

Behavioural Responses of Yunnan Snub-Nosed Monkeys (*Rhinopithecus bieti*) to Tourists in a Provisioned Monkey Group in Baimaxueshan Nature Reserve

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Keywords

Rhinopithecus bieti · Wildlife tourism · Behavioural responses · Baimaxueshan Nature Reserve

Abstract

The appearance of tourists brings about behavioural changes in some primates. Primate behavioural responses to human activities can reflect their survival strategy. Little is known about how the behaviour of *Rhinopithecus bieti* changes in the presence of tourists. Here we provide the first detailed description of interactions between a provisioned group of *R. bieti* and tourists at Xiangguqing in Baimaxueshan Nature Reserve from July 2012 to June 2013. We found that *R. bieti* had different response rates to the 5 most common human actions (shout, photograph, offer food, clap, and wave). Results indicated that *R. bieti* expresses 10 behavioural reactions (threat, escape, vigilance, warning, panic, alliance, attack, foraging, approach, and staring) to tourists' actions. On the whole, most of the monkeys' responses were unfriendly or hostile; a small number were neutral and affiliative. Behavioural responses were also significantly different among the different age/sex classes. Immature individuals engaged in more affiliative

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0015-5713/17/0876-0349\$39.50/0

behaviours than adult individuals, and adult males tended towards more hostile behaviours. The behaviour of *R. bieti* towards tourists showed both tension and adaptability. Scientific management of provisioned monkey groups and strict regulation of tourist behaviour is needed in order to protect the animals from the negative effects of tourism-related disturbance.

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Introduction

Wildlife tourism is one of the largest international tourism markets [Fennell, 2008]. Tourism catered around non-human primate species has developed into a profitable industry with strong market demand [Fennell, 2008; Klailova et al., 2010]. In some places, it has served as a method to promote the conservation of threatened species and their habitats [Plumptre et al., 2002; Shutt, 2014]; this type of wildlife tourism can be a win-win situation for both the government and the animals [Balantyne et al., 2009]. Wildlife tourism involving provisioning or habituation of wild animals has drawn public attention and created controversy, especially with non-human primates [Wallis and Lee, 1999; Hsu et al., 2009]. Some researchers suggest that inappropriate and unregulated non-human primate tourism has resulted in harmful consequences such as habitat disturbance and destruction, a high risk of infectious disease transmission, abnormal hormone or metabolic levels, the alteration of natural behaviours, and ultimately a negative effect on social structure, reproduction, and development [Obua, 1997; Jones-Engel et al., 2005; Hsu et al., 2009; Maréchal et al., 2011; McKinney, 2014; Shutt, 2014; Maréchal et al., 2016].

Primate tourism directly impacts the natural behaviours of non-human primates [Wheatley, 1999; Fuentes and Wolfe, 2002; Sponsel et al., 2002; Wingfield and Romero, 2011]. Hsu et al. [2009] reported that adult male Formosan macaques (*Macaca cyclopsis*) at Shou-Shan Nature Park in Taiwan participated in conflicts at a higher rate than members of other age/sex groups, and food provisioning increased both the frequency and duration of this aggression. Threat displays in Tibetan macaques (*M. thibetana*) significantly increased as a result of tourist behaviours at Mt. Huangshan in China [Ruesto et al., 2010]. Maréchal et al. [2011] reported that male Barbary macaques (*M. sylvanus*) in Morocco showed higher rates of self-directed behaviour when their interactions with humans increased. It is also known that habituating western lowland gorillas (*Gorilla gorilla gorilla*) to tourists is highly stressful for the gorillas, as evidenced by frequent displays of aggression, different time budgets, and even altered ranging behaviour [Cipolletta, 2003; Blom et al., 2004]. Similarly, Muiyambi [2005] found that tourism leads to an increased frequency of aberrant behaviour in mountain gorillas. The effect of primate tourism on the animals' behaviour requires further study in order to create sustainable wildlife tourism programmes and conserve these species [McKinney, 2014].

At present, research on the impacts of primate tourism has mainly focused on *Macaca* spp., *Cebus* spp., and *Pongo* spp. [Tutin et al., 1995; Sabbatini et al., 2006; Klailova et al., 2010; Maréchal et al., 2016a, b]. We found no published data about the behavioural responses of snub-nosed monkeys (*Rhinopithecus* spp.) to tourism. Yunnan snub-nosed monkeys (*R. bieti*) are threatened colobine monkeys that inhabit high-altitude temperate forests in the Hengduan Mountains in Northwestern Yun-

nan and Southeastern Tibet [Long et al., 1994]. This species of diurnal primate subsists on lichens and the leaves of angiosperms [Grueter et al., 2009; Li et al., 2011]. *R. bieti* forms large, multilevel social groups consisting of many 1-male, multi-female units (OMUs) and associated all-male units [Li et al., 2014]. This species is kept at only 2 or 3 zoos in China. Approximately 60% of the world's population of *R. bieti* live in Baimaxueshan Nature Reserve [Li et al., 2010]. Due to strong market demand and a mandate to protect this species, a government-sponsored tourism program at Xiangguqing (within Baimaxueshan Nature Reserve) for *R. bieti* began in 2010. Whether tourism-related disturbance has affected the monkeys, or whether the monkey-human relationship has turned to open conflict, as with *M. thibetana* at Emei Shan, China, was previously unknown.

We studied the behavioural responses of Yunnan snub-nosed monkeys to tourists in a provisioned monkey group at Xiangguqing from July 2012 to June 2013. Our aim was to explore the monkeys' reaction to tourism-related disturbance and to test the following hypotheses and predictions:

Hypothesis 1

Response rates to tourists in *R. bieti* are different for different kinds of behaviours. As the monkeys become habituated to humans, more common tourist behaviours will stimulate less of a response, and more unusual behaviours would elicit greater response rates.

Hypothesis 2

Response patterns to tourists in *R. bieti* are different for different kinds of tourist actions.

Hypothesis 3

Different age/sex classes of *R. bieti* respond to tourist behaviour differently. Immature monkeys tend to be more playful and exploratory than adults [Li et al., 2014]. Thus, we expect immature monkeys to adapt to humans more quickly than their parents and show more friendly behaviour. Adult monkeys, in contrast, should reject human interference through, for example, threats or even attacks.

Materials and Methods

Study Site and Animals

We carried out this study at Xiangguqing (99°22' E, 27°37' N), in the southernmost region of Baimaxueshan Nature Reserve, Yunnan Province, China. The study site includes multiple habitat types: mixed coniferous and deciduous broadleaf forest, subalpine fir forest, montane sclerophyllous oak forest, subtropical evergreen broadleaf forest, and pine forest. The average annual temperature over the course of the study was 9.8°C at 3,038 m elevation, and annual rainfall during the same time period was 1,371 mm. Temperature and precipitation were strongly seasonal [Li et al., 2014].

The focal monkey group is a stable provisioned group, having been separated from a local natural group in May 2008. The study group inhabits subtropical evergreen broadleaf forest, mixed deciduous broadleaf and conifer forest, and pine forest from 2,600 to 3,200 m in altitude. The focal group consists of 88 individuals belonging to 8 OMUs and 1 all-male unit. In July 2012, it included 11 adult males, 26 adult females and 51 immature monkeys. Successfully displaying monkeys to tourists has required provisioning twice a day, at 09:00 and 17:00, at various provi-

sioning locations since the end of 2009. The food provided accounts for very little of their total consumption. At each feeding, the monkeys were given approximately 10 kg of lichens, 3 kg of carrots, 3 kg of corn, and 1.5 kg of pumpkin seeds.

Tourism for the Focal Group

These tourists are primarily domestic travellers, including locals and Chinese people from other cities, but there are a small number of foreign visitors. Tourists generally visit during the weekend or on holidays. The provisioned monkeys at Xiangguqing are well habituated to observers and since 2010 can be approached to within 5–30 m [Li et al., 2013]. In an attempt to maintain the natural state of *R. bieti* as much as possible, tourists can only see the monkeys at provisioning sites from 09:00 to 11:30. Tourists are advised that they can “see the monkey closely,” and visitors are encouraged to stop briefly to see and photograph the monkeys. On occasion, a few unruly tourists throw food to the monkeys.

Behaviour Definitions

Visitor behaviour was classified into 5 categories: shout, photograph, offer food, clap, and wave. We divided the sampled monkeys into 3 age/sex classes according to fur colour and body size: adult male (largest individuals of the group, long white hair on flanks), adult female (ischial callosities visible, nipples long and drooping), and immature individuals (back and limbs light grey, including subadult males, subadult females, juveniles and infants). A response was defined as at least 1 behavioural change in monkeys owing to the presence or behaviour of the tourists [Hsu et al., 2009]. We adopted the definitions of monkey behaviour following Li et al. [2013], and referred to McKinney [2014] to define the 5 tourist behaviours (Table 1). Tourist-monkey interactions were classified into 3 categories: hostility (threat, escape, vigilance, warning, panic, alliance, and attack), neutrality (foraging), and affiliation (staring and approaching).

Data Collection and Analysis

We conducted behavioural observations of tourists and monkeys from July 2012 to June 2013 when there were visitors at the site. We collected 411.2 h of recorded data during 255 observation days through scan sampling and focal sampling [Altmann, 1974]. The average observation time lasted 1.6 h per observation day. When tourists and monkeys appeared at the same time, we used scan sampling to record data for humans that included the number of people and each person's activity category (2,564 events). Focal sampling was used to record data for the behavioural response of monkeys including the number of monkeys, their age/sex classes, and behavioural category (445 events).

Data were analysed using Microsoft Excel 2003 and SPSS 18.0. We used a χ^2 test to determine the significance of rate differences in the 5 kinds of response. We employed independent-sample t-tests to compare the frequency of behaviour across 3 age/sex classes (adult male, adult female, and immature monkeys) each observation day to determine whether the behavioural responses to the 5 classes of human activities differed significantly between them. All tests were 2-tailed with $p \leq 0.05$ as the threshold to reject the null hypothesis. Principal component analysis was used to analyse interactions between tourists and *R. bieti*, which might help us to distinguish between hostile, affiliative or neutral responses related to the different tourist behaviours.

Results

*Behavioural Responses of *R. bieti* to Tourist Actions*

Each day, an average of 14.6 tourists (range 3–62 per day) visited the site, and each tourist spent an average of 56.4 min (range 26–125 min) with the monkeys. We recorded 2,564 total instances of visitors' behaviour towards the monkeys during tourism activities. Individual *R. bieti* responded 445 times, representing a response

Table 1. Ethogram of tourist-monkey interactions observed for *R. bieti* at Xiangguqing in Baimaxueshan Nature Reserve from July 2012 to June 2013

<i>Behaviours performed by tourists</i>	
Shout	Tourists raise a cry towards monkeys with the intention of attracting their attention
Photograph	Tourists take a photo of the monkeys with a camera or phone with or without using the flash
Offer food	Food is thrown to monkeys to attract their attention and encourage them to come nearer
Clap	Tourists clap their hands to produce an audible sound to attract the attention of monkeys
Wave	Tourists wave to attract the attention of monkeys
<i>Behaviours performed by monkeys</i>	
Threat	Gnash their teeth to threaten tourists who are close to them and their offspring or who perform other behaviours perceived as potentially dangerous
Escape	Rapidly run away when monkeys perceive danger or potential danger
Vigilance	Observe tourists closely to prevent the development of a dangerous situation
Warning	Utter warning sounds or shake a tree to warn tourists
Panic	More than 3 monkeys jump on the ground or tree, rapidly run away, full of tension
Alliance	Alliance with 1 or more group members toward a common opponent
Attack	Adverse reaction when close to tourists, especially when food is provided
Foraging	Accept, play with, and look for food or other objects thrown by tourists
Approach	Proximity with and enthusiasm towards tourists
Staring	Watch tourists intently

rate of 17.36%. All 5 behaviours (shout, photograph, offer food, clap, and wave) received a response from the monkeys (Fig. 1). Nevertheless, the response rates to the 5 behaviours showed significant differences ($\chi^2 = 54.24$, $df = 4$, $p < 0.01$). The behaviours in order of increasing rate of response from the monkeys were as follows: offer food, photograph, wave, clap, and shout. The response to photography that used the camera's flash accounted for 100% of the responses to all 7 events.

Interactions between Tourists and R. bieti

We found that *R. bieti* not only has different response rates to the behaviour of tourists ($\chi^2 = 443.869$, $df = 7$, $p < 0.01$), but also adopts different behavioural strategies. For instance, when people shouted at the monkeys, they responded with 9 kinds of behaviour: threat, approach, escape, vigilance, panic, alliance, staring, warning, and attacking. When offered food, the monkeys responded in 6 ways: threat, foraging, approach, staring, escape, and warning others, as shown in Figure 2. On the whole, unfriendly, hostile actions accounted for 84.04% of responses (threat 35, escape 111, vigilance 178, warning 36, panic 10, alliance 2, attack 2), 1.8% were neutral (foraging 8), and 14.16% were affiliative (staring 39 and approach 24). Statistical analyses suggested a significant difference between the 3 activity categories ($\chi^2 = 93.342$, $df = 2$,

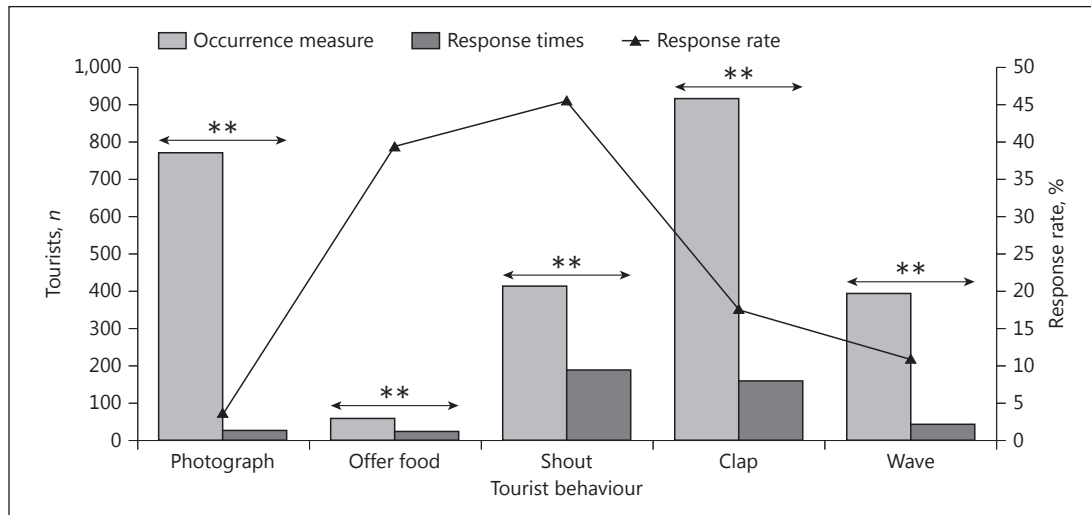


Fig. 1. Behavioural response rates of *R. bieti* and the number of tourist behaviours. ** $p < 0.01$.

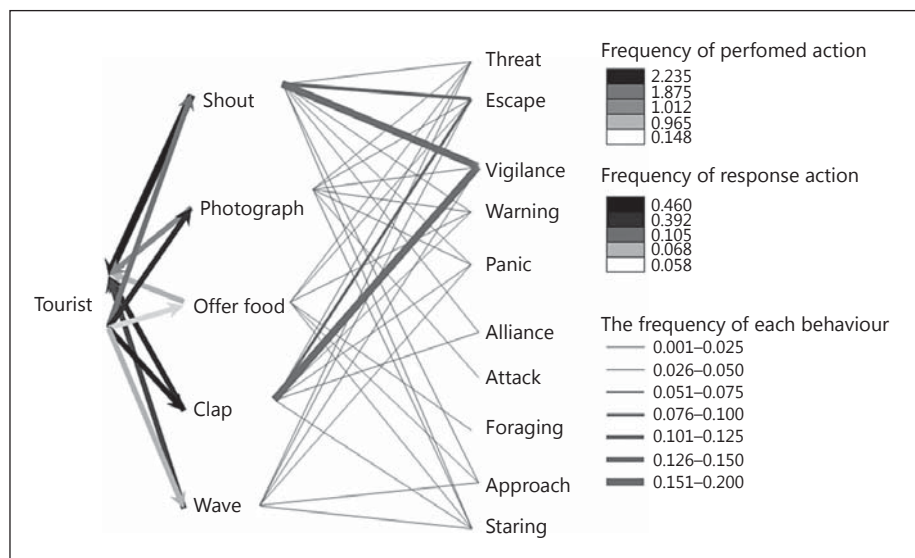


Fig. 2. Behaviour relation diagram of tourists and monkeys at Xiangguqing in Baimaxueshan Nature Reserve.

$p < 0.01$). Using principal component analysis to analyse interactions between tourists and *R. bieti*, we found that 5 principal components are threat (13.61%), escape (13.55%), vigilance (12.93%), warning (12.72%), attack (12.59%), and all are hostile responses to the different tourist behaviours (Table 2).

Table 2. Principal component analysis to analyse interactions between tourists and *R. bieti*

Component	Initial eigenvalues			Extraction of sum of squares loaded		
	total	% of variance	cumulative %	total	% of variance	cumulative %
Threat	1.089	13.613	13.613	1.089	13.613	13.613
Escape	1.084	13.551	27.164	1.084	13.551	27.164
Vigilance	1.034	12.925	40.089	1.034	12.925	40.089
Warning	1.017	12.717	52.806	1.017	12.717	52.806
Attack	1.007	12.587	65.393	1.007	12.587	65.393
Foraging	0.975	12.191	77.585			
Approach	0.941	11.760	89.345			
Staring	0.852	10.655	100.000			

Variation in Behavioural Responses between Age/Sex Classes

We found that threats ($t = 5.331$, $df = 508$, $p < 0.01$), escapes ($t = 5.019$, $df = 508$, $p < 0.01$), vigilance ($t = 6.701$, $df = 508$, $p < 0.01$), and warnings ($t = 4.406$, $df = 508$, $p < 0.01$) were more prevalent in adult monkeys than they were in immature individuals. Conversely, affiliative behaviours (e.g. approach and staring) were far less frequent in adults than they were in immature individuals ($p < 0.05$). Further, threats ($t = 2.709$, $df = 508$, $p < 0.01$) and vigilance ($t = 2.487$, $df = 508$, $p < 0.05$) were more commonly displayed by adult females than immature individuals, while approach and staring occurred less than in immature individuals ($p < 0.01$). Threats ($t = 4.706$, $df = 508$, $p < 0.01$), escapes ($t = 2.035$, $df = 508$, $p < 0.05$), vigilance ($t = 2.079$, $df = 508$, $p < 0.05$), and warnings ($t = 3.071$, $df = 508$, $p < 0.01$) were significantly more frequent in adult males than immature individuals. In contrast to adult females, adult males showed greater hostility in the form of threats ($t = 2.261$, $df = 508$, $p < 0.05$) and warnings ($t = 1.734$, $df = 508$, $p < 0.05$; Table 3).

Discussion

Behavioural Adaptability to Tourist Disturbance in R. bieti

Long-term, low-intensity interference by humans can result in wildlife adapting to their presence [Klailova et al., 2010]. For wild *R. bieti* observed continuously in long-term studies, observation distances tend to decrease (e.g. 50 to 20–30 m), and their reactions to human activities change from limited tolerance to basic habituation [Ren et al., 2008; Li et al., 2014]. This study's results, in which a provisioned group of *R. bieti* showed behavioural plasticity towards tourists, are consistent with those previously described. *R. bieti* responded at different rates to 5 tourist actions (shout, photograph, offer food, clap, and wave). Habituated individuals have greater self-inhibition responses than non-habituated individuals [Fan and Xiang, 2013] as observed in *Alouatta pigra*, *M. sylvanus*, *P. pygmaeus morio* and *G. g. gorilla* [Behie et al., 2010; Maréchal et al., 2011; Muehlenbein et al., 2012; Shutt, 2014]. Habituated non-human primates change their behaviour to deal with tourist interference in order to protect

Table 3. Variation in behavioural responses to tourist actions among age/sex categories for *R. bieti* at Xiangguqing in Baimaxueshan Nature Reserve from July 2012 to June 2013

	AF vs. IM	AM vs. IM	AM vs. AF	AD vs. IM
Threat				
<i>t</i>	2.709	4.706	2.261	5.331
<i>p</i>	0.007	0.000	0.024	0.000
Escape				
<i>t</i>	0.799	2.035	1.296	5.019
<i>p</i>	0.424	0.042	0.196	0.000
Vigilance				
<i>t</i>	2.487	2.079	-0.433	6.701
<i>p</i>	0.013	0.038	0.665	0.000
Warning				
<i>t</i>	1.490	3.071	1.734	4.406
<i>p</i>	0.137	0.002	0.084	0.000
Attack				
<i>t</i>	1.000	1.000	0.345	1.374
<i>p</i>	0.318	0.318	0.730	0.170
Foraging				
<i>t</i>	-1.146	-2.460	-1.398	-1.146
<i>p</i>	0.252	0.014	0.163	0.252
Approach				
<i>t</i>	-3.116	-3.909	-1.460	-2.775
<i>p</i>	0.002	0.000	0.145	0.006
Staring				
<i>t</i>	-3.141	-3.225	-0.153	-2.037
<i>p</i>	0.002	0.001	0.878	0.042

AF, adult female; AM, adult male; AD, adult individuals; IM, immature individuals. Bold indicates significance. "Panic" and "alliance" are group behaviours, so we did not compare these 2 behaviours.

themselves [McKinney, 2014; Maréchal et al., 2016a]. For instance, *Cebuella pygmaea* reduced their tweeting, play, and aggressive behaviour [de la Torre et al., 2000], *A. pigra* moved higher in the trees [Treves and Brandon, 2005], *A. seniculus* and *G. gorilla beringei* reduced time spent feeding and increased travel time and distance [Muyambi, 2005; Westin, 2007]. At Xiangguqing, the time budgets of the provisioned monkey group were undoubtedly altered; this study's focal group spent 33.4% of their time feeding, less than the 39% observed in the wild group, and increased their rest time [Li et al., 2013; Li, unpubl. data].

Although this provisioned group has acclimated to tourism to a certain degree, close human contact and the monkeys' curiosity leads to frequent human-monkey interactions. Monkeys most commonly display affiliative behaviours towards friendly actions on the part of the tourists, but in response to dangerous or potentially dangerous actions from tourists they respond with threat displays or evasion. Primates enter a state of tension when humans are close to them, triggering their defensive behaviours [Kinnaird and O'Brien, 1996; Zhao, 2004; Berman et al., 2007]. In re-

sponse to tourists at Xiangguqing, the number of hostile responses (e.g. vigilance, escape) far exceeded the number of affiliative ones. Operant conditioning is a natural extension of classical conditioning, and long-term human-induced disturbance can cause a conditional response in animals [Jiang, 2004]. Increased interactions between humans and monkeys will cause greater habituation in *R. bieti*, leading to a change in the monkeys' behaviour [Fan and Xiang, 2013]. Long-term human disturbance will eventually result in permanent adaptation and behavioural change [Maréchal et al., 2016a]. For example, monkeys will know to congregate at a given time and place every day, or in response to a fixed frequency whistle, for feeding. They may also develop a conditional response, such as calling for or otherwise soliciting food.

Different Responses among Age/Sex Classes

Immature individuals and adults differed in their response to tourists. Immature individuals were much more likely to display affiliative behaviour and less likely to display hostile behaviour than adult monkeys. This was also observed in *C. imitator* and *M. cyclopis* [Hsu et al., 2009; McKinney, 2014]. As the monkeys in this provisioned group came from a larger wild monkey group in 2008, and most of the immature individuals were born after 2008, wildlife tourism had been experienced throughout their lives. This is another potential explanation for why young monkeys were more comfortable with people and engaged in affiliative behaviours.

Like *M. thibetana*, *M. fascicularis*, *M. cyclopis*, and *A. palliata*, adult male *R. bieti* showed greater hostility to tourist behaviour [Fuentes and Gamerl, 2005; Fuentes, 2006; Berman et al, 2007; Hsu et al., 2009; McKinney, 2014]. The frequency of adult male avoidance and aggressive behaviour is rooted in fierce competition between males of this species [Yu et al., 2009]. Disadvantaged individuals are threatened by, then angry at visitors [Zhao, 2004; Ji et al., 2010]. In New World monkeys, langurs and anthropoids, each OMU is an independent community with its own territory [Dunbar, 1988], which is defined by the limits of what the group's leader male could protect. When tourists approached snub-nosed monkeys and engaged in potentially dangerous behaviour, the OMU leaders would fight, especially during the breeding and birth seasons. Like other snub-nosed monkeys, mothers protecting their infants were also prone to engage in conflict with humans [Schino et al., 2004]. Female *R. bieti* invest heavily in the care and protection of offspring, although females rarely attack for other reasons [Zhao et al., 2011; Cui et al., 2014]. This is consistent with the observed behaviour of Japanese macaques (*M. fuscata*), which were more likely to attack after giving birth than before [Schino et al., 2004].

In conclusion, since the beginning of snub-nosed monkey tourism at Xiangguqing, the behaviour of *R. bieti* has shown a few changes. The monkeys have not yet shown the levels of aggression towards humans that habituated *M. thibetana* at Mt. Huang and Mt. Emei have. In this study, *R. bieti* did not appear to attack tourists. However, this does not mean that the impacts of tourism are not equal or greater on snub-nosed monkeys compared to the macaques. It is worth noting that prolonged contact with humans may lead to greater behavioural changes. We argue that scientific management of provisioned monkeys and strict regulation of tourist behaviour are important for the well-being of the animals.

Acknowledgements

We are grateful to our field assistants Jianhua Yu, Jinming Yu, and Lizhong Yu. We thank Baimaxueshan Nature Reserve for our work permit. Financial support was provided by grants from NSFC [No. 31470461, 31200294, 31370410], National Key Programme of Research and Development, Ministry of Science and Technology [No. 2016YFC0503200], Sichuan Youth Science and Technology Foundation (No. 2015JQ0024).

Disclosure Statement

All research protocols reported here adhered to the regulatory requirements of and were approved by the animal care committee of the Wildlife Protection Society of China. The authors have declared that no competing interests exist. The authors alone were responsible for doing the research and writing the paper.

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