprive the male of his secure position in the troop. Accordingly a fight between the leader male and the most powerful male langur of the male group is the most violent of all, and it is the first stage of the conflict between the troop and the group. The issue of the battle plays a decisive role in the reorganization of the troop.

It was in the second stage of conflict when the issue of the fight became clear between  $L\text{♂}$  and the leader that subadult and juvenile males were expelled by  $L\text{♂}$  not only from the troop but the home range of the troop. One-

year-old *DJ* was included among the expelled males. Usually an infant male one year old is more active in his play than a female, though he still depends much on his mother in daily life. For example, until the incident happened, *DJ* spent most of the time in the mother's bosom, frequently sucking her breast when she was taking a rest. In spite of his immaturity, he was regarded by the invaders, *L♂* and other group males as an antagonist to be expelled from the troop.

In the third stage of the conflict, *L♂* drove the other male group members out of the troop. In the male group being an undeveloped and loose organization, the group members are usually neither cooperative nor antagonistic. No antagonistic relations could be seen between them when they attacked the 30th troop. But after a conflict with the troop male, they came into antagonism with one another to get the status of the leader in the troop. The male langurs, *M♂* and *N♂*, that made more active an attack on the 30th troop than any other male showed the most active and the strongest resistance to the new troop leader *L♂* who tried to expel them.

SUGIYAMA (1960) who observed the division of a troop of Japanese monkeys at Takasakiyama in 1959 reported as follows concerning the leading males on the occasion of the troop-division. The branch troop was formed by many males of the peripheral part of the original troop including three lig males, *Hosi*, *Siro*, and *Kuri*, which ranked highest in the young-male-class, but hardly had ranking distinction among them in the original troop. *Hosi* which played the most active role in the opening and achievement of the troop-division became the leader of the branch troop with overwhelming superiority to the other males. Accordingly a great ranking distinction was created between him and the others. In the troop of Japanese monkeys, many males can remain in the troop together with the predominant male, while in the troop of langurs, males other than the predominant one are never allowed in the troop.

The above-mentioned three stages of conflict suggest to us that male langurs come to have non-compromising and very antagonistic relations with one another, once they join the troop that comprises mostly females, while the high social order of *Macaca* including Japanese monkeys, that is, the ranking order among males makes it possible for them to coexist in one troop without causing troubles. This very difference may be considered to be a basic cause for differences in the social organization and the troop size between *Macaca* and *Presbytis*. The coexistence of many males in the troop of *Macaca* under the ranking makes possible the multiplication of troop members, strengthens the troop against the enemy, and stabilizes the troop life.

JAY (1963a) observed a large troop of approximately 60 langurs including several adult males at Kaukori village near Lucknow in north India. With planted trees including roadside trees and fruit trees as the base of living, that troop made daily activities. As that place is isolated from the other habitats and troops, so it is quite within the bounds of possibility that the troop may

differ in social composition and troop size from that in the open habitat. How did the full-grown adult males come to coexist in that large-sized langur troop? What principle of coexistence do they have? These two questions must be solved.

It is possible to suppose that non-existence of an aggressive male group in the neighborhood has made the troop develop into a multi-male-troop including several males without having great social changes for many years. If this supposition is right, it follows that these adult males were born and brought up in this troop.

#### E. An Aggregation of Females and Their Young as the Foundation of the Troop

*A connection between the leader male and females:* In the above-mentioned three stages of conflict between males, females assumed an aggressive gesture and engaged themselves in fight very actively only when either they or their infants were attacked. During the time the leader male of their troop was fighting severely with the male group, the females remained quiet watching the fight. And when the issue of conflict became clear, they followed the victor. Eventually not a single female did follow the ex-leader that lost the fight.

As will be discussed minutely in the next report (SUGIYAMA 1966), the females of the 2nd troop that lost their own leader immediately followed the leader of the 4th troop that had made a violent attack on the 2nd troop. On the occasion of a conflict between the leader males of the 3rd and the 4th troop, these females remained behind the leader of the 4th troop to keep clear of the leader of the 3rd troop, though they had not so antagonistic relations with him.

In this way, a connection between the leader male and females is too ready to break off, while the attachment of females to the home range seems to be considerably strong. The home range of the new 30th troop after a reorganization was quite the same with that of the old 30th troop. Though *L*♂ must have had a thorough knowledge of the area west of the home range of the 30th troop in the time of the male group, he did not attempt to expand or change that home range on his own initiative. The case of the 2nd troop to be reported in the next report is a typical example of it. In short, after conquering a nearby troop, that is, the 2nd troop, the leader of the 4th troop tried to unify both the troops into one, but neither the members of the 2nd troop nor those of the 4th troop except the leader would leave their own home ranges. Though the leader of the 4th troop was received by the 2nd troop as the new leader, he failed to bring them together under a single sway.

Judging from the troop organization, the foundation of the troop is an aggregation of females and their young. Males may be regarded as those who joined this fundamental aggregation afterwards.

*The social life of deer:* The following are two typical examples of mammals

which lead a group life.

Females and their offsprings are the nucleus of the society of Japanese deer (*Cervus nippon nippon*) in Nara, which were studied by KAWAMURA (1957). A dominant male establishes a mating territory during the mating season and copulates with females of a mother-young group that has entered the territory. When the mating season is over, this territory goes out of existence. And males form a loose aggregation themselves. As male infants grow up, they leave the mother-young group and take independent action, or join the other males.

*The social life of vicuña:* According to the study of vicuña (*Vicugna vicugna*) of Camelidae by KOFORD (1957) in Peru, South America, one dominant male gathers many females to form a band and maintains a territory, while the other males form a male troop. Though the bands of vicuña exist irrespectively of the seasons, if a band male becomes weak, he is immediately superseded by another stronger male. Young males leave their band and join a male troop. On the other hand, a grown up male in the male troop creates his own territory and gathers young females of two years old from nearby bands to form an independent band.

It is possible to suppose from the society of Japanese deer that generally an aggregation of females and infants forms the foundation of the troop of mammals. Taking advantage of sexual contact with a female in the mating season, males may have come into the troop life in the course of evolution. The society of vicuña may be considered to be in such an evolutionary stage as a strong male and a mother-young group are always bound together. The social pattern of hanuman langurs is very similar to that of vicuña as a phenotype. It has become clear by our survey that on the occasion of a social change in the troop of hanuman langurs females have weaker affection to the leader male than to the home range. In their society the foundation of the troop may be thought to be an aggregation of females and their young, too.

#### F. Infant Biting

After antagonism between males was settled, one incident happened that all the infants of the troop were bitten to death by the new leader,  $L\hat{\sigma}$ . Such an incident as this could be observed not only in the case of the 30th troop stated in this report, but in a social change of the 1st troop in March, 1963 (KAWAMURA to be reported). It was the same in the 2nd troop from which the leader male was artificially excluded for experiment in June, 1962 (SUGIYAMA 1966). In the case of the 5th troop females that had their infants did not join the new troop, so that infant-biting did not occur (YOSHIBA, in preparation). Exceptionally in the case of the 7th troop, the new leader made attacks on six infants but did not kill them (SUGIYAMA & YOSHIBA, in preparation).

Infant-biting may be regarded as a general phenomenon to some extent, though there are some exceptions. In any case, the male excitedly attacked only the females that took their infants in the arms. Then all the troop females fled this way or that to make their escape. Soon after the infant dropped



away, the mother began to show a sign of oestrus and copulated with the leader,  $L\delta$ . Why does the new leader bite the infants to death? The reasons may be as follows:

1. The exclusion of nuisances from the troop

It is possible to suppose that like adult and juvenile males infants were treated by the new leader as the objects to be expelled from the troop he intended to establish. In all the troops where infant-biting happened, adult females and females expected to reach maturity in a few years were not expelled to the end. Being the objects of sexual gratification, only these females were regarded as necessary and receivable for the establishment of the new troop, but the rest were driven away as nuisances.

The fact that only one of the three females of one year old in the 30th troop was bitten by  $L\delta$  seems to imply that a female of one or two years old is on the borderline whether she should be received like adult females or expelled from the troop.

2. Sexual urges

Another cause is the sexual urge of the male that bit infants. Mainly on the basis of the data of eight troops, the delivery of female langurs is usually made every other year, and it is rarely the case that the mother langur of an infant under one year old grows sexually excited. But the female that gave birth to a dead child or lost a child shows a sign of oestrus as well as the females that have no infants of their own.

When the mating season of Japanese monkeys comes, a male monkey attacks an estrous female monkey violently and bites her. After repeated attacks, the male monkey and the female monkey have consort relations with each other. It is thought that the motive of his attack is to make the strong social bond with her (ITANI 1954).

One motive of the infant-biting of a male langur seems to make the strong social bond with an estrous female. It is not contradictory to the hormonal process: non-sucking-stimulus decreases the secretion of lactogenic hormone and correlatively increases gonadotropin, which urges a female to oestrus.

JAY (1963b) says that the weaning period of infant langurs is about 15 months after their birth. In the case of the 30th troop almost all the females had their own infants 6-11 months of age. Without expelling their infants out of the troop,  $L\delta$  could not have satisfied his sexual urges, namely, one of his main motives of an attack on the troop, though he succeeded in driving the ex-leader and the juvenile males away. The fact is that  $L\delta$  excluded all the infants from the troop by means of infant-biting and that he led the females into oestrus. On the other hand, these females also would not have had the sexual urges, if there had been their infants in the troop.

There were ten adult females in the 7th troop that had no infants. Though it was the only troop that did not go through severe infant-biting, the sexual activity of the troop was promoted by the oestrus of these females.

### 3. The discrimination of children

A male langur may be able to discern between his own children and the others. The male langur of a stable troop was never observed to bite infants even in the case that almost all the females had their infants and that few females had the possibility of oestrus. Moreover, as I have already reported (SUGIYAMA 1965), the troop male allowed the infants to make all sorts of behavior freely, and he had no antagonism to juvenile males.

After being expelled from the 30th troop, the ex-leader  $Z\delta$  returned to the troop again and stayed there for only one day (on June 7). Then  $Z\delta$  did not attack or bite the infants of the troop.

The difference between  $L\delta$  and  $Z\delta$  in their attitude towards the infants in the same state seems to imply that the male langur can discern between his own infants and the others. This does not mean that he can identify his real infants, but that he can vaguely discern the infants he has known since their birth from the others.

In the troop of macaques in which many males coexist, it seems impossible for a male to discriminate his own children from the others. Accordingly, such a sort of behavior as infant-biting has never been known to us in macaques. It may be concluded that the discrimination of his own children from the others is possible only to the male of the one-male-troop of langurs.

Though three reasons have been mentioned, these have close relation to the purpose of the new leader to integrate the troop.

As mentioned above, the sexual urge of the dominant male in the male group is one of the greatest motives that makes him attack the bisexual troop in order to take it by force. He must exclude all the nuisances except necessary females out of the troop after he captures it, and he must integrate the females under his sway. In order to attract their attention fully to him by demonstrating his power to an extreme, he must expel the males of the troop and furthermore cut off the relationship between the females and the infants.

And then it becomes possible that on the basis of the new social organization rigidly formed in this way the troop male discerns his children from the others and takes quite different attitudes to them. Therefore, the last reason can be regarded as the development of the male's activity from the first two. This last reason regulates more strictly the condition of the reorganization of the bisexual troop, and prohibits the coexistence of other males except his offsprings and brothers in the troop, which have no blood-relationship with the troop male. The bisexual troops repeats the rejuvenation of the social organization to maintain the one-male-troop.

It is worth notice that infant-biting effectively works to control the increase of population in the highly populated area.

The troop of mountain gorillas (*Gorilla gorilla beringei*) is either a one-male-troop or a small multi-male-troop, which has from one to seven adult males in it. The full-grown adult male usually called 'silver-back' is only one in the

troop of gorillas (KAWAI & MIZUHARA 1957). It is said that though juveniles and infants have no positive relations with a young adult male called 'black-back,' they are all allowed in the troop by the dominant silver-back male and that sometimes they are seen to play around him or to mount on his back for fun (SCHALLER 1963). In the case of gorilla it is not clear what relation is formed between the juveniles and the infants and the males that come from the outside of the troop on the occasion of a social change. But the possibility seems to be great that like the troop of hanuman langurs the social organization of one-male-troop has basically advanced the relationship between father and his offspring to a new stage.

#### G. Sexual Activity and Maternal Behavior

The infants that were inflicted an injury on by the new leader left the troop one by one, for their mothers did not give protection to the infants yet active and alive. This process had no exception in the desertion of more than fifteen infants from the 30th, the 2nd, and the 1st troops. Why did the mother abandon her infant?

Such a social impact as an attack on the bisexual troop by the male group or a change of the leader may have actuated the sexual urges of the females in the 30th troop, or activated their oestrus. Otherwise, we could not understand why the sexual activity of the females so far unobserved suddenly began only a few hours after a severe attack of the male group. Without a special reason, namely, a social change, most females of the 30th troop that had to suckle their infants under one year of age cannot have shown violent oestrus early in June.

It is also possible to estimate that the stronger becomes the tie between the new leader male and the mothers, the weaker and the less active grow their attention and protective behavior to their infants. Even if the mother did not take up so positive an attitude to the infant as to cut off the ties between them by rejecting approach and suck, her maternal behavior would grow gradually weak. The fact that the mother langur  $D_{\text{♀}}$  that was following the new leader after the incident of the 30th troop approached her son  $D_{\text{♂}}$  of one year old at a distance of 100 meters, but did not positively come nearer to him (at 11:35 on June 10) is a sufficient data to estimate that the mother had already strengthened the ties with the leader male more strongly than with her son of one year old.

The infant over six months of age, if healthy, can run, climb up and down the tree, and eat solid food to some extent. If necessary, he returns at once to the bosom of the mother, which he regards as the sucking place, the resting place, and the shelter in his daily life. In this stage of growth the mother can give full protection to him by her passive behavior.

Infant-biting occurred when she was turning her attention and interest to the newcomer male from the sucking infant that yet needed her protection. The strong protection of the mother was especially required when the injured and inactive infant had to escape death. In reality, her concern about the infant

was growing weaker. For example, the mother  $A\varphi$ 's attitude toward the injured infant  $AI$  observed on June 11 tells us more clearly how these incidents happened.

The process of a mother's desertion of her injured infant could be more closely observed in an artificial social change of the 2nd troop. In the next report will be treated a comparison of different phenomena between an artificial social change of the 2nd troop and an incident of the 30th troop, general consideration of the social organization of hanuman langurs (SUGIYAMA 1966).

### CONCLUSION

Most troops of hanuman langurs living near Dharwar in south India are one-male-troops with only one full grown adult male as the leader. Subadult and juvenile males are much fewer than females of the same generations in the troop. Moreover, there exists a male group independent of the bisexual troops. The troop-male shows extreme strain to the male group and tries to drive it away when it approaches. Usually the male group runs away without offering any resistance to him, but sometimes a male of the male group actively attacks the male of the bisexual troop. If he succeeded in the attack, he expels not only the troop-male but all the other males including juveniles out of the troop. Accordingly, even one-year-old males are contained in the male group.

Male group members fight with each other to get the status of the leader in the troop, and the most dominant male drives out the other males at the end. After that, all the infants of the troop are bitten by the new leader male to death.

The males expelled from the troop forms another male group, while male group members that have failed to enter the troop return to the habitat of low ecological value.

Though in Dharwar a social change occurs in a troop at intervals of 4.5-5 years on average, it may have relation to the high population density of langurs. Because of the high population density, all the part of the forest, that is, the area that provides langurs with abundant food and many shelters from the enemy, is occupied by bisexual troops, so that the forest part leaves no room for the male to live in peacefully.

The males of the male group makes frequently an attack on the bisexual troop to get females and a secure place to live in. Once a social change occurs in this way, all the males of the troop are expelled from it. Consequently, the troop undergoes rejuvenation of social organization and becomes a new one-male-troop (one adult male+5-10 adult females+2-3 juvenile females). With an increase of males in the male group, social changes are more liable to occur.

In the sparsely-populated area the male group may be able to get a secure

place to live in. Consequently, the frequency of attacks on the troop will decrease. This gives the bisexual troop more chances to develop into a multi-male-troop without undergoing rejuvenation of social organization, and prevents an increase of male group members.

Such an impact as an attack of the male group or a change of the leader male activates the oestrus of females in the attacked troop and strengthens the ties between the new leader and them.

After capturing the troop, the new leader attacks and bites infants. He may treat them as the objects to be excluded from the troop like the other males including juveniles when he begins to sway the troop. Or he may need to attack and exclude them from the troop so as to make the strong social bond with the females. From these motives and other, the new leader may have bitten the infants as a kind of demonstration to strengthen the ties between him and the females and to integrate the females under his sway. The mother whose attention was turned to the new leader by a strong stimulus abandoned her injured infant that needed her protection. Then she showed a sign of oestrus and copulated with the new leader. The copulation made more firm the ties between the male and the female.

The frequent rejuvenation of social organization to become a new one-male-troop enables the leader male to discern his own offsprings from the others. From the fact that the new leader male tries to attack and expel from the troop not only the ex-leader but all the males including juveniles one year old, and that he bit the infants of the troop one by one, it may be inferred that they cannot possibly be the real offsprings of his own. Thus the reorganized new troop starts a new troop life together with adult and juvenile females firmly tied with the new leader male.

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