ROLE OF MOTHER AND ALLOMOTHERS IN INFANT INDEPENDENCE IN CAPPED LANGUR *TRACHYPITHECUS PILEATUS*

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We investigated the mother-infant relationship and allomothering in Capped Langur *Trachypithecus pileatus* in Pakhui Wildlife Sanctuary, Arunachal Pradesh, India, from July 2001 to June 2003, based on observations of five mother-infant pairs. Infants spent 75% of the time on ventro-ventral contact during the first three months, 71% of which was on nipples in the first month, which decreased gradually thereafter. The time of contact with mother varied significantly ($p< 0.01$) across the months. A significant negative correlation (Pearson: $r = -0.963$, $p <0.01$) was found between the time infants spent with mother with increase in age (n=5 mother-infant pairs; 60 observations). Infants started straying away from mothers at around 16 days of age, and moved away as far as 3 m at the age of 30 days. The distance away from the mother increased up to 5 m at the age of 3 months, and they spent about 20% of their time away from the mother at the age of a year. Neonates spent 9.2% of the day with allomothers, and this increased to 25% for the next 15 days. It decreased gradually from the second month, and allomothering was not observed from the eighth month. The process of infant's independence started at the age of 6–8 months and was completed by 12 months, with infants spending 80% of their time away from the mother.

Key words: Allomothering, Capped Langur, mother-infant relationship, maternal rejections, ventro-ventral contact

INTRODUCTION

Primate infants are born dependent on their mothers (Strier 2007) and mothers play a significant role throughout the offsprings' lives (Hrdy 1999). The mother-infant relationship and parental care has special significance in mammals because it ensures the survival of infants and sets the stage for relations among the members of the troop. A long period of postnatal development is a characteristic feature of primates. Newborns depend on their mothers for nutrition, transport, protection, and mothers also help them to develop skills to become independent and integrate within the society (Förster and Cords 2002; Harlow and Harlow 1965; Hinde and Spencer-Booth 1967; Jensen *et al*. 1967; Xi *et al*. 2008).

The other important aspect of social behaviour in colobines is an affiliation between allomothers and infants (Horwich and Manski 1975; Jay 1963; Kumar *et al*. 2005; McKenna 1979, 1981; Stanford 1992; Vogel 1984). The relationship of mothers and allomothers with infants in the group leads to the growth and development of an infant in a socially coordinated manner (Kumar *et al*. 2005). It has been argued that allomothers provide assistance to the mother so that she can have time for foraging (Stanford 1992; Vogel 1984; Xi *et al*. 2008); infants learn to manage in the absence of their mothers, which ensures proper socialization with others members of the troop (McKenna 1981); and immature females of the troop also get an opportunity to handle infants (Hrdy 1976; Lancaster 1971). The mother may derive benefits from the allomothers' cooperation in territorial defence, in anti-predation, and save on time and energy that can be devoted for infant care (Garber *et al*. 1984; Koenig and Rothe 1991). Allomothering thus increases the chances of the infant's survival. The development of mother-infant relationship in nonhuman primates also influences the ontogeny of social behaviour (Nicolson 1987).

Studies on mother-infant relations and infant development in captive and free-ranging Old World monkeys have concentrated mainly on *Macaca mulatta* (Berman 1980a, b, 1990, 1992; Berman and Kapsalis 1999; Maestripieri 1994a, b, 2001; Simpson 1985; Stevenson-Hinde and Simpson 1981), *M. silenus* (Krishna *et al*. 2008), *M. radiata* (Singh *et al*. 1980) and *M. fuscata* (Schino *et al*. 1993, 1995, 2003; Schino and Troisi 2001). Other primate species studied are *Papio* spp. (Altmann 1980; Nash 1978), *Cercopithecus aethiops* (Fairbanks and McGuire 1985; Lee 1984; Struhsaker 1971), *C. mitis stuhlmanni* (Förster and Cords 2002), *Cercopithecus neglectus* (Kirkevold and Crockett 1987), *Presbytis entellus* (Dolhinow and Murphy 1982), *Cebus capucinus* (Manson 1999), and *Callimico goeldii* (Schradin and Anzenberger 2001). Studies on mother-infant relationships and behaviour development of infants are scarce on colobine monkeys (Horwich 1974a, b; Horwich and Manski 1975; Jay 1963; Medhi 2004; Sugiyama 1965). To

help fill in this lacuna, we undertook a study on the mother-infant relationship and allomothering in the Capped Langur in Pakhui Wildlife Sanctuary, Arunachal Pradesh, India.

The Capped Langur *Trachypithecus pileatus* is restricted to Northeast India, Bangladesh, north-western Myanmar, Bhutan, and southern China (Ahsan 1994; Khan and Ahsan 1986; Roonwal and Mohnot 1977; Srivastava 1999; Zhang *et al*. 1981). It is largely folivorous and a canopy dweller (Choudhury 1989; Stanford 1991), lives in a troop of 5–8 individuals, mainly with one-male multi-females composition. The Capped Langur is designated an endangered species in India (Walker and Molur 2007) because the population and troop size are becoming smaller due to fragmentation and loss of habitat, and use of its flesh and body parts in traditional healthcare and socio-cultural practices (Kumar and Solanki 2004). The Capped Langur falls under the Vulnerable category (A2cd+3cd, ver 3.1) as per IUCN (2013) Red List.

MATERIAL AND METHODS

Study Site

Pakhui Wildlife Sanctuary (26º 3.7′–27º 16.2′ N; 92º 7.5′–92º 22′ E; 862 sq. km) is located in East Kameng district of Arunachal Pradesh. The Sanctuary is surrounded by rivers on three sides, namely Kameng in the north and west, and Pakke in the east, and shares a common boundary with Nameri National Park, Assam. It receives an average annual rainfall of 2,545 mm. The annual mean maximum temperature is 31º C, and the mean minimum temperature is 18º C. Average relative humidity is 84%. The altitudinal variation ranges from 100 m to 2,040 m above sea level (Solanki *et al*. 2008). The Sanctuary harbours different vegetation types, namely tropical evergreen forest, tropical semi-evergreen forest, and subtropical forests (Champion and Seth 1968). A total of 234 woody species of flowering plants (angiosperms) have been recorded from the lowland areas of the Sanctuary.

Several rare and endangered species of fauna inhabit the Sanctuary. There are four species of primates: *Macaca mulatta, M. assamensis*, *Trachypithecus pileatus*, and *Nycticebus bengalensis*. The ungulates comprise Gaur *Bos frontalis*, Barking Deer *Muntiacus muntjak*, Sambar *Cervus unicolor*, Goral *Naemorhedus goral*, Wild Goat *Capricornus sumatraensis*, and Wild Pig *Sus scrofa*. The Asian Elephant *Elephas maximus* and Tiger *Panthera tigris* also occur. The Sanctuary is also rich in avifauna with 257 bird species, including four species of hornbills (Datta *et al*. 1998; Singh 1991, 1994).

Study Animals

Two well-habituated troops of Capped Langur (HP1 and HP2) were observed for a period of two years (July 2001 to June 2003). Initially, group HP1 comprised eight individuals (1 adult male, 5 adult females, 1 subadult female and 1 infant) and HP2 comprised seven individuals (2 adult males, 4 adult females and 1 juvenile). Five infants (2 females and 3 males) were born between December 2001 and March 2002 in these troops. All the five infants were selected and observed for 12 months to understand their social interactions and activity patterns with their mothers and allomothers in the troop. Each mother and her infant were identified on the basis of facial, physical and other features like the shape of the tail hairs. A summary of the age and sex of the selected infants is provided in Table 1.

Table 1: Name of infant/mother, and sex and date of birth of infant

Infant's name / Mother's name	Sex of infant	Date of Birth
HP1-I / HP1A	Female	23.12.2001*
HP1-II / HP1B	Female	02.02.2002 (- 2days)**
HP1-III / HP1C	Male	05.03.2002 (- 4days)**
HP2-I / HP2A	Male	18.01.2002 (- 5days)**
HP2-II / HP2B	Male	11.02.2002*

*Birth observed; ** Estimated birth date – based on sighting date of newborn.

Table 2: Types of interaction recorded between mother and infant, and infant and allomothers

	Interaction categories		Description
1.	Time in mother's contact	:	Time an infant spent in ventro-ventral or in any other type of body contact (including nipple contact).
2.	Time off <3 m away from mother	:	Time that infant remains within 3 m of the mother.
3.	Time off >3 m away from mother	:	Time that infant remains more than 3 m away from the mother.
4.	Maternal restriction	:	Number of times/hour the mother restrained the infant from moving away, or pulled the infant back after it strayed.
5.	Maternal rejection	:	Number of times/hour the mother pushed the infant away from her or denied nipple access.
6.	Allomothering	:	Infants being taken care of by non-mother females

Data collection and analysis

The observations were recorded by the first author with binoculars from a distance of 10–30 m. The data on mother-infant relationships and allomothering were collected through focal sampling with a 5-min sampling interval (Altmann 1974) for all the five mother-infant pairs for 12 months from the birth of the infants. Total 660 scans were collected for the selected pairs per month.

Instantaneous recording included noting the number of times the mother prevented her infant from moving away, and rejecting the infant when it tried to access her nipples (Martin and Bateson 1993). At each sampling interval, we recorded 6 types of behavioural interactions between the mother and infant, and infant and allomothers (Table 2). These behavioural interactions are well-described by Horwich and Manski (1975), Berman (1980a), Förster and Cords (2002), and Schino *et al*. (2003).

RESULTS

Pattern of infant-mother contact

Infants (n=5) spent about 75% of their time in contact with the mother during the first three months (Fig. 1). Subsequently, contact time with the mother decreased gradually with increase in age. When infants were 12 months old, the average time spent with the mother was 18% (±3.1). A significant negative correlation (Pearson: r = -0.963, $p < 0.01$) was found between the time infants spent with mother with increase in age (n=5 mother-infant pair; 60 observations). On the 16th day, infants started straying away from their mothers. When about 30 days old, infants spent about 3% of their active time straying (< 3 m) away from mothers. This distance increased with the age, with the distance strayed away from the mother increasing to 5 m at the age of 3 months. The incidences of straying for the

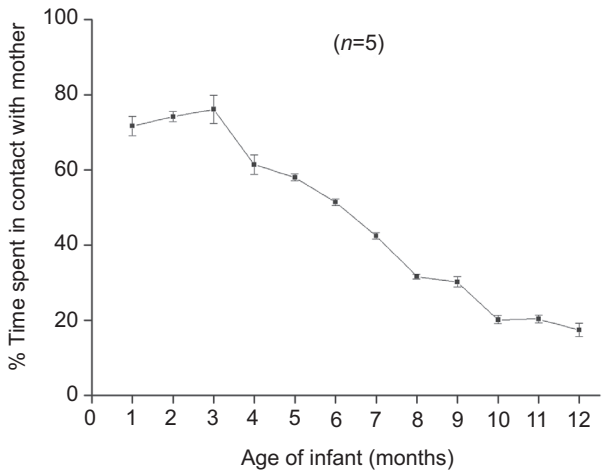

Fig. 1: Time infants spent (%) in contact with mother with age

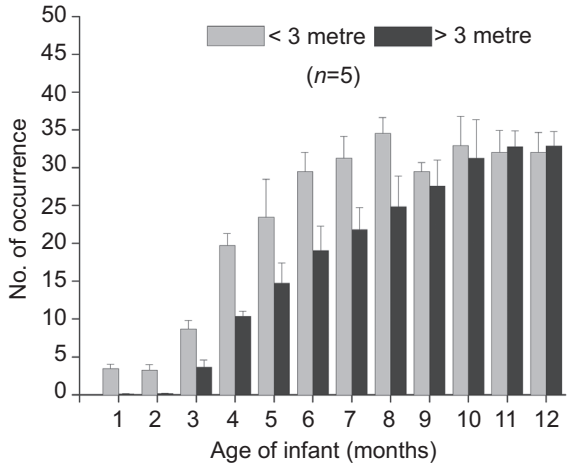

Fig. 2: Distances infants strayed away from mothers with age

< 3 m and > 3 m distance categories analysed showed an increase with the months (Fig. 2), which were statistically significantly (t test; t=2.3; p<0.05). Infants, by the age of 12 months, spent about 32% of their active time away from mothers.

Maternal restrictions and rejections

Mothers restricted the movements of infants in their early stages of life. Such restrictions were observed on 22 occasions, when infants were a month old. These restrictions reduced gradually with age, and mothers hardly restricted the infants when they were about six months old (Fig. 3).

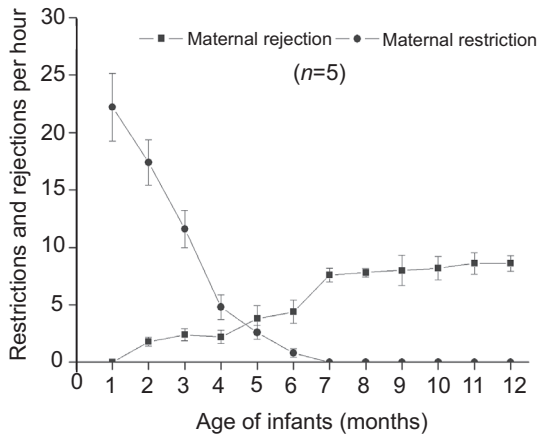

Fig. 3: Maternal restriction and rejections with age of infant

Mothers also discouraged infants' access to their nipples with age. The rejections started at the age of 2 months, and gradually reached around 7.4 (± 1.3) rejections/hour at 9 months of age. Thereafter, rejections were stable at between 8.8–9.2 rejections/hour until 12 months of age (Fig. 3).

Allomothering

We observed two live parturitions during the study, and allomothering was observed three hours after these births.

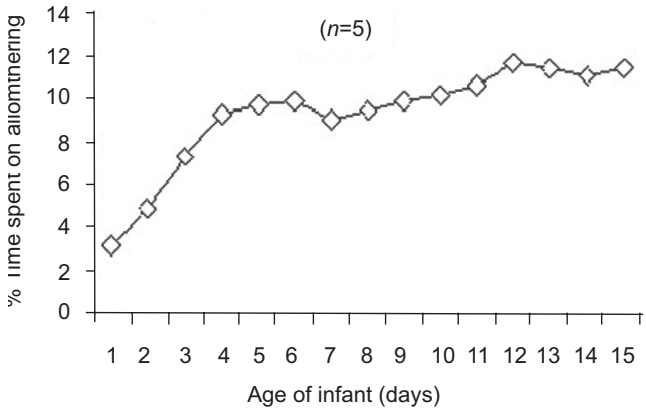

Fig. 4: Mean time spent (%) /day by neonates with allomothers

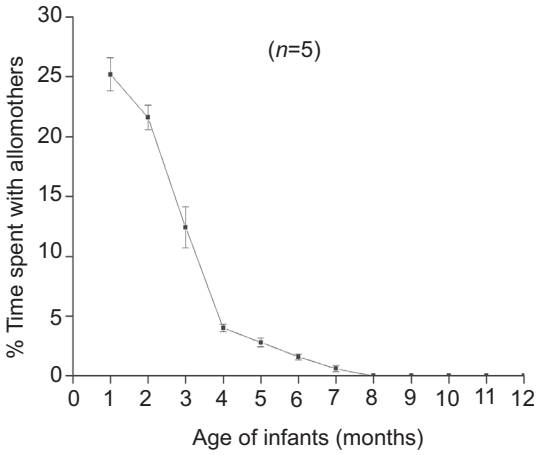

Fig. 5: Mean time spent (%) /month by infants with allomothers

Neonates were tended by three allomothers (individually) for an average of 9.2% (*n*=2) of the day during the first 15 days, and allomothering increased gradually till 15 days (Fig. 4). Considering the data on all five infants, it was found that the average time infants spent with allomothers constituted one-fourth of the daylight hours (25.34 ±2.84 %) during the first month (Fig. 5). After this, the association with allomothers decreased gradually, constituting about 5% in the fourth month, and was observed only on rare occasions in the seventh month; allomothering was not recorded in the eighth month (Fig. 5).

DISCUSSION

The early relationship between infants and their mothers is determined through the mothering style that varies among the individuals within a group, and also with different primate species. The difference is derived from the mother's prior experience in rearing infants and her rank in the group (Förster and Cords 2002). In this study on Capped Langur, maternal attachment and protection lasted about three months, and during this period, infants spent 75% of their time in ventro-ventral contact. During this period, the mother kept her newborn in close physical contact and never refused the infant's demands for contact and access to her nipples, and frequently restrained the attempted movements of the infant away from her during the first two months. Wild primate mothers carry their neonate wherever they move individually or in a social troop (Simonds 1974), barring members of Strepsirrhini. The neonate is generally too weak and physically uncoordinated in holding the mother when she walks. Therefore, the mother either holds it on her lap while sitting, or clinches it to her belly when she moves. In the Capped Langur, the mother holds the neonate in a ventro-ventral position with one forelimb and walks on three limbs during the 10 initial days after parturition (Kumar *et al*. 2005). To move between trees separated by some distance, the mother comes down to the ground instead of jumping.

Hinde and Atkinson (1970), Hinde and Spencer-Booth (1967), and Berman (1980b) related the degree of independence of the infant with the duration an infant remains away from the mother. We observed a similar trend with the degree of independence being related to the time spent away from the mother, and also by the distance kept away from her with age. Zothansiama (2013) also reported on the variations in distances kept away from the mother with age in captive Stump-tailed Macaque *Macaca arctoides* in India. The independence of an infant is controlled by the mother's behaviour to seek contact and proximity with the infant (Berman 1980a). With increase in age of the infant, the mother actively participates in developing independence in her infant by rejecting its attempts to contact her. In our study, Capped Langur mothers were recorded to reject the infants' demand for contact nine times in an hour at the age of 12 months, and they took a progressively smaller role in maintaining proximity and contact. The restrictions on moving away were more stringent in the early stage of the infant. Förster and Cords (2002) also recorded a similar pattern of maternal restriction in Blue Monkey. Thus, the mother ensures safety and also provides an opportunity to the infant to learn about the natural environment.

Kumar *et al*. (2005) observed live parturition in Capped Langur and recorded frequent allomothering of newborn that was of a few minutes duration only. However, Fairbanks (1989) and Berman (1990) indicated that mothers were less possessive and protective, and allowed allomothers to hold older infants longer than smaller ones. The mother's role in the infant's independence is often measured by the number of rejections an infant receives from the mother at the time of suckling (Altmann 1980; Förster and Cords

2002; Maestripieri 1995). Maternal rejections in our study were observed from the second month of the infant, and the frequency of rejections increased with the age of the infant, which is similar to Rhesus Macaque *Macaca mulatta* (Berman 1980a, 1990) and Blue Monkey *Cercopithecus mitis* (Förster and Cords 2002). In Bonnet Macaque *Macaca radiata*, the frequency of nipple contact drops by 50% after the second week of birth and the process for environment exploration begins at this stage, which gets completed at 12–15 months (Singh *et al*. 1980). However, in Lion-tailed Macaque *Macaca silenus*, there is sudden increase in nipple contact till the age of five and a half months; thereafter, there is a sharp decline in infants making nipple contact (Krishna *et al*. 2008).

Allomothering or infant transfer among the females of a troop is a prominent feature of several colobine species (Agoramoorthy 1991; Bernstein 1968; Hill 1972; Hrdy 1976; Jay 1962, 1963; Kumar *et al*. 2005; Prakash 1961; Poirier 1968; Quiatt 1979; Riedman 1982; Sugiyama 1965, 1967; Tanaka 1965; Wooldridge 1969), and allomothering is more common in colobine species than in Cercopithecines (Newton and Dunbar 1994). In the Capped Langur, maternal ambivalence phenomenon was observed on the first day of infant's life, just after three hours of postpartum (Kumar *et al*. 2005). Studies on several colobine species, including *Presbytis entellus* (Dolhinow 1982; Scollay and DeBold 1980; Sugiyama 1965; McKenna 1981), *P. johnii* (Poirier 1968), *P. pileata* (Stanford 1992), and *Colobus guereza* (Horwich and Manski 1975) have shown maximum allomothering occurring in the first month of the infant's age. We found it to be frequent (25%) in the Capped Langur in the first few months, gradually declining, and allomothering was not observed after the sixth month. Allomothering in the youngest stage does not occur normally among Cercopithecines, and newborn infants are only allowed to be touched or groomed by other members of the troop in later stages of life (Lancaster 1971; Rowell *et al*. 1964; Sugiyama 1965), but in Capped Langur, other members of the troop are also allowed contact with infants immediately after birth (Kumar *et al*. 2005). Capped Langur allomothers frequently interact with infants when they are with their mothers, the mothers passing on their infants mostly to adult females and occasionally sub-adult females of the troop. Infant handling by allomothers is primarily decided by the mother of the infant. Capped Langur mothers rarely attempted to retrieve infants from allomothers, which helps socialization in the infant. It appears that in this way, mothers try to cultivate a sense of independence in the infants. The mother's reinforcement behaviour is noticed in the form of rejection of nipple contact and relaxing restrictions on the infant's movement away from her, making the infant independent at the age of 6–8 months. At 12 months, infants remain 80% of time away from mothers and move away up to five metres, and spend 20% of the time with mothers. Thus, infants build their confidence by being independent in the natural environment, and can explore it for better survival.

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