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REPRODUCTIVE BEHAVIOUR OF THE ASSAMESE MACAQUE (*MACACA ASSAMENSIS*) IN DARJEELING DISTRICT, INDIA

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INTRODUCTION

Population growth and survival of any species are closely related with its reproductive abilities. Like many other primates, the Assamese macaques (*M. assamensis*) form bisexual, multimale groups of varying sizes where adult males are always larger than the adult females. They are found in India, Nepal, Bhutan, Bangladesh, Myanmar, China, Thailand, Vietnam, Cambodia and Laos. In India this species is confined to Uttaranchal, Sikkim, West Bengal, Assam, Arunachal Pradesh, Mizoram and Meghalaya. The present study was carried out on *Macaca assamensis pelops*, one of the two subspecies of Assamese macaque occurring in India (West Bengal, Sikkim and as far east at the great bend of the Brahmaputra river flowing through Assam and Arunachal Pradesh), Bhutan and Nepal. This subspecies prefers broad-leaved evergreen forests of high altitudes, whereas the *M. assamensis assamensis* occurring in China, North and East Myanmar, North East India, Northern Laos, Northwest Thailand and North Vietnam (Jones *et al.*, 2004) prefers to inhabit plain lands. There are several studies on the reproductive behaviour of rhesus (*Macaca mulatta*) and bonnet (*Macaca radiata*) macaques (Lindburg, 1971; Drickamer, 1974; Simonds, 1965; Rahaman & Parthasarathy, 1969) but no such record exists for the Assamese macaque from India.

In *M. radiata* copulation occurs all around the year with a peak during September to November and births recorded from March to July (Simonds, 1965). Fooden (1971) found the peak birth season of Assamese macaque from April to June in Thailand. Prakash (1958) claimed that

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M. mulatta from Rajasthan had two distinct breeding seasons in a year. Southwick, Beg and Siddiqi (1961) found the greatest frequency of sexual behaviour occurring from October to December in *M. mulatta*. In Lindburg's (1971) view, mating in *M. mulatta* begins in September, reaching its peak during November to first half of December. He also recorded a mating season from early July to end of January in Uttar Pradesh, India. Bernstein and Cooper (1998) also contributed their observations on some of the behavioural peculiarities like male and female taking male ejaculate and vaginal plug formation by male semen in reproduction of *M. assamensis*. The present study is based on the reproductive behaviour of free ranging Assamese macaques from the Darjeeling district of West Bengal, India. The study also helped in comparing the seasonality of mating and birth in other macaque species with that of *M. assamensis*. The results indicated a distinct breeding season from September to February with a peak from October to December. Majority of the births were recorded between March and June which was in confirmation with the findings of Fooden (1971) in Thailand.

STUDY AREA

Natural populations of the Assamese macaque occur in the submontane areas of Darjeeling district in West Bengal. This area consists of the lower Himalayan mountain ridges and foothills with deep gorges and steep slopes covering a geographical area of nearly 3149 sq. km. The district lies between 26°31'–27°13' N latitude and 87°59'–88°53' E longitude. The study was conducted on 13 free ranging groups in different parts of the district ranging from an altitude of 180–2270 m. The rivers and their tributaries are shallow and become turbulent during monsoon. Climatic conditions are variable from humid subtropical to temperate depending on the elevation. Summer lasts from April to mid June followed by the monsoon that extends till September. Maximum temperatures range between 18.5° and 37°C depending on the elevation, while the minimum is between 0° and 8.5°C. Humidity is very high and thick clouds with moisture prevail through the greater part of the year. Annual rainfall varies between 250 and 320 cm.

Survival of this species is threatened due to habitat loss and the increase in human-animal conflicts. Several mortality factors like trapping, landslides, road kills and intentional poisoning have been identified in the study area. A total of 27 groups have been recorded from this area, of which 13 were monitored for 3 successive years. Mean group size was 19.48 ± 2.28 . Of the two focal groups studied, Group A with 17 monkeys was located near Rambhi on the bank of river Teesta at an elevation of 231 m. The other Group (B) with 23 monkeys inhabited an open valley land with steep slopes, 6 km away from Kurseong town at a height of 1370 m. Group B inhabits a site close to human habitation and frequently comes to the road that leads to Kurseong town and is highly vulnerable to human-monkey conflicts.

Overall flora in this zone represents Himalayan subtropical wet hill forest the composition changing with altitude and climatic conditions.

METHODS

Data for this study was obtained from observations on diurnal activities on two focal and 11 other free ranging groups for three successive years (1997-1999). The natural cycle of 3 seasons (summer, monsoon and winter) was considered to describe the activity pattern throughout the year. All analysis and interpretations were based on diurnal observations undertaken from 0500 hrs in the morning till 1700 hrs, which was around the time of sunset. Scans were repeated at every 15 minute intervals on all the members of a group hence one-hour recording involved 4 scan results. The number of records per activity in each scan was expressed as the percentage of total number of records made in each scan (Clutton-Brock, 1974) This was followed to treat the collected data in each scan equally. Biases due to visibility differences, distribution of scans, variable daylight etc could not be avoided. However, for each attribute the mean number of records was considered and variations were confined to a very small portion of all the records to remove the influence on the overall activity budget.

All of the 10 categories of behaviour recorded were estimated on the basis of relative distribution of their percentages. Each activity record was analysed by summation of all records of all categories and expressing them as percentage of the total number of records collected per day by scan sampling method.

$$Ac = (A_i / A) \times 100$$

where Ac = Percentage of activity (any one of the ten selected activities) recorded.

A_i = total scan records of that activity in a day

A = total scan records of all activities observed in a day.

During the study period a total of 14180 scan records of all activities were analysed. Group A averaged 82.32 scans daily and Group B 74.35. Distinct seasonal variations were noticed in few of the selected 10 categories of activities. Observation hours per day were 11 and mean contact hours ranged between 6.01 and 9.1. Average observation days for each season in a year were 12.

Only the data on mating frequencies are presented here. However reproduction also involves many other associated incidents, which were collectively termed as reproductive behaviour. A combination of group scan and ad-libitum sampling (Altmann, 1974) was used during field observation. The significance of the variations in percentage of scanned activities in different seasons, zones and time period of the day were examined from the results by Three way-ANOVA at 5% level. Chi-square (X^2) test was also applied to estimate the significance wherever required. Quantitative analysis by ANOVA and Chi-square methods were applied to scan sampling data and not to Ad libitum sampling, which came mostly from informal observations. Almost 72% of the data were from scan sampling. Age-sex composition was decided following the description of Southwick, *et al.*, (1961).

RESULTS

Observations were made for 1650 hours involving 1081 contact hours and 14180 scan records, of which mating incidents and other reproductive activities involved a total of 128 scan records. Seasonal variations were recorded in the proportion of different activities in 10 categories (*e.g.*, resting; grooming; feeding; locomotion, play, agonistic interaction, reproductive activities, vocalisation, sleep and drinking,) for daily observation. Daily activity used to start between 0530–0550 hrs in Group A, as recorded in the maximum number of scans. Group B began their day during 0540–0600 hrs slightly later than Group A.

The sagging of the testis and redness in the sexual skin easily identified adult males participating in copulatory acts. Adult females also have the prominent reddish swelling or bulbous outgrowth in the perineal region. This perineal swelling or sexual skin change was observed in the breeding season. From the observations it was noticed that sexual maturity was attained at about 4 years in females and nearly 4.5–5 years in males.

Juveniles were not dependent on their mothers, and neither do the mothers nurse them. Their scrotum and teats were not very prominent but visible externally. Infants were much smaller in size and nursed by the mothers. Average sex ratio of adult male to adult female was 0.48 ± 0.08 in group A and 0.34 ± 0.06 in group B.

Table 1. : Age sex composition of Group A.

Category	1996	1997	1998	1999	Mean
AM	3	3	3	3	3.00
AF	6	5	7	8	6.50
JJ	4	5	2	6	4.25
II	4	3	5	4	4.00
Total	17	16	17	21	17.75

Table 2. : Age sex composition of Group B.

Category	1996	1997	1998	1999	Mean
AM	3	3	2	2	2.50
AF	8	7	7	7	7.25
JJ	9	5	4	2	5.00
II	3	4	0	6	3.25
Total	23	19	13	17	18.00

[AM = adult male; AF = adult female; JJ = juvenile; II = infant]

Breeding Season

The mating season was usually observed to be from post monsoon (September) to late winter (February) and in rare instances extended till May-June. The peak breeding season was noticed between October and December (Fig. 1). Maximum mating records (95.6%) were obtained during this period which was much lower during January and February (3.1%) recording a minimum in May-June. These observations were consistent with the findings of Southwick, Beg and Siddqi (1961) in *Macaca mulatta* where the highest frequency of sexual behaviour also occurred during October-December. Prakash (1958) however claimed that Rhesus breeds twice in Rajasthan, India. Observation during monsoon yielded negligible results on this aspect.

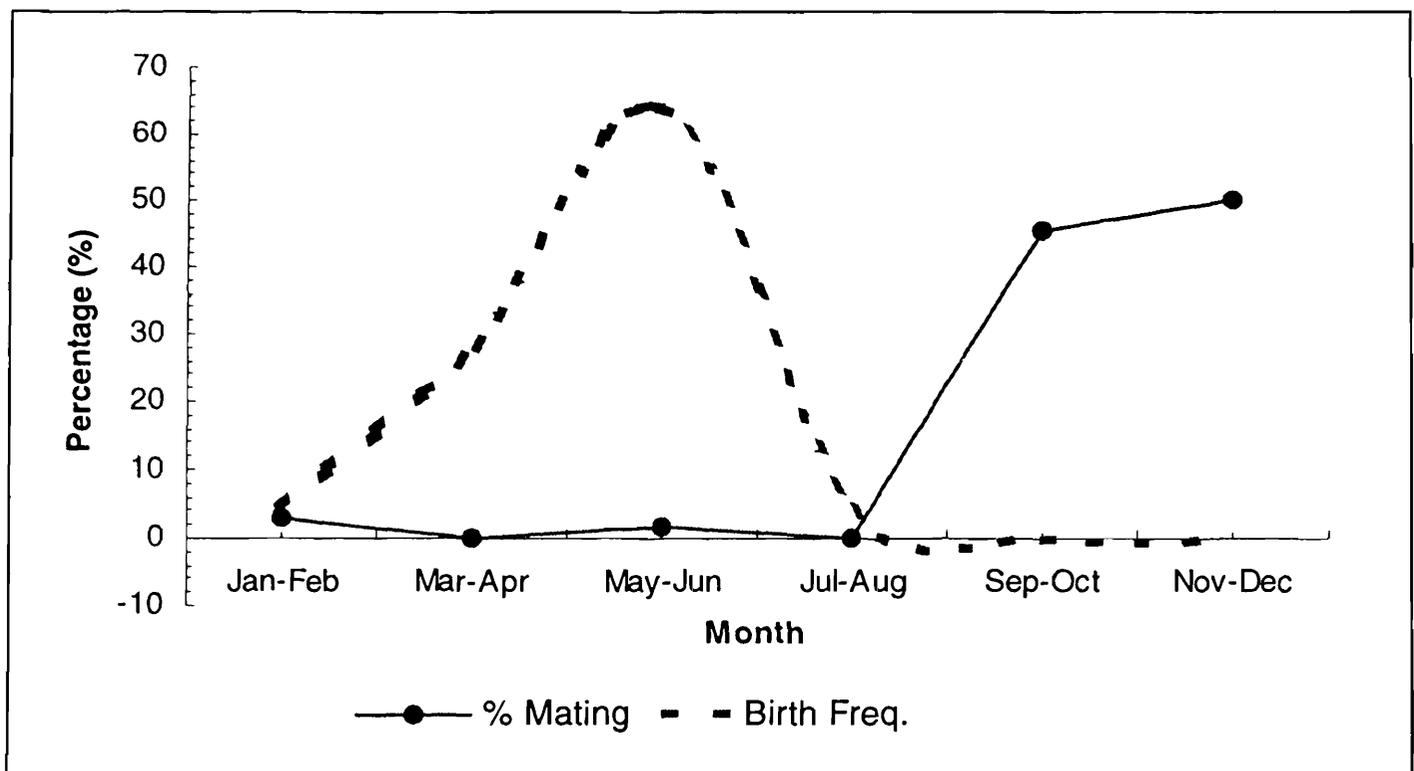


Fig. 1. : Relationship between mating pattern and birth.

Birth season

Most of the births were recorded between May and June, but newborns were seen during the period from March to June every year. Though very low in percentage, instances of birth were also noticed in July-August suggesting a bimodal curve in the birth season. Data obtained in this study was insufficient to confirm the possibility of two birth seasons in the Assamese macaque. One case of twin birth was also recorded in 1999 with both infants surviving. Total recorded births in group A and B were 10 and 12 respectively during the study period. Cases of mortality were observed in almost all the groups. Human-monkey interaction was greater in Group B where 7 deaths were recorded of which 6 were accidental. Group A had 4 deaths in which one was by predation of a dog.

The reproductive rate was determined from the ratio of newborn infants to mature females. It varied between 37.5% (lowest) and 85.7% (highest) for the two study groups. However, Group A had comparatively a stable rate varying between 50% and 71%. The average reproductive rate for all the groups (N=13) was around 53.1%. Viability of the offsprings effected this ratio much more in Group B due to its proximity to human habitation and resultant conflicts. Reproductive rate in Group B was highest (85.71%) in 1999 though it varied only from 37.5% to 57.14% during the entire study period.

Correlation between the timing of birth season, mating and various environmental factors were also examined. Breeding occurred during a period of decreasing day length and birth took place when day length increased gradually. Low temperature, moisture, rainfall and moderate fruiting in the trees were characteristics of the breeding season. Significant variation was noticed in the seasonal distribution of mating events in the focal groups ($\chi^2 = 34.9$, $P < 0.05$) as they are concentrated during winter season between Sept-October and Jan-Feb. However differences between the two focal groups in different seasons and time periods of the day were statistically insignificant ($F = 0.87$, $P < 0.05$). Both the groups revealed a similar pattern of seasonality in copulation and birth irrespective of their differences in habitat utilisation and interaction with humans.

COPULATION

The entire process of copulation is spread over three main phases of activity *viz.* (1) precopulatory, (2) copulatory and (3) postcopulatory. Of a total of 157 mating events from the focal groups, 128 were recorded from direct scan results and the remaining 29 were from other scans.

The precopulatory period included consorting, soliciting and the associated activities. Adult males were seen to mate with several females and consorting was often noticed during the breeding season, which lasted for even up to 36–40 hours at a stretch. The dominant male usually shows more consistency in maintaining the consort pair. In one focal group, a female was seen mating with more than one male within 5–6 hours of duration. But majority of the associations lasted from a few minutes to a few hours. Instances were there when the female of a consort pair was noticed pulling the tail of its male partner, which in turn examined the genitalia of this female and mating took place eventually. Sometimes these acts started with solicitation by the female moving around a male with her raised tail and the male licking her vaginal exudate. Males in all the study groups usually emitted a pre-copulatory sound or call like *kharrrr....* in a low and intense tone at the onset of mating (in 73% of total mating records) or even during the process. This sound was clearly audible from a distance of 10–15 yards and easily distinguishable from other vocalisations.

Copulation : Almost 79.7% of the total mating events recorded occurred during 0600–1000 hours. The interval between two subsequent mating in the same pair was observed to be at least

5–7 minutes and in rare instances after 18–20 minutes. In this macaque species males are generally single mount ejaculators. On an average 1.6 matings occurred everyday in each group. However, during the breeding season Group A recorded 2.5 matings/day and Group B 4.1 matings/day. Females were often seen grimacing at her partner. The other members of the group had the tendency to interrupt or chase the pair engaged in mating. Aggression towards a mating pair occurred in nearly 73 mating events. Most of the time adult males were targeted. A maximum of 11 mounts were observed among different partners of a group in a single day during a breeding season. Male to male mounting, juvenile male mounting adult female and infants mounting juveniles were considered as play behaviour. The mating partners utilised ground surface, tree branches, rocks and hilltops as their mating places but the maximum time they mated near the ground (49.6%) and much less on the tree branches (10.2%).

The most common Post-copulatory behaviour was a subsequent grooming between two partners. Often the female groomed the male (63%). Males were seen examining the flow of ejaculate and even tasting it while females also inspected their genitalia. There were several agonistic interactions between adult males of a group after mating. The female partner was often chased and harassed by the other male members. Among the total aggressive interactions in the study group 31.4% was associated with sexual behaviour. Among them, adult and sub-adult males were involved in 67% incidents. There were frequent intra-group clashes.

Inter specific breeding

In the present study incidents of penetration by *Macaca mulatta* individuals in the group of Assamese macaque living in the transitional zone were recorded. Hence chances of interbreeding could not be ruled out. Some earlier field evidences (Bernstein, 1968) of occasional entry by extraspecifics have been recorded and hybrids within the genus *Macaca* were also observed in captivity. Home ranges of *M. mulatta* and *M. assamensis* overlap near the foothills where troops of both the species have chances to interbreed, but is yet to be confirmed.

DISCUSSION

The major part of this work was based on two focal groups located in two different locations, one inside the forest and the other close to the human settlement. The study revealed that mating attempts and antagonistic reactions were much higher in the group near human habitation. No substantial growth in the troop size because of the anthropogenic pressures of various forms was also observed. This study established that *M. assamensis* has a close similarity with the breeding seasons of *M. mulatta*. Viability of infants was so variable that it effected the reproductive rate of Group B. It has also been observed that forest groups are more stable and less aggressive than the groups living in close proximity to human beings.

Much of the sexual behaviour displayed by *M. assamensis* was similar to that in *M. mulatta* and *M. radiata*. Some workers found uninterrupted breeding cycle in *M. radiata* throughout the year (Sugiyama, 1971; Parthasarathy, 1972) whereas *M. assamensis* has a definite breeding season. However, the peak breeding period is identical in both the species. Malik (1992) found mating in rhesus monkey restricted between October and February. *M. assamensis* resembles many other species of this genus with respect to the reproductive season.

Bernstein (1980) reported mounting at the rate of 0.3/hour in *M. arctoides* which was slightly higher (0.2–1/hour) as seen in in this study. Lindburg (1971) recorded antagonism related with sexual behaviour comprising about 22% of the total agonistic interactions, while this study showed a higher aggression (31%). Aggressiveness and mounting frequencies were higher in the group having direct interaction with humans.

Imanishi (1960) reported the association of reddening in face and genital regions with the mating period in both male and females of Japanese macaque (*M. fuscata*). This was clearly observed in the females from the study area, and it was associated mostly with lactating females. Bernstein and Cooper (1998) commented on the activities like females taking male exudate as an unsuitable occurrence for any biological explanation. They did not find the grooming of male just after or before the mating to have any direct relation with the copulatory act, because males use coercive mating tactics in general (Cooper & Bernstein, 2000). But this opinion is not fully consistent with the findings of present study. Allogrooming was observed between the partners in around 70% of the mating events.

Possibility of interbreeding with other rhesus monkeys needs to be studied extensively. This population occupies the western most limit of Assamese macaque's range in India. Further study on both the subspecies of Assamese macaque is necessary considering its fragmented population and data deficiency in various aspects.

SUMMARY

The present study is based on the observations made on the seasonality of breeding and birth; sexual maturity; copulatory process and related activities in the Assamese macaque (*Macaca assamensis*) in Darjeeling. The intensive study was conducted for three years on two free ranging groups inhabiting different locations. The main objective was to identify the reproductive strategies in the wild, which could help in designing a future management plan for the population and help in the conservation of this species.

Groups found near human settlements had higher mating frequencies and antagonistic interactions between the members, but vulnerability of the immature individuals prevented any substantial increase in population during the study period.

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