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Use of forest strata by Sichuan snub-nosed monkeys *Rhinopithecus roxellana* in spring and winter in Qinling Mountains，China*

ZHANG Peng[1,2]，LI Bao-Guo[1**]，WATANABE Kunio[2]

1. College of Life Sciences，Northwest University，Xi'an 710069，China

2. Primate Research Institute，Kyoto University，Inuyama 484－8506，Japan

Abstract We studied a free ranging provisioned group of the Sichuan snub-nosed monkey in their natural habitats. Group members spent 14% of their daytime on the ground，53% in the low stratum and 33% in the canopy. Use of forest strata differed among age-sex classes. Adult males spent 27% of daytime on the ground，20% of their foraging time on the ground and 29% of their resting time on the ground，all of which were significantly longer than the other classes. They traveled frequently on the ground（53%）but rarely in the canopy（15%）. To cross canopy gaps they preferred to grasp the branches on both sides and then shifted themselves in one direction，however，they often descended to the ground to avoid leaping the gaps. In contrast，subadult females and juveniles foraged and rested mostly in the lower stratum and/or canopy. Subadult females and juveniles spent significantly more time traveling in the canopy than adult animals. They rarely foraged or rested on the ground and tended to cross the canopy gaps by leaping. Juveniles were at a greater risk of falling from trees than adults. Factors such as body weight that affected their spatial distribution and locomotion were also examined [*Acta Zoologica Sinica* 52（3）：429－436，2006].

Key words Snub-nosed monkeys，*Rhinopithecus roxellana*，Forest utilization，Tree crossing mode

秦岭川金丝猴冬季和春季在自然栖息地的空间利用*

张 鹏[1,2] 李保国[1**] 渡边邦夫[2]

1. 西北大学生命科学学院，西安 710069

2. 京都大学灵长类研究所，犬山市 484－8506，日本

摘 要 2000年9月到2003年3月共计197天的时间里，我们采用目标动物取样法（Focal animal sampling）和行为的全事件记录法（All occurrence sampling）对一群生活在秦岭北坡周至保护区内的秦岭金丝猴（*Rhinopithecus roxellana*）在自然栖息地内空间利用的进行了研究。当猴群在离开人工投食区进行自由活动时我们开始收集数据。结果表明：秦岭川金丝猴在不同年龄性别组的个体对植被的空间利用明显不同，它们花费每天活动的14%的时间在地面上活动，53%时间在树叉处活动，33%的时间在树冠中间活动。与其它年龄性别个体相比，成年雄性有27%的观察时间在地上活动，并且20%的取食时间或29%的休息时间是在地上的，明显地高于其它年龄性别组的个体。群体迁移时，成年雄性有53%的时间在地上移动，而只有13%的时间是在树冠层移动的。在通过不同树冠的时候，成年雄性经常会同时抓住两边再把身体摆过去。它们也经常下到地上迁移而回避在树间跳跃。相比之下，亚成年雌性和青少年猴更加经常地在低植被层和树冠层中找食和休息。它们明显地比成年猴更加频繁地在树冠中移动，却很少下地。它们还经常使用跳跃的方式通过树冠间的空隙。从观察到摔下树的事例分析，青少年猴从树上摔下来的风险比成年猴大。本文进而讨论了影响秦岭金丝猴空间分布和移动的因素，比如说身体的重量等［动物学报 52（3）：429－436，2006］。

关键词 秦岭川金丝猴 空间利用 树间移动行为

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** Corresponding author. E-mail：baoguoli@nwu.edu.cn

In conformity with their diet and forest habitat, most colobinae species evolved toward arborealism (Davies, 1994). Thus they have gracile body form, slender limbs and digits and a long balancing tail. Their locomotion is rapid quadrupedal walking and agile leaping between tree gaps. The Sichuan snub-nosed monkeys *Rhinopithecus roxellana* exclusively inhabit temperate forests in the mountainous highlands of central and southwestern China, at 1 500 to 3 400 m above sea level (Hu et al., 1989; Chen et al., 1989; Li et al., 2000). They consume buds, flowers, catkins, leaves, barks and lichens which are their main winter foods (Li et al., 2000; Li et al., 2003). They were suggested to be typically arboreal by their extraordinary ability to leap, climb and balance in trees (Chen et al., 1989; Shi et al., 1982), which might be similar as the related species, Guizhou Snub-nosed monkeys *Rhinopithecus brelichi* (Bleisch et al., 1993). An ability to stay in the canopy is an effective anti-predator strategy (Ren et al., 2000a), because a number of potential predators such as panthers *Panthera pardus*, jackals *Cuon alpinus*, lynxes *Lynx lynx* and wolves *Canis lupus* live in their habitat (Shi et al., 1982, Hu et al., 1989). The locomotive repertoire of the Sichuan snub-nosed monkey consists largely of leaning, leaping, swinging and climbing in trees (Ren et al., 2000b). They travel a long distance everyday and their home range is wider than other colobine monkeys (Ren et al., 2000b; Li et al., 2000). Their ability for crossing gaps in the canopy is probably the single most important determinant of path length in their natural habitat (Cant, 1992). They could enhance their leaping ability to straightening their tree travel path as other mountainous arboreal primates have done (Cant, 1992).

Nevertheless, Sichuan snub-nosed monkeys display many of the characteristics of terrestrial *Cercopithecines*. Physical characteristics of this species such as the brachial index, the crural index, intermembral index and shot digit are more similar to terrestrial *Cercopithecine* species than to most arboreal colobines (Napier and Napier, 1967). They are the heaviest of the colobine species and also demonstrate obvious sexual dimorphism. These characters have deviated from the pattern of other extant colobines and reflect a tendency towards territoriality (Davison, 1982; Wu, 1993). The Yunnan Snub-nosed monkeys *Rhinopithecus bieti*, a related species with the Sichuan snub-nosed monkeys, were terrestrial 70% – 90% of the day (Wu, 1993) or 10% – 35% of the day (Kirkpatrick and Long, 1994). Hanuman langurs *Presbytis entellus* in undisturbed locations commonly spent 30% – 40% of the day time on the ground (Newton, 1992). It has been noticed that adult males of the Sichuan snub-nosed monkeys guard their group when foraging on the ground (Ren et al., 2000a) and Yan et al. (1995) reported an adult male fighting with a wolf *Canis lupus* on the ground. Ren et al. (2001) reported the Sichuan Snub-nosed monkeys spent 15% of their times on the ground in winter. He suggested adult males tended to be more territorial than other age/sex classes, because they are searching for fallen seeds and guarding the group on the ground. However, Xie and Chen (1989) suggested adult males might stay in higher strata than adult females, because they could detect predators and locate their group more easily from the canopy than from the ground.

Terrestrialism of the Sichuan snub-nosed monkeys is still disputable. Our study is aimed to understand precise use of forest strata by this monkey. This paper is concerned mainly with how monkeys using forest strata and their locomotive behavior in crossing tree gaps. Our results indicate a variation of terrestrialism between age/sex classes of the monkeys. During our observations, several falls from trees were observed, the relationship of these falls and the forest-strata utilization of Sichuan snub-nosed monkeys will also be discussed.

1 Materials and methods

We observed behaviour for twelve months from September 2000 to March 2003 on the northern slope of the Qinling Mountains near Yuhuangmiao Village in Zhouzhi National Nature Reserve, Shaanxi, Central China (33° 48′68″N, 108°16′18″E). The area is covered with secondary deciduous broadleaf forests or deciduous broadleaves mixed with coniferous trees, from 1 400 – to 2 896 m (Li et al., 2000). The climate is considered to be semi-humid mountainous (Li et al., 2000). The vegetation was about 10 meters high and many wide gaps could be found. A forest floor abundant in granite rocks and the lack of understory shrub are characteristics of the habitat of this area. More information is see in Li et al. (2000) and Zhang et al. (2006).

This study group has been observed and habituated since 1995 (e. g., Li, et al. 2000; Zhang et al., 2003). The group size was around 95 in the spring of 2000 and fluctuated from 45 to 82 in this study period. The daily activities of the group were usually carried out in the Gongni Valley during observation time, which is about 4 km in length and is surrounded by ridges of 100 to 400 m in width and 30 to 100 m in height. The provisioning site was located at the Sanchakou site in the lower part of the Gongni Valley. The group of Sichuan snub-nosed monkeys was composed of several one-male units (Zhang et al., 2003). The members of one-male units tended

to stay in the same tree during the daytime (Qi et al., 2004). No solitary males or male groups were observed during the study period.

Data were collected in non-provisioning time when the monkeys were moving around in the Gongni Valley, to avoid the influence of provisioning. Our 197-day observation fell in the winter (October 2001 to February 2002, November 2002 to January 2003) and spring (March to May 2002), during which the average temperature was 6.1℃ with a minimum of −12℃ in January, 2002.

Monkeys were categorized into seven age/sex classes as follows: *adult males*, some seven years and older, with outstandingly large bodies covered with extremely long golden guard hairs at the cape area and granulomatous flanges were very obvious. *Adult females*, some five years and older, with body size about half the size of adult males. The golden guard hairs in the cape area were much shorter than those of adult males. Some individuals had visible granulomatous flanges. However, they were much smaller than those of adult males. Their breasts and nipples were large and easily seen. *Subadult males* were estimated to be five to seven years old, and although their bodies were similar in size to adult males, they were more slender. The golden guard hairs on the cape area were shorter and sparser than those in adult males. *Subadult females* were estimated to be three to four years old and their body size was about two-thirds the size of adult females. They lacked golden guard hairs at the cape area and their breasts and nipples were smaller than those in adult females. *Juveniles* were estimated to be one to three years old and their body size was less than two-thirds of that of adult females. Their body hair was light brown and gradually turned to a reddish gold color. Sexual differentiation was difficult because of their underdeveloped external genitalia. They were usually observed actively playing. *Infants* were estimated to be three months to one year old. Their hair was light brownish gray or light brown, which looked white in the sunshine. *Newborn babies* were estimated to be three months old and younger. Their hair was darkish gray and turned to be light brownish gray after about two months. They rarely left their mothers or the females carrying them. A more detailed description is available in Zhang et al. (2003).

The individual physical characteristics allowed identification of all adult males, all adult females, 8 subadult females and 8 juveniles in the group. The continuous recording method was used to record strata utilization (Altmann, 1974). Focal animals were randomly selected from identified animals each day and followed for 30 minutes per session. In total, 435 sessions of data were collected from identified individuals, including 15.6 ± 3.9 sessions for each adult males ($n=8$), 4.1 ± 1.4 sessions for each adult females ($n=26$), 13 ± 0.5 sessions for each subadult females ($n=8$) and 12.5 ± 0.75 sessions for each juveniles ($n=8$).

Habitat structures were divided into three categories: ground, low stratum (ground up to half of the height of the vegetation) and canopy. Activities were classified into traveling, resting or foraging. *Traveling* included the movement of the focal animals in the forest. Movement to the provisioning ground when artificial foods were provided was not included. *Resting* included sitting, grooming and sleeping. *Foraging* included searching for food items and feeding out of provisioning site. Fighting and playing (especially juveniles) were more common on warm days and sometimes occurred during foraging times, these activities were therefore included in the foraging category.

Four patterns (leap, lean, swing and climb up) of crossing a gap between canopies were observed. A *leap* was recorded when an animal jumped from a branch of one tree to another; a *lean* was recorded when an animal held branches of both take-off tree and target tree and moved in one direction; a *swing* was recorded when an animal crossed a gap by hanging below the branches (semi-brachiation) and a *climb up* was recorded when an animal descended to the ground and climbed up the target tree. We used *ad libtium* to take descriptive notes on falling accidents from more than five meters.

Kruskal-Wallis H or Wilcoxon Signed Ranks test was used to analyze the age-sex differences of use of forest strata among focal animals. The Chi-square test was used to examine the age/sex differences of crossing modes between canopy gaps and the Fisher's exact test was used to examine the differences in falls between age/sex classes. Statistical significance was set at less than 0.05.

1 Results

2.1 Forest utilization

The monkeys spent 14% ± 8% of daytime during observation on the ground, 53% ± 6% in the low stratum and 33% ± 11% in the canopy ($n=50$). The use of forest strata differed between age-sex classes on the ground (Kruskal-Wallis H test, $\chi^2=36.4$, $df=3$, $P<0.001$) and in canopy ($\chi^2=26.3$, $df=3$, $P<0.001$) (Fig.1). Adult males spent more time on the ground than other classes and subadults and juveniles spent more time in the canopy than adult animals. Adult males tended to utilize the ground (28% ± 6% of their daytime) more than the canopy (18% ± 11%, Wilcoxon Signed Ranks test, $z=-2.1$, $P<0.05$). By contrast, adult females utilized the canopy (33% ± 6% of their daytime)

more than the ground (13% ±3%, $z = -4.5$, $P < 0.001$). Subadult females and juveniles also utilized the canopy (41% ±8% and 44% ±4%, respectively) more than the ground (8% ±2%, $z = -2.5$, $P < 0.05$ and 6% ±2%, $z = -2.5$, $P < 0.05$, respectively).

Adult males spent 27% ±4% of their time foraging, while adult females spent 30% ± 3%, subadult females 36% ± 6% and juveniles 53% ± 12%. All classes were observed foraging on the ground (Fig.1). However, adult males foraged on the ground (20.4% ±4.6% of their foraging time) more frequently than the other classes (9% ±3%, 3% ±3% and 3% ±2% for adult females, subadult females and juveniles respectively, $\chi^2 = 37.2$, $df = 3$, $P < 0.001$). Subadult females foraged on the ground significantly less than adult females ($z = -3.9$, $P < 0.001$). Adult males tended to spent more forage time in the low stratum (45% ±5%) than in the canopy (35% ±6%, $z = -2$, $P < 0.05$). By contrast, adult females, subadult females and juveniles foraged for a longer time in the canopy (51% ±9%, 60% ±7% and 54% ±5% respectively) than in the low stratum (40% ±8%, $z = -2.9$, $P < 0.01$, 37% ±6%, $z = -2.5$, $P < 0.05$ and 43% ±5%, $z = -2.4$, $P < 0.05$, respectively).

Adult males spent 64% ± 5% of their daytime resting, while adult females spent 61% ± 6%, subadult females 56% ± 17% and juveniles 38% ± 14% in this activity. Adult males rested on the ground more frequently than other classes ($\chi^2 = 32.4$, $df = 3$, $P < 0.001$) and in the canopy less frequently ($\chi^2 = 13.5$, $df = 3$, $P < 0.01$, Fig.1). Adult males were frequently observed sitting far from their unit members. They tended to spend more time resting on the ground (29% ± 5%) than in the canopy (9% ±7%, $z = -2.5$, $P < 0.05$). In contrast, subadult females and juveniles rested more frequently in the canopy (23% ±10% and 22% ±7% respectively) than on the ground (11% ±4%, $z = -2$, $P < 0.05$ and 8% ±2% $z = -2.5$, $P < 0.05$, respectively).

Adult males, adult females, subadult females and juveniles spent respectively 9% ± 0%, 9% ± 0%, 8% ±1% and 9% ±1% of the daytime in traveling. Adult males traveled on the ground more than the other age-sex classes ($\chi^2 = 35$, $df = 3$, $P < 0.001$, Fig.1). Subadult females traveled significantly less frequently on the ground than adult females ($z = -4.2$, $P < 0.001$) and juveniles ($z = -3.3$, $P < 0.001$). Adult males spent 53% ±7% of their traveling time on the ground, which was significantly longer than the time they spent traveling in the low stratum (32% ±5%, $z = -2.5$, $P < 0.05$) or in the canopy (15% ±6%, $z = -2.5$, $P < 0.05$). By contrast, adult females, subadult females and juveniles spent 42% ±8%, 53% ±4% and 49% ±5% of their traveling time in the canopy respectively. These were significantly longer than time traveling on the ground, (26% ±5%, $z = -4.3$, $P < 0.001$, 9% ±3%, $z = -2.5$, $P < 0.05$, and 21% ±6%, $z = -2.5$, $P < 0.05$, respectively).

2.2 Tree crossing mode

The monkeys frequently used slower, reliable modes such as *lean* (50%) or *climb up* (24%) to cross gaps between canopies. *Leap* (17%) and *swing* (9%) were rarely used to cross canopy gaps (Table 1). Differences in tree crossing modes between the age/sex classes were apparent. Adult males descended to the ground and climbed up another tree more frequently than expected (Chi-square text, $\chi^2 = 20.0$, $P < 0.01$), whereas subadult females used this mode less than expected ($\chi^2 = 24.9$, $P < 0.01$). Animals sometimes swung from a higher branch to a lower branch and results showed that subadult

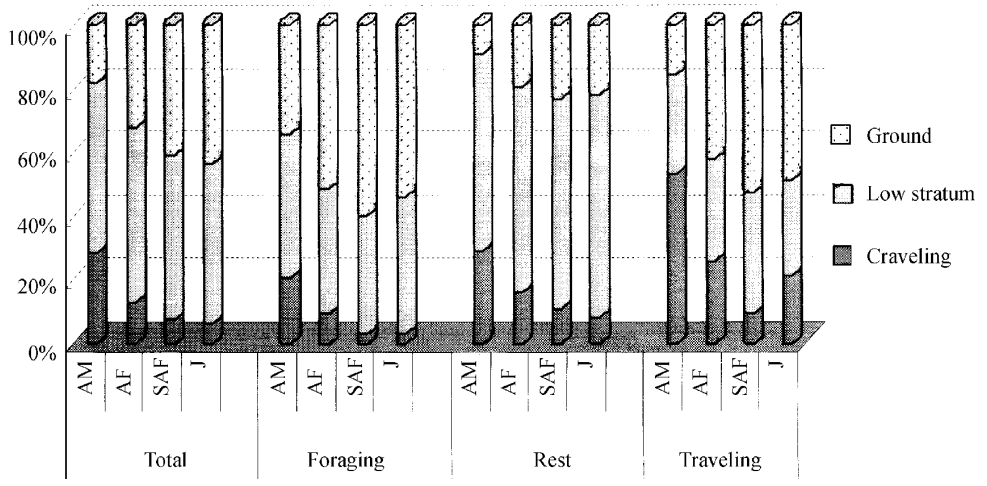

Fig.1 Use of forest strata in different age-sex classes ($n = 50$)
AM means adult male, AF means adult female, SAF means sub-adult female, J means juvenile.

females swung less frequently than expected ($\chi^2 = 4.6$, $P<0.05$). Subadult females and juveniles most frequently performed leaping (subadult females, $\chi^2 = 7.6$, $P < 0.01$ and juveniles, $\chi^2 = 72.9$, $P < 0.01$). In contrast, adult animals crossed canopy gaps by leaping significantly less than expected (adult males, $\chi^2 = 30.7$, $P<0.01$ and adult females, $\chi^2 = 18.7$, $P<0.01$). Adult animals performed a long-distance leap of more than 10 meters only during urgent situations such as chasing another monkey, escaping a disturbance or during a rushing display by adult males. In these situations boisterous sounds of branch braking could be heard and occasionally monkeys accidentally fell.

Table 1 Tree gap crossing modes of different age-sex classes

	Leap			Lean			Swing			Climb up			Total
	n	Exp	χ^2	*n*	Exp	χ^2	*n*	Exp	χ^2	*n*	Exp	χ^2	
Adult male	13*	53	30.7	152	159	0.3	35	27	2.3	117*	78	20	317
Adult female	46*	86	18.3	268	254	0.8	46	43	0.2	147	124	4.2	507
Subadult female	49*	33	7.6	108	98	1	8*	17	4.6	31	48	6	196
Juvenile	121*	57	72.9	151	168	1.8	27	29	0.1	37*	82	24.9	336
All members	229			679			116			332			1 356

* Difference is significant, $P<0.05$.

2.3 Suffering from falls

We recorded a total of 9 injuries or mortality resulting from falls in the 197 days of observation. The height of the falls ranged from 5 to 20 m and the death of one juvenile and one newborn baby were confirmed (Table 2). One adult male, one adult female and five juveniles were injured. The right arm of the male was broke and thus could not use his hand in the month afterwards. The adult female was crippled for 13 months or more after the injury. Other individuals required 1 to 17 minutes to recuperate before moving off again. The six juveniles and infants that fell accounted for 30% of the numbers in their age classes during the observation period ($n = 20 \pm 3.5$) whereas the two adults accounted for only 6.9% of adult monkeys ($n = 32 \pm 5.4$). Juveniles and infants therefore appeared more susceptible to injurious accidents than adults ($P = 0.026$, Fisher's exact test). All falls by juvenile were seen in winter (January to March), whilst those by adults and the baby occurred along the course of social events in spring (April and May).

Table 2 Incidence of falls

Date	Sex	Age	Description	Height	Outcome
01/22/2002	F	2 years	Leap to cross gap	20 m	Died immediately for broken skull
01/29/2002	?	3 years	Traveling in crown	10 m	Survived with 2-minute recuperation
02/01/2002	?	2 years	Lean to cross gap	10 m	Survived with 1-minute recuperation
02/05/2002	?	3 year	Lean to cross gap	10 m	Survived with 1-minute recuperation
03/23/2002	M	3 years	Leap in low stratum	15 m	Survived with 4-minute recuperation
03/30/2002	F	3 years	Leap to cross gap	15 m	Survived with 1-minute recuperation
04/12/2002	F	Adult	Leap gap to chase another animal	10 m	Broken leg with a calm recuperation of 17 minutes
05/16/2002	M	Adult	Leap gap to chase another animal	10 m	Broken arm with a recuperation of 11 minutes
04/16/2003	M	1 day old	Lost by an allomothering subadult female	5 m	Died after two days

3 Discussion

Adult males spent more time on the ground than other age/sex classes while subadult females and juveniles were more arboreal, which confirmed the conclusion of Ren et al. (2001). Adult males of the Sichuan snub-nosed monkeys weight 15.0 – 39.0 kg (Liu, 1989). They tended to support themselves by holding branches when they crossed canopy gaps instead of leaping, as the risks associated with falling are considered to be more serious for the heavier adult males (Cartmill and Milton, 1977). Wu (1993) also described that adult male of *R. bieti* avoid leaping between tree gaps compared with adolescent. We surmise the combination of heavy body weight and discontinuous tree canopies appear to be the main factors

associated with the terrestrial habits of adult male Sichuan snub-nosed monkeys.

Adult females, at only half the weight of adult males (Liu, 1989), spent more time traveling in the trees than on the ground. To cross gaps between trees, adult females use more reliable modes than leaping. They frequently descend to the ground and moved to their target tree instead. The tree canopy in their habitat was less horizontally continuous and the mean distance between canopies was large (Ren et al., 2000a). Animals traveling exclusively on the tree must often make a detour. Hence, the choice of the climbing up tree sometimes would require less energy expenditure than to lean or swing. Relatively smaller sampling sizes for each adult female might also influence results of their forest utilization. This dispersion is due to a large number of sampled adult females in the group.

Subadult females and juveniles spent most of their time in the trees and rarely came down to the ground. They would "see" a relatively larger number of canopy gaps that could be crossed only by leaping than adult animals because of their shorter dimensions. They suffered from more injuries or mortal falls by their frequently leap to cross a gap between trees. Harsh weather and/or slippery branches may have influenced these falls as all juvenile falls were observed in winter. The lack of an understory shrub layer and the abundance of granite rocks on the forest floor could increase severity of injuries associated with falls. Predation may also influence spatial distribution of this animal. Adult males might be able to fight with predators (Yan et al. 1995). However, adolescent might be more vulnerable to terrestrial predators (Shi et al. 1982; Hu et al. 1989). Staying in trees is a good way to avoid terrestrial predators.

The differences observed in strata utilization during foraging suggest that the age-sex classes of Sichuan snub-nosed monkeys might show some dietary diversification. Adult males foraged significantly more on the ground than in the canopy, whereas subadult females and juveniles foraged most often in the trees. On the ground, adult males and females foraged for grass roots, moss, fallen nuts, bird eggs and insects (Chen et al., 1989; Ren et al., 2001; Li et al, 2001), and were observed to forage on fallen nuts and grass roots in snow covered ground (Ren et al., 2000b; Zhang personal observation). While in the trees, the subadult females and juveniles consumed many food items such as leaves, buds, bark and lichen (Li et al., 2001), they rarely foraged on the ground.

Primates of different sizes have both dietary/energetic requirements (e.g., Demment, 1983) and physical capability with regard to habitat use (e.g., Fleagle, 1976). In gorillas *Gorilla gorilla gorilla*, a species showing obvious sexual dimorphism, female spent more time in arboreal feeding than adult males, and use of different part of trees by males and females may permit their groups to forage cohesively with large trees (Remis, 1998). The diversified diet of the Sichuan snub-nosed monkeys might also be an adaptation to the natural food supplies in their habitat (Li et al., 2003). Provisioning aggregates food in a small area and attracts monkeys to forage on the ground. Competition for food and space leads to many agonistic interactions during provisioning time. Adults appeared to forage more frequently on the provisioning ground, while adolescent frequently foraged natural food in trees to avoid competition. In non-provisioning time, our results suggested diversified diets in this species as well. The Sichuan snub-nosed monkeys are noted for their large foraging groups that include 300 to 600 animals (Ren et al., 2000b). We surmise the dietary diversification between different age classes may contribute to this species living in very large foraging groups.

It was noticed that spatial dispersion of resident males was affected by group composition and distribution of periphery males, e.g., Yunnan snub-nosed monkeys *Rhinopithecus bieti* (Wu, 1993). Guarding unit members from a male intruder was a characteristic behavior of adult males living in a one-male unit (Davies, 1994). When unit members were approached by another male, the resident adult males of the one - male unit sometimes emitted bark-grunts while still on the ground and then climbed up the tree and ran towards their unit members (Zhang personal observation). They also kept close to their unit females when additional males appeared (Ren et al., 2000b; Qi et al., 2004). However, additional males or all-male groups did not follow the study group during observation periods (Zhang et al, 2003). The time adult males spent on the ground away from unit females in this study group suggest that resident males in a reproductive unit have less harassment from other males.

Sichuan snub-nosed monkeys are the most widely distributed of the four species of Snub-nosed monkeys (Ren et al., 2000b). Arborealism of this species seems to vary across populations in different habitats. Our data suggested semi-arborealism of Sichuan snub-nosed monkeys in the Qinling Mountains populations, though a wide variation appeared in age/sex classes. However, populations in Shenongjian area, a southern habitat with elevation from 398 to 3 105 m, seem to forage on the ground less frequently than the Qinling populations (Ren et al., 2000b, Li et al., 2004). Terrestrial traveling seemed to be common for Yunnan snub-nosed monkeys who live in elevation

from 3 600 to 4 150, though the observed trends may be different (Wu, 1993; Kirkpatrick and Long, 1994; Long et al., 1998). In contrast, both Guizhou snub-nosed monkeys and Tokin snub-nosed monkeys *Rhinopithecus avunculus* who inhabit subtropical forests are more arboreal. Elevations of their habitats are relatively lower, from 1 000 m to 2 300 m for the Guizhou snub-nosed monkeys and from 200 to 1 200 m for the Tokin snub-nosed monkeys (Boonratana and Le, 1998; Bleisch et al., 1993). Forest structures vary widely in different habitats of the Sichuan snub-nosed monkeys. Gaps between canopies might be larger and more frequent in northern habitats than in southern habitats. We suppose terrestriality of the Sichuan snub-nosed monkey might be influenced by their forest structure in different habitats. Frequent terrestrial activity of the Qinling Mountain Sichuan snub-nosed monkeys could be an adaptation to harsh conditions in their habitat.

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