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Reproductive Strategies of *Trachypithecus pileatus* in Arunachal Pradesh, India

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Abstract We studied reproductive behavior of free-ranging capped langurs (*Trachypithecus pileatus*) in the Pakhui Wildlife Sanctuary, Arunachal Pradesh, India. Four species of primates —*Trachypithecus pileatus, Macaca mulatta*, *M. assamensis*, and *Nycticebus bengalensis*— live there. We studied the mating seasons, mating frequency, copulatory attempts, time spent in copulation, and interval between 2 successive copulations, gestation length, and interbirth interval of 4 groups of capped langurs during 2001–2003. We observed 2 mating seasons in a year. The first was larger, comprising 5 months (September–January), and the second was short, April and May. Mating was intensive in the morning session (0600–1000 h); 57% of total mating events occurred then. The average gestation period was 200 d. November was the most favorable month for breeding. In a year, 107 mating events occurred involving 5 adult females. Average time per mounting attempt is 12 s. Duration of mounting was the maximum in November. Interbirth interval was 23 months and 10 d. The birth season was 129 days, December–April; 53% of births occurred in February and March. Average birth rate is 0.386 birth/female/yr.

Keywords birth interval · breeding season · gestation length · mating behavior · reproduction · *Trachypithecus pileatus*

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Introduction

Understanding reproduction has expanded beyond the underlying physiological and endocrine mechanism and includes the mating strategies that individuals adopt in their natural environments. The hormonal basis of sex remains the evolutionary question, and sexual behavior and reproductive strategies are the ecological ones (Jolly 1985). The strategy balances costs and benefits of reproductive activities (Keverne 1989). The strategies associated with mating and bearing and caring for the young are the essential features of reproduction, and the patterns particular species adopt are influenced by features of the environment. Life history variables and reproductive parameters of wild population are also important, for practical reasons, to evaluate the condition of populations and to understand the adaptive value of the traits in life history (Dunbar 1988).

Capped langurs are indigenous to northeast India (Borang 1995; Choudhury 1989; Srivastava 1999). Their global distribution is restricted in Bangladesh, northwestern Myanmar, Bhutan, and Southern China (Ahsan 1994; Khan and Ahsan 1986; Roonwal and Mohnot 1977; Stanford 1991; Srivastava 1999; Zhang *et al*. 1981). There had been no study on reproduction in a wild population of capped langurs in India or elsewhere since Stanford's (1991) preliminary study on their reproductive ecology in Bangladesh. Different researchers have studied reproductive aspects of various other colobine species: *Trachypithecus vetulus* (Harvey *et al.* 1987; Rudran 1973); *T. geei* (Subba 1989; Subba and Santiapillai 1989); *T. johnii* (Roonwal and Mohnot 1977; Sunderraj 2001); *T. obscurus* (Badham 1967; Burton 1984; Hrdy and Whitten 1987); *Presbytis femoralis* (Bennett 1988; Pitra *et al.*1995); *P. thomasi* (Kunkun 1986); *Nasalis larvatus* (Gorzitze 1996; Yeager 1990); *Semnopithecus entellus* (Agoramoorthy 1987, 1991; Borries *et al*. 1991; Koenig and Borries 2001; Nikolei and Borries 1997; Rajpurohit and Sommer 1991; Srivastava *et al.* 1991). Among Colobinae, reproductive behavior of *Semnopithecus entellus* is the most studied.

We are the first researchers to gather vital information on aspects of the reproductive strategy of wild capped langurs.

Materials and Methods

Study Site

We conducted the study at the Pakhui Wildlife Sanctuary, between 92° 7.5′ – 92° 22′ E and 26° 3.7′ – 27° 16.2′ N. It is an area of 861.95 km^2 in East Kameng District, Arunachal Pradesh. The sanctuary is naturally surrounded by the rivers on 3 sides and shares a common boundary with the Nameri National Park, in Assam on the fourth side. It receives an average annual rainfall of 2545 mm. The mean annual maximum temperature is 28°C and the minimum is 19°C. Average relative humidity is 84%. The latitudinal variation ranges from 100 m to 2040 m above sea level. The sanctuary has a rich varied flora: tropical evergreen forests, tropical semievergreen forests and subtropical forests (Champion and Seth 1968). Secondary forest is also present along the margin of the sanctuary (Datta 2000). Researchers have recorded

234 woody species of flowering plants (angiosperms) from the lowland areas of the sanctuary. The sanctuary is rich in biodiversity; it harbors several rare and endangered species of flora and fauna. Four species of primates (*Macaca mulatta, M. assamensis, Trachypithecus pileatus*, and *Nycticebus bengalensis*) live in the sanctuary.

Study Groups

We collected data on reproductive strategy from 4 groups of *Trachypithecus pileatus* during September 2001–August 2003 (Table I).

Observations

Kumar followed HP1 from dawn to dusk to observe their sexual activities for 10–15 consecutive days each month during the first fortnight of the month. We observed 3 other groups —HP2, KHR, and WB— for 5 d/month per group on the same site where we collected information on births. We collected quantitative data on sexual solicitation, mounting, duration of mount, interval between mounts, frequency of mounting, and temporal distribution of mounts via sampling *ad libitum* per as Altmann (1974) and estimated the gestation length as per Altmann *et al.* (1977) suggested. We recorded the births in the group ≤10 d from their occurrence because it is difficult to have the exact date and time of birth in natural populations. We based the birth rate calculation on the number of births in all the groups in a year per the formula of Rajpurohit *et al*. (1994). We also recorded postcopulatory activities via focal individual sampling (Altmann 1974) with 5-min intervals.

Results

Sexual Solicitation

We recorded a total of 34 events of sexual solicitation by HP1. On 12 occasions male responded positively to solicitations initiated by estrous females. On 5 occasions he also solicited females via a physical display, viz., spreading his hind limbs to expose his erect penis toward the female.

Table I Sizes and age-sex composition of study groups

Troop name	AdM	AdF	SAdM	SAdF	J	I	Total
HP1	1	5	-	1	-	1	8
HP2	2	4	-	-	1	-	7
WB	1	4	-	1	2	-	8
KHR	1	5	1	1	-	1	9

AdM = adult male; AdF = adult female; SAdM = subadult male; SAdF = subadult female; J = Juvenile; I = Infant.

Mating Behavior

Details of mating behavior—mating season, percentage of copulatory mounts per mo, and categories of mounts— are in Fig. 1. Mating took place in 2 seasons: September–January and April–May. The highest percentage of copulatory mounts occurred in November. Both successful copulatory mounts (SCM) and unsuccessful copulatory mounts (UCM) occurred during the study. A total of 107 copulatory mounts occurred during the observation period: 61% were unsuccessful and 39% were successful. SCMs are significantly less (t=2.520, df 6, p<0.05) than UCM. The maximum number of mounts (27.7% UCM and 23.8% SCM) occurred in November and the minimum number (6.2% UCM and 4.8% SCM) in December. The mean length of SCMs, combining both the mating seasons, is 21.98 ± 2.50 s. The maximum length of SCM (31.20±8.07 s) is in November and the minimum (11.50± 1.22 s) in September (Table II). The monthly variation in total time taken during successful copulation is insignificant (F=1.649, n= 42, p<0.163).

Capped langurs have a distinct temporal pattern of copulatory attempts (Fig. 2). SCMs and UCMs were more frequent in the morning (0600–1000 h) followed by evening (1400–1800 h) ones. Langurs made fewest copulatory attempts during midday. The maximum copulatory episodes occurred between 8000 and 9000 h. During postcopulatory activities, males and females groomed each other and fed and rested together. Males were groomed longer (24.52±0.86 min) than females (18.43± 0.99 min) and rested (41.98±2.69 min) more than females (35.57±2.18 min) did.

Birth Rate and Birth Seasonality

A total of 17 births occurred in all groups. The number of births varied from troop to troop and year to year. WB and KHR exhibited the highest birth rate (0.50 infant/ female/yr) and HP2 had the lowest birth rate (0.25 infant/female/yr) (Table III). The mean birth rate from the 4 focal groups was 0.386±0.043 births/female/yr.

All births occurred December 19–April 26. The birth season was *ca.* 129 d. February and March were the peak birth months; 53% of births occurred then: 5

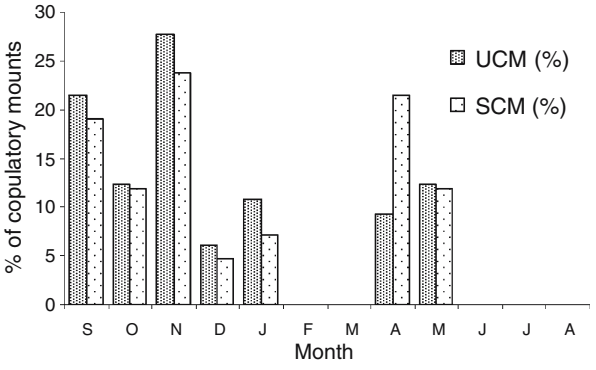

Fig. 1 Monthly distribution of copulatory mounts.

Table II Total and average time spent (s)/mo copulating and no. of successful copulatory attempts

Month	No. of pairs observed	No. of SCM	Total time spent in copulatory mount (sec)	Average time spent/copulatory mount (s)
SEP	3	8	92	11.50±1.22
OCT	2	5	97	19.40±1.96
NOV	2	10	312	31.20±8.07
DEC	1	2	33	16.50±4.50
JAN	1	3	74	24.66±4.81
FEB	—	—	—	—
MAR	—	—	—	—
APR	2	9	218	24.22±1.0
MAY	2	5	132	26.4±3.23
JUN	—	—	—	—
JUL	—	—	—	—
AUG	—	—	—	—
	13	42	958	21.98±2.50

(29.4%) in March and 4 (23.5%) in February (Fig. 3). No birth occurred from May to November. The sex ratio was 1:1.67 (M:F) among the infants of known sex. Gestation varied from 196 to 205 d, and average gestation was 200 d, based on 4 females.

Discussion

Sexual solicitation is a very important aspect of reproductive behavior, initiates pairing for successful breeding. In wild capped langurs, the female solicits the male to mount (Islam and Husain 1982; Stanford 1991). Various modes of female solicitation occur in wild capped langurs: head-shaking, presenting to male, and raising a forelimb. Head-shaking is also a common mode of solicitation in other colobine species: *Trachypithecus vetulus* (Rudran 1973), *T. johnii* (Poirier 1970), and *Nasalis larvatus* (Estes 1991). However, solicitation can lead to aggression when a

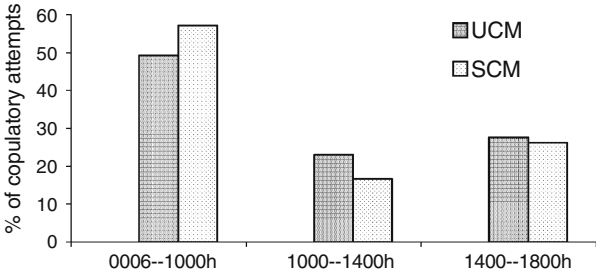

Fig. 2 Temporal distribution pattern of copulatory attempts.

Table III Birth and birth rate from 4 focal groups September 2001–August 2003

Year	Group identification	Group size	Adult females	Births	Birth rate
2001	HP1	8	5	1	0.20
	HP2	7	4	1	0.25
	WB	8	4	2	0.50
	KHR	9	5	3	0.60
2002	HP1	9	5	2	0.40
	HP2	8	4	1	0.25
	WB	10	4	2	0.50
	KHR	12	5	2	0.40
2003	HP1	11	6	2	0.33
	HP2	9	4	1	0.25
Mean	HP1	9	5	1.00	0.31
	HP2	9	4	2.00	0.25
	WB	9	4	2.50	0.50
	KHR	10.5	5	1.00	0.50

dominant male tries to initiate sex. Dominant males often threaten or chase females before mating with them.

Mating is seasonal in *Trachypithecus pileatus*. The length of the mating season (September–January and April–March) in Pakhui WLS (Fig. 1) is different from that in Bangladesh (October–February and April: Stanford 1991). Mating did not occur during the rainy season in either population. The majority of births in *Trachypithecus pileatus* occurred between December and April; the maximum births occurred in March (Fig. 3). The habitat type, condition, and its seasonal pattern might have influenced the season of birth. The birth season in Pakhui capped langurs was related to food availability. The flora of Pakhui WLS is represented by 137 plant species, of which 53 (39%) are food plants (Solanki 2003 unpublished report). The broad range of food plant species indicates the richness of the habitat. The diversified diet that individuals derived from the food plants comprised fruits from 24 species, young leaves from 22 plants, flower and flower buds from 13 species, and mature leaves from 6 species. During the birth season females spent 54.2% of total feeding time on young leaves, 19.2% on flowers and flower buds, and 15.5% on fruits. Capped

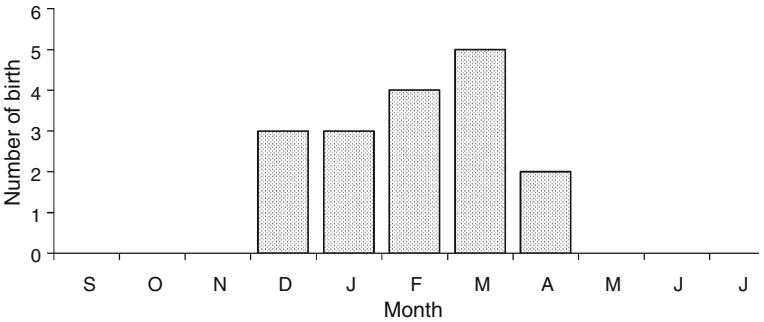

Fig. 3 Distribution pattern of capped langu's births.

langurs devoted the majority of their feeding to young leaves of *Ficus gomerata*, *Morus leviegata*, *Gmelina arborea* and flowers of *Sterculia villosa, Bombax ceiba*, and *Albizzia lucida* during the peak period of births. The feeding pattern changed during the postbirth season (May–July), when subjects devoted 70% of their time eating young leaves and 14.5% to fruits.

Probably the most important factor for any species in the regulation of lifetime fertility is the interval between successive births. The time the species takes to enable their young to fend for themselves and gestation length are important factors in determining birth interval (Short 1985). The normal interbirth period in wild populations of Pakhui capped langurs is 23 months and 10 d, which is close to the interbirth period (24 mo) in the capped langur population in Bangladesh (Stanford 1991). Rudran (1973) reported 22–25 months as the interbirth period for *Trachypithecus vetulus*, which is also similar to that of the Pakhui population. The few field studies on colobine birth intervals and timing of births in *Semnopithecus entellus* support the hypothesis that the number of births in a population correlates with habitat seasonality (Jay 1963). Boggess (1976), and Bishop (1979) tested the hypothesis on Himalayan and non-Himalayan populations of *Semnopithecus entellus*. Studies on a non-Himalayan population of *Semnopithecus entellus* by Agoramoorthy (1991), Harley (1985), Hrdy (1977), (Sommer *et al.* 1992), Sugiyama (1967), and (Winkler *et al*. 1984) also confirm the relationship.

Gestation length is one of the important features to assess the reproductive potential of a species. The variability in the gestation length between the species is enormous (Short 1985). The average gestation length for capped langurs at Pakhui WLS is 200 d (196–205 d), which is very similar to that of *Semnopithecus entellus* (199–204 d) as reported by Agoramoorthy (1991) and (Sommer *et al.* 1992) and 202 d for *Trachypithecus vetulus* (Harvey *et al*. 1987; Rudran 1937). Gestation length of the capped langurs was also higher than that of other primate species such as *Cebus apella*: 151–155 d (Janson 1984; Nagle and Dinari 1983); *Macaca leonina*: 160 d (Feeroz 2003); and *Papio cynocephalus*: 181.5 d (Bentley-Condit and Smith 1997). Two births in capped langurs occurred during the day (Kumar *et al*. 2005).

Two very distinct mating seasons, September–January and April–May, and the birth season, December–March, are the very vital periods for survival of the species. The frequency and duration of copulation were greater in November. Maximum births occurred during February and March. Any disturbance on the habitat during the mating and birth seasons, and more specifically, in November, February, and March, could affect the success of breeding in the langurs. The vital data on different aspects of reproduction in capped langurs will be very useful for the management of their population and conservation in the wild and more so in captive breeding programs.

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