STUDIES OF BEHAVIORAL ECOLOGY AND CONSERVATION BIOLOGY OF THE WHITE-HEADED LANGUR, *PRESBYTIS LEUCOCEPHALUS*, IN CHINA

Progress Report (III) of Fieldwork between July 1997 and January 1998

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Submitted in February, 1998

With financial support from several international funding bodies, a fieldwork on the behavioral ecology and conservation biology of the white-headed langur, *Presbytis leucocephalus*, has been being conducted in Bapen Reserve, Fusui County, and Longrui Reserve, Ningming County, from Sep. 2, 1996 (see the previous two progress reports). This is to report the fieldwork from July 1997 to January 1998. The work received financial support from *Primate Conservation, Inc.*, *American Society of Primatologists, Davis Expedition Fund, L.S.B. Leakey Trust, Wenner-Gren Foundation for Anthropological Research,* and *Earthwatch.* Ten volunteers from Earthwatch and two assistants attended the fieldwork (see Appendix I).

Field work was conducted in Bapen Reserve. Data included those on phenology of food plant species, behavioral ecology of the white-headed langur, and climate. Based on the population survey conducted earlier (see the first two progress reports), a campsite was established in the working area (a valley called *Kemaishi*) in August 1997, where was in the main distribution range (with most population in the reserve), and data collection was carried out there. During the stay on the site, we got heavy rain and the river nearby flooded, which interrupted our daily living material supply. In the meantime, drinking water was a big problem because the river had been polluted. Thus, the camp was moved to a new working area (a valley called *Longgengshuang*, for detail see bellow) in October 1997, where we have been collecting data till now. The new working area was in the same distribution range (a different valley in the same hill-group, see the previous reports). In September 1997, we drove to the second working area by vehicle everyday for data collection on phenology and behavioral ecology, and the data on climate was collected at the Reserve Headquarters where we lived and where was 5.5 km away from the second working area. The data we are going to report bellow were collected from September 1997 to January 1998.

Definition *Sample*: A sample is obtained by scanning animal behaviours every 10 min. Its size thus depends on number of animals in the observed group. *Record*: In each sample, activity of each group member is noted down. Such a note is a record; thus the number of records is equal to the number of samples timed by number of individuals observed. *Visible Time*: Time spent for watching animals. *Contact Time*: Time spent for spotting animals that are both visible and invisible (because animals are in bush thus not seen but locality is known). *Wild Time*: Time spent in the wild, including walking and data collection (and excluding resting at the campsite). *Fieldwork Time*: Time spent for fieldwork, including wild time and time for traveling.

Fieldwork Fieldwork time was 131 days, 20 days of which were in September, 25 in October, 30 in November, 31 in December 1997, and 25 in January 1998. Climate

was continuously measured from 2100 of 14 September, 1997, to 1937 of 23 January, 1998. Longgengshuang was the working area, including the *vallies* of Longgengshuang, Longli, Longwang, Longgu, Longying, Longhou, Longgengqiao, Longyagui, Longgengthu, and Longwu. The campsite was located in the working area, at 22°27'N and 107°52'E (measured with GPS 38 Personal Navigator™).

A. Climate Data, including air relative humidity, rainfall, and highest and lowest temperatures, were collected at the Reserve Headquarters from September 14 to October 8, 1997, during which the data were collected at 2100 everyday, and on the campsite since October 8, 1997, using *Pronamic* rain-gauge (made in Denmark) and *Diplex* thermometer (made in the UK). From October 8 to 21, the data were collected at around 2100, and from October 22, 1997, to January 23, 1998, the data were collected at around 2000. The detail information is shown in Table 1 bellow.

Table 1 Phenological information collected from September 1997 to January 1998 (n=131)

	Temperature (°C)			Humidity (%)			Rainfall (mm)			
Month	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Sum	Mean
Sept.(n=15)	29	17	23.2	93	77	83.5	33	0	75	5.0
Oct. (n=32)	31	11	24.0	97	58	89.8	10	0	67	2.1
Nov. (n=29)	31	10	19.5	98	59	86.6	3	0	5	0.2
Dec. (n=32)	28	9	15.9	98	42	82.7	10	0	19	0.6
Jan. (n=23)	29	5	14.3	98	58	82.3	12	0	16	0.7

In December and January, there were 5 foggy/misty days respectively.

B. Phenology Before the work, a coding system of food plant species had been established according to local people who had experience about the white-headed langur's diet. The system included 39 species. Each species was coded with a number, thus the 39 species were recorded as from Species No. 1 to Species No. 39. One species (Species No. 39) was excluded from the system in the work in September because it was found to be a domestic plant and eaten by the white-headed langur in the cage other than in the wild. Two species (Species No. 36 and Species No. 38) were picked out from the system during the work in October, because they were not seen to be eaten by the langurs in the wild but in captivity and because the two species were not found in the working area. During the observation of feeding ecology in October, two new species were added to the system and coded as Species No. 40 and Species No. 41. Another two new species found to be eaten by langurs in November were added in December and coded as Species No. 42 and 43. There are 40 species in total in the system so far.

In the field, the researcher and his assistant searched for the plants, tagging each individual with a piece of tin (with a number on it). Searching was carried out along the hill-foot, trails, on hill-top, and on cliff, and tagging was opportunistic in the initial visit. Ten individuals were tagged for each species From the second time, the tagged plants were visited according to the sequence established previously.

Each plant was scored in terms of food items. For leaves, three classes were divided; they were *young leaves (YL)*, *old leaves (OL)*, and *senescing leaves (SL)*. Total score of the three classes was 4. For flowers, two classes were divided; they were *flower bud (FLBD)* and *open flower (OPFL)*. Total score was 4. Fruits were also divided into two classes; that is, *immature fruit (IMFR)* and *mature fruit (MFR)*.

Total score of them was also 4.. Food Plant Species No. 24 had only stem, flowers, and fruits. It was a parasitic species. The stem was scored as 1 for living and 0 for dead. In scoring the vegetation components, a component was scored as 0 when it disappeared from the canopy. For example, when no flowers were found on the canopy of a plant, the total score of flower was 0; when only flower buds appeared in abundance, it was scored of 4 for *FLBD*, 0 for *OPFL*, and the total score was 4 for that plant. When part of a component (leaves, for example) had fallen down, the total score was >0 and <4, depending on the amount of the remaining part.

Most of the vegetation was bush, trees in which were too small to climb up. The researcher could be only on the ground when collecting the data. However, it was also very difficult to carry out the work either due to too much penetrating light (light that penetrated leaves) or due to too sharp contrast between leaves and the background of sky because the greenness of leaves was used in distinguishing youngness of leaves. The light green leaves were judged to be young and dark to be old. As a strategy, the assistant bended the selected trees down dor the researcher who made the estimate. For those big trees (such as kapok trees), the researcher made the estimate at a distance (through binoculars).

Canopies often mingled together. Vines and lianas climbed up on tree canopies. These made it hard to do the estimate of proportions of canopy components. In this case, the assistant cleared the non-selected foliage or vines off the selected trees so as to show a complete profile of the selected trees. For selected vines and lianas, individuals climbing on short trees were selected. Selected plants were not cut at all and the surrounding of plants living naturally in shade was not disturbed so as to avoid man-made influence to the data.

This work took about 170 h in total, 40 h of which in September, tagging and scoring 246 plants; 55 h in October, tagging and scoring 130 new plants and re-visiting the 246 plants; 29 h in November, visiting the 376 plants that had been tagged previously; 22 h in December, re-visiting the 376 plants, tagging and scoring two new plants that belongged to two different species; and 24 h in January, visiting the 378 plants tagged.

There are 378 plants so far tagged in total, including 40 species. Thirty-seven species had ten individuals each to be tagged. One (Sp. No. 11) had only six individuals, and two species (Sp. No. 42 & 43) had only one individual tagged each, because no more were found though we have searched thoroughly in the working area.

Based on the data of feeding ecology (see below), ten species that were most heavily used by the langurs during the past months have been established, the information of which is shown below.

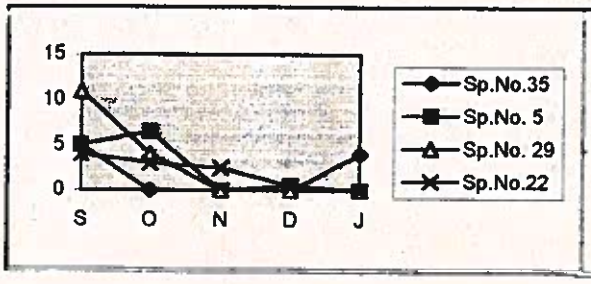

Figure 1

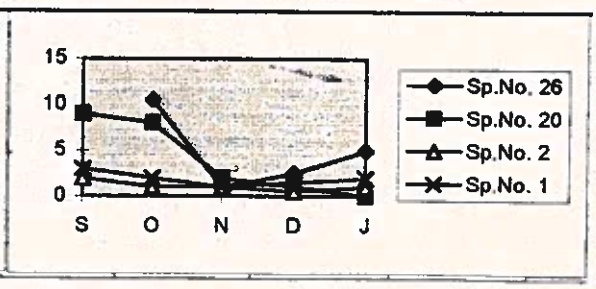

Figure 2

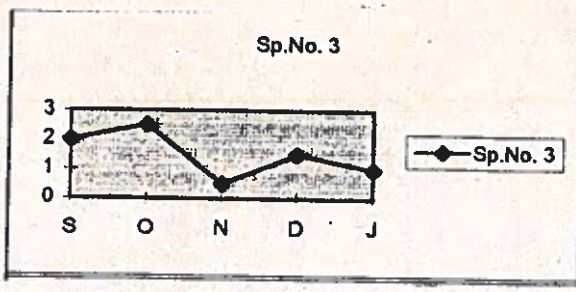

Figure 3

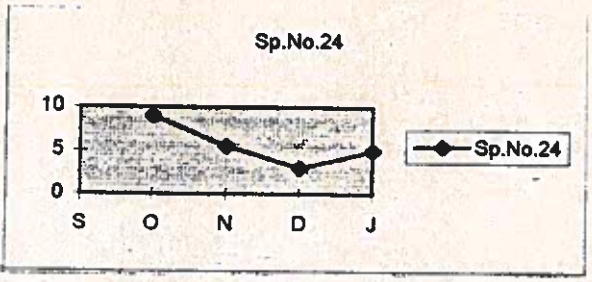

Figure 4

Figures 1-3 show the change of young leaves of the ten species, and Figure 4 the change of stem (living/dead) of the Species No. 24. Figures 5-7 show the change of mature leaves and 8 the change of fruits of Species No. 20 which was seen eaten by the langurs.

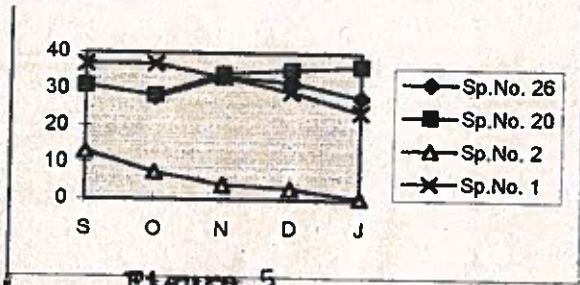

Figure 5

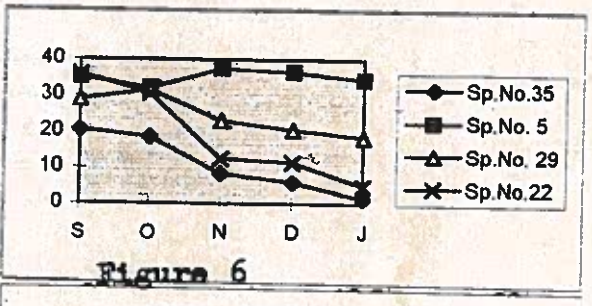

Figure 6

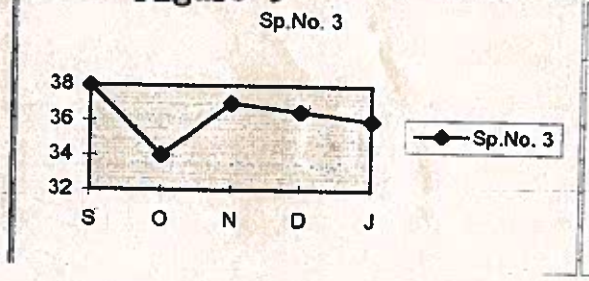

Figure 7

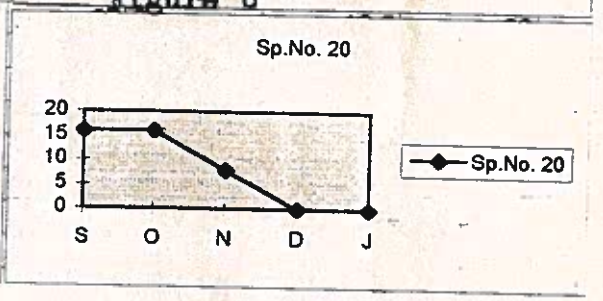

Figure 8

These figures indicate that production of young leaves fluctuated with time and that some species (Sp. No. 1, 3, 5, 20, 26, and 29) were evergreen because the canopies maintained lots of mature leaves all the time. Other species lost leaves with the time from the autumn to the winter.

C. Behaviour Data included feeding, resting, moving, playing, grooming, and others, substrate (rock+ground, or tree), height (top, upper, middle, lower, and hill-foot, each accounting for 20% of the height), locality, time of encountering, food plant species no. (see the section of Phenology), and the food items (young leaves, old leaves, bud, flower, and fruit). The data were collected every 10 minutes using scan sampling technique. The first samples were made 10 minutes after the encountering time. When time was on, searching and recording langurs were limited in 2 min. Individuals that were not seen in the time period were marked with "absent"--when locality was known, the code of height was recorded. When possible, the researchers stayed in bush or crops while observing animals. Observation was conducted through binoculars for most of the time due to the distance. A working day began in the early

morning and ended in the evening (time changed with the seasons), with a 2-hour rest period after lunch (because langurs largely stayed in bush and thus were invisible).

Table 2 shows the detailed information of time during the observation in the field.

Table 2 Information of time spent in the field

	Wild*(h)	Contact(m)	Visible(m)	Samples	Records
Sept.	42	290	253	29	100
Oct.	85	1650	1260	165	665
Nov.	77	2218	2120	212	1809
Dec.	75	2409	2220	226	2020
Jan.	61	2090	2010	201	1437
Total	340	8657	7863	833	6031

*For the meaning of the headings, see ***Definition.***

Based on the encountering site, group composition, external features of some individuals, langurs' behavior, and their response to humans, seven groups have been identified. The 833 samples were collected from the 7 identified groups, identified individuals, and solitary males. Table 3 shows the detailed information of composition of the 7 groups and the samples collected from them.

Table 3 Group Composition and Number of Samples Collected from the 7 Identified Groups

	GA1*	GA2	GA3	GA4***	GA5	GA6	GA7	TOTAL
Adult M	1	1	1	6	1		1	11
Adult F	1	5	5	3	1		9	24
Subadult M				1				1
Juvenile	2		2			2		6
Infant			3**		1****			4
Un-iden.			2		4	5		11
Total	4	6	13	10	7	7	10	57
Samples (%)	128(15.4)	42(5.0)	95(11.4)	230(27.6)	6 (0.7)	12(1.4)	12(1.4)	525(63.0)[1]

1. There were 308 samples (37%) collected from un-identified langurs and solitary males.
2. * The group composition changed later because two members (the female and a juvenile) disappeared from the group. **One of the infant was born in December. The former composition therefore included only two infants. ***A social change (group take-over) took place in the group in the early December. Before the change, the group was composed of one adult male, three adult females, two subadult males, two juveniles, and two un-identified members. ****The infant was born in November.

Since the social change occurred in the early December, the group GA4 often appeared in two subgroups. One subgroup ranged from 2 to 4 members in group size; the other from 6 to 8. The two subgroups kept a distance (over 150 m) or stayed at different hill-sides for most of the day-time and joined together in the early morning and in the evening. The group was seen staying outside its original core area (the valley called Longying No. 1) for much time, which was not seen before the social change. In the mean time, another group, GA7 was seen staying in the group's core area, during which the langurs did not seem to keep them in secrete, as did by other invaders.

The results of behavioural observation are summarized in Table 4.

Table 4 Summary of the results of behavioural observations

Activity	Resting	Feeding	Moving	Playing	Grooming	Others	absent		Total
(records)	1700	329	497	72	533	27	2873		6031
Height	Top	Upper	Halfway	Lower	Hill-foot	unknown			Total
(records)	414	365	565	1390	1433	1864			6031
Diet	Food Plants*	Sp. 26	Sp. 20	Sp. 2	Sp. 1	Sp. 35	Sp. 24		Total
(records)		95(28.9)	52(15.8)	20(6.1)	17(5.2)	16(4.9)	15(4.6)		
		Sp. 5	Sp. 29	Sp. 22	Sp. 3				
		13(4.0)	11(3.3)	10(3.0)	7(2.1)				256(77.8)**
	Food Items	*YL*	*OL*	*SL*	*L***	*Stem*	*MFR*	unclear	Total
		161(48.9)	64(19.4)	1(0.3)	2(0.6)	15(4.6)	53(16.1)	33(10.0)	329(99.9)

* Only the ten most heavily used species are listed here. ** There were 329 feeding records in total. ***L includes leaves of all phases.

Young leaves accounted for a large proportion in the langur's diet. The change in diet with time will be related to the phenological information on completion of the whole fieldwork.

Of the 6031 records, 2837 records were marked clearly with the substrate (tree/rock), of which 1642 (57.9%) were made from the langurs in trees and 1195 (42.1%) from those on rock. Table 5 shows the detailed information of the relationship between activities and substrate.

Table 5 Activities on Different Substrate

	Feeding	Resting	Moving	Playing	Grooming	Others	**Total**
In Trees	263(9.4)	798 (28.7)	233 (8.4)	33 (1.2)	247 (8.9)	18 (0.6)	1592(57.2%)
On Rock	11 (0.4)	677 (24.3)	222 (8.0)	20 (0.7)	256 (9.2)	6 (0.2)	1192(42.8%)
Total (%)*	274 (9.8)	1475 (53.0)	455 (16.4)	53 (1.9)	503 (18.1)	24 (0.8)	2784(100%)

* Records from the individuals whose behavior was not seen clearly have been excluded from this table. The 2784 records were collected from the langurs whose activities and substrate were both seen clearly.

It has been found in the past months that the white-headed langur spent large amount of time on lower levels (lower and hill-foot) of the hills. Table 6 shows the activities at different levels of hill.

Table 6 Activities and the levels of height

	Feeding	Resting	Moving	Playing	Grooming	Others	**Total (%)***
Top	4	151	37	1	38	3	234 (8.6)
Upper	8	168	49	5	32	1	263 (9.6)
Halfway	5	265	71	14	73	0	428 (15.7)
Lower	87	602	130	14	250	7	1090 (40.0)
Hill-foot	104	295	168	19	110	13	709 (26.0)
Total	208	1481	455	53	503	24	2724 (99.9)

*The sum of visible records was 827.

Spacing among Groups I have identified two types of loud call in the previous months and have known that they seemed to function in different contexts. Type I was to keep spacing among groups. According to modern theory in behavioural ecology, signal recipient should check signaler so as to avoid being cheated. The Type I loud call vocalizer may face with the same problem. The vocalizers normally

jump about vigorously to show themselves to the recipients while vocalizing. The jumping may be indicative in showing how strong the vocalizer is. Solitary old males did not have a home range in the wild and they were often chased by other groups' young breeding males. They often moved very slowly (perhaps due to the age). The following record is interesting:

In the morning on Jan. 16, a solitary male (old) emitted Type I loud calls on a rock first and then stayed in bush (thus was invisible) while vocalizing. There were about 5~6 Type I loud calls. He didn't jump about while vocalizing.

This seems to indicate that he was using this vocalization to keep other potential group(s) away. However, he has been too old to fight with young males so did not show himself to other potential rivals. Thus he seemed to be cheating other langurs by vocal signaling.

Seed Predator or Disperser? The langurs fed heavily on fruits of Sp. No. 20 in November and early December. Two fresh dung particles were examined in November and 4 in early December. There were no complete seeds found in the particles. I tested the hardness of seeds by chewing, which indicated that the seed-shell was vulnerable and very easy to chew into small pieces. Thirty fruits were measured using calipers. Data were collected on two dimensions, one was the longest diameter, the other was the shortest diameter. After being measured, a fruit was pilled to remove the seed on which the same data were collected. The data were averaged respectively for fruits and seeds to obtain the means. Then, the means of seed dimensions were divided by the means of fruit dimensions so as to evaluate the amount of seed in the langur's diet. The results are shown in Table 7.

Table 7 Measurement of fruits and seeds of food plant species No. 20 (mm)

	Fr. Dim. 1	Fr. Dim. 2	Mean	Sd. Dim.1	Sd. Dim.2	Mean	Percentage
1	4.11	3.26	3.68	3.05	2.04	2.54	69.00
2	4.10	3.15	3.62	3.44	2.41	2.92	80.70
3	4.12	3.25	3.68	3.20	2.48	2.84	77.20
4	4.08	3.23	3.66	3.15	2.50	2.82	77.00
5	4.09	3.06	3.58	3.00	1.85	2.42	67.60
6	3.50	3.08	3.29	3.00	1.64	2.32	70.50
7	4.08	3.00	3.54	3.00	1.80	2.40	67.80
8	3.88	3.50	3.69	3.00	1.84	2.42	65.60
9	3.38	3.10	3.24	2.60	1.64	2.02	62.30
10	4.36	3.52	3.94	3.10	2.02	2.56	65.00
11	4.08	3.68	3.88	3.20	2.10	2.65	68.30
12	3.54	3.10	3.32	3.10	1.86	2.48	74.70
13	3.88	3.00	3.44	3.22	2.00	2.61	75.90
14	4.00	3.44	3.72	3.00	2.02	2.51	67.50
15	3.76	3.22	3.49	3.00	1.84	2.42	69.30
16	4.08	3.50	3.79	3.50	2.00	2.75	72.60
17	3.50	3.00	3.25	2.80	1.82	2.31	71.10
18	3.94	3.04	3.50	3.20	1.92	2.56	73.10
19	3.64	3.02	3.33	3.00	2.88	2.94	88.30
20	3.90	3.30	3.60	3.00	1.86	2.43	67.50
21	4.10	3.32	3.71	3.30	1.84	2.57	69.30
22	3.86	3.40	3.63	2.62	1.70	2.16	59.50
23	3.88	3.30	3.59	3.20	1.60	2.40	66.80

24	3.70	3.20	3.45	3.20	1.74	2.47	71.60
25	3.08	3.58	3.33	3.00	1.84	2.42	72.70
26	4.10	3.60	3.85	3.30	1.70	2.50	64.90
27	3.92	3.20	3.56	2.82	1.84	2.33	65.40
28	4.08	3.34	3.71	3.00	1.94	2.47	66.60
29	3.80	3.40	3.60	3.14	1.84	2.49	69.20
30	4.44	3.60	4.02	3.40	1.84	2.63	65.40

These data indicate that, (1) for the food plant species No. 20, the white-headed langur was a seed predator other than a dispersor, and (2) seeds accounted for large amount of fruits they ate (around 70% of the fruit eating records).

Conservation During the fieldwork, I also collected other information in relation to the conservation management of the langurs. It included poaching, vegetation cutting (including vegetation clearance), influence of agricultural work to the langur's survival, and the Reserve Headquarters' administration and management. All of these issues will be detailed in the final report.

Preliminary Findings The Reserve Headquarters has a policy for conserving vegetation for the langurs. According to the policy, local people are permitted to cut trees only at hill-foot. Those who cut trees on the hill-top will be fined. This is problematic in that langurs prefered staying at lower levels of hill (lower part and hill-foot). In the meantime, no people like climbing up to the tough and dangerous hill-top to cut trees. They cut trees only at hill-foot. The langurs carried out their activities (especially some important activities, such as feeding) at lower levels. Thus, the policy does not function to alleviate the conflict between wildlife and humans.

Work Plan for the Next Half Year (from February to September, 1998) 1. Continue collecting data that we have been collecting, 2. collect data on the langur's locomotion behavior so as to evaluate the species' adaptation to the habitat of limestone hills, 3. classify habitat types in terms of the degree of disturbance, 4. collect data on frequency of encountering langurs in different types of habitat, 5. identify food plant species, and 6. collect data on plant species composition in different types of habitat so as to describe the habitat features. The final report will be submitted on completion of the period.

Financial Accounting This will be reported in the final report.

PENDIX I: LIST OF FIELD WORKERS

1. Li, Zhaoyuan, principal investigator of the project, responsible for the whole project and collecting data on phenology and behavioral ecology in the field.

2. He, Jie, male, 66 yr., retired staff of Bapen Reserve, local assistant of the project (a cook).

3. Lu, Qiang, 25 yr., local assistant of the project, helping the PI on data collection.

4. He, Tianyin, 25 yr., local assistant of the project, transporting living material to the campsite, and responsible for daily life.

5. Ten Earthwatch volunteers, collecting data on behavioral ecology and processing data in the field, trained before starting fieldwork. They were: Claire Schwaner (UK), Daphne Gillett (UK), Tristina Guidry (USA), Egon Barth (Germany), Margrit Barth (Germany), Amy Sundermeier (USA), Selina Green (UK), Annabel Lacaux (Spain), Carlheinz Muennighoff (Germany), and Elizabeth Blass (USA).