American Journal of Primatology 70:169–174 (2008)

RESEARCH ARTICLE

Social Organization of Black-and-White Snub-Nosed Monkeys (*Rhinopithecus bieti*) at Deqin, China

LIANG-WEI CUI[1,2], SHENG HUO[3], TAI ZHONG[4], ZUO-FU XIANG[5], WEN XIAO[3]*, AND RUI-CHANG QUAN[6]*
[1]*Faculty of Conservation Biology, Southwest Forestry College, Kunming, People's Republic of China*
[2]*Kunming Primate Research Center, Kunming Institute of Zoology, Chinese Academy of Sciences, Kunming, People's Republic of China*
[3]*Department of Life Science and Chemistry, Dali University, Dali, Yunnan, People's Republic of China*
[4]*Yunnan Baima Snow Mountain National Nature Reserve, Deqin, Yunnan, People's Republic of China*
[5]*College of Life Science and Technology, Central South University of Forestry & Technology, Changsha, Hunan, People's Republic of China*
[6]*Xishuangbanna Tropical Botanical Garden, Chinese Academy of Science, Mengla, Yunnan, People's Republic of China*

Data on social organization of two bands of black-and-white snub-nosed monkeys (*Rhinopithecus bieti*) were collected when the monkeys were crossing an open spot at Nanren and Bamei (northwest of Yunnan, China) using a sampling rule where individuals within one social unit are spatially closer to each other than individuals between social units. The typical pattern of social organization in this sample was multiple adult females (AFs) and their offspring with one adult male (AM) in a one-male unit (OMU), similar to that of many other colobines. In such units, on average one male is associated with 4.0 AFs and 2.5 of their offspring. Moreover, there are multimale/multifemale units and monogamous units besides OMUs. All bisexual units traveled together with at least one all-male unit as a cohesive band. In two bands of monkeys, 87% of AMs in bisexual units were within OMUs, 7.8% within monogamous units and 5.2% within multimale, multifemale units. In the Bamei band, 6.7% of AMs were in the all-male unit. The size of OMUs in the Nanren band was larger than that of the Bamei band, with more AFs and juveniles, which may be related to better conservation in the Nanren band's habitat. For the Nanren band, the average number of AFs in OMUs varied across time, increasing from 4.3 in 1994 to 5.1 in 2001, and then decreasing to 3.8 in 2005. This article suggests three possible explanations for this variation, but more data are needed for these hypotheses to be tested. Am. J. Primatol. 70:169–174, 2008.

Key words: social organization; one-male unit; monopolization; *Rhinopithecus bieti*

INTRODUCTION

Colobine monkeys show great diversity in their social organization, including monogamy, matrilineal-harem, matrilineal-multimale and patrilineal-multimale societies [Newton & Dunbar, 1994]. In Asian colobines, the typical pattern of bisexual groups is multiple females and their offspring with a single male (one-male units [OMUs]), usually associating with at least one all-male unit (AMU) or solitary males; in some species, however, bisexual groups contain multimales, with two or, rarely, three or more males [Kirkpatrick, 2007]. It has been reported that both single and multimale groups are found in *Trachypithecus leucocephalus* [Li & Rogers, 2003], sometimes within one population [e.g., *Presbytis entellus*: Newton, 1988; *Nasalis larvatus*: Boonratana, 2002].

There is wide variation in OMU size and the number of adult females (AFs) in OMUs among species and within populations of the same species of Asian colobines. The extremes of OMU size range from 11–34 monkeys with only 4–12 AFs in *P. entellus* [Newton, 1987] to 5–13 animals with 2–5 AFs in *Presbytis pileata* [Stanford, 1991a]. The percentage of adult males (AMs) in bisexual units within OMUs varies between species, ranging from

Contract grant sponsor: Doctoral startup fund of Southwest Forestry College; National Geographic Society; The Nature Conservancy.

*Correspondence to: Wen Xiao, Department of Life Science and Chemistry, Dali University, Dali, Yunnan, P. R. China 671000. E-mail: jwenxiao@hotmail.com

*Correspondence to: Rui-Chang Quan, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Science, Mengla, Yunnan 666303, P. R. China. E-mail:quanre@163.com

Liang-Wei Cui and Sheng Huo contributed equally to this work.

Received 11 December 2006; revised 13 July 2007; revision accepted 26 July 2007

DOI 10.1002/ajp.20471
Published online 25 September 2007 in Wiley InterScience (www.interscience.wiley.com).

zero in *Trachypithecus cristatus* [Curtin, 1980; Furuya, 1961] to 100 in *Rhinopithecus brelichi* [Bleisch et al., 1993]; and also varies among different populations of a species [refer to Kirkpatrick, 2007]. The ratio of AMs to AFs in OMUs can differ to a large extent between species, ranging from 1.0:1.7 in *Simias concolor* [Watanabe, 1981] to 1.0:8.0 in *N. larvatus* [Boonratana, 2002], and also between different populations of a species [refer to Kirkpatrick, 2007].

The number of AMs in a group should be related to the monopolizability of females [Emlen & Oring, 1977; Wrangham, 1980]. If a male can monopolize reproductive access to multiple females and defend them against other males, the optimal male strategy will be harem-defense polygyny [Emlen & Oring, 1977]. When a male cannot monopolize females, a multimale group will form and reproductive competition will be most pronounced within rather than between groups. In these cases, the optimal male strategy may then be to share females rather than risking lost reproductive chances [van Schaik & van Hooff, 1983].

Black-and-white snub-nosed monkeys (*Rhinopithecus bieti*) inhabit a restricted area ($<25{,}000\,km^2$) of the trans-Himalayas between the Mekong River (to the west) and Yangtze River (to the east), and between latitudes of 26°14′N and 29°20′N [Long et al., 1996]. The physical condition of the area is harsh for fieldwork because of steep slopes, deep gorges and 4–6 months of snow-covered winter. *R. bieti* monkeys mainly live in fir forests where visibility is very poor, and they are also very shy of humans. Under these conditions, short-terms surveys of the monkeys indicated that <1,700 individuals lived in 15 isolated groups of this species in its whole range [Xiang et al., 2007; Xiao et al., 2003] of which about 80% of the populations resided in the northwest of Yunnan, and 20% in southeast of Tibet [Long et al., 1996]. Moreover, only six of 15 groups have been counted since 1979, they are Nanren group [≈300; G. MacLennan, personal communication], Lijiang group [≈50; Yang, 2000], Fuheshan group [≈80; Liu & Zhao, 2004], Gehuaqing group (≥360) and Xiangguqing group (≥200) in Yunnan [Xiao et al., 2003]; and the Xiaochangdu group in Tibet [≥210; Xiang et al., 2007]. Information on the social organization of this species has been limited to one study of the Wuyapiya population [Kirkpatrick et al., 1998]. The population was composed of 15–18 OMUs that traveled together in a cohesive band with at least one AMU. The largest OMU was composed of 14–16 members; the AMU was variable in composition with a core of two AMs and several juveniles. Sub-AMs were most often associated with the AMU [Kirkpatrick et al., 1998]. These findings offer useful base counts of the population, but lack any systematic data on the species' social organization.

In this survey, we systematically collected data on the social organization of two bands of *R. bieti* whenever the monkeys were crossing open areas in a field. This study is designed to present quantitative data on the social organization, analyzing the difference in composition of OMUs between bands and changes in each band over time.

MATERIALS AND METHODS

Study Sites and Study Populations

Data on the social organization of two bands of *R. bieti* were collected at two different sites when the monkeys were observed crossing an open gully. One band of over 175 individuals inhabited the forests around the village of Nanren, Yunnan, China (99°40′E, 28°34′N, Baima Snow Mountain Nature Reserve) at the northernmost range of the Wuyapiya band [Kirkpatrick et al., 1998]. The vegetation in this area is typified by striking altitudinal zonation. In general, alpine meadows change into conifer forests at <4,300 m, giving way to oak forests at 3,800–3,600 m and oak shrubs at <3,600 m [Cui et al., 2006a]. The second monkey band observed is estimated to include <50 individuals [Long et al., 1996] and inhabits the relatively undisturbed forests around the village of Bamei, Yunnan (98°43′E, 28°54′N), northwest of the Nanren band. The vegetation here is primarily composed of conifer forests at higher altitudes and oak forests at lower elevations.

Social Composition of the Band

Characters for determining age–sex classes of *R. bieti* individuals [Kirkpatrick, 1996] were used during the course of sampling. An AM can be distinguished from an AF on the basis of the striking sexual dimorphism in body weight ($\bar{M}/\bar{F} \approx 2$) [Kirkpatrick, 1996]. Female *R. bieti* become mature at 4.5 years of age, and males at about 6.5–7.0 years of age [Zou, 2002]. A sub-AM is larger than an AF in body weight, and characterized by longer and more strongly contrasting black-and-white hair; they are usually excluded from OMUs and appear in AMU or as solitaries. Immatures clasping their mothers' bellies were considered infants during the course of movements, and other immature individuals moving independently on the ground were regarded as juveniles [Cui et al., 2006b]. Because these monkeys were not habituated enough to be observed at close distances (<100 m), they were observed with a monocular telescope (Nikon ED II, 25–56X: Nikon Corporation, Tokyo, Japan) from a protruding ridge opposite a slope used by the monkeys. But from a distance of >300 m, it was difficult to consistently differentiate sub-AMs from AFs; we may therefore report a biased estimate of sex ratios of males to females.

Bisexual units of *R. bieti* traveled together and often used the same travel path, but boundaries existed between units. Units were obvious particularly when they crossed gullies terrestrially or traveled above the tree line [Kirkpatrick et al., 1998]. Social units within these bands could be distinguished because the individuals within social units were spatially closer to one another than individuals between social units when the monkeys were crossing an open area, such as gullies and bald rocks at higher altitudes [Cui et al., 2006b].

Data on the social organization of the Nanren band of *R. bieti* were collected three times. The first set of data was obtained from a June 1994 video-recording (made by Zhi-Nong Xi on a Sony, PVW-537: Sony Corporation Company, Tokyo, Japan) of the monkeys' crossing an open gully of >20 m in width. The distance between the photographer and the monkeys was approximately 500 m. Only 17 bisexual units could be distinguished in part because of frequent changes in the focus of the video. AMUs were not recorded. Additional observations were made directly using a telescope.

The second observation was carried out on November 6, 2001 when the majority of the monkeys were passing orderly through a 20-m width of gully. The distance between the observer and the monkeys was estimated to be approximately 600 m. As the monkeys traveled quickly across the gully in two parallel lines and the anterior individuals mingled together, only 15 social units could be recorded in their entirety. Again, AMUs were not observed.

The third observation was conducted on January 1, 2005 when the monkeys were crossing orderly a gully of about 15-m width between conifer forests. The distance between the observer and the animals was estimated to be approximately 400 m. Several individuals in the front of the procession were not identified because they had entered the opposite forests before sampling. A total of 29 social units and two AMUs were recorded.

The *R. bieti* observed at Bamei traveled through a large area characterized by bald rocks on November 27, 2004. The distance between the observer and the group was approximately 300 m. Because this band of monkeys moved in sequence, the whole procession was recorded in its entirety.

Data Analysis

A two-level nested analysis of variance with the Tukey Honestly Significantly Different test was used to compare various characteristics of OMUs composition in the Nanren band across time and between the Nanren and Bamei band. The statistical analyses were conducted using STATISTICA 6.0 (StatSoft, Inc. Tulsa, OK). The tests were two-tailed and the threshold for significance was set at $P \leq 0.05$.

RESULTS

Composition of Social Units of the Nanren Band Across Time

A total of 133 individuals were recorded within 17 social units in June 1994, of which 88% were OMUs ($n = 15$), 6% were monogamous units ($n = 1$) and 6% were multimale, multifemale unit (MMU) ($n = 1$). The single MMU consisted of two AMs, three AFs and two juveniles. In November 2001, a total of 152 monkeys were recorded, including 151 animals within 15 bisexual units (93.3% of the units were OMUs [$n = 14$], and 6.7% were MMU [$n = 1$]) and one solitary AM. The MMU consisted of two AMs, seven AFs, three juveniles and three infants. In January 2005, a total of 225 monkeys were recorded in 31 units, of which 83.9% were OMUs ($n = 26$), 9.7% were monogamous units ($n = 3$), and 6.4% were AMUs ($n = 2$). Of three monogamous units, one unit was composed of one AM, one AF and their single infant; and the remaining both consisted of pairs of adult monkeys. The two AMUs consisted of one all-AM unit (nine monkeys) and one all-sub-AM unit (24 individuals). Age–sex composition of OMUs in the band across time is shown in Table I.

Composition of the Band of *R. bieti* at Bamei

A total of 73 individuals were recorded in 15 social units, of which 80.0% were OMUs ($n = 12$), 13.3% were monogamous units ($n = 2$) and 6.7% were AMU ($n = 1$). Composition of OMUs for this band is also shown in Table I. One of the monogamous units was composed of an AM and AF, and the other included a bisexual pair and a single infant. The AMU consisted of one AM and possibly eight sub-AMs. All bisexual units were at the front of the procession, and the AMU was at the rear.

Changes in OMUs Composition

OMU size of the Nanren band was significantly larger than that of the Bamei band ($F_{1,63} = 17.34$, $P < 0.001$), with more AFs ($F_{1,63} = 13.66$, $P < 0.001$), more juveniles ($F_{1,63} = 9.48$, $P < 0.01$) and no difference in the number of infants ($F_{1,63} = 2.82$, $P > 0.05$). There was a significant difference in OMU sizes among the different periods for the Nanren band ($F_{2,63} = 4.98$, $P < 0.01$). The Nanren band showed more individuals per unit (HSD, $P < 0.05$), more AFs ($F_{2,63} = 4.97$, $P < 0.01$; HSD, $P < 0.05$) and more juveniles ($F_{2,63} = 4.06$, $P = 0.02$; HSD, $P = 0.044$) in 2001 than in 2005 and no difference between the other 2 years (HSD, $P > 0.05$ for all). No difference was found in the number of infants per unit ($F_{2,63} = 0.40$, $P = 0.67$).

TABLE I. Age–Sex Composition of OMUs in Bands of *Rhinopithecus bieti*

Location/year	Mean±SD (sum, range)						Ratio		
	Adult male	Adult female	Juvenile	Infant	OMU size	*N*	AM:AF	IM:AD	Infant: AF
Nanren/1994	1.0±0.0 (15, 1–1)	4.3±1.2 (64, 3–7)	2.1±1.0 (31, 0–4)	0.8±1.0 (12, 0–3)	8.1±1.5 (122,5–10)	15	1.0: 4.3	1.0: 1.8	1.0: 5.3
Nanren/2001	1.0±0.0 (14, 1–1)	5.1±2.0 (72, 3–8)	2.4±1.9 (34, 1–8)	1.1±1.6 (16, 0–6)	9.7±3.6 (136, 5–17)	14	1.0: 5.1	1.0: 1.7	1.0: 4.5
Nanren/2005	1.0±0.0 (26, 1–1)	3.8±1.1 (98, 2–7)	1.3±1.1 (35, 0–5)	1.0±0.8 (26, 0–3)	7.1±2.6 (185, 4–16)	26	1.0: 3.8	1.0: 2.0	1.0: 3.8
Baime/2004	1.0±0.0 (12, 1–1)	2.8±0.8 (34, 2–5)	0.8±0.6 (9, 0–2)	0.4±0.7 (5, 0–2)	5.0±1.6 (60, 3–9)	12	1.0: 2.8	1.0: 3.3	1.0: 6.8
Two bands	1.0±0.0 (67, 1–1)	4.0±1.5 (268, 2–8)	1.6±1.3 (109, 0–8)	0.9±1.1 (13, 0–6)	7.5±2.9 (503, 3–17)	67	1.0: 4.0	1.0: 2.0	1.0: 4.5

OMUs, one-male units; AM, adult male; AF, adult female; IM, immatures; AD, adults.

DISCUSSION

The modal pattern of bisexual units observed in these two bands of *R. bieti* is of multiple females in OMUs with their offspring, findings consistent with the previous report for this species [Kirkpatrick et al., 1998]. In such units, one AM associated with 4.0 AFs and 2.5 offspring on average. In the two bands of monkeys, 87% of AMs within bisexual units were in OMUs, 7.8% in monogamous units and 5.2% in MMUs. In the Bamei band, 6.7% of AMs were found in the AMU. All bisexual units formed a large cohesive band traveling together, just as reported previously [Kirkpatrick, 1996]. In addition, there existed at least one AMU in each band, though their composition varied widely within one band [Kirkpatrick et al., 1998] and across bands. Thus, this study quantitatively supports the previous report of the social organization of *R. bieti* [Kirkpatrick, 1996], and is also similar to reports for many other colobines [Kirkpatrick, 2007; Newton & Dunbar, 1994].

OMUs of *R. bieti* varied widely in their sizes and in the number of AFs within and between bands and across time. Such variation raises new questions and demands for additional study to arrive at convincing explanations. The OMU size of the Nanren band in 2001 was as large as 17 monkeys with as many as eight AFs. However, in 1994 the OMU size was as low as five individuals with three AFs. In the Bamei band, the largest OMU comprised nine monkeys with up to five AFs; the smallest OMU included only three individuals with two AFs. Such within-species variation has also been reported in other colobines [*S. concolor*: Watanabe, 1981; *P. entellus*: Newton, 1987; *N. larvatus*: Boonratana, 2002]. A single Hanuman langur male has been reported to be able to monopolize up to 12 AFs [Newton, 1988], far more than in the largest bisexual unit found in this study. Additional information about the degree of estrus synchrony in this species is needed to understand why there appears to be a threshold in the number of AFs that can be monopolized by one male. For the Nanren band, the average number of AFs in OMUs varied across time; AFs increased from 4.3 in 1994 to 5.1 in 2001, and then decreased to 3.8 in 2005. This fluctuation has three possible explanations. First, AFs in OMUs increased to a threshold larger than 5.1 after 2001, then were reduced rapidly by the fissions of units. Second, the AFs per unit increased up to 5.1 on average, and then began to decrease for unknown reasons. Third, the fluctuation might be because of changes in the surrounding environment over time. Additional systematic and long-term data must be gathered to test these hypotheses.

In our study bands of *R. bieti*, six monogamous units were recorded, four in the Nanren band and two in the Bamei band. The monogamous units may be the residual parts of larger OMUs or MMUs,

which split into two or more smaller units, or formed by a pair of solitary adults. It is also possible that they may consist of a young male that is just in the process of attracting females to him to form an OMU, or an older AM who has lost all of his females but one. Moreover, females may sometimes leave their group to join a lone male following OMUs [Stanford, 1991b; Steenbeek et al., 2000]. These pairs may be transitory in these cases. However, more data are needed to track the dynamics of bisexual units.

In our study, the two MMUs may be formed by sons maturing in an OMU and tolerated by their father, or a male unable to monopolize the females in his OMU or tolerating other males only if the potential fitness is greater than the costs. However, the temporary MMUs in Asian colobines might be related to the gradually increasing aggression between males which resulted in a group split [Kirkpatrick, 2007].

The similar habitat types and lichen food sources distributed in large patches in Bamei and Nanren led us to predict similar demographic features in these two bands of *R. bieti*. However, the Nanren band consisted of larger OMUs with more AFs and juveniles. The Nanren band ranged inside a national nature reserve established in 1988, whereas no nature reserve has yet been established for the Bamei group. Thus, the differences in composition may be related to the difference in conservation status and disturbance in their habitats; poaching, logging and other human disturbances have previously been reported to affect group size [Dunbar, 1987; Struhsaker, 1997].

The percentage of AMs in bisexual units within OMUs of *R. bieti* was not consistent over time and within bands. Observations of the Nanren band in 2005 and the Bamei band in 2004 found the percentage to be 100, consistent with previous reports of *R. bieti* [Kirkpatrick et al., 1998] and *R. brelichi* [Bleisch et al., 1993; Bleisch & Xie, 1998]. But the percentage of AMs in bisexual units was lower in the Nanren band in 2001 and 1994, 93.3 and 91.4 respectively. In *Rhinopithecus roxellana* species, this percentage ranged from 77 to 100 within different bands [Ren et al., 1998]. These percentages in all the four species of *Rhinopithecus* were within the range seen in other colobine monkeys, ranging from 66 to 100 [*Pygathrix nemaeus*: Lippold, 1977] to 100 [*R. brelichi*: Bleisch et al., 1993; *N. larvatus*: Bennett & Sebastian, 1988; Yeager, 1990; *S. concolor*: Watanabe, 1981].

CONCLUSIONS

This study describes the social organization of two bands of *R. bieti*. The basic social unit of this sample is multiple females and their offspring with one male in an OMU, which is consistent with the social organization seen in many other colobines. Multimale/multifemale units and monogamous units are also found. All of the above noted social units travel together with at least one AMU as a cohesive band. The OMUs size and composition varies within bands and across time. Thus, it is necessary that further research is done on the social organization of populations of this species at other sites under different environmental conditions to clarify what factors determine this diversity.

ACKNOWLEDGMENTS

ZhiNong Xi kindly provided the 1994 videotape of the Nanren band and gave permission to us to use it in this study. Special thanks are extended to two anonymous reviewers for their good suggestions and editing of our manuscript, Edward Friedman and Timothy Hildebrandt for editing our manuscript and the staff and leaders of the Bamei Snow Mountain Nature Reserve for their assistance.

REFERENCES

Bennett EL, Sebastian AC. 1988. Social organization and ecology of proboscis monkeys (*Nasalis larvatus*) in mixed coastal forest in Sarawak. Int J Primatol 9:233–255.

Bleisch W, Cheng AS, Ren XD, Xie JH. 1993. Preliminary results form a field study of wild Guizhou snub-nosed monkeys (*Rhinopithecus bieti*). Folia Primatol 60:72–82.

Bleisch WV, Xie JH. 1998. Ecology and behavior of the Guizhou snub-nosed langur (*Rhinopithecus* [*Rhinopithecus*] *brelichi*), with a discussion of socioecology in the genus. In: Jablonski NG, editor. The natural history of the Doucs and snub-nosed monkeys. Singapore: World Science Press. p 217–240.

Boonratana R. 2002. Social organization of proboscis monkeys (*Nasalis larvatus*) in the Lower Kinabatangan, Sahah, Malaysia. Malay Nat J 56:57–75.

Cui LW, Quan RC, Xiao W. 2006a. Sleeping sites of black-and-white snub-nosed monkeys (*Rhinopithecus bieti*) at Baima Snow Mountain. J Zool 270:192–198.

Cui LW, Zhong T, Xiao L, Xiao W. 2006b. Group size and composition of black-and-white snub-nosed monkey (*Rhinopithecus bieti*) estimated by feces of sleeping sites at Mt. Baima Snow. Zool Res 27:337–343.

Curtin SH. 1980. Dusky and banded leaf monkeys. In: Chivers DJ, editor. Malayan forest primates. New York: Plenum Press. p 107–145.

Dunbar RIM. 1987. Habitat quality, population dynamics, and group composition in colobus monkeys (*Colobus guereza*). Int J Primatol 8:299–330.

Emlen S, Oring L. 1977. Ecology, sexual selection and the evolution of mating systems. Science 197:215–223.

Furuya Y. 1961. The social life of silvered leaf monkeys. Primates 3:41–60.

Kirkpatrick RC. 1996. Ecology and behavior of Yunnan snub-nosed langur (*Rhinopithecus bieti*). Ph.D dissertation. Davis: University of California. 295p.

Kirkpatrick RC. 2007. The Asian colobines: diversity among leaf-eating monkeys. In: Campbell CJ, Fuentes A, MacKinnon KC, Panger M, Bearder S, editors. Primates in perspective. Oxford: Oxford University Press. p 186–200.

Kirkpatrick RC, Long YC, Zhong T, Xiao L. 1998. Social organization and range use in the Yunnan snub-nosed monkey *Rhinopithecus bieti*. Int J Primatol 19:13–51.

Li ZY, Rogers E. 2003. Social organization of white-headed langurs *Trachypithecus leucocephalus* in Fusui, China. Folia Primatol 75:97–100.

Lippold LK. 1977. The douc langur: a time for conservation. In: Rainier HSHP, Bourne GH, editors. Primate conservation. New York: Academic Press. p 513–538.

Liu ZH, Zhao QK. 2004. Sleeping sites of *Rhinopithecus bieti* at Fuhe Mountain. Primates 45:241–248.

Long YC, Kirkpatrick RC, Zhong T, Xiao L. 1996. Status and conservation strategy of the Yunnan snub-nosed monkey. Chin Biodivers 4:145–152 (in Chinese with English abstract).

Newton PN. 1987. The social organization of forest Hanuman langurs (*Presbytis entellus*). Int J Primatol 8:199–232.

Newton PN. 1988. The variable social organization of Hanuman langurs (*Presbytis entellus*), infanticide, and the monopolization of females. Int J Primatol 9:59–77.

Newton PN, Dunbar RTM. 1994. Colobine monkey society. In: Davies AG, Oates JF, editors. Colobine monkeys: their ecology, behavior and evolution. Cambridge: Cambridge University Press. p 311–346.

Ren RM, Su YJ, Yan KH, Li JJ, Yin Z, Zhu ZQ, Hu ZL, Hu YF. 1998. Preliminary survey of the social organization of *Rhinopithecus* [*Rhinopithecus*] *roxellana* in Shengnongjia National Nature Reserve, Hubei, China. In: Jablonski NG, editor. The natural history of the Doucs and snub-nosed monkeys. Singapore: World Science Press. p 269–278.

Stanford CB. 1991a. The capped langur in Bangladesh: behavioral ecology and reproductive tactics. In: Szalay FS, editor. Contributions to primatology. Vol. 26. Basel: Karger. p 1–179.

Stanford CB. 1991b. Social dynamics of intergroup encounters in the capped langur (*Presbytis pileata*). Am J Primatol 25:35–47.

Steenbeek R, Sterck EHM, de Vries H, van Hooff JARAM. 2000. Cost and benefit of the one-male, age-graded, and all-male phases in wild Thomas's langur groups. In: Kappeler PM, editor. Priamte males; cause and consequences of variation in group composition. Cambridge: Cambridge University Press. p 130–145.

Struhsaker TT. 1997. Ecology of an African rain forest: longing in Kibale and the conflict between conservation and exploitation. Gainesville: University Press of Florida. 434p.

van Schaik CP, van Hooff JARAM. 1983. On the ultimate cause of primate social systems. Behaviour 85:91–117.

Watanabe K. 1981. Variations in group composition and population density of the two sympatric Mentawaian leaf-monkeys. Primates 22:145–160.

Wrangham RW. 1980. An ecological model of female bonded primate groups. Behaviour 75:262–300.

Xiang ZF, Huo S, Wang L, Xiao W, Quan RC, Zhong T. 2007. Distribution, status and conservation strategies of the black-and-white snub-nosed monkey *Rhinopithecus bieti* in Tibet. Oryx (in press).

Xiao W, Ding W, Cui LW, Zhou RL, Zhao QK. 2003. Habitat degradation of *Rhinopithecus bieti* in Yunnan, China. Int J Primatol 24:389–398.

Yang SJ. 2000. Habitat, diet, range use and social organization of *Rhinopithecus bieti* at Jinsichang. Ph.D dissertation. Kunming, Yunnan, China: Kunming Institute of Zoology.

Yeager CP. 1990. Proboscis monkeys (*Nasalis larvatus*) social organization: groups structure. Am J Primatol 20:95–106.

Zou RJ. 2002. Domestication, reproduction and management of *Rhinopithecus bieti*. In: Quan GQ, Xie JY, editors. Research on the golden monkeys. Shanghai: Shanghai Science and Education Press. p 417–444.