



Grooming pattern in captive Macaques: A comparative study

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Abstract

A comparative study on grooming behavior was done on three species of macaques, namely, Assamese macaque (*Macaca assamensis*), rhesus macaque (*Macaca mulatta*) and northern pig-tailed macaque (*Macaca leonina*) under captivity in Aizawl Zoological Park, Aizawl, India. Observations were recorded by Focal Sampling Technique. Time spent on different acts of grooming, and grooming visible and non-visible sites was recorded. Generally 75% of the time was spent on removal of ectoparasite and skin flakes (hygiene related acts). The time spent on various grooming acts varied in different age and sex categories in all three species. Time spent on grooming visible and non-visible sites was more in the Assamese macaque. Time spent on visible and non-visible site by all age and sex categories in all three species was found to be significant ($p < 0.05$). The pattern of variations on grooming visible and non-visible area was similar in all the species. Time spent on grooming non-visible sites was more than on the visible sites. Adult males and females spent more time on grooming visible areas in all the species. Dissimilarity among macaque species and between age and sex category in grooming visible areas was significant. Grooming site preference is predisposed by the sex and age of individuals.

Key Words: Captivity, Grooming, Macaque species, Non-visible sites, Pattern, Site Selection, Visible sites

Introduction

Grooming refers to the act of treading and manipulation of the body surface (Hutchins and Barash, 1976; Tanaka & Takefushi, 1993) which encompasses all forms of care and attention (Saunders, 1988). It constitutes a major social activity in many species of social mammals (Mooring *et al.*, 1996; Hart, 2000; Heitor *et al.*, 2006) including rodents (Ferron and Lefebvre, 1982) and bats (Wilkinson, 1986). In primates, grooming is an integral part of life (Dunbar, 1988, 1991, 2010; Grueter *et al.*, 2013). Some species of macaques (such as *Macaca nemestrina*, *Macaca fascicularis*, *Macaca fuscata*, *Macaca mulatta*, *Macaca radiata*), larger apes such as bonobo (*Pan paniscus*), chimpanzee (*Pan troglodytes*), and baboon (*Papio cynocephalus*) devote as much as 20% of their total daytime for grooming (Sparks, 1967; Goosen, 1987; Dunbar, 1991; Lehmann *et al.*, 2007; Schino, 2007; Shutt *et al.*, 2007). The social functions of grooming include the establishment and maintenance of affiliative relationships and the reduction of tension and aggression between individuals (Terry, 1970; Saunders, 1988; Kimura, 1998; Kutsukake and

Clutton-Brock, 2006). In addition to its hygienic functions, grooming is generally considered to maintain social bonds between group members (Dunbar, 1988; Henzi and Barrett, 1999; Schino and Aureli, 2008). Grooming also has important direct health consequences for wellbeing of primates via removal of ectoparasites such as lice, fleas, and ticks (Freeland, 1981; Saunders and Hausfater, 1988; Tanaka and Takefushi, 1993; Eckstein and Hart, 2000; Hart, 2000; Zamma, 2002; Kutsukake and Clutton-Brock, 2006). Several factors affect grooming patterns in animals, one of which is kinship. Kinship explains a large fraction of the variance in grooming patterns (Schino, 2001; Chapais and Berman, 2004). Seyfarth (1977) suggested that grooming is also directed by dominance hierarchy (i.e. preferential grooming of high-ranking animals). Other studies have documented increased grooming down the hierarchy (O'Brien, 1993; Parr *et al.*, 1997; Lazaro-Perea *et al.*, 2004). These conflicting findings may result from differences in social and ecological contexts, which influence how resources are distributed in a social group. In different primate groups, participation in grooming bouts differs between the sexes and with life history stage. Some studies have considered grooming as a female-

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biased behavior established during the first year of life, with females grooming almost twice as often as males (Simonds, 1974; Young *et al.*, 1982). Females tend to form strong social bonds with other females (Wrangham, 1980) and grooming becomes a major contributory factor to these social bonds (Silk *et al.*, 2003, 2006, 2010). The age of an individual also plays a role in the amount of grooming received or given. In baboons, adult females initiate grooming bouts mostly (Saunders, 1988). Males provide important services, such as protection against infanticidal attacks and harassment (Smuts, 1985; Saunders, 1988; Silk *et al.*, 2003; Nguyen, 2012) by peripheral males, females may be motivated to groom males in return for these services. Most of these differences referred to natural populations which encounter varied ecological situations. In captivity, animals may be less constrained by ecological limits with reduced time constraints. Captive primates can devote large proportion of their time in grooming (Leve *et al.*, 2016). A study was planned to understand how different macaque species under similar environmental situation (in captivity) behave in grooming acts, and patterns. Do age, sex, and hierarchy in the captive groups exhibit specific preference in grooming site selection?

Materials and Methods

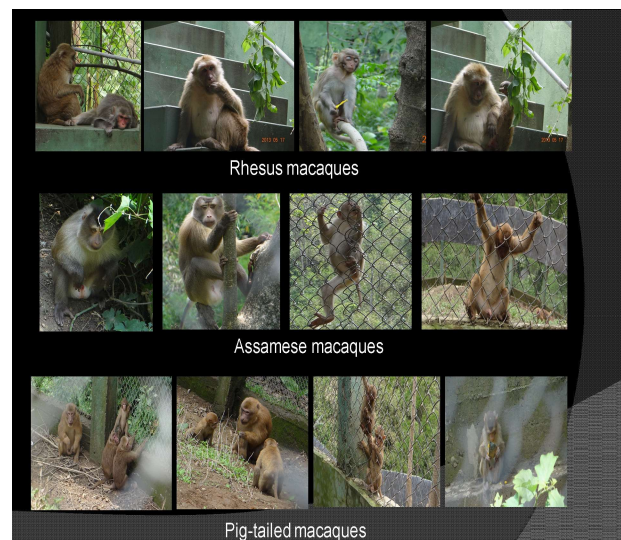
Subjects and study site

The study was conducted on captive primates inside the Aizawl Zoological Park, Aizawl, India. Seven species of primates: *Macaca mulatta*, *Macaca assamensis*, *Macaca arctoides*, *Macaca leonina*, *Hoolock hoolock*, *Trachypitecus pileatus* and *Nycticebus bengalensis* are maintained in the Zoo. Three macaque species, Assamese macaque (*Macaca assamensis*), rhesus macaque (*Macaca mulatta*), and northern pig-tailed macaque (*Macaca leonina*) were selected for this study. These groups were maintained in independent cages with floor area of 850m². All the groups were in multi-male and multi-female composition. The detailed composition of the group of each species studied is given in Table 1. All three species are presented in photoplate 1.

Data collection and analyses

The study was carried out during non breeding period for 2 months (April-May-2012). The data collection on acts, pattern, and site selection for

grooming was recorded using Focal animal Sampling Technique (Altmann, 1974). Observations were recorded on a 10-minute interval basis per hour and for 11 hours in a day (7:00 a.m. to 6:00 p.m.), and 6 days in a week. Thus a total of 3168 observational episodes were recorded for each macaque species and 9504 episode for all macaques under study. Data collected on time spent on different grooming act by individuals of all sexes and age groups by each species was recorded and presented in terms of percentage. The variations among different sex and age groups in all the species was tested using Kruskal Wallis test, a nonparametric analysis of variance (ANOVA). Time spent on grooming different body sites was recorded in minutes. Grooming sites were divided into visible sites and non-visible sites. Visible site includes ventral part of upper arms, hand, chest, belly with genital region, feet, ventral part of legs and thigh, tail tip, fore arm. Non-visible site includes head and neck, face, shoulder, dorsal part of upper arm, dorsal area of legs and thigh, back with anal region. Variation in total time and the average time spent (minutes) grooming visible and non visible sites by three species was compared between the species using tested using one tailed 't'- test. Variation in time spent by different sex and age group among three species was tested using Dunn's multiple comparison tests. Mann-Whitney U test was employed for the pair-wise comparison between different species.



Photoplate 1. Representation of macaque species studied

Results and Discussion

Acts of grooming

The time spent (%) on different acts of grooming (removal of ectoparasite, skin flakes, social function and sexual courtship) by different age group in the 3 species is given in **Tables 2, 3 and 4** respectively. Generally 62-64% of the time was spent on removal of ectoparasite (hygiene) and that was the major activity in captive macaques. Social

function was the next important acts where macaque species spent 23-26% of time. Time on removal of skin flakes (dead skin cells) was also a hygiene related activity where time spent varied between 9-11% of total time spent on grooming. Thus in captive macaque hygiene upkeep was major purpose where they spent 70-75% of time. While grooming the groomer eats the parasite and the skin flakes are thrown away by the groomer.

Table 1. Age and sex composition of study groups

Age group	Number of individuals		
	Assamese macaque	Rhesus macaque	Northern pig-tailed macaque
Adult male (AM)	4	4	4
Adult female (AF)	3	5	3
Juvenile male (JM)	1	2	3
Juvenile female (JF)	2	3	2
Infant (IF)	2	2	2
Group size	12	16	14

Table 2. Time spent (%) by individuals of different age and sex categories of Assamese macaque on different activities during grooming

Activities	Time spent (%)					
	Assamese macaque					
	AM	AF	JM	JF	IF	Average time
Removal of ectoparasite	69.3	58	57.8	58.9	66.2	62.04 (± 5.34)
Skin flakes	8.4	11.3	17.1	12.2	8.6	11.52 (± 3.53)
Social function	20.2	20.2	29.1	22.7	27.3	23.9 (± 4.1)
Sexual courtship	2.1	1.6	2.5	1.4	0	1.52 (± 0.95)

(Kruskal Wallis Value (H) = 17.871, $P < 0.01$)

Table 3. Time spent (%) by individuals of different age and sex categories of rhesus macaque on different activities during grooming

Purpose	T Time spent (%)					
	Rhesus Macaque					
	AM	AF	JM	JF	IF	Average time
Removal of ectoparasite	65.1	61.7	60.5	61.7	63.1	62.42 (± 1.75)
Skin flakes	11	8.4	10.8	9.2	9.2	9.72 (± 1.12)
Social function	21.1	26.6	26.4	26.9	27.6	25.72 (± 2.62)
Sexual courtship	2.7	3.2	2.3	2.1	0	2.06 (± 1.22)

(Kruskal Wallis Value (H) = 17.884, $P < 0.01$)

Table 4. Time spent (%) by individuals of different age and sex categories of northern pig-tailed macaque on different activities during grooming

Purpose	Time spent (%)					
	Northern Pigtailed Macaque					
	AM	AF	JM	JF	IF	Average time
Removal of ectoparasite	62.6	65.2	65.2	63.8	65.6	64.48 (± 1.25)
Skin flakes	13.2	11.3	11.2	9.6	10.7	11.2 (± 1.3)
Social function	21.9	22.6	20.8	24.8	23.7	22.76 (± 1.55)
Sexual courtship	2.2	0.8	2.6	1.6	0	1.44 (± 1.05)

(Kruskal Wallis Value (H) = 17.871, $P < 0.01$)



The variation in times spent for various acts of grooming by different age and sex categories by each species was tested using Kruskal Wallis test and found highly significant ($P<0.01$) in all three species (Table 2, 3, 4). Very less time spent on sexual courtship in all the cases. Grooming for sexual courtship always ended with an unsuccessful mounting attempt, therefore, it can be distinguished from grooming for social function. The time spent on grooming for different acts by all three species were almost similar and no inter-specific variations were apparently evident.

Site of grooming

Visible sites

The time spent on grooming visible sites by different age and sex groups of the 3 species is given in Table 5. Average time spent on grooming visible sites by Assamese macaque was more (1140 min), followed by rhesus macaque (1068 min) and northern pig-tailed macaque (924 min). Average time spent on grooming visible areas varied significantly ($p<0.01$) across the species and Assamese macaques spent more time on grooming visible areas than other two species. Total time spent on visible areas by different age and sex categories of each macaque species was tested using Dunn's multiple comparison tests. Each macaque species spent time on grooming visible areas was different and the variations found significant ($p<0.05$) however Assamese macaque spent more time on grooming visible area (Table 5). Pair-wise comparison was done using Man-Whitney test (Table 6). Adult females of Assamese macaques and rhesus macaques spent more time ($p<0.01$) than females of northern pigtailed macaques. Similarly, juvenile males of Assamese macaques and rhesus macaques also spent more time ($p<0.01$) grooming visible sites in comparison to northern pigtailed macaque (Table 3). The infants of Assamese macaques spent more time on grooming visible area as compare to the infants of northern pigtailed macaques ($p<0.01$). However, the infants of Assamese macaques, rhesus macaques and northern pigtailed macaques; the adult males and juvenile females of Assamese macaques, rhesus macaques and northern pigtailed macaques did not show significant variation on the amount of time spent on grooming visible areas. Adult males spent almost equal time on grooming visible areas in all the species. The variations

among macaque species grooming visible areas were significant; age and sex are major factors leading to these variations.

Non-visible area

The time spent on grooming non-visible areas by different age groups of the 3 species is given in Table 7. Assamese macaque spent an average time (1642 min) on grooming non-visible areas was more than rhesus macaque (1600 min) and northern pig-tailed macaque (1382 min) and the variation was found to be significant ($p<0.01$) across the species. Total time spent on non-visible area by age and sex categories of each macaque species was different across the categories. Assamese macaque spent significant more time on grooming non-visible area; this was tested using Dunn's multiple comparison tests and the variation found significant ($p<0.05$). Pair-wise comparison was done using Man-Whitney U test (Table 8). Pair-wise comparison revealed that the adult males of Assamese macaques and rhesus macaques spent significantly more time ($p<0.01$) on grooming non-visible sites than the adult males of northern pigtailed macaques. The adult females of Assamese macaque spent more time ($p<0.05$) on grooming non-visible sites than the adult females of other two macaques. The infants of Assamese macaques and rhesus macaques spent more time ($p<0.01$) on grooming non-visible sites than the infants of northern pigtailed macaques. However, the infants of rhesus macaques and Assamese macaques did not show significant variation in the time spent on grooming non-visible sites. The juvenile males and juvenile females of Assamese macaques, rhesus macaques and northern pigtailed macaques did not show significant variation. Age is not a contributory factor for time spent on grooming non-visible sites

Comparison of time spent on visible and non-visible sites

The pattern of variations on grooming visible and non-visible area was similar. All macaques spent more time on non-visible sites; however variations among species were distinct. Assamese macaque spent more time and northern pig-tailed macaques spent less time on grooming. Paired t-test was carried out to compare the time spent on grooming visible sites and non-visible sites and comparison was found significant ($p<0.001$).



Table 5. Time spent on grooming visible areas among different age and sex categories by each macaque species.

S N	Name of species	Duration of grooming (minutes)					Average time*
		Adult male	Adult female	Juvenile male	Juvenile female	Infant	
1	Assamese macaque	770	980	1210	1200	1540	1140 \pm (287.66)
2	Rhesus macaque	720	1120	1020	1120	1360	1068 (\pm 231.34)
3	Northern pig-tailed macaque	600	860	920	1020	1220	924 (\pm 226.89)

*(p<0.001)

Table 6. The pair-wise comparison test for grooming visible areas among age and sex group in the different macaque species.

(* Significance level) U=Mann-whitney value, W=Wilcoxon value, p= probability value

SN	Individual pairs	U	W	P
1	Adult female of Assamese and rhesus macaque	440	905	0.878
2	Adult female of Assamese and northern pig-tailed macaque	70	535	0.001*
3	Adult female of northern pig-tailed and rhesus macaque	42	507	0.001*
4	Juvenile male of Assamese and rhesus macaque	331	796	0.072
5	Juvenile male of rhesus and northern pig-tailed macaque	186	486	0.002*
6	Juvenile male of Assamese and northern pig-tailed macaque	287	752	0.013*
7	Infant of Assamese and rhesus macaque	410.5	875.5	0.549
8	Infant of rhesus and northern pig-tailed macaque	268.5	733	0.086
9	Infant of Assamese and northern pig-tailed macaque	196.5	661.5	0.001*

Table 7. Time spent on grooming non-visible areas among different age and sex categories by each macaque species

SN	Name of species	Duration of grooming (minutes)					Average time*
		Adult male	Adult female	Juvenile male	Juvenile female	Infant	
1	Assamese macaque	1640	1750	1480	1680	1660	1642 \pm 99.59
2	Rhesus macaque	1380	1900	1500	1620	1600	1600 \pm 192.87
3	Northern pig-tailed macaque	1320	1440	1360	1490	1300	1382 \pm 80.74

*(p < 0.001)

Table 8. The pair-wise comparison test for grooming non-visible areas among age and sex group in the different macaque species

SN	Individual pairs	U	W	P
1	Adult male of Assamese and rhesus macaque	280	745	0.010*
2	Adult male of rhesus and northern pig-tailed macaque	187	652	0.001*
3	Adult male of Assamese and northern pig-tailed macaque	414	879	0.560*
4	Adult female of Assamese and rhesus macaque	422	587	0.66
5	Adult female of Assamese and northern pig-tailed macaque	328	793	0.050*
6	Adult female of pig-tailed macaque and rhesus macaque	338	803	0.08
7	Infant of Assamese and rhesus macaque	426	891	0.713
8	Infant of rhesus and northern pig-tailed macaque	221	686	0.001*
9	Infant of Assamese and northern pig-tailed macaque	240	705	0.001*

(* Significance level) U=Mann-whitney value, W=Wilcoxon value, p= probability value)

Grooming was assumed to have originally evolved for hygienic purpose: removing debris and ectoparasites from the hair and skin (Tanaka and Takefushi, 1993; Zamma, 2002; Akinyi *et al.*, 2013). The act of grooming and amount of time spent for each activity varied significantly across



the age and sex categories within group of each macaque species studied (Table 2, 3, 4). Nearly 75% of their time was spent in up-keeping of body hygiene by all the species, a major activity during grooming. Inter specific variations on time spent on hygienic needs by all age groups was almost equal, no significant variations were evident. Results of this study indicates that all the three macaque species (Assamese macaque, rhesus macaque and northern pig-tailed macaque) of all age group showed that the grooming is mainly for their hygienic needs followed by social function in captivity. The early studies also suggested that grooming is assumed to satisfy an individual's hygienic needs such as removal of ectoparasite, skin flakes and debris (Hutchins and Barash 1976; Barton, 1985). A study conducted by Rodrigues and Boevig (2019) on captive chimpanzee and bonobos indicated that in absence of ecological constraints primates showed similarity in grooming behavior and exhibited behavior plasticity. Other research in captive setting also reported that grooming is affected by individual histories and management practices (Stevens *et al.*, 2006). Individuals with atypical rearing histories are less extraverted and groom less than the individuals who are mother reared (Freeman and Ross, 2014; Freeman *et al.*, 2016). Social grooming was next important activity with an average of 25% time spent on that. Group cohesion and mother-infant social bond strengthen are major achievement of social grooming. A history of individuals under this study was not well known and therefore it appears that all individuals were mother reared hence intra-individual variations on acts of grooming were not distinct. However, among macaques, northern pig-tailed macaque spent comparatively more time (98.44%) on hygiene and social grooming than Assamese macaque and rhesus macaque. But this pattern of inter-specific grooming behavior is also not significant. This study clearly indicates that captive group of macaques undertakes grooming for maintaining body hygiene during non mating period. Time spent for courtship activity was negligible in all cases because no breeding/successful mating was observed. Period of this study was a non breeding season for *Macaca assamensis* (Mitra and Alfred, 2007), *Macaca mulatta* (Southwick *et al.*, 1961). *Macaca leonina* is not seasonal breeder however a peak breeding

activity of this species does not fall within the period of this study (Feeroz, 2003).

In monkeys, body site preference during social grooming are also known to be influenced by social variables such as levels of affiliation between individuals, strength of social bond and their dominance level (Allanic *et al.*, 2020). In long-tailed macaques (*Macaca fascicularis*), female-female dyads focus their grooming on face and frontal areas and in contrast to this male-male dyads preferred grooming back and tail (Moser *et al.*, 1991). In rhesus macaques (*Macaca mulatta*) and hanuman langur (*Semnopethicus entellus*) dominance influenced body site preference, low ranking groomees tending to face away from high ranking groomer (Boccia *et al.*, 1989; Borries, 1992). The present study shows that the macaques spent more time grooming on non-visible areas than visible area. Preference of site during grooming in all the three species is strong and significant. Assamese macaques (*M. assamensis*) spent more time grooming visible and non-visible areas than rhesus macaques (*M. mulatta*) and northern pig-tailed macaques (*M. leonina*). Adult females, juveniles, and infants spent more time grooming visible area than males. Age and kinship also influenced the site selection. This was also confirmed by Allanic *et al.* (2020) for wild bonobos (*Pan paniscus*). Time for grooming non-visible/inaccessible areas was not similar as visible areas but the pattern in variation of time among the three macaque species was same; Assamese macaques (*M. assamensis*) spent more time than other two species and females spent more time than males. However, grooming of inaccessible/invisible body sites goes along with position in which groomer and groomee face away from each other. Thus, the groomee might present its back to a groomer in order to prevent the release of aggression due to eye contact (Boccia *et al.*, 1989). In the present study, the adult males show highest difference between grooming visible and non-visible area and followed by adult females, juveniles, and infant. This difference may be due to the ranking or age. On other hand, the infants who are mostly groomed by his/her mother and do not show any significant difference between grooming visible and non-visible area. This clearly indicates that grooming site preference is reflected by the ranking or age of individuals.



Conclusion

Major act of grooming in captive macaque is hygiene upkeep; they spent 70-75% of time. The variation in times spent for various acts of grooming significantly varied in age and sex categories by each species. The present study shows that the macaques spent more time grooming on non-visible areas than visible area. Preference of site during grooming in all the three species is strong and significant. Assamese macaques (*M. assamensis*) spent more time grooming visible and non-visible areas than rhesus macaques (*M. mulatta*) and northern pig-tailed macaques (*M. leonina*). Grooming site preference is affected by the ranking or age of individuals. Captive

environment of Zoo also plays a role in variation of pattern and acts during grooming.

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