

MAJOR CATEGORIES OF VOCAL BEHAVIOUR IN WILD SICHUAN GOLDEN MONKEY (*RHINOPITHECUS ROXELLANA*)

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Abstract

Sichuan golden monkeys are distributed in montane forests. Their vocal sounds have important functions in their situation of life. On the basis of observation of vocal behaviour and sound recording, this paper presents the major categories of vocalizations produced by free-living Sichuan golden monkeys, and describes their emission with accompanying troop behaviour and body movements. Differences between wild and captive animals are simply analysed here.

Key words Sichuan golden monkey (*Rhinopithecus roxellana*), Vocal behaviour, Sound spectrogram

Vocal communication among nonhuman primates has been primarily investigated among the terrestrial macaques and baboons. Communication among forest-dwelling species has been less studied, perhaps in part due to observational difficulties. However, vocal behaviour appears to be more crucial for communication in arboreal than terrestrial species (Waser, 1982), due to decreased visibility of group members in arboreal species. Sichuan golden monkey, *Rhinopithecus roxellana* is an endangered colonial endemic to China. Up to now, many studies have been conducted, mainly focusing on anatomy, ecology, social behaviour, resources and protection (Ye et al., 1987; Chen et al., 1989; Quan et al., 1981). Very little information exists regarding the vocal communication of this arboreal primate. Categorization and general description of golden monkey vocalization have been provided by Tenaza et al. (1988) and Clarke (1990), based on brief observation of captive pairs. Xie et al. (1989) reported the analysis of vocal behaviour with data collected from captive and wild golden monkeys. This study, on the basis of long-term observation of behaviour and a large number of sound recording, presents the major categories and sound spectrogram of vocalizations produced by free-living Sichuan golden monkeys, and the analyses of the differences between capt-

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ive and wild condition.

METHODS

Our studies were conducted at two areas. One is Yuhuangmiao located on the northeastern edge of the reserve in Zhouzhi County in the north slope of Qinling Mountain, the other is Taishanba in Ningshan County near the reserve in the south slope of Qinling Mountain (Fig.1). There were three troops living in both the regions. The climate in the south slope is warmer and wetter than in the north slope. The vegetation includes coniferous forest, coniferous-broadleaf mixed forest, deciduous broadleaf forest and secondary deciduous broadleaf forest.

It is difficult to observe the activity pattern of golden monkey in the wild, since they dwell in the forest and their home ranges are very large. For this, we followed the troop to observe the vocal behaviour and recorded the vocal sound far from them about 10—30m away, until we couldn't follow them. Sometime we also went into the center of dispersion of a troop to do the work. Through fixing the microphone head on the top of long stick, then putting it near the monkeys, at the same time researchers must hid at the back of tree or big stone, the process of sound recordings would be easily completed. Our data were collected from October 1979 to May 1990 for about 85 hrs., over 32-day.

Vocalizations were recorded by a CKK RC-6662 cassette recorder with a microphone head. Verbal description of contexts, identity of the vocalizing animals and troop behaviour, as well as the vocalization was ventriloquial or not ventriloquial, were added directly to the tape. Vocal sounds were made into intensity-time diagram and frequency spectrum diagram by Audio Frequency Spectrum Type 3311 and 1/3 Octave Filter Set.

RESULTS

1 Amazement call: When golden monkeys meet villagers or other animals, the finders make amazement call "O-ga" which is very short and clear with a little sharp (Duration is 36ms, maximum intensity is 38 dB), then the troop stops its movement, pays their attention to the strangers, and communicates each other with some kinds of vocal sounds being usually "O-ga". At that time, the troop is comparatively quiet, and no amazing impression in individuals.

2 Alarm call: When the troop is approached by strangers, its members display very nervousness. First-ranked or higher-ranked males have loud alarm call "Wuka, Wuka" which is longer in duration (132ms) and higher in intensity (52dB) than the amazement call, other monkeys of the troop almost keep silence. After the first-ranked male, which is the strongest male in a troop, sounded a kind of alarm call "Gag-agaga", the rest individuals of the troop run away and climb to trees far from them. "Gagagaga" calls resemble shrill and short sounds emitted by cocks.

3 Warning call: Higher-ranked males sit on higher branches of tree, and lower-ranked males and females located on the lower part of branches of the same tree. However, these lower-ranked monkeys sometime move beyond the their power sphere, i.e., get into the higher branch status as well as the extent of authority of the higher-ranked ones. In this situation, first warning call "Gugu, Gugu" is made by higher-

ranked males to threaten them. When the first warning call is ineffective, that is to say that lower-ranked monkeys will continue to move, then the second warning call is loudly emitted by higher-ranked males. Meanwhile, higher-ranked males open mouths and eyes wide, show teeth, put neck and chest ahead to threaten lower-ranked monkeys. If the second warning call is still ineffective, the third warning call is made, which is very loud and short, and then higher-ranked ones attack lower-ranked ones, until they stop the behaviour of exceeding higher-ranked one's power sphere. This call occurs rarely in the wild. In general, the first or second warning call is enough. Duration and intensity of warning calls are 184—144 ms and 32—39 dB, but from first warning call to the third warning call, the duration will become shorter and the intensity will turn higher as well.

4 Peaceful call: As troops are moving, eating, playing and resting, nearly all the individuals usually call "Yiwu, Yiwu", which is a smooth voice. There are occasionally "Jigu, Jigu" and "O—, O—" made by adult monkeys, "Jiji, Jiji" and "Wuwa, Wuwa" by juveniles. These voices mean that individuals are under very peaceful state. Among the vocal sounds of the golden monkey, the intensity and average frequency of the peaceful call are much lower (22—35dB and 0.77—1.02KHz), the duration is shorter (54—42ms).

5 Contacting call: Meeting strangers, sometimes a troop is divided into small groups. Adult males of a small group make a explosive call "Ge, Ge, Ge" or sometimes a long call "Wua, Wua" so that groups merge into a troop. When adult females look for their babies, they also emit sounds like this. Its intensity is very high (46dB) so that monkeys apart from each other can hear.

6 Other vocalization: Other vocalizations produced by golden monkeys in this study include variety of whine, chuck, hoos, belches and moans that occur infrequently relative to the major kinds of vocal behaviour. Vocal communication appears to be complex in this species, and remains poorly understood.

Sound spectrogram is analysed as follows (Table 1, Fig.2).

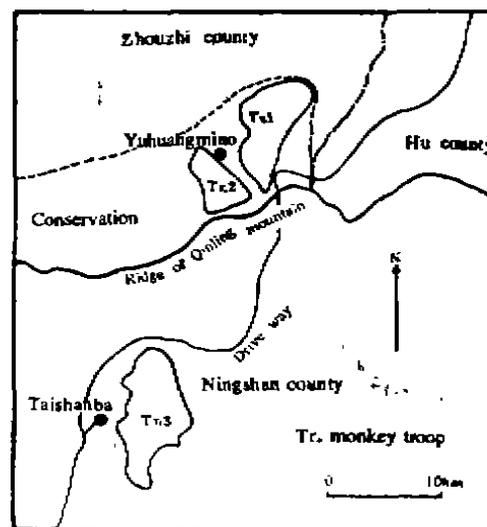


Fig.1 Map of survey areas

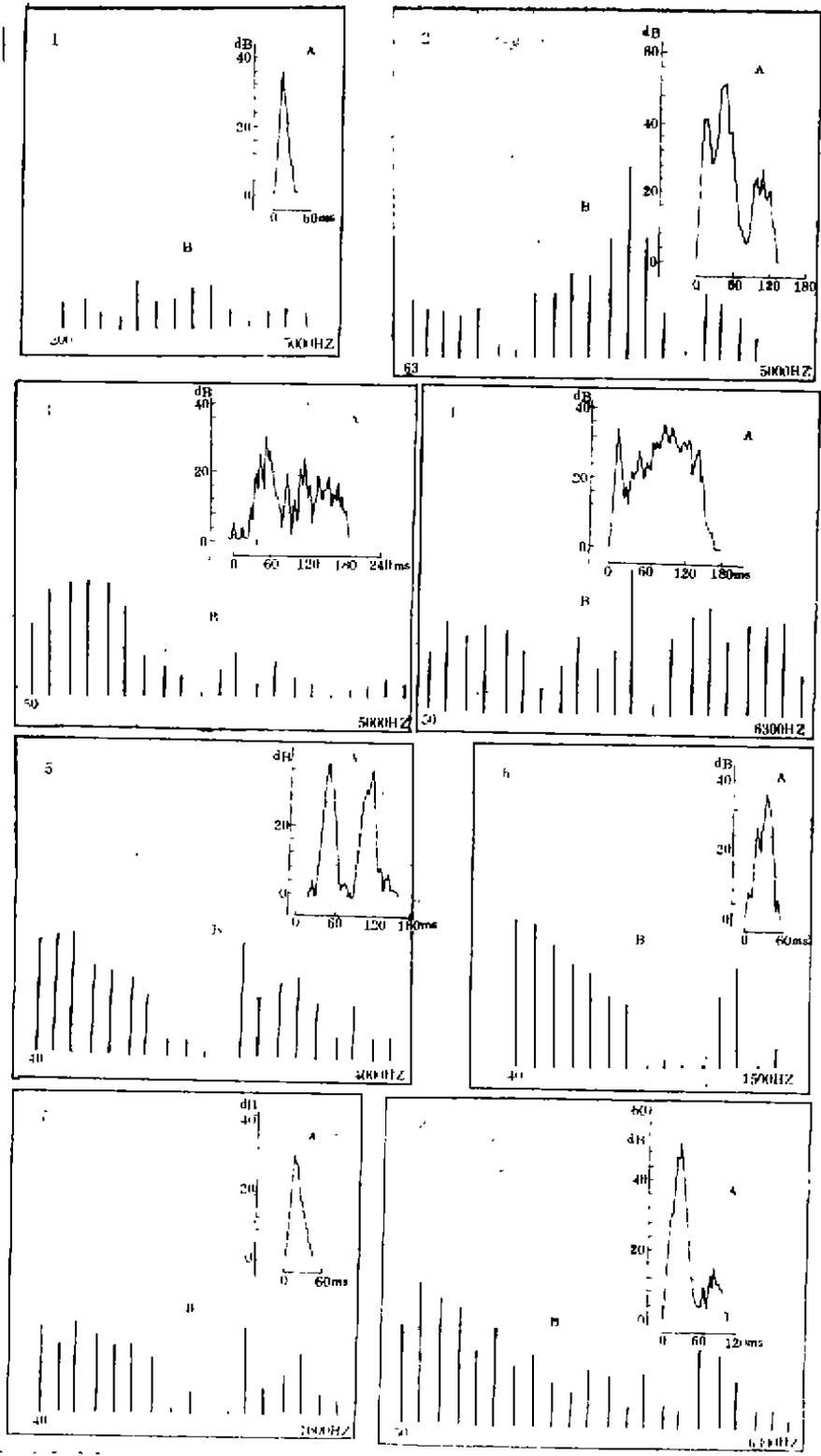


Fig.2 Sound spectrum of the call
 A. Intensity-time diagram B. Frequency spectrum diagram
 1. Amazement call ("O-ga") 2. Alarm call ("Wuka") 3. First warning call ("Gugu")
 4. Second warning call ("Gugu") 5. Third warning call ("Gugu") 6. Peaceful call
 ("Ylwu") 7. Peaceful call ("O-") 8. Contacting call ("Wua")

Table 1 Analytical results of sound spectrogram from major categories of vocal sounds of wild Sichuan golden monkeys

Category of call	Phoneticizing	Duration (ms)	Frequency ranges (Hz)	Average frequency (Hz)	Frequency ranges of energy concentration (Hz)	Maximum intensity (db)	
Amazement call	O-ga	36	200-5000	2600	1680, 2790-3160	38	
Alarm call	Wuka Gagagaga	132	63-5000	2531.5	63-1103, 1883-3443, 4223-4743	52	
Warning call	first	Gugu	184	50-5000	2525	50-1288, 2773, 3268	32
	second	Gugu	164	50-6300	3175	50-1612, 2550, 3487, 4112-5987	36
	third	Gugu	144	40-4000	2020	40-1290, 2332, 2749-2957, 3582	39
Peaceful call	Yiwu	64	40-1500	770	40-664, 1182-1288	35	
	O-	48	40-1600	820	40-620, 1118, 1412	30	
	Wuwa	42	50-2000	1025	—	22	
	Jigu Jiji						
Contacting call	Ge Wua	105	50-8300	3175	50-1850, 4850-5150	46	

As showed above in Table 1, the intensity of alarm and contacting call is the highest among these calls. However, the duration of alarm, warning and contacting call is longer than other calls. There are more high frequencies in amazement, alarm, warning and contacting call than in peaceful call. It is also found from Fig.2 that call energy concentrates on frequency ranges. These can be explained that differences of sound spectrogram of the call are related to purposes.

DISCUSSION

As observed by Tenaza et al. (1988) and Clarke (1990), some vocalizations are apparently "ventriloquial" or "cryptic", in that they occur with no accompanying movement of mouth, face, head, or trunk, i.e., with no visible sign that vocalization is being made. For example, the peaceful call made by animals that are acting as they vocalize usually belongs to it. During the warning call, the vocalizing animal's mouth, face, abdomen, torso, or some combination of these movements are visible to observers. Thus, in the wild, this vocal behaviour is same as in captive. It has been suggested that ventriloquial vocalizations may serve as antipredator function in some primate species (Brown, 1982; Snowden et al., 1981). The golden monkey's gaping nostrils may be the main emissive source for its loud ventriloquial sounds. Nasal emission would explain how such loud calls can be produced while the animal's mouth is occupied by chewing food and without need for modifying facial configuration (Tenaza et al., 1988).

Higher primates may possess vocal systems in which signals are stereotyped or discrete (Tenaza et al., 1988). Clarke (1990) showed that vocal sounds of captive golden monkeys were generally not classified by the type described by Tenaza et al. (1988) due to highly intergraded nature, except for the discrete precopulatory and threat vo-

calizations. The major categories of vocal sounds recognized in the present study can be considered stereotyped with little or no overlap.

Many of the vocalizations emitted by golden monkeys occur in the context of antiphonal sequences. These sequences differ both qualitatively and quantitatively from the duetting of monogamous primates, in that nearly all sequences consisted of only two calls, whereas the duets of monogamous primates contain a number of calls that appear to require careful coordination between the duetting partners (Deputte, 1982; Haimoff, 1981; Mackinnon et al., 1984; Serpell, 1981). The brief and stereotyped nature of these antiphonal sequences suggest that in the wild these may function as contact or cohesion calls allowing for the location of spatially dispersed group members (Brown et al., 1979; Gautier et al., 1977), or alternatively, as part of territorial advertisement choruses (Marler, 1968; Oppenheimer, 1977). The majority of sequences occur when the animals are far away from one another. Although they have antiphonal sequences, free-living groups of golden monkeys usually engage in choruses, unlike the duets in the captive pairs mentioned by Tenaza et al. (1988), because their troops have numbers of individuals (in Qinling Mountain a troop usually consist of 70—150 individuals), and their spatial dispersion is very large.

Vocalizations are emitted frequently by both sexes. However, Tenaza et al. (1988) described that the whine and bawl were emitted mainly by males, whereas the chuck and shrill call were made exclusively by females. An even more exaggerated asymmetry exist in gorillas, in which most vocalizations are occurred mainly by silverbacked males (Marler et al., 1977). The sexual asymmetry in vocal behaviour of golden monkeys is not unique. We can not decide that there are the same results in the wild. Adult male golden monkeys are more vocal than adult females.

Most major vocalizations observed in the wild accompanied by troop behaviour and body movement as mentioned above. Thus, major types of vocal behaviour of free-living golden monkeys can be easily distinguished according to troop behaviour, ventriloquial or not ventriloquial call, and duration, intensity and syllable of sounds.

It is important that vocal communication maintains stability of population. The first role is leading troop activity. When individuals of a troop communicate each other by listening amazement call, some members fight enemy and evade far from the enemy. The second role is maintaining group order. With higher-ranked male's warning call, dominant and subordinate relations will be formed among the members of the group. The third role is reducing consumption of energy of troop members. Under higher-ranked male's warning call struggle among individuals of a group has been reduced, so consumption of energy of a group is reduced.

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中文摘要

野外川金丝猴声音行为的主要类型

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川金丝猴 (*Rhinopithecus roxellana*) 栖息于高山森林中, 营树栖生活, 其声音通讯在社群活动中有重要意义。通过长期野外行为的观察和声音的录制, 本文报道了川金丝猴在野外自然活动条件下声音行为的主要类型, 明显可以辨别出惊异声、警戒声、警告声、呼唤声和安静状态下的叫声, 并进行了声谱分析, 发现其声谱的差异主要与声音目的有关, 同时描述了每类声音发出相伴随的群的行为和身体运动的变化, 讨论了笼养条件下和野外状况下川金丝猴声音行为的异同。

关键词 川金丝猴; 鸣叫行为; 声谱

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