

Behavioural analysis of bonnet macaque - human interaction in deciduous forest of Alagar Hill (eastern ghats), South India

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Abstract: A study was conducted on the behavioral responses of bonnet macaques, *Macaca radiata* (Family: Cercopithecidae), following intensive interactions with human beings in deciduous forests of Alagar Hill (eastern ghats), Madurai City (12°18'N and 76°42'E), south India. Totally, ten types of behavioural responses were selected, described and recorded by direct observation for 30 days (240 h) during the post-monsoon seasons (October–November) of 1999 and 2000. The recorded responses were grouped into four types of offensive (open-mouth threat, follow-up, chase and attack) and five types of submissive (acceptance, tree-shaking, group-breaking, hiding and escape) behaviours. Our basic data suggested that submissive behaviours (624 responses of 5 types; 62.12%) were more expressed in bonnet macaque population of Alagar Hill when compared to offensive behaviours (380 responses of 4 types; 37.9%) due to heavy anthropogenic pressures and a variety of disturbances to their natural life from both pilgrims and local inhabitants. Based on these results, certain public awareness measures are suggested to reduce the anthropogenic threat to bonnet macaque populations of Alagar Hill in south India.

Resumen: Se realizó un estudio sobre las respuestas en el comportamiento de los macacos de gorro, *Macaca radiata* (familia: Cercopithecidae), después de interacciones intensivas con seres humanos en los bosques caducifolios del Cerro Alagar (Gates Orientales), Ciudad Madurai (12°18' N y 76° 42' E), sur de la India. En total fueron seleccionados, descritos y registrados diez tipos de respuestas de comportamiento por medio de observación directa durante 30 días (240 h) durante las estaciones post-monzónicas (octubre – noviembre) de 1999 y 2000. Las respuestas registradas fueron agrupadas en cuatro tipo de comportamientos ofensivos (amenaza con la boca abierta, seguimiento, persecución y ataque) y cinco tipos de comportamientos sumisos (aceptación, zarandeo de árboles, rompimiento del grupo, ocultamiento y escape). Nuestros datos básicos sugirieron que los comportamientos sumisos (624 respuestas de 5 tipos; 62.12%) se expresan más en la población de macacos de gorro del Cerro Alagar en comparación con los comportamientos ofensivos (380 respuestas de 4 tipos; 37.9%) debido a fuertes presiones antropogénicas y a una variedad de disturbios en su vida natural causados tanto por los peregrinos como por los habitantes locales. Con base en estos resultados, se sugieren medidas de concienciación del público con el fin de reducir la amenaza antropogénica a las poblaciones del macaco de gorro de la colina Alagar en el sur de la India.

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Resumo: Este estudo foi realizado para avaliar a resposta comportamental do macaco de boné, *Macaca radiata* (Família: Cercopithecidae), a uma interação intensiva com os humanos em florestas decíduas da colina de Alagar (Gates Orientais), cidade de Madurai (12° 18' N e 76° 42' E) no sul da Índia. No conjunto foram seleccionados dez tipos de respostas comportamentais, descritas e registadas por observação directa durante 30 dias (240 horas) durante as estações da pós-moção (Outubro – Novembro) de 1999 e 2000. As respostas comportamentais registadas foram agrupadas em quatro tipos de agressividade (ameaça de boca aberta, seguimento, caça e ataque) e cinco tipos de submissão (aceitação, abano de árvores, afastamento do bando, esconder e fuga). Os dados básicos sugeriram que os comportamentos de submissão (624 respostas de 5 tipos; 62,12%) foram mais expressivos na população de macacos de boné na colina de Alagar quando comparados com os comportamentos agressivos (380 respostas dos 4 tipos; 37,9%) devido às fortes pressões antropogénicas e à variedade dos distúrbios ao seu ambiente natural por peregrinos e habitantes locais. Baseado nestes resultados, certas

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populações de macaco de boné na colina de Alagar no sul da Índia.

Key words: Alagar hill, anthropogenic threat, behavioral responses, bonnet macaque–human interactions, offensive behaviour, submissive behaviour.

Introduction

The bonnet macaque, *Macaca radiata* belongs to the family Cercopithecidae (Order: Primates). This common “red-faced” monkey is widely distributed in southern India (Simonds 1965). It is popular for its abundance and adaptation to a wide variety of non-forest habitats. In fact, this species is relatively more common in rural and suburban habitats than in the interior of forests. According to Sinha (2001), bonnet macaques exhibit a remarkable tendency to leave their forest habitat and to move towards human habitations, where they enjoy an unpredictable “love-hate” relationship with human beings. They are voracious feeders and are omnivorous. Their diet includes leaves, fruits, grasses, seeds, tender shoots and insects (Sinha 2001). Thus, bonnet macaque troops often raid human habitations in both village and urban areas, plantations, temples and agricultural ecosystems for a variety of omnivorous foods. Naturally, this has often led to conflict between bonnet macaques and human beings. Such situations continue to remain problematic in Alagar Hill. The deciduous forest of Alagar Hill (eastern ghats) is a popular pilgrim as well as picnic centre in

southern India with a long history. Although the bonnet macaque is a species that pilgrims / local people of Alagar Hill interact very frequently and constantly, nothing is known about its behavioral responses towards human actions. Available studies on the behavioural responses of different species of monkeys were related to intra-specific interactions between different sex and age classes (Singh 1986, 1989) or between same sex during scavenging on provisioned food (Sunita Ram *et al.* 2003). According to Sinha (2001) information on behavioral responses of bonnet macaques following intensive interactions with human beings is totally absent. The present study based on this objective, provides for the first time some baseline data on behavioral responses shown by *M. radiata* following intensive interactions with human beings in Alagar Hill, south India.

Materials and methods

Study area

The study area is the reserve forest of Alagar Hill which forms a discontinuous minor range in the Deccan Plain and appears as an

extension of the eastern ghats. It is located 22 km northeast of Madurai City (latitude 12°18'N; longitude 76°42'E; altitude: 275 m above mean sea level). The deciduous forest of Alagar Hill is composed of both disturbed and protected vegetation. The highest peak, Thalaianaiparai (879 m) is situated in the centre of the reserve forest. A perennial spring namely Nupuragangi (425 m) is a pilgrim centre. The valley that connects the foot hills and Nupuragangi is called Silambar valley, and it lies to the south-west of Thalaianaiparai (6 km). Another famous pilgrim center, a temple of Lord Muruga is situated (350 m) in the middle of this valley, just below Nupuragangi. Silambar valley, being a pathway to both pilgrim centers is subjected to heavy anthropogenic stress. It forms an ideal natural as well as disturbed habitat for bonnet macaques where they co-exist with local people as well as visiting pilgrims. More details of the study area are given in Sriganesan (1984, 1987) and Krishnan *et al.* (2000).

Sampling

The study area includes an initial forest track from the foothills, followed by a motor road (3-5 km) towards Nupuragangi. Additional areas of observation consisted of areas around the Lord Muruga temple and Nupuragangi, where intensive interactions between visitors and the macaque troops were observed. The motorable road and good sightings of the macaque troops on either side facilitated easy and accurate recordings on their behaviours. The behavioural responses of the macaque troops following interactions with visitors were recorded by direct observation using scan sampling method of Altmann (1974). A simple and adequate description of this method was given in Mathur (1994). By this method, several individuals of free ranging population of the bonnet macaques were randomly observed one after another in succession, for a given fixed time. This kind of instantaneous sampling of responses was also facilitated by the selection of well defined as well as easily recognizable behavioural elements. No other criteria like age, sex, social rank and kinship of the individuals were considered during sampling. No data were collected on the frequency of a given behaviour

in a given individual. The study areas were walked silently along with visitors and the behavioral responses of macaques during their interaction with visitors recorded. Behavioural responses expressed spontaneously during interactions as well as those induced by the behaviour of visitors were both recorded. The total period of observation included 30 days (15 each in October-November of 1999 and 2000). Each day's observation was spread over eight hours, from 10.00 AM to 5.00 PM at different zones of the study area depending on the density of macaque troops and visitors. The total duration of observation was 240 h. All observations were conducted only on Sundays.

We recorded the following nine behavioral responses : 1. Open-mouth threat: a common aggressive behavior involves displaying the lower teeth, flattening of the ears against the head and thrusting of the head forward, 2. Tree-shaking : running and climbing the tree, followed by shaking it, 3. Chase: direct chasing of the visitors with food, especially women and children with repeated open-mouth threats, 4. Acceptance : accepting food materials from visitors with facial expressions such as extreme caution and fear, 5. Attack: contact aggression on the body of the visitors after chasing, 6. Hiding: climbing and hiding behind the tree branches or bushes, often accompanied open mouth threat, 7. Escape: running away into the interior of the forest with several kinds of vocalizations and remaining hidden from view for at least 5 minutes, 8. Follow-up: following closely behind visitors with food for minimum 3 minutes either aggressively or normally and 9. Group-breaking: running away from the troop once they noticed or threatened by the human gang. The observed behaviours were classified into each type and the percentage of each calculated over the total number of observations for 30 days. This primary data was further grouped into two major types of behaviours (offensive and submissive). The data was subjected to analysis of dispersion. The difference between the offensive and submissive categories was analyzed by Mann-Whitney U test. We also made observations on selected behavioural responses of visitors those were displayed towards monkeys. A "snapshot" data was collected by using scan sampling method

for 11 h in July of 2004. The selected behavioural responses are : 1. Chase: run after monkeys with sticks and stones, 2. Attack: attack on their body with sticks and stones, 3. Warning: by loud voice without any chase or attack, 4. Threatening: by using sticks without attack, 5. Provisioning: supply of food, 6. Love: intense affection towards monkeys and 7. Fear: agitated feeling while encountering or crossing the monkeys. These data are highly preliminary in nature.

Results and discussion

Table 1 contains the data on observed behavioural responses of the bonnet macaques, following interactions with visitors at Alagar Hill. The total number of behavioural responses recorded during the 30 days of observation (240 h) was 1004. The most common offensive response in terms of highest frequency was OM. It was followed by FU almost equally. The other two offensive behaviours viz., CH and AT were expressed in lowest frequencies suggesting the high levels of non-contact offensive responses (OM and FU) in scanned population of the bonnet macaques at Alagar Hill. We observed that monkeys identify and follow particularly visitors having food materials (even inedible materials) openly in hands, eating them on their way, or hiding them after noticed the monkeys. Any kind of negative responses from visitors has reciprocally induced a variety of responses, more often OM. They stared at visitors and expressed OM repeatedly. Stare was categorized

as non-contact aggressive behaviour in Sinha's unpublished ethogram of bonnet macaque behaviours (as quoted in Sunita Ram *et al.* 2003). Such interaction between monkeys and visitors was occasionally ended up in CH as well as AT, if the visitors are oldest persons, women and children. AT was rarely expressed under severe conflicts between the monkeys and visitors.

Conversely, AC was the most common submissive response in terms of its highest frequency, followed by HI. It suggested clearly that the bonnet macaques of Alagar Hill interact with visitors and local people mainly for provisioned food. We observed that monkeys have accepted the provisioned food very cautiously from the visitors and quickly withdrawn into their troop or forest areas. Any kind of negative responses from visitors has induced TS, GB and ES. ES was rarely observed under a severe conflict between monkeys and visitors. They had simply crouched down out of sight in the trees and bushes. Under severe conflicts, they ran away very fast and far. It is hypothesized that the monkeys have learned to exploit a variety of food materials from visitors by expressing submissive behaviours, which apparently increase their survival on provisioned food during the scarcity of natural diets in the forest. Similarly the bonnet macaques of Mudumalai Wildlife Sanctuary, Tamilnadu have regularly moved between two distinct habitats. One was a relatively more forested zone where they foraged on natural

Table 1. Behavioural responses of bonnet macaque following interaction with human beings in Alagar Hill, south India.

Types of behaviour	Codes	No. responses recorded / 30 days (240 h)	Percentage (%) of types
Acceptance	AC	170	17
Open-mouth-threat	OM	148	15
Follow-up	FU	142	14
Hiding	HI	132	13
Tree-shaking	TS	127	13
Group-breaking	GB	110	11
Escape	ES	85	8
Chase	CH	55	5
Attack	AT	35	3
Total		1004	100

Table 2. Total scores for two major types of behaviour of bonnet macaque in Alagar Hill, south India (data pooled from Table 1).

Types of behaviour	Codes for responses pooled (From Table 1)	Total responses recorded / 30 days (240 h)	Percentage (%) of types
Offensive	OM, FU, CH, AT	380	38
Submissive	AC, TS, GB, ES, HI	624	62
Total		1004	100

Table 3. Descriptive statistics for data given in Table 1.

Statistics	Major categories	
	Offensive	Submissive
Total No. responses / 240 h	380	624
No. subcategories pooled	4	5
Mean No. responses / 240 h	95	124.8
SD	33.68	31.21
SE	16.84	15.61
Coefficient of variation (%)	35.46	12.57

diets. The other was a human-occupied area, where they either interacted with tourists and directly obtained food from them, or scavenged on remains left behind by the visitors (Sunita Ram *et al.* 2003).

Statistical scrutiny of data given in Table 1 using Mann-Whitney U test revealed no significant difference between the two major categories of behaviour viz., offensive and submissive. However, data on total number of pooled responses/240 h (Table 2) as well as mean number of responses/240 h (Table 3) have supported the high level expressions of submissive behaviour in the bonnet macaques population of Alagar Hill. The estimate of coefficient of variation for submissive behaviours (12.6%) was also relatively low when compared to offensive behaviours (35.5%). This indicated the low degree of inter-sample variability in the categories of submissive behaviour. Many earlier studies have established a fact clearly that forest monkeys were less aggressive than urban dwellers (Lindburg 1971; Roonwal 1979; Singh 1969; Southwick *et al.* 1976). According to Sinha (2001) although shy in their natural forest

habitats, bonnet macaques inhabiting human habitations are not in the least afraid of people. Our study areas at Alagar Hill were overcrowded daily by a thick floating-population of visitors and local people, especially on Sundays during which sampling was conducted. Thus the observed fraction of offensive behaviours in the bonnet macaques could be manifested from their interactions and conflicts with visitors. Sunita Ram *et al.* (2003) have provided evidences for human-induced changes in the behavioural responses of the wild bonnet macaques. According to them, provisioning of wild bonnet macaques usually lead to changes in behaviours, both at the level of individual and that of social interactions. The intra-group aggression was increased significantly during scavenging. Similar behavioural changes were noticed in the present study (Krishnankutty unpublished data). Age, sex, social rank and kinship are other major factors reported to influence the expression of aggressive behaviours in monkeys (Altmann 1968; Berstein & Carolyn 1985; Hamburg 1971; Moller *et al.* 1968). The present study excluded these factors during sampling and analysis.

Table 4 provides the major human behavioural responses those were displayed by visitors towards the bonnet macaques at Alagar Hill. PR was recorded in highest frequency, suggesting the fact that friendly behaviour was displayed by a considerable number of visitors towards the submissive individuals. However, other negative responses (TH, WR, CH and AT) were also constantly and frequently recorded. By and large, the data supports the generalization of Sinha (2001) that bonnet macaques enjoy an intense love-hate relationship with the people of south India. We have assumed that submissive behaviours dominate in the macaque population of Alagar Hill possible due to heavy anthropogenic stress. Human disturbances in the reserve forest core area are diverse in nature. Cattle grazing, wood removal and logging, collection of minor forest products are the major causes for the deterioration of natural habitats of bonnet macaques in this area. Moreover, the population is disturbed directly as well as heavily by local people, and by visitors and their activities. We witnessed a variety of human disturbances to bonnet macaques in these areas such as threatening, severe attacking, violent induction of offensive behaviours and chasing with sticks and stones. According to Abraham & Balakrishnan (1993), bonnet macaques have been killed as serious agricultural pests by human beings in the forest, of Wynad, Kerala. We suggest the following measures to protect the bonnet-macaque population of Alagar Hill from anthropogenic threats: (1) Prevention of incursions of local people/visitors in to the interior of forest the natural habitats of monkeys, (2) Establishment of natural food resources in core forest area with the aim of attracting monkeys away from human-occupied zones and (3) Establishment of permanent boards and distribution of "dos and donts" packages to visitors with instructions to display friendly behaviour towards bonnet monkeys.

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Table 4. Human behavioural responses towards bonnet macaques at Alagar Hill, south India.

Types of behaviour	Codes	No. responses recorded / 11 h
Provisioning	PR	86 (64)
Threatening	TH	62 (43)
Warning	WR	55 (38)
Fearness	FE	42 (29)*
Love	LO	38 (21)*
Chase	CH	28
Attack	AT	17

Values within paranthesis are responses by men.

* Responses by women (FE) and children (LO).

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