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Short communication

Preliminary observations on the differences in reproductive behaviour between breeding and non-breeding captive lion-tailed macaques (*Macaca silenus*) housed in Indian zoos

Avanti Mallapur [a,b,1,*], Natalie Waran [a], Shirley Seaman [a], Anindya Sinha [b]

[a] *Animal Behaviour and Welfare Group, Division of Veterinary Clinical Studies, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Easter Bush Veterinary Centre, Easter Bush, Roslin, Midlothian EH25 9RG, UK*
[b] *Culture, Cognition and Consciousness Unit, National Institute of Advanced Studies, Indian Institute of Science Campus, Bangalore, Karnataka 560012, India*

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Abstract

Rearing history and levels of abnormal behaviour exhibited by lion-tailed macaques housed in Indian zoos was found to influence their ability to breed. Proven breeders were born in zoos while the non-breeding individuals were confiscated from private owners. Proven breeders also exhibited significantly lower percentages of abnormal behaviour and higher levels of social interactions and autogrooming when compared to the non-breeding macaques. These differences may have been due to non-breeders being housed in isolation and in contact of humans. This could have had an influence on the development of reproductive and social behaviours during the early stages in their lives.

Keywords: Animal welfare; Reproductive behaviour; Rearing history; Lion-tailed macaque; Zoo; India

* Corresponding author at: 800 Bearses WAY, 2 East B Cape Crossroads, Hyannis 02601, Massachusetts, USA. Tel.: +1 508 364 3296/6802.
E-mail address: avantim@yahoo.com (A. Mallapur).
[1] Tel.: +91 80334 4351; fax: +91 80334 6634.

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1. Introduction

The lion-tailed macaque is an endangered species (Nameer et al., 2001) endemic to the tropical rainforests of the Western Ghats in southern India (Singh et al., 1997). In the 1980s, when population numbers were dwindling in the wild, scientists decided that the species required sanctuary in captivity (Foose and Conway, 1985). National and regional breeding programmes were set up in America and Europe.

Conservation breeding programmes such as these are used to complement in situ conservation efforts to save species that are on the verge of extinction (IUDZG/CBSG (IUCN/SSC), 1993). In Indian zoos however, the breeding programme for the lion-tailed macaque proved unsuccessful even though the lion-tailed macaques were distributed across 18 zoos in country. The main reason for the failure of the breeding programme is the low number of breeding females in the Indian captive population. The current situation of lion-tailed macaques in Indian zoos suggests that further research needs to be conducted in order to identify the factors the have a detrimental influence breeding and reproductive behaviour in this species, especially the females. The aim of this study was to identify the factors that influence reproductive behaviour and social behaviour in lion-tailed macaques housed in Indian zoos. The differences in reproductive behaviour between non-breeding lion-tailed macaques and proven breeders were recorded to help identify these factors.

2. Methodology

This behavioural study was conducted on seven non-breeding and three breeding groups, and 10 singly-housed individuals housed in 12 Indian zoos (Table 1). Observations were conducted between July 2002 and December 2003.

At each zoo, the individuals were studied for a period of nine hours during the day between 08:30 and 17:30 h. Each behavioural sampling session was initiated with an instantaneous scan (Martin and Bateson, 1994). This was followed by a focal animal sample (Martin and Bateson, 1994) of one of the individuals in the group for a duration of 15 min (refer to methodology and ethogram in Mallapur et al., 2005). The next scan was conducted after the completion of this focal animal sample.

2.1. Data analyses

Each individual's breeding status was ranked for analysis (Table 2). These ranks were then used to analyse the differences between breeding and non-breeding individuals. The Mann–Whitney *U*-test was used to compare behavioural data from breeding groups with those of non-breeding groups while the Kruskal–Wallis test was used for multiple comparisons of similar groups (Siegal and Castellan, 1988). To test for an association between rearing history and ability to breed, the Spearman's rank-order correlation was used (Siegal and Castellan, 1988). All P values that have been reported are two-tailed. SPSS (Version 7.5) was used to conduct the statistical analyses.

Table 1
The group compositions of captive lion-tailed macaque groups housed in the 12 study zoos in India

Zoo[a]	Number of lion-tailed macaques studied		Breeding history
	Group composition[b]	Total[c]	
AAZP	1:1:2[d]	2 (1:1:0)	Proven breeder [B[d]]
GCP	1:1:0[e]	2 (1:1:0)	Non-breeder [NB[e]]
JZ	1:1:1	2 (1:1:0)	Proven breeder
MBZ	**1:0:0**[f], 1:0:0, 0:1:1	3 (2:1:0)	Singly-housed individuals [SI[f]], proven breeder
MZK	**1:0:0**, **1:0:0**, 1:1:0	4 (3:1:0)	Singly-housed individuals, non-breeder
MZT	**1:0:0**, **0:1:0**	2 (1:1:0)	Singly-housed individuals
NBP	1:1:0	2 (1:1:0)	Non-breeder
NZP	1:1:0	2 (1:1:0)	Non-breeder
PZ	1:2:0	3 (1:2:0)	Non-breeder
SCZG	1:3:0	4 (1:3:0)	Non-breeder
SMZ	**1:0:0**, **1:0:0**, **1:0:0**	3 (3:0:0)	Singly-housed individuals
TZ	**1:0:0**, **1:0:0**, 1:4:0	7 (3:4:0)	Singly-housed individuals, non-breeder

[a] The full names of the zoos have been mentioned in Mallapur (unpublished).
[b] Refers to the number of sexually mature males: sexually mature females: young (infants and juveniles) at each zoo.
[c] The total number of animals observed at each zoo. Young were not observed for during this study.
[d] Groups that have bred over the past 5 years.
[e] Groups that have not bred over the past 5 years.
[f] Individuals that have been housed singly. These individuals are marked in bold in the group composition column.

Table 2
Ranks given to non-breeders, proven breeders and singly-housed individuals for analysing differences between them by using statistical tests such as Kruskal–Wallis

Rank	Males	Females	Group
Singly-housed individuals	0	0	0
Non-breeders	1	1	1
Proven breeders	2	2	2

3. Results

Females with proven breeding history (B) exhibited presenting without lipsmacking, which resulted in inspection towards other lion-tailed macaques, at significantly greater frequencies per hour in comparison to non-breeding females (NB, $U = 1.000$, $N = 13$ and 3, $P < 0.05$). B females also exhibited presenting with lipsmacking, which resulted in inspection towards lion-tailed macaques more frequently than NB females ($U = 0.000$, $P < 0.05$).

Non-breeding individuals exhibited bared-teeth display more frequently towards visitors and zoo staff than proven-breeders ($U = 20.000$, $N = 20$ and 6, $P < 0.05$). Similarly, B individuals also exhibited warning growl to conspecifics more frequently than NB animals ($U = 34.500$, $P < 0.05$). B individuals, exhibited total social interactions to a greater percentage than NB macaques ($U = 55.500$, $N = 20$ and 6, $P < 0.01$).

Auto-grooming was exhibited to a significantly greater percentage by breeding males in comparison to NB males ($U = 4.000$, $N = 7$ and 3, $P \leq 0.05$).

When rearing history and percentage abnormal behaviour exhibited was compared across singly-housed lion-tailed macaques, proven breeders and non-breeding individuals, a significant difference was found. Proven breeders exhibited a significantly lower percentage of when compared to NB and singly-housed individuals ($\chi^2 = 11.21$, d.f. = 2, $N = 10, 20, 6$, $P \leq 0.005$). Rearing history ranks (for rearing history ranks, refer to Table 3 in Mallapur et al., 2005) were negatively correlated with ability to breed. The results showed that non-breeding individuals, especially the males, were confiscated in comparison to the proven breeders who were zoo-born ($\rho = -0.56$, $N = 36$, $P < 0.001$).

4. Discussion

In this study, there was a marked difference in the behavioural repertoires exhibited by non-breeding lion-tailed macaques and those with proven breeding history. Individuals who had bred in the past 5 years exhibited lower percentages abnormal behaviour. Most importantly, non-breeding individuals were confiscated from private owners while proven breeders were predominantly born in zoos.

In the case of the captive lion-tailed macaques in this study, females that had bred in the past exhibited social interactions and reproductive behaviours towards the males in their group to a much greater level than non-breeding females. The current inability to breed of groups in which either the male or female/s or both have been confiscated from private owners suggests that being reared in isolation and in the presence of humans could have deprived them of an appropriate social environment. In lion-tailed macaques, especially in the case of males, field biologists have observed that reproductive behaviours such as courtship and copulatory behaviour develop at an early age of 1–3 years (Sharma, personal communication). This early social deprivation could have led to the development of abnormal behaviours such as self-injurious behaviours and stereotypies, which may be due to the absence of species-specific environmental stimuli essential for the development of a natural behavioural repertoire.

Scientists have suggested that early social isolation from conspecifics (e.g. Anderson and Chamove, 1985; Chamove et al., 1984; Mootnick and Baker, 1994) or even specifically absence of mother-rearing (Hediger, 1964; Carlstead, 1996) could result in the absence of specific stimulation required for the normal development of behaviours, especially those that are social or reproductive in nature. In another study conducted on non-human zoo primates in India, macaques that were confiscated from private owners (reared in isolation and in human contact) exhibited abnormal behaviours and did not reciprocate courtship signals or behavioural sequences (Mallapur and Choudhury, 2003). Similar observations were recorded with the captive lion-tailed macaques in the present study, especially in the case of the males in non-breeding groups. In several cases, males were observed to mount females on their side or head, which clearly suggested that they did not know how to copulate (Mallapur, personal observation). Some males were observed to continuously ignore all observed accounts of presentation exhibited by female lion-tailed macaques in

the group, even when they were in peak oestrus. These males spent a considerable proportion of their time interacting with humans.

Human contact during the early stage of life could also pose a problem by leading to socialisation with humans. This could lead to the development of several behavioural patterns not found in free-ranging or mother-reared infants (Hediger, 1964; Carlstead, 1996; Mallapur and Choudhury, 2003; Mallapur, in press). In this study, captive lion-tailed macaques that were confiscated from private owners were observed to display aggressive behaviour such as bared-teeth face towards humans frequently even directing sexual behaviours towards them. Although both males and females exhibited these behaviours, males continued to do so even when one or more females in his group were in oestrus. Females, on the other hand, exhibited reproductive behaviours towards the males during oestrus. Mootnick and Baker (1994), recorded similar behaviours in their study on eight species of gibbons (*Hylobates*) and in another study on domestic cats (*Felis domesticus*) that were hand-reared (Mellen, 1992).

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References

Anderson, J.R., Chamove, A.S., 1985. Early social experience and the development of self-aggression in monkeys. Biol. Behav. 10, 147–157.

Carlstead, K., 1996. Effects of captivity on the behaviour of wild mammals. In: Kleiman, D.G., Allen, M.G., Thompson, K.V., Lumpkin, S. (Eds.), Wild Mammals in Captivity: Principles and Techniques. University of Chicago Press, Chicago, USA, pp. 317–333.

Chamove, A.S., Anderson, J.R., Nash, V.J., 1984. Social and environmental influences on self-aggression in monkeys. Primates 25, 319–325.

Foose, T.J., Conway, M., 1985. Models of population management of lion-tailed macaques resources in captivity. In: Heltne, P.G., Alan, R., Liss, C. (Eds.), The Lion-Tailed Macaque Status and Conservation. Academic Press, New York, USA, pp. 329–342.

Hediger, H., 1964. Wild Animals in Captivity. Dover Publications, New York, USA.

IUDZG/CBSG (IUCN/SSC), 1993. The World zoo conservation strategy: the role of the zoos and aquaria of the world in global conservation. Chicago Zoological Society, Chicago, USA, pp. 26–33.

Mallapur, A., in press. Managing primates in zoos: Lessons from animal behaviour. Curr. Sci.

Mallapur, A., Choudhury, B.C., 2003. Behavioral abnormalities in captive non-human primates. J. Appl. Anim. Welfare Sci. 6, 275–284.

Mallapur, A., Waran, N., Sinha, A., 2005. Factors influencing the behaviour and welfare of captive lion-tailed macaques (*Macaca silenus*) housed in Indian zoos. Appl. Anim. Behav. Sci. 91, 337–353.

Martin, P., Bateson, P., 1994. Measuring Behaviour. Cambridge University Press, Cambridge, UK, p. 222.

Mellen, J., 1992. Effects of early experience on subsequent adult sexual behaviour using domestic cats (*Felis catus*) as a model for exotic small felids. Zoo Biol. 11, 17–32.

Mootnick, A.R., Baker, E., 1994. Masturbation in captive *Hylobates* (gibbons). Zoo Biol. 13, 345–353.

Nameer, P.O., Molur, S., Walker, S., 2001. Mammals of the Western Ghats: a simplistic overview. Zoos' Print 16, 629–639.

Siegal, S., Castellan, N.J., 1988. Nonparametric Statistics for the Behavioral Sciences. McGraw-Hill, New York, 144.

Singh, M., Singh, M., Kumara, H.N., Ananda Kumar, M., D'Souza, L., 1997. Inter- and intra-specific associations of non-human primates in Anailmalai Hills, south India. Mammalia 61, 17–28.