The Bioscan 5(2) : 259-262, 2010
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES

AGGRESSIVENESS AND THE INTENSITY OF PROVISIONING (ARTIFICIAL FEEDING) HANUMAN LANGURS AROUND JODHPUR (RAJASTHAN)

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KEY WORDS
Semnopithecus entellus
Aggressiveness
Provisioning
Intensity, Jodhpur

Received on :
27.03.2010
Accepted on :
07.05.2010

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ABSTRACT
A behavioural study in free-ranging Hanuman langur (*Semnopithecus entellus*) around Jodhpur (west Rajasthan) was conducted during 2008-2009. Different patterns of agonistic behaviour and aggressiveness in different langur groups were observed depending on the intensity of provisioning during the study period. The effects of artificial feeding were examined between two troops having minimum and maximum provisioning by local peoples. Results are based on focal animal sampling and *ad libitum* sampling of 17 adult females in the group Kailana II (low provisioning) and Mandore troops of the langur population of Jodhpur. The behaviour of their aggressiveness was observed. Mandore troop having high provisioning and more interacting with human population was observed to be more aggressive and play more agnostic interaction within and between two troops compared to low provisioned troops. Highly provisioned troop had high-intensity aggression (68.9%) and aggressiveness. In Mandore total 85 incident were observed when troop members play a major role in aggressiveness. Studies on the nature of changing the aggressiveness with the intensity of provisioning and or human interaction are essential for a basic understanding of the behavioral strategies that individual displays when faced with changing food rapidly.

INTRODUCTION

Primate societies are generally structured organizations with fairly clear social rules that determine patterns of interactions between different classes of individuals comprising these societies. Kinship and dominance rank, for example, are important factors regulating within-group cooperation and competition among individuals in typical cercopithecine societies, including that of macaques (Smuts, 1987). Individual primates, however, are also capable of occasionally altering their usual patterns of interactions, especially when the social or ecological environment makes such behavioural flexibility advantageous (Cheney and Seyfarth, 1990). Short-term behavioural changes in response to changing conditions of food availability and distribution have been investigated in only a few species of primates, both in captivity and in the wild. Although most studies have documented the nature of feeding competition and aggression that develops within groups faced with either low availability or clumped distribution of food, they have not typically focused on the mechanisms by which social tensions are subsequently reduced. Little is known about the nature of such behavioural interactions in free-ranging primates faced with variability in food distribution and abundance. A particularly interesting situation is that of a number of Asian and African cercopithecine groups that are occasionally provisioned or have adapted to scavenging from neighbouring human habitations.

Provisioning of free-living primate groups usually leads to a significant increase in competition among individuals for the newly available resources. Changing patterns of social interactions and aggressiveness between troop members have been studied in two groups Kailana-II (B-20) and Mandore (B-8), under two different conditions of foraging.

MATERIALS AND METHODS

Study animal

The Hanuman langur, (*Semnopithecus entellus* Dufresne, 1797) is the most adaptable and widespread south Asian colobine non-human primate of the Indian subcontinent. The species has been the subject of investigation because of its unique behaviour pattern including infanticide (Sugiyama, 1965; Mohnot, 1971; Hrdy, 1974; Roonwal and Mohnot, 1977; Makwana, 1979; Sommer and Mohnot, 1985; Agoramoorthy and Mohnot, 1988; Rajpurohit *et al.,* 2003).

These langurs live in a wide range of habitats from the Himalayas (v 3600m altitude) and peninsular forests to semiarid woodlands, in villages and towns and in cultivated lands (Roonwal and Mohnot, 1977; Vogel, 1977). These animals are known for their remarkable adaptability, the species also has a highly variable social organization. The two basic types of social groups are bisexual troops and all-male bands. Troops are matrilineal groups of adult females and offsprings with either one adult male (unimale bisexual troop or harems) or more than one adult male (multi-male troops).

Study area

Jodhpur is located in Rajasthan (altitude about 241m MSL the tour station, 26º.18ºN and longitude 73º.08ºNL) at the eastern edge of the Great Indian Desert. The town stands on a hilly sand stone plateau, which covers approximately 150 km^2. The plateau is inhabited by a geographically isolated population about 2000 Hanuman langurs (Rajpurohit *et al.,* 2006). The langurs feed on the vegetation which is xerophytes open scrub and some groups raid crops and they are not shy and spent most of the day time on the ground (Mohnot, 1971; Sommer, 1985; Rajpurohit, 1987; Winkler, 1988; Srivastava, 1989). Additionally most langurs are highly fed by local people for religious reasons.

The size of natural and provisioned fed groups varies considerable between groups (Winkler, 1988). The reproductive units are varied between 35-40 one male troops (average size 38.5 members ranges 7-120). (Mohnot, 1974; Winkler, 1988; Rajpurohit, 1987; Rajpurohit *et al.,* 2006). Each troops occupies it own home range of about 0.5 -1.5 km^2., the home range of bands are often not well defined because they can regularly move over areas over of up to 10-15 km^2. The climate is dry with maximum temperature of up to 50ºC during May and June and minimum temperature around 0ºC during December and January. Jodhpur receives 90% of its scanty rain fall (annual average 360 mm) during the manson (July to September).

The vegetation is of the open scrub type, with 'thor' (*Euphorbia caducifolia*) dominating the hillocks, 'angraji banwalia' (*Prosopis juliflora*) and 'bordi (*Ziziphus mauritiana*) on the slopes of the rocky habitats and palms and 'khejree' (*Prosophis cineraria*) on the sandy plains. Various other xerophytes are also available to the langurs. In the gardens and orchards large fruit trees of mango (*Mangifera indica*) and black plum (*Eugenia jambolana*) are common while several other medium sized fruit tree are also cultivated.

The group spent approximately 68% of the observation time in foraging on its natural diet; during the remaining period the group gathered for provisioned food from tourists visiting the garden. Provisioning was marked by a sharp increase in aggression and feeding supplants within the group. Dominant females directed contact aggression specifically towards higher-ranked subordinates, while subordinate females increased non-contact aggression towards their dominant counterparts. Allogrooming was, however, much more reciprocated at the group level during provisioning. Subordinate females also initiated relatively more allogrooming towards those dominant individuals who were most aggressive during this period. Social tensions thus increase markedly when langurs move from natural foraging to competing for provisioned food.

RESULTS

The behaviours that have been considered in the present analysis include foraging, scavenging, allogrooming, affiliation, total aggression, non-contact aggression, contact aggression, aggressive approach, retreat and feeding supplant. Foraging has been defined as the feeding by the study individuals on any component of their natural diet; this includes leaves, flowers and fruits of different food plants and/or insects has been used here. The foods offered by tourists during direct interactions and their scavenging on the remains left behind by these visitors are also part of foraging. Allogrooming (used interchangeable with grooming) refers to the manipulation of the fur and skin of an individual by another with the fingers, mouth, or teeth in order to remove bits of dirt, dead skin, ectoparasites or dried blood from wounds. Total aggression is also a composite behaviour, constituted by agonistic interactions of two kinds. Contact aggression, involving actual physical contact between the adversaries, includes the more severe acts of bite hard, chase, hold down, pinch, pull roughly, push, and slap. Non-contact aggression, in contrast, consists of agonistic interactions at a distance that do not involve any physical contact; these include the relatively milder acts of aggressive scream, bared-teeth display. Aggressive approach refers to an approach made by an individual towards another that is followed by the former displaying any of the acts of non-contact and contact aggression listed above. Retreat, on the other hand, consists of the moving away or fleeing of an individual from another in response to an act of non-contact and contact aggression shown by the latter. Feeding supplant consists of the replacement of a feeding individual by another at a feeding site, which may or may not be accompanied by snatching of the food by the supplanting individual.

Natural foraging and provisioned feeding

The study group regularly moved between two kinds of habitats within their home range. One was a relatively more forested area where they foraged on their natural diet of leaves, flowers, fruits and/or insects. The other was a more open area in the vicinity of the forest and garden, where they either interacted with feeders or tourists and directly obtained provisioned food from them, or scavenged on remains left behind by the visitors. Although social interactions of all kinds regularly occurred in both these areas, the ones displayed in the former area have been considered in this analysis to be associated with natural foraging and those in the latter area with scavenging by the study group when provisioned with typically human food. The adult females of the troop spent relatively longer periods of time in the foraging area during the observation period (91.5 h) than in the area where they scavenged (47.7 h), because they invariably rested during periods of inactivity in the former area and also because tourists were usually present in the provisioning area only during evenings.

Feeding competition on provisioning

There was a marked increase in social tension in the study groups during periods of provisioning which was usually manifested as enhanced aggression among the adult females of the troop. Thus, the overall rates of total aggression and its two components – non-contact aggression and contact aggression – as well as aggressive approach and feeding supplant increased significantly during this period from those exhibited during natural foraging.

DISCUSSION

Changes in social structure in response to ecological parameters have often been observed in different animal societies. Although most of these species usually have an evolutionarily

selected basic pattern of social organization, intraspecific variations do arise in response to fluctuations in the local environment. One form of such variation consists of short-term behavioral changes that may allow individuals to overcome rigid constraints imposed by the prevailing social structure, and thus, effectively compete with each other under changing conditions of resource availability. Provisioning of wild primate groups usually leads to changes in behavioural strategies, both at the level of individual activity and that of social interactions. Although individual behavioural patterns and food choices in naturally foraging and provisioned groups have been investigated (Altmann and Muruthi, 1988), observations on the nature of changing social relationships within such groups have remained surprisingly neglected. Such studies are, however, essential for a basic understanding of the behavioural strategies that individual displays when faced with rapidly changing food regimes and the mechanisms that facilitate the promotion of social harmony in the midst of rising intra-group competition for food. The free-ranging group of Hanuman langur investigated here regularly alternated between bouts of natural foraging and visits to a site where they were provisioned with human food. The clumped distribution of the provisioned food around their human sources was likely to be directly responsible for the observed significant increase in intragroup aggression, aggressive approaches and feeding supplants during these periods over that during natural foraging. Bonnet macaques are generalist feeders (Ali, 1986; Krishnamani, 1994). Opportunities for monopolization of food are, therefore, rare during natural foraging and strong competition may not occur under these circumstances. The provisioned food, in contrast, was markedly clumped in distribution, not only in time, but also in space within a small area habituated by large numbers of tourists or feeders. Thus, access to both the tourists and the food items themselves, appeared to be largely indefensible under these conditions; limited contest competition could, however, occur once an individual was able to gain access to a particular item. The exact extent to which the elevated levels of feeding competition, observed during scavenging regimes, depend on the temporal and spatial availability, size and nutritional quality of the food provided, nevertheless, needs to be investigated further. Potentially expensive acts of aggression over provisioned food appeared to be demonstrated more by high-ranked females. Thus, challenges during contest competition would most likely come not only from individuals of higher rank, but from those most closely ranked in the dominance hierarchy as well. Another mechanism that may yield a similar pattern of interactions is that low-ranking, subordinate females may avoid costly conflicts by physically occupying positions away from high-ranking individuals, thus giving rise to specific group spatial structures during feeding competition (Barton and whiten, 1993). Moreover, females across the rank hierarchy enjoyed comparable scavenging success when provisioned, in contrast to what has earlier been observed in female Japanese macaques (Ali, 1986) and olive baboons (Barton and whiten, 1993). Finally, the hypothesis that aggression may be preferentially directed towards certain individuals during enhanced feeding competition and may not simply be an emergent property of individual positional choices comes from the observation that, when provisioned, subordinate females displayed enhanced aggression towards their dominant adversaries and significantly reciprocated the aggression that they received. Feeding competition during provisioning was marked by a significant increase in contact aggression directed by high-ranked females towards each other. Although potentially very costly, contact aggression becomes necessary when individuals physically compete for choice food items. The intensity of competition over provisioned food was manifest also in the appearance of agonistic acts directed by subordinate females towards their dominant counterparts a feature rather unusual for adult female Hanuman langur in most troops. Such females, however, could obviously not afford costly aggressive encounters; enhanced aggression with the dominance hierarchy, therefore, principally consisted of non-contact aggressive acts. It has been suggested that stable linear hierarchies in female primates are a result of conflict competition for food. Interestingly, however, the dominance hierarchy in this particular troop of bonnet macaques became comparatively unstable under conditions of provisioning. While, during natural foraging, there existed a significant negative correlation between aggressions received by individual females from their dominant adversaries and the aggression that they showed towards them, this completely changed when the same individuals were provisioned. A strong competitive advantage due to positions of high rank in the dominance hierarchy, nevertheless, did reveal itself as greater success enjoyed by dominant females during feeding supplants. Although, overall, there were no significant differences in feeding rates across the dominance hierarchy, there could be other behavioural measures reflecting the advantage of being a high-ranked female, which have not been considered in this study. These could include, amongst others, differences in total feeding time, daily food intake or even dietary diversity (Post *et al.,* 1980) such parameters need to be investigated further among the troop from a regime of natural foraging to that of provisioning. Individuals were able to opportunistically spend only short periods of time at the provisioning site and even this was marked by high rates of scavenging as well as intense conflict over food. Individuals could now perhaps devote little time to such energy- and time-intensive interactions as allogrooming. There was a significant effect of habitat type on aggression rates during the study period. Aggression was higher than expected in the mandore troop with garden habitat and having more provisioning feeding and lower aggression than observed expected in the Kailana-II having law provisioning.

ACKNOWLEDGEMENTS

The authors are grateful to S.M. Mohnot Emeritus Professor of Zoology and Chairman, Primate Research Center, Jodhpur for constant encouragement and to Prof. Devendra Mohan, Head, Department of Zoology, J.N.V. University, Jodhpur for providing facilities and logistic support during this study. Thanks are due to UGC, New Delhi (SRFship to DL) and for financial support under major project (No. F.30-200/2004 (SR) dt.10 Nov 2004 and No. F.34-400/2008(SR) dt. 2 Jan., 2009).

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