Chapter 11
Out of Asia: The Singular Case of the Barbary Macaque

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11.1 Introduction

The case of the Barbary macaque (*Macaca sylvanus*) is a rather interesting one for several reasons. For one, it is the only species of the genus *Macaca* that is found outside Asia. Its ancient lineage and present fragmented distribution in Africa, so strikingly afar from the other macaque species, place it central to all discussions on macaque phylogeography. It is also one of a handful of primate species that live in a cold/snowy environment for a significant part of the year. For these reasons, the species represents an excellent model to study macaque evolution and dispersal and primate adaptation to temperate/cold climates. Currently, two disjointed and highly fragmented populations of this species exist in the wild, in Morocco and Algeria. Outside Africa, a free-ranging population of macaques inhabits the Rock of Gibraltar. The species is probably the most intensively studied macaque after rhesus (*M. mulatta*) and Japanese (*M. fuscata*) macaques. However, much of this body of research is based on the small and highly provisioned Gibraltar population or on free-ranging captive populations in three parks in Germany and France. Fewer studies have been conducted on wild/non-provisioned Barbary macaques.

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The Barbary macaque is listed as endangered in the IUCN 2010 Red List of Threatened Species, and the total population size in the wild is estimated at between 5,000 and 6,000 individuals. The rapid decline in population numbers in the recent decades and the increasingly negative impacts of human interactions on the species make it vital that conservation measures are strengthened at the earliest opportunity. In this chapter, we first review the literature on wild Barbary macaques to describe their geographic distribution, ecology and behaviour. We then briefly describe the nature and frequency of interactions between Barbary macaques and humans in both historic and present times and discuss factors threatening the survival of this species. Finally, as a case study of human-macaque interactions, we analyse the effects of tourist pressure on the behaviour of Barbary macaques at our field site in the Middle Atlas Mountains of Morocco.

11.2 The Geographic Distribution and Socioecology of the Barbary Macaque: A Short Overview

In historic times, the Barbary macaque was an inhabitant of parts of Europe and all of North Africa, from Libya and Egypt to Morocco (Delson 1980; Camperio Ciani 1986). Its current distribution is limited to small relict patches of forest and scrub, in the rocky and mountainous parts of the Rif and Atlas Mountains (Morocco) and in parts of the Tellian Atlas in Algeria (Fa 1984a; Camperio Ciani 1986; Ménard and Vallet 1993; Scheffrahn et al. 1993). As such, the Barbary macaque is the northernmost African non-human primate. The current distribution of this species ranges from a latitude of around 31° 15′N to 36° 45′N and from a longitude of around 7° 45′W to 5° 35′E (Fooden 2007). A small free-ranging and provisioned population of around 200 macaques inhabits the Upper Rock Nature Reserve of Gibraltar. Being the only African macaque species, the distribution of the Barbary macaque is far away from the other extant macaque species in southeast Asia, from Pakistan and India in the west to Japan in the north and Indonesia in the southeast. The geographic distribution of the various *Macaca* species reflects their phyletic origin (Abegg and Thierry 2002). The Barbary macaque belongs to the *silenus-sylvanus* group, from which three other phyletic groups *fascicularis*, *sinica*, and *arctoides* evolved (Fooden 1976; Abegg and Thierry 2002).

As mentioned above, the Barbary macaque is now an endangered species. The species density estimates of the last few decades suggest a dramatic and steady decrease in the number of macaques in Algeria and Morocco. The total population size decreased from an estimated 21,000 individuals around 40 years ago (Taub 1975) to 10,000–16,000 in the early 1990s (Lilly and Mehlman 1993; von Segesser et al. 1999; Table 11.1). At present, the total population is estimated to be between 5,000 and 6,000 (van Lavieren and Wich 2009; Siân Waters, personal communication). More detailed and frequent population surveys have been conducted in Morocco, particularly in the Middle Atlas Mountains (e.g. Deag 1977; Camperio

Table 11.1 Population and density estimates for the Barbary macaque since 1968

Location	Estimate	Year of survey	Reference
	N monkeys/km^2		
MAM,[a] Morocco	70	1968	Deag (1974, 1984)
	43	1977	Taub (1977)
	28	1994	Camperio Ciani et al. (2005)
	≥7	2002	Camperio Ciani et al. (2005)
	≥12.1	2005	van Lavieren and Wich (2009)
	Population size (*N* monkeys)		
MAM, Morocco	4,000–5,000	2005	van Lavieren and Wich (2009)
Morocco	17,000	1974	Taub (1975)
	6,000–10,000	Unknown	Ross (2004)
Total population	≤21,500	1974	Taub (1975)
	15,000	Unknown	von Segesser et al. (1999)
	5,000–6,000	2009	van Lavieren, unpublished

[a]*MAM* Middle Atlas Mountains

Ciani et al. 2005; van Lavieren and Wich 2009), but the decline is also evident in the Algerian populations (von Segesser et al. 1999). In the early 1970s, Deag (1984) estimated a macaque density of around 70 individuals per km^2 in the Middle Atlas Mountains. By 2002, the density had already dropped to between seven and ten individuals per km^2, and in 2005, the average number of monkeys in the Ifrane National Park was as low as seven individuals per km^2 (Camperio Ciani et al. 2005; Table 11.1). This is a very low figure and is due to habitat fragmentation, competition over food sources between macaques and humans and their livestock and the illegal capturing of infants for the pet trade. With such a small population size, the survival of the species is even more uncertain, considering the fact that both the Algerian and Moroccan sub-populations are small and highly fragmented, with large gaps (up to around 700 km) existing between them. For example, in the sub-population living in the Ifrane National Park, in the Middle Atlas Mountains, fragmentation of the forested areas prevents migration between groups and poses a threat to their survival. Moreover, a recent study showed that wild populations are genetically distinct from one another and show low overall genetic diversity (Modolo et al. 2005). This poses a major threat for population viability, as small, fragmented sub-populations with low genetic diversity are clearly more vulnerable to factors such as human disturbance and infectious diseases. For example, the introduction of a new disease to the small Gibraltar population of Barbary macaques could quickly eliminate the whole population (Fa and Lind 1996; Honess et al. 2006). Such a dramatic event could also occur in the wild populations, as interactions between macaques and humans are frequent in both Morocco and Algeria. This highlights the need for effective conservation plans to be designed and implemented urgently, to save those populations.

The Barbary macaque is one of very few primates that live in temperate cold climates (Hanya et al. 2011). In its native habitat, the species is found in cedar-oak (*Cedrus atlantica* and *Quercus ilex*) and deciduous oak forests (*Q. faginea* and *Q. afares*), scrub, grassland and rocky ridges (Fooden 2007). It can be considered a flagship species of the cedar and oak forests of Morocco and Algeria, an ecosystem with a high degree of biodiversity and a number of rare and endemic plant and animal species. The elevation distribution of the Barbary macaque is considered to lie at altitudes between 400 and 2,300 m (Fooden 2007). As such, this species experiences strong seasonal differences, from dry and hot summer months, when temperatures can reach up to 40 °C, to wet and snowy winter months with temperatures often going below 0 °C (Majolo et al. under review). As a possible consequence of such strong seasonality and the limited time availability of some food sources, the Barbary macaque is a very eclectic forager. Its diet comprises leaves, seeds, fruit, fungi, plant and animal matter, sap and roots (Ménard 2002).

Sexual dimorphism can be observed in relation to body length (males: 550–600 mm, females: 450 mm) and weight (males: 15–17 kg, females: 10–11 kg; Fa 1989). Furthermore, males have elongated canines that play an important role in dominance-related behaviours. The maximum recorded lifespan is 28 years in captivity (Sue Wiper, personal communication 2011; Fooden 2007), but monkeys are unlikely to live beyond 15–17 years in the wild. Sexual maturity is reached at around 6 years of age in males and 5 years of age in females (Ménard et al. 1985). The Barbary macaque is a seasonal breeder with a mating season occurring between October and January and births occurring between late March and July/August (Dixon 1998). Similar to other macaque species, in the mating season females show significant perineal swellings, during which ovulation occurs (Möhle et al. 2005). In the wild, Barbary macaques live in multimale-multifemale groups of 10–60 individuals with a sex ratio ranging between 0.6 and 1.6 females per male (Ménard 2002). Conversely, the provisioned groups of Gibraltar are composed of around 60–80 individuals. In Morocco and Algeria, group size and composition can vary dramatically, probably due to differences across seasons and years in food abundance. In Morocco, the average group size in the Ifrane National Park is around 15–25 individuals, whereas it might be higher in the Rif Mountains (Siân Waters, personal communication 2011). The Barbary macaque is considered a relatively tolerant species (i.e. Grade III) according to the classification proposed by Thierry (2000). This means that group members should form a shallow dominance hierarchy and conflicts should be often undecided and/or result in counter-aggression to the aggressor by the recipient (Thierry 2007). Moreover, Barbary macaques should have a low degree of kin bias in grooming distribution and a high frequency of reconciled conflict at the group level (Thierry 2000). However, this picture may not fully represent wild populations. For example, two recent studies (McFarland and Majolo 2011a, b) found that 5% of conflicts were undecided and less than 4% resulted in counter-aggression in two wild groups of macaques living in the Middle Atlas Mountains of Morocco. Therefore, more data on the social behaviour of wild populations are necessary before we can draw firm conclusions on the social style of this species.

11.3 The Barbary Macaque and Its Interactions with Humans: A Historic Perspective

The recorded history of the interactions between humans and Barbary macaques goes back in time to the first civilizations of the Mediterranean area (Goudsmit and Brandon-Jones 2000). At that time, the Barbary macaque was probably distributed from Morocco to Egypt, if not further East along the Mediterranean coast, and maybe also in some parts of Europe (e.g. Spain; Taub 1984). The Phoenicians, around the tenth century B.C., were probably the first civilization to report the presence of the Barbary macaque when they began trading in North Africa and across the Mediterranean Sea (Fa 1984b; Goudsmit and Brandon-Jones 2000). The Barbary macaque is also likely the tailless monkey reproduced in various Greek, Etruscan, and Italian artefacts (McDermott 1938, cited in Fa 1984b). Reports of the Barbary macaque can also be found in Aristotle's work, which classified this species as being a distinct group from the baboons known at his time. It is difficult to determine the frequency and nature of human-macaque interactions in early historic times. However, McDermott (McDermott 1938, cited in Fa 1984b) reports that some North African civilizations considered Barbary macaques solar deities. Barbary macaques were known to the Egyptians, and several remains, attributable to this species, found in Italy and the rest of Europe suggest that they were kept as pets (Groves 2006). Moreover, the Greek historian Diodorus describes three cities near Carthage (modern Libya) where the monkeys lived in the same houses as humans and shared food with them (Fa 1984b). This description closely resembles what currently happens in some villages and cities of India, where langurs and macaques live in close association with humans (e.g. Srivastava and Begum 2005). Some other North African human populations, however, were reported by Herodotus and Lucian to eat monkeys. In this respect, Fa (1984b) claims that the nature of human-macaque interactions differed between geographic regions. It is possible that tribes from the region now corresponding to Tunisia and Libya regularly ate monkeys as part of their diet, whereas this habit was not present in north-east Africa (Morocco and Algeria; Fa 1984b). Such differences may have originated from the same belief, which viewed monkeys as sacred animals (Joleaud 1931, cited in Fa 1984b), but resulted in two different traditions. According to this explanation, some tribes ate the monkeys to obtain their strength while others protected them and tolerated, if not welcomed, the presence of the monkeys in and around their cities.

11.4 Human-Macaque Interactions in Gibraltar

The free-ranging provisioned population of Barbary macaques in Gibraltar lives in the Upper Rock Nature Reserve, a protected area of around 97 ha (Shaw and Cortes 2006; Cortes and Shaw 2006). The first documented evidence of macaques in

Gibraltar dates to 1740, though speculation remains that they were present much earlier than this time (Fa 1981). Accurate historical estimates of population numbers are hard to come by (Shaw and Cortes 2006), but it is known that, from 1946 until the late 1980s, population management kept numbers between around 35 and 40 individuals (Martin 1997). After this management ceased, population size increased rapidly, reaching over 200 individuals in 1997 (Martin 1997). Since 1998, when population control measures began to be reapplied, the Gibraltar population has fluctuated between 170 and 250 individuals (Shaw and Cortes 2006; Shaw, personal communication 2011). Population size has remained relatively stable over the last few years, thanks to the birth control programme implemented by the reserve authorities (Cortes and Shaw 2006).

Barbary macaques represent a very significant tourist attraction, as most of the approximately 800,000 tourists coming to Gibraltar each year visit the nature reserve to see the famous 'Rock apes' (Fuentes 2006). Interactions between tourists and the macaques are extremely frequent (O'Leary and Fa 1993; Fuentes 2006; Shaw and Cortes 2006), not least because taxi drivers and other tour guides encourage tourists to approach the macaques or use food to lure the macaques to climb onto the tourists for photographs (Fuentes 2006). This practice leads to high levels of aggression from the macaques to tourists and results each year in a significant number of visitors receiving bites (Fa 1992; Fuentes 2006). Such episodes can attract international press coverage, with potentially negative consequences for the tourism industry and local economy of Gibraltar.

In addition to their interactions with tourists in the Upper Rock Nature Reserve, Barbary macaques in Gibraltar have a long history of moving down into the town itself and coming into contact – and conflict – with the local inhabitants (Cortes and Shaw 2006). This situation is not new: forays by the macaques into town to raid orchards and gardens were documented as early as 1875 (Fa 1981). Indeed, provisioning of the macaques up on the slopes of the rock was first introduced in 1913 to counter this problem, although this early attempt at range restriction failed abjectly, with a report some months later of animals 'taking over part of the town' (Fa 1981). Conflict in the town between macaques and Gibraltarians has been particularly problematic since the early/mid-1990s, when the macaque population started to increase dramatically. On several occasions, this has led to fissioning of troops and splinter groups attempting to establish home ranges that overlap urban areas (Shaw and Cortes 2006). The current management of the population has, however, largely been successful in minimising movements of macaques into town and reducing levels of macaque-human conflict (Fuentes 2006).

The close proximity and frequent occurrence of physical contact between Barbary macaques and humans both in the Upper Rock Nature Reserve and in the city of Gibraltar itself may increase the risk of infection and disease transmission between the animals and humans, and *vice versa* (Honess et al. 2006). For the macaques, introduction of zoonotic diseases could have catastrophic consequences (Honess et al. 2006). Recently, the Gibraltar macaque population has been screened and serologically tested for various diseases (Honess et al. 2006), and it was found that this population harbours at least two potentially zoonotic diseases – hepatitis A

(Honess et al. 2006) and simian foamy virus (Engel et al. 2008). The source of infection is not clear, and monkeys that were positive to hepatitis A did not show any sign of illness (Honess et al. 2006). So far at least, there is no evidence of any transmission of disease from macaques to humans at this site (Honess et al. 2006). Overall, transmission of diseases from non-human primates to humans is relatively rare (e.g. Huff and Barry 2003), whereas infection of monkeys from humans is more frequent (Weigler 1992). However, the potential for macaque-human and/or human-macaque disease transmission remains a real risk in Gibraltar, where human-macaque interactions are both frequent and close. Strategies to control the ranging patterns and the demography of the Barbary macaques, together with effective education programmes to control the behaviour of tourists towards the monkeys, are necessary to avoid having urbanised monkeys and to limit close interactions with humans. Moreover, periodic health checks of the population, followed by vaccination or treatment of ill individuals, seem important to maintain the Gibraltar population of macaques.

11.5 Human-Macaque Interactions in Morocco and Algeria

The distribution of the Barbary macaque reduced in historic times from the whole North African Mediterranean coast to Morocco and Algeria, which roughly corresponds to western Maghreb. Climate change may have been partially responsible for such a reduction. The geographic area inhabited by the Barbary macaques has become drier in the last 1,000 years, favouring the erosion of the mountains and the reduction of forest cover, which may ultimately have reduced the distribution of the macaques (Thirgood 1984). Human activities were also responsible for the decline of the species, considering that the North African coast has been inhabited by humans continuously for thousands of years. Although little is known about the Imazighen (or Berbers), who were present in the Maghreb as settled cultivators before the arrival of the Arabs in the seventh century A.D., the populations inhabiting or invading the Maghreb have been responsible for the continuous deforestation and hunting of the Barbary macaque to such an extent that the habitat and the macaque population have never been able to recover (Taub 1984). Deforestation significantly increased since colonialism as wood was exported for commercial use. For example, during the Fascist period, Libya experienced a mass colonisation of more than 30,000 peasants from Italy who cut down most of the remaining forests of the country (Thirgood 1984). Currently, deforestation, overgrazing by livestock (mainly sheep and goat herds) and various forms of human interference such as the illegal trade in infant macaques represent the main causes of the decline of this species in the wild (Mehlman 1989; van Lavieren 2008).

The largest population of Barbary macaques inhabits the Middle Atlas Mountains of Morocco (Camperio Ciani et al. 2005; van Lavieren and Wich 2009), but it is scattered across a number of medium to small forest patches. The Middle Atlas Mountains are often referred to as the ‘castle of water’, as approximately 40% of

Fig. 11.1 A young Barbary macaque on sale in Tangiers, Morocco (Courtesy and copyright: R. Troostwijk)

Morocco's fresh water comes from this region. The mixed cedar/oak forest of the central Middle Atlas Mountains is today still the home of approximately 5,000 macaques (van Lavieren and Wich 2009). This forest is unique and offers a large array of natural resources to humans, such as wood, lichens and charcoal production. However, these resources are being over-exploited, resulting in the degradation of the forest area. The large numbers of sheep and goat herds that graze in the forest year round are destroying the forest and its undergrowth and causing food competition for other species living in this habitat. Additionally, the illegal trade in infant macaques for the pet trade has become one of the greatest threats to the survival of the species (Fig. 11.1). Between 1996 and 2007, an estimated 300 infants were captured from the wild annually in the birth season and sold in the markets of Morocco to tourists (van Lavieren 2008). The macaques are smuggled to Europe where many eventually end up in sanctuaries or zoos. These animals are sometimes euthanised because of a lack of shelter space (van Lavieren 2008). The illegal trade in macaques to Europe originates mainly from Morocco. Although there have been a few unconfirmed cases deriving from Algeria, all confirmed cases of smuggled macaques originate from Morocco, as affirmed by Spanish customs and the ex-owners who bought their pets there.

A recent survey in Europe, conducted in 2011 by AAP (www.aap.nl), showed that around 75 macaques per year were offered for shelter to sanctuaries and zoos, between 2006 and 2010. This number is likely to be an underestimation, as not all macaques are reported to the authorities or sheltering organisations. Robinson and Redford (1991) calculated that the average maximum percentage sustainable off-take is around 2.5% of the total population of a primate species. According to this method, the maximum number of Barbary macaques that can be harvested in the Middle Atlas Mountains on a yearly basis, without it causing an immediate threat to this sub-population, is 125 macaques annually. However, such a figure does not take into account mortality rate or habitat fragmentation. This means that the actual off-take number may be close to or higher than the maximum number of sustainable off-take. Therefore, the risk of extinction for the sub-population of Barbary macaques in the Middle Atlas Mountains is extremely high (Kenney et al. 1995).

The Moroccan Primate Conservation Foundation (http://www.mpcfoundation.nl) has conducted extensive research and has initiated various projects in cooperation with the Moroccan authorities and national and international NGOs to combat this illegal trade, but so far, these actions have not been sufficient. Due to a lack of active law enforcement, there are still macaques openly sold throughout Morocco. Animal welfare is not a priority in Morocco, and until recently, it was still a common belief that there is an abundance of macaques in the wild. In 2009, a CITES capacity-building training was organised for the Customs Service, and this training demonstrated that there is still a long way to go before CITES regulations are correctly enforced in Morocco. Also, the absence of professional facilities to shelter confiscated macaques makes it hard for the Customs Service to enforce the laws. However, the Moroccan authorities have shown great interest in working on these issues, and new projects are planned for the future. A national action plan for the conservation of the Barbary macaque in Morocco was created in October 2011, and the implementation of this plan will hopefully have a positive outcome for the future of this species.

11.6 Case Study: Wildlife Tourism in Morocco

In January 2008, two of us (BM and MQ) established a longitudinal field project in the Middle Atlas Mountains of Morocco to study the ecology and social behaviour of the Barbary macaque (see http://barbarymacaque.blogs.lincoln.ac.uk). The study site is located in the oak and cedar forest near the city of Azrou (33° 24′N to 005° 12′W), at an altitude between 1,500 and 2,000 m above sea level. In 2009, a multi-disciplinary collaboration between three institutions (the Universities of Lincoln and Roehampton in Great Britain and the Ecole Nationale Forestiére d'Ingénieurs in Morocco) was established to study the nature of human-macaque interactions in

the Middle Atlas Mountains from a biological and social anthropological perspective. Our ultimate goal is to analyse the effects of such interactions on the local communities and the Barbary macaque in an attempt to save the species while not negatively affecting the local economy. Our first study looked at how tourist pressure affects the behaviour of the Barbary macaque (Maréchal 2010; Maréchal et al. 2011). At a number of sites in the Middle Atlas Mountains, tourism focused on the Barbary macaque has begun and has significantly increased in the last few years. It has been proposed that developing this tourism may provide a powerful tool for the conservation of wild Barbary macaques (Mouna and Camperio Ciani 2006). The situation in the Atlas Mountains is not yet comparable to that in Gibraltar, as tourist numbers are much lower and there is no formal tourism 'industry' in place. However, as concerns have been raised about the impact of tourism on wild macaque populations elsewhere (Tibetan macaques in China: Berman et al. 2007, Formosan macaques in Taiwan: Hsu et al. 2009; Barbary macaques in Gibraltar: O'Leary and Fa 1993), studies on the effects of tourists' presence or their interactions with the animals are extremely important for the conservation of the species. For this reason, our aim was to explore the impact of tourism on the behaviour of adult male Barbary macaques belonging to one of the troops regularly visited by tourists (Maréchal 2010).

11.6.1 Methods

The study was conducted at the field site in the Middle Atlas Mountains, and data were collected between 21 February and 11 May 2010 on 12 male macaques belonging to the 'tourist' troop. The troop consisted at the time of the study of 51 monkeys: 12 adult and 1 subadult male, 12 adult and 1 subadult female, 18 juveniles and yearlings and 7 infants. Focal behavioural observation and scan sampling techniques (Altmann 1974) were used, with data collection starting at approximately 7:30 am and continuing until approximately 5:30 pm, 5 days per week. Scan samples every 20 min were used to collect data on the activities of the males (i.e. feeding/foraging, resting, moving, social and others, e.g. mating) and to quantify tourist presence and number. Focal samples lasting 10 min were used to quantify males' rates of grooming and aggressive behaviours, tourist proximity to focal animals and the occurrence of feeding interactions between tourists and the monkeys (where tourists gave food items by hand or threw food towards the macaques). Two focal samples were recorded for each male per day, one in the morning and one in the afternoon. A total of 180.5 h of data were collected.

We calculated the activity budgets (i.e. the percentage of scans spent in each activity during the study period) of the study animals and analysed the relationship between tourist numbers, their time spent with the monkeys, their distance to the monkeys and the daily frequency of friendly and aggressive interactions between the monkeys. We used seven proximity categories (i.e. in physical contact; 0 to ≤ 1 m; 1 to ≤ 2 m; 2 to ≤ 5 m; 5 to ≤ 10 m; 10 to ≤ 20 m; over 20 m) to analyse the effect of the distance between tourists and the monkeys.

Table 11.2 Activity budgets (% of time spent in each activity) of Barbary macaque groups in provisioned and non-provisioned conditions

Habitat (number of troops)	Feeding/ foraging	Resting	Moving	Social behaviour	Others	Reference
PR, Morocco (1)	21	46	16	11	6	This study
PR, Gibraltar (1)	9	32	38	10	11	Fa (1986)
NP, Morocco (4)	34	27	12	20	7	Majolo et al. (under review)
NP, Morocco (1)	49	14	22	11	4	Fa (1986)

PR provisioned, *NP* non-provisioned

11.6.2 Activity Budget of Provisioned and Non-provisioned Macaques

Table 11.2 provides data on the activity budgets of provisioned and non-provisioned Barbary macaques in Morocco and Gibraltar. Although direct comparisons with other studies are problematic as only adult males were observed in the current study, activity budgets differ substantially between non-provisioned and provisioned Barbary macaque groups. Under provisioned conditions, there is a decrease in feeding/foraging time and an increase in resting time. Previous studies have commented that in non-provisioned conditions, Barbary macaques generally spend more time feeding and foraging than resting (Fa 1986; Defter 1995; Ménard 2004). For this species, food resources in the wild are thought to be relatively evenly distributed and of low energetic value (Ménard 2002), and a long period of foraging and feeding is required to meet nutritional demands. The longer time spent resting by provisioned macaques could be because individuals gain their nutritional requirements in a short amount of time and/or due to the higher fat content of provisioned food that requires more time for digestion (Altmann 1992).

11.6.3 The Effect of Tourism on Grooming

The amount of time that macaque males spent grooming other group members was not related to the mean number of tourists present throughout the day (Pearson correlation: $r=0.225$, $n=47$, $p=0.129$) or to the proportion of time that tourists were present at the site (Pearson correlation: $r=0.243$, $n=47$, $p=0.100$). However, grooming time was significantly related to proximity between tourists and macaques (Spearman correlation: $r_s=0.886$, $n=7$, $p=0.019$); when tourists were in closer proximity, the monkeys spent less time grooming. These results indicate that tourists approaching the study animals too closely may interrupt their grooming interactions by either attracting them with food and/or otherwise disrupting their activity. In pygmy marmosets (*Cebuella pygmaea*), tourist presence was found to be unrelated to social grooming (de la Torre et al. 2000). In African lions (*Panthera leo*), it was observed that grooming was less frequent when tourists were present (Hayward

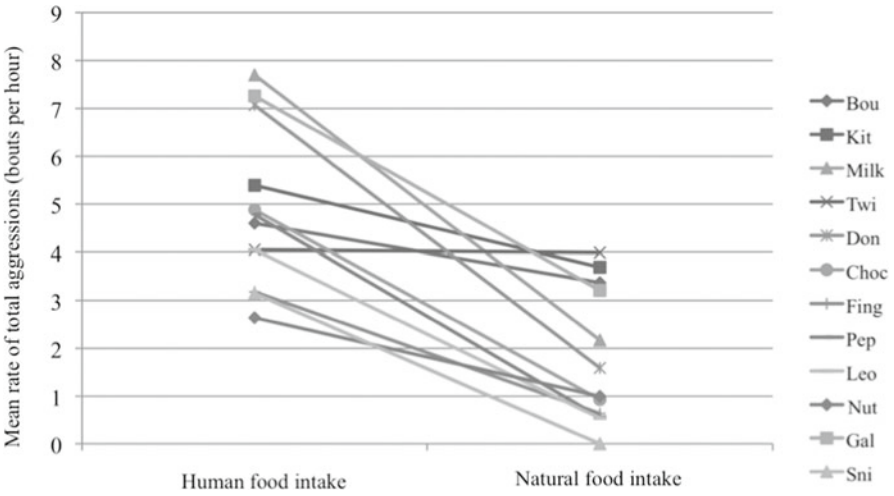

Fig. 11.2 Mean rate of aggression given or received during human and natural food intake in the study of 12 Barbary macaque males

and Hayward 2009). Bearing in mind the important hygienic and social functions of grooming (Dunbar 1991), our data suggest that close interactions between animals and tourists should be avoided.

11.6.4 The Effect of Tourism on Rates of Intraspecific Aggression

On average, males were involved in an intra-specific aggressive interaction 5.1 times per hour, a rate that is very close to that seen in a Barbary macaque group provisioned by tourists in Gibraltar (i.e. 5.2 aggression/h; Fa 1986). The rate at which males were involved in aggression interactions with other group members was not related to either the mean number of tourists present throughout the day (Pearson correlation = 0.062, $n = 47$, $p = 0.677$) or to the proportion of time that tourists were present at the site (Pearson correlation: $r = 0.263$, $n = 7$, $p = 0.074$). However, the rate of aggression was significantly associated with tourist proximity (Spearman correlation: $r_s = 0.929$, $n = 7$, $p = 0.003$); males were more frequently involved in aggressive interactions when tourists were in closer proximity. Looking specifically at how feeding by tourists may affect aggressive behaviour, it was found that males' rate of aggression during tourist-related feeding was significantly higher than when consuming natural food (paired *t*-test, $t_{11} = 6.304$, $p < 0.001$; Fig. 11.2). These results suggest that the close proximity of tourists elevates rates of intraspecific aggression. This effect may again be due to the occurrence of feeding, which inevitably involves

close proximity between the macaques and people. Hill (1999) compared the rates of aggression between provisioned and non-provisioned conditions in Japanese (*Macaca fuscata*) and rhesus macaques (*M. mulatta*) and found that provisioned groups had higher levels of aggression. In Tibetan macaques (*M. thibetana*), it was reported that the increase in the rate of adult aggression in provisioned monkeys was a key factor driving increased infant mortality in such troops (Berman et al. 2007). Furthermore, Hsu and colleagues (2009) recently found that food provisioning increased both the frequency and duration of aggression among Formosan macaques (*M. cyclopis*).

11.6.5 The Effect of Tourism on the Behaviour of Barbary Macaques

The results of this research are consistent with previous studies of provisioned macaque groups confronted with tourist presence. Provisioning seems to affect the activity budgets of Barbary macaques. Most importantly, the presence and behaviour of tourists affected the behaviour of the study males in ways that may have negative effects on the welfare of the animals. If tourism related to Barbary macaques in Morocco is to be developed further, it may be necessary to manage tourist sites carefully in order to eliminate or limit these negative impacts. Such mitigating measures would be welcomed as the significant economic benefits of the wildlife tourism industry could potentially make a very significant contribution to the conservation of this endangered species.

11.7 Conclusions

In this short review, we have attempted to highlight the possible problems that may arise when humans and Barbary macaques interact or come into conflict. Little is known about wild Barbary macaques or the type and effect of their interactions with humans in historic times or at present. Such information is crucial to protect this endangered species. In Gibraltar, more effective regulations should be put in place to avoid episodes of monkeys biting tourists and to limit the risk of having urbanised monkeys. Very encouraging steps have recently been taken in this direction. At the same time, education programmes could help tourists to visit the Upper Rock Nature Reserve without risk of injury. In Morocco and Algeria, more should be done to protect the Barbary macaques in their natural habitat. Strict control of illegal logging and overgrazing of livestock can have immediate benefits for the population viability of this species. In the areas that have been allocated to forest regeneration, the numbers of mixed goat/sheep herds should be minimised or the presence of such herds completely prevented. For the trade of monkeys, law enforcement

against poachers, sellers and smugglers should be the highest level of priority. In order to implement effective measures to protect the Barbary macaques, the international community should work together with the Moroccan and Algerian governments. Effective controls at the borders of the Moroccan and of some European countries may significantly limit the trade in this species. Finally, the education of potential buyers of macaques is an important measure to combat the trade. In 2007, 2010 and 2011, a large-scale educational programme took place in the ports of Algeciras and Tarifa (Spain), and Tangiers (Morocco), with information handed out to the tourists on their way to Morocco for a holiday. These projects were very successful and should be repeated as often as possible. Taking away the demand for infant macaques will eventually reduce the trade and help us protect this fascinating and unusual primate species.

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