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The Tangjiahe, Wanglang, and Fengtongzhai Giant Panda Reserves and Biological Conservation in The People's Republic of China

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ABSTRACT

The People's Republic of China has designated a system of reserves in the mountains that rim the Sichuan Basin as areas to be managed specifically for the conservation of the giant panda Ailuropoda melanoleuca. *We were invited to visit three of these reserves in April and May 1981 as guests of the China Association for Science and Technology and the Ministry of Forestry. Two reserves, Wanglang (27,000 ha) and Tangjiahe (40,000 ha) are located in the headwaters of the northern tributaries of the Chang Jiang (Yangtze) in the Min Shan, 400 km north of Chengdu. The Fengtongzhai (40,000 ha), type locality of* Ailuropoda, *is in the Qionglai Shah, 250 km west of Chengdu. We describe the physiography, faunistic and floristic position, and conservation management of these areas. Major issues in the conservation of* Ailuropoda *are discussed.*

INTRODUCTION

The animals and plants found in the mountains that rim China's Sichuan Basin have fascinated scientists and generated considerable public

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attention in the West at least since 1869 when the French naturalist Armand David (Fox, 1949) collected there. Western knowledge of this area was expanded through the publications by Wilson (1913), Schafer (1938), Engelmann (1938), Allen (1938, 1940) and the several expeditions organized to collect or capture the area's most dramatic mammalian inhabitant: the giant panda *Ailuropoda melanoleuca*. Giant panda expeditions (summarized in Morris & Morris, 1966, 1981; Perry, 1969; Sheldon, 1975) reached a frenzied peak in the 1930s. But with World War II and the political events that followed, new natural history information reaching the West from this area virtually ceased until 1974 when the Giant Panda Expedition of the Wanglang Reserve (1974) published an account of their 1968–69 investigations (see also Wang & Lu, 1973).

Unknown in the West, or at least to us, was that as early as the late 1950s China had begun to establish wildlife refuges (see Giles, 1978, for definitions of classes of wildlife management areas). During the mid-1970s the Sichuan Bureau of Forestry (1977) conducted extensive surveys in the mountains to determine the distribution and relative abundance of a number of rare mammals including *Ailuropoda* (Fig. 1), red panda *Ailurus fulgens*, golden monkey *Pygathrix roxellana*, white-lipped deer *Cervus albirostris*, sitka deer *C. nippon*, serow *Capricornis sumatrensis* and takin *Budorcas taxicolor*. Additional wildlife refuges were established based on the findings of these extensive surveys. A second front in China's conservation effort has been the initiation of a coordinated ecological and biomedical research programme to strengthen conservation management of *Ailuropoda* in the 200,000 ha Wolong Biosphere Reserve located in the Qionglai (=Chunglai) Shan (mountains, range) west of Chengdu (Wang Meng-hu & Bi Feng-zhou, pers. comm.).

After nearly a half century's lapse, the process of learning to communicate between China and the West is in motion in many sectors. For the Smithsonian, the decade following the Chinese gift of a pair of giant pandas to the people of the United States (housed at the National Zoological Park in Washington, DC) has seen continued communications. In 1979, a Smithsonian delegation visited China to discuss a range of cultural and scientific projects. One of the first joint projects to be discussed was an ecosystem survey in a reserve to be selected that would emphasize *Ailuropoda* conservation. Vice Premier Feng Yi met with the delegation and gave his approval to the proposal with the China Association for Science and Technology (CAST) to coordinate plans for the survey. It was suggested that this project should form an important

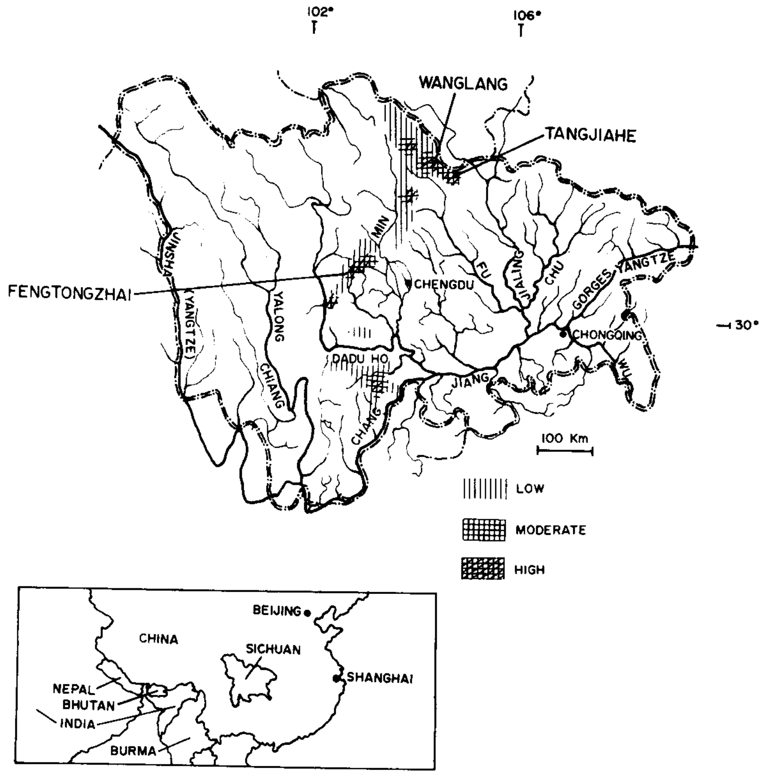

Fig. 1. The distribution of *Ailuropoda melanoleuca* based on surveys conducted by the Sichuan Bureau of Forestry (from Sichuan Bureau of Forestry, 1977). The locations of the Tangjiahe, Wanglang, and Fengtongzhai reserves are indicated.

corollary to the international effort in *Ailuropoda* conservation with the World Wildlife Fund which was concentrating its efforts at the Wolong Biosphere Reserve.

We, as a Smithsonian delegation, met with a counterpart team including representatives from the Ministry of Forestry, *Academia Sinica*, China Association for Science and Technology, and the Beijing Natural History Museum. After our initial discussions, we were invited to visit three of the smaller panda reserves in Sichuan: Wanglang, Tangjiahe, and Fengtongzhai (Fig. 1). In this report we present profiles of each of these areas based on our observations, staff background briefings that were held at each site, literature available to us, and discussions with our colleagues both in China and the United States (see

Acknowledgements). We compare these areas and summarize what is known of *Ailuropoda* distribution, habitat requirements and feeding adaptions. With this as a basis, we propose working hypotheses that can be used to guide research and management efforts for this very specialized species and the ecosystem of which it is a part.

THE GIANT PANDA RESERVES

Wanglang

The Wanglang Reserve (32°35′N; 104°45′E)[1] is a 27,700 ha steep-sided basin (2000–4600 m) containing four smaller distinct watersheds at the headwaters of the Fu Chiang (River) on the northeastern escarpment of the main spine of the Min Shan (Fig. 2). The western slopes of this basin are drained by the Min; the eastern by the eastern-most tributary of the Jialing. Thus, the Wanglang is at the very headwaters of the Fu, Min, and Jialing, the three major tributaries of the Chang Jiang (Yangtze) that drain the Min Shan and the northern Sichuan Basin (Fig. 2).

Skins of *Ailuropoda* were reportedly obtained by Berezowski from the Min Shan on the Sichuan-Gansu Border as early as 1884–7 (in Perry, 1969) and signs of *Ailuropoda* presence were noted in these mountains by the botanical explorer Wilson (1913). This range was not investigated by the 'panda expeditions' to Sichuan before World War II, which concentrated their efforts in the southern end of the Qionglai Shan west of Chengdu (summarized in Morris & Morris, 1966, 1981; Perry, 1969). With the information provided by the Giant Panda Expedition (1974), Wang & Lu (1973), and Chorn & Hoffmann (1978), the fine film on the natural history of *Ailuropoda* made in China with English narration, and the recent book edited by Zhu & Li (1980) this has become the better known panda area to observers outside China.

Wanglang was established in 1965 with a management policy to promote protection, utilization, scientific research and propaganda (education). While impetus for establishing the Reserve was *Ailuropoda* conservation, considerable attention was also focused on the conservation of *Pygathrix*, *Budorcus*, and other rare species. It is

[1] This and subsequent locations we give are the approximate centres of each reserve. The reserve locations published in Wang (1980) appear to be those of the cities administratively responsible for those areas and not the reserves proper.

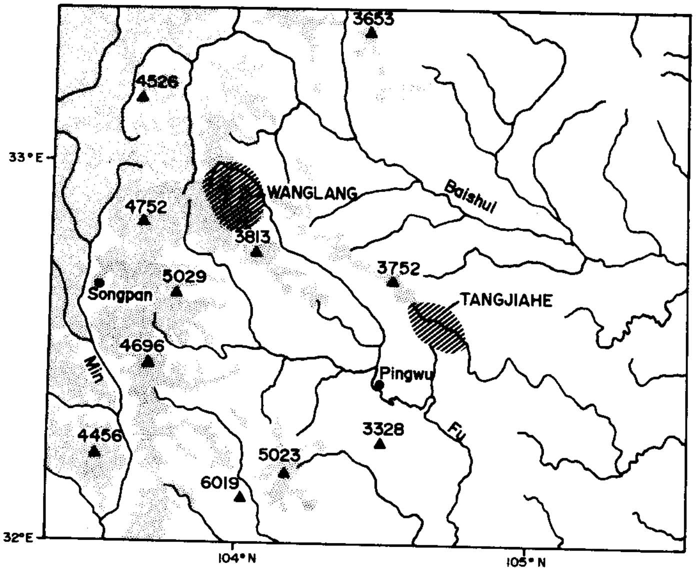

Fig. 2. The locations of the Wanglang and Tangjiahe reserves in the Min Shan. The area above 3000 m is stippled; note the extreme upper watershed position of these reserves. The open, high-altitude habitats above 3000 m are probably barriers to *Ailuropoda* dispersal.

administered through the county of Pingwu and is accessible by good roads. The reserve is 430 km north of Chengdu via the town of Pingwu. The 90 km from Pingwu to the reserve were easily travelled by two-wheel drive van during April. We were told that this road is much more difficult to traverse during the summer rains. Prof. Wang Sung noted that a decade earlier the Giant Panda Expedition walked four days to reach what is now the Reserve boundary which provides some indication of rate of development in these mountains. Access in the Reserve is provided through 18 km of road along the main drainage, the Beima Ho (River), and a road in the Chunganchai Guo (basin or valley). There are trails in the other valleys. Along the Beima Ho there is a border station at 2400 m, a new reserve headquarters at 2450 m, 9 km upstream. 8 kilometres beyond there is a substation at the juncture of the Yangdu and Dawantan Guo. A hydro-electric plant for the headquarters was under construction.

In close proximity to the Reserve is the Beima (white horse) commune, a major settlement for Tibetan minorities. Some hunting apparently takes place in the vicinity of the Reserve by these people. We were told the Reserve is utilized extensively by universities and research institutes for scientific study. Some commercial and television filming has been undertaken as part of the education effort for the Reserve. At least one giant panda captured from this reserve was sent to France as a gift of state.

In our official briefing we were told that the average annual temperature is 10 °C with 1800 mm of precipitation. Forest occupies 44 %, mountains 19 %, and rocks 37 % of the surface area. There are five recognized habitat zones along the 2000 m elevational gradient: rocks and subalpine, original conifer forest, bamboo mixed with secondary forest, secondary forest, and mountain steppe (grasslands)/shrub areas. The parent material is limestone. After travelling through the reserve we were impressed with how the effects of elevation, slope, exposure, narrow valleys, rain shadow, wind and possibly fire and past human activities combine to produce a patterning of vegetation types (Fig. 3). These are not the elevation correlated belts described by Sheldon (1975) for his *Ailuropoda* study site in the Qionglai Shan, but patches. Protected valleys, basins and ridges harbour conifer forests; contiguous to these on exposed slopes, which

Fig. 3. Wanglang Reserve (April 1981): Looking northeast across the Beima Ho valley; the far ridge is the Reserve boundary.

extend down to relatively low elevations, were grasslands with shrubs. The deep side canyons or gorges at lower elevations were dry with scattered conifers and little ground cover. In viewing this reserve J.S. was reminded of the Salmon River Mountains and the canyons of the Salmon and Snake rivers in Idaho, USA (Seidensticker *et al.*, 1973).

The report by the Giant Panda Expedition (1974) emphasized that bamboo is distributed in the Wanglang only where there was a mild microclimate which was further influenced by past human-related disturbances. Far from there being vast, homogeneous bamboo stands, which is the impression one gets from reading Sheldon (1975) and others in the Qionglai Shan, the bamboo here is patchy and restricted to the sheltered valleys and slopes. This suggests that the bamboo which supports *Ailuropoda* can only flourish within a rather restricted set of environmental conditions. This is surprising given the wide distribution of some of these genera (Table 1). Wanglang is at the edge of those limits and thus is an important site for the study of the ecology of these bamboos (Numata, 1979*b*).

Stands of bamboo pictured in the book by Zhu & Li (1980) and described by the Giant Panda Expedition (1974) are not present now. It was in Wanglang that the bamboos *Sinarundinaria* '*chungii*' and *Thamnocalamus spathaceus*[2] flowered in 1976. The dead bamboo culms remained standing or broken under a *Picea* and *Tsuga* forest canopy. Some bamboo seedlings were apparent but were growing slowly. Here and there a young conifer seedling was evident. The forest had an empty look. Our impression was that bamboo stands suppress the growth of seedling conifers and that only after bamboo flowering can young conifers establish. In the mountains of Japan, *Phyllostachys* bamboo eventually drops out of the successional series and conifers and hardwoods dominate (Numata, 1979*a*). Are the conifer/bamboo associations a stable (or climax) vegetation type or not? That is a basic question and central to *Ailuropoda* conservation.

Our hosts reported that the spring after the major bamboo flowering, the reserve staff recovered the remains of 24 *Ailuropoda*. Six years earlier the Giant Panda Expedition (1974) had estimated there was a population numbering about 200 in Wanglang. This would not seem a high rate of

[2] Dr T. R. Soderstrom has identified bamboo specimens from Wanglang collected by Prof. Zhu Jing as the above rather than *Fargasia spathacea* for *T. spathaceus*. The specimen identified as *S. chungii* (see Zhu & Li, 1980) does not match the type specimen for this species in the US National Museum.

TABLE 1
Observations on Bamboos in Four Panda Reserves

Min Shan		Western Escarpment	
Wanglang[a]	*Tangjiahe*[b]	*Wolong*[c]	*Fengtongzhai*[b]
Sinarundinaria sp. flowered 1976, 2400 m *Thamnocalamus* (*Fargesia*) *spathaceus* flowered 1976; 2490–3000 m; we[b] observed this species not flowering among stands of dead culms, 2800 m	*Sinarundinaria* sp. was observed in flower, 1981, 2100 m and ±2-year-old seedlings	*Phyllostachys nidularia*? identified from photos *Arundinaria 'fangiana'* flowering at 2800 m, 1981 *Thamnocalamus* (*Fargesia*) *spathaceus* and/or *omeiensis* flowering at 2600 m, 1981 *Sinarundinaria* sp. flowering at 2600 m other *Sinarundinara* below 2000 m	*Phyllostachys nidularia*? we observed this not in flower at at 1700 m *Sinarundinaria* sp. Different species from Min Shan, we observed this species not flowering at 1700 m

Characteristics of these Bamboo Genera

Genera	*Rhizome/neck*	*Years between flowering*	*Culms reach full stature*	*Stem diameter (mm)*	*Leaf length (cm)*	*Growth of new shoots*	*Habitat*	*World distribution of genus*
Thamnocalamus (Fargesia)	Sympodial, clump forming	≈90+	?	5	6–13	Summer, autumn	Conifer/*Betula* forest, higher elevation, shaded forest	Himalayas, China, S Africa
Sinarundinaria	Sympodial, clump forming	≈90+	≈6 years	4–5	9–11	Late summer, autumn	High elevation, shaded forest, some species at lower elevations	E Africa, Madagascar, Himalayas, S India, Sri Lanka, China, Philippines
Arundinaria	Monopodial. running culms, widely spaced	? long	?	3	6–8	Late spring, summer	Variable, shaded woodland	E China, Japan, SE United States
Phyllostachys	Monopodial, running culms, widely spaced	60–120	?	18	10+	Early spring, stores in energy rhizomes through summer	Temperate, open in sun	Assam, Burma, China

Identification and characteristics of bamboo were provided by T. R. Soderstrom.
[a] Specimens provided to T.R.S. by Professor Zhu Jing.
[b] Our observations were made in late April 1981.
[c] Specimens provided to T.R.S. by G. B. Schaller.

mortality considering that massive loss of a critical food supply. However, in our briefing, officials told us that *Ailuropoda* mortality was much greater than these figures indicate, so much so that any attempt to initiate an investigation of *Ailuropoda* ecology here now was considered to be relatively futile.

The steep slopes in the Reserve were marked with extensive land slips and in some places the slips had blocked streams to create lakes. We were told these disturbances were the result of a 1976 earthquake whose epicentre was reported to be 80 km to the east. The dead bamboo culms together with earthquake damage left one with the impression that a 'natural catastrophe' had befallen the land. This is how our hosts described the situation. Earthquakes are a frequent if irregular occurrence at the edge of the Tibetan Plateau. Bamboo flowering, the death of the culms, and what may be a five-year delay before new culms have reachd full size, is a major, 100 year or so pulse in the system (Soderstrom, 1979). Both earthquakes with associated land slips, and the growth cycle of bamboo, are natural processes affecting the patterning and structure of the vegetation.

In the short time we spent on the ground we noted abundant mammal signs. During a 2 km walk at 2600 m in a *Picea/Tsuga* forest in the Dawatan Guo, thick with dead bamboo culms, we heard a *Pygathrix* group, observed the tracks of and heard a Tibetan black bear *Ursus thibetanus*, observed the tracks and faeces of *Budorcas*, *Capricornis* and musk deer *Moschus moschiferus*, and saw one *Moschus*. In seven piles of faeces of *Cuon alpinus*, the reserve staff identified the hair of *Moschus* in five and of *Budorcas* and tufted deer *Elaphodus cephalophus* in two. In a 5 km walk to 2800 m along an old timber-cutter's road through *Betula/Picea/Tsuga* forest with a dead bamboo culm understorey and abundant *Usnea* lichens on the *Betula*, our group observed and found many tracks of *Moschus*, observed one blood pheasant *Ithagianis cruanthus* and many tracks of *Budorcas*. We saw two pikas, probably *Ochotona thibetana*, at 2560 and 2620 m. They were using burrows in the moss at the bases of logs in a damp, forested creek bottom. This contrasts with *O. princeps* in North America, which is almost exclusively found in open boulder fields, often above the tree line. Near headquarters Prof. Wang Sung observed one *Mustela siberica*. The calls of numerous pheasants *Phasianus colchicus* were heard in the early morning from the open grass/brush slopes (Fig. 3). We saw no sign nor were we shown any sign, recent or old, of *Ailuropoda*.

Tangjiahe

Tangjiahe (32°35′N; 104°45′E) is a 40,000 ha montane basin 60 km southeast of Wanglang on the other end of the same major ridge system (Fig. 2). Travel between the two is through the deep, dry canyons of the upper Fu and Jialing and their tributaries. Early western travellers did not report visiting this area (Wilson, 1913; Perry, 1969; Morris & Morris, 1981). We were able to drive to the Reserve headquarters in one day by good roads from Chengdu (370 km). It is 170 km by road between the reserve headquarters and Pingwu. Located as it is in the Jialing drainage system, the reserve is administered through Qingchuan County rather than Pingwu.

Tangjiahe was established as a reserve in 1978 with the management goal '. . . to conserve the giant panda, takin, and golden monkey—the rare and precious animals of China'. The area included in the Reserve is the watershed for two major drainage systems with elevations ranging from 1200 m to 3900 m. The lower canyons are gorges. Higher, the valleys are broader, steep-sided and have large alluvial deposits (Fig. 4). As it was described to us '. . . there are four rivers (three of which make up one of the drainage systems) in the reserve; 48 gorges of major extent and 123 smaller ones'. Average annual precipitation is 1500 mm; the average annual temperature is 11 °C. The parent material is limestone. There has been extensive logging up to 2000 m and selective logging above that. Some reforestation is in progress at lower elevations but many of the logged slopes remain open and grass-covered.

There is a staff of 25 living with their families at a headquarters area with a number of buildings which total 10,000 m^2 floor space. This was the former location of the area's saw mill. Heat and lights are provided with a 200 kw hydro-electric plant. There are roads in the major valleys passable by two-wheel drive van; additional roads in the upper valleys were passable with a four-wheel drive vehicle. The commune that ran the logging operation was being transferred. At the time of our visit, there were 66 farmers and their families (350 people) cultivating the lower slopes and alluvial fans. Before logging there was a mixed deciduous forest between 1200 and 1900 m; between 1900 and 2600 m is *Betula-Picea-Abies* forest; between 2600 and 3100 m *Acer-Picea*; and above 3100 m the habitat is open (Fig. 4). Four soil types were recognized: montain yellow, montain brown, montain green, and montain grassland.

An estimated 200 *Ailuropoda* live in the reserve and the staff estimated

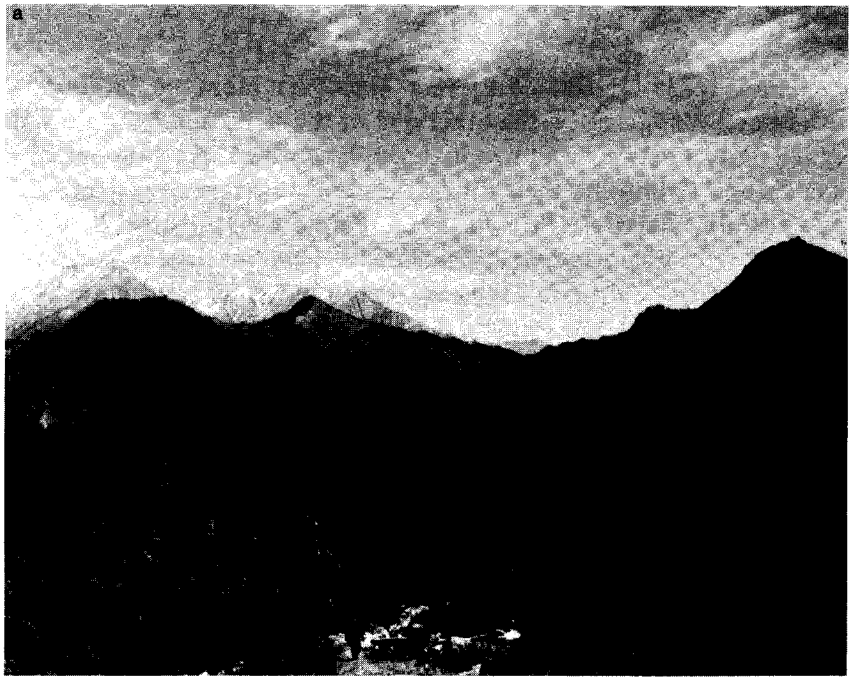

Fig. 4. Tangjiahe Reserve (April 1981): (a) Looking northeast toward the reserve boundary on the border between Sichuan and Gansu. (b) From the same location at Hongshi Ho (2100 m) looking southwest into unlogged forest and *Ailuropoda* habitat.

60 % of these were juveniles and subadults. They are restricted to the vegetation zone between 2100 and 2800 m, or '. . . the belt of bamboos proper for them'. There has been no mass flowering of bamboo here and there were no extensive stands of dead bamboo culms. We did find bamboo seedlings that were at least 2 years old (T. R. Soderstrom, pers. comm.) and *Sinarundinaria* plants that had bloomed the previous autumn (Table 1). In the reserve there were whole hillsides of *Sinarundinaria* bamboo with little other forest cover except for scattered *Magnolia* (Fig. 5). On these hill sides the land slips were overgrown with bamboo (see Fig. 5), and one has the impression that the absence of conifers is due to some disturbance, logging or fire. Forestry officials indicated to us that fire, for unknown causes, is a problem here and needed to be controlled. What is important is that in response to disturbance bamboo established as the dominant vegetation type in some sites and grassland established in other very similar sites. Understanding this difference will be a key research problem.

b

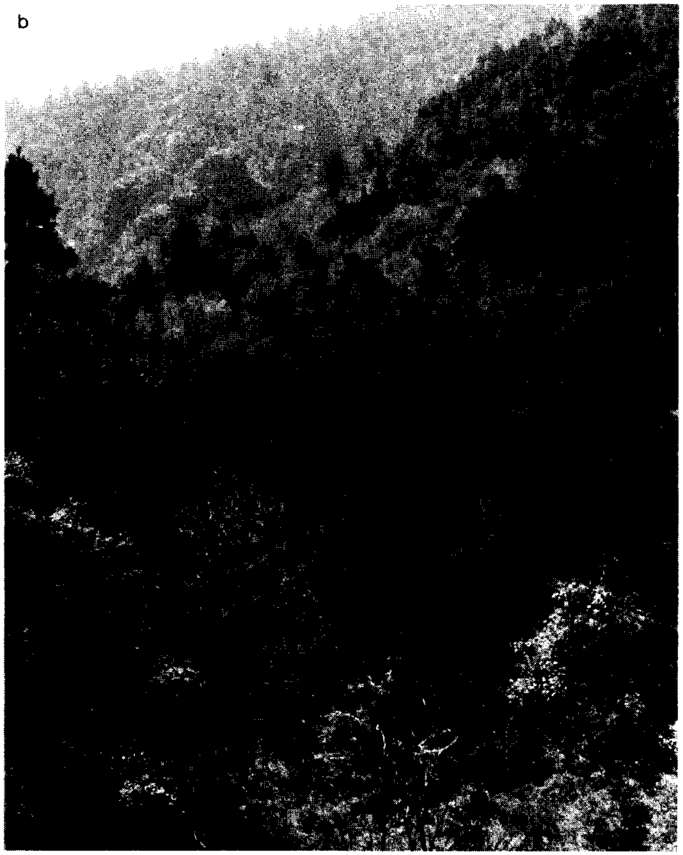

Fig. 4—*contd.*

In the half day we were able to spend on the ground, we observed a group of 27+ *Pygathrix* on a *Betula/Picea* dominated hillside. We found faeces of *Ailuropoda* in two localities. During the previous night a small group of *Budorcas* had moved through a logged-over alluvial terrace in the valley bottom and fed on forbs and the small stems and buds of shrubs. Our hosts reported that *Budorcas* were regularly observed in these areas in the spring when they come down to feed on the new buds and grass. They reportedly moved to the higher ridges with the summer rains. At the juncture of two major canyons in the fork of the road were faeces of *Cuon alpinus* and *Panthera pardus*. The *Cuon* faeces contained the hair of *Moschus* and *Pseudois*, according to the reserve staff. Remains in the *Panthera* faeces could not be identified.

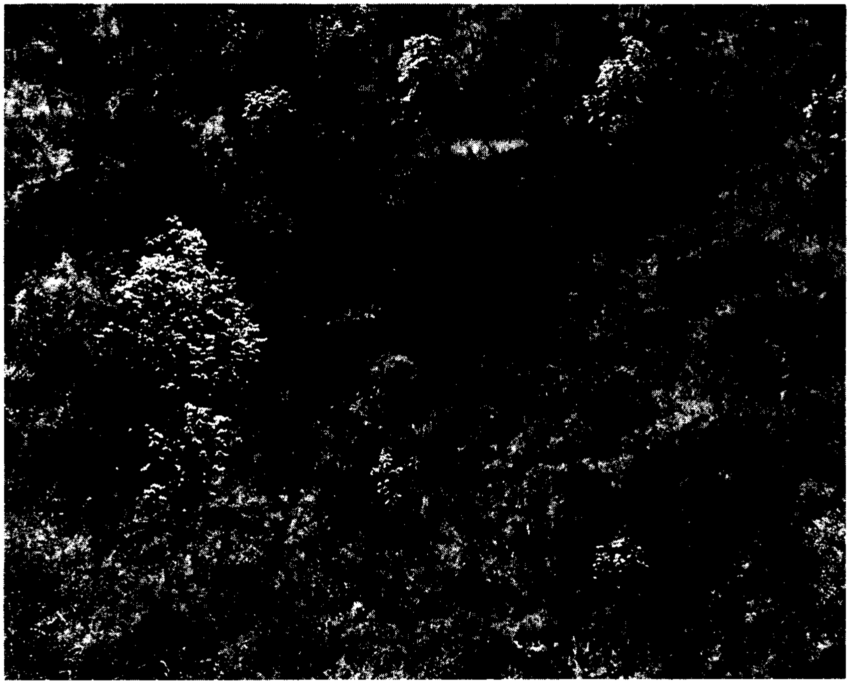

Fig. 5. Bamboo with *Magnolia* in flower on the steep slopes above the Hongshi Ho (2100 m), Tangjiahe (April 1981). Note that the old landslip is revegetated with bamboo.

Our observations and discussions indicated that the open, grass-covered slopes in logged areas were utilized by *Budorcus*. Information on the use of this habitat by the other ungulates was much less clear. The bamboo zone in the reserve appeared to be more continuous than in Wanglang, which indicates that the microclimate here was not as extreme; a major topographic feature must protect the basin from the winds that so markedly influence distribution of bamboo in Wanglang. But at Tangjiahe the bamboo zone is just that, a rather narrow belt bounded at the high elevations by open rock and meadows and below by what are now logged areas. It is here that *Ailuropoda* must survive.

Fengtongzhai

The Fengtongzhai Reserve (30°30′N; 102°55′E) (Fig. 2) is located in the upper Qingyi Jiang watershed in the Qionglai (=Chunglai) Shan and is administered through Baoxing County. Baoxing is referred to in the accounts by the early western travellers as Muping (= Mouping), a former autonomous principality that became part of former Sikang Province in 1935. David (Fox, 1949) obtained the type specimen of *Ailuropoda* here in 1869. Roosevelt (1930) and Graham (Perry, 1969) found signs of *Ailuropoda* near here during their investigations but failed to obtain specimens. A botanical exploration trip to this area in 1939 was described by Hu (1956). We were able to reach reserve headquarters (30 km north of Baŏxing) in a one-day journey (271 km) by car on good roads through Yaan from Chengdu. David's journey took seven days.

The Reserve includes the western slopes (1400 to 4600 m) of the Dung Ho watershed and extends from Baoxing north for about 50 km. The only road is located in the valley bottom but trails provide access to the major drainages, the Bangai Guo and Dengchi Guo. This 40,000 ha area was established as a reserve in 1979. It is not listed in Wang (1980). The reserve is managed by a staff of 17 who live with their families at a new headquarters. The management objective for the reserve was the conservation of *Ailuropoda*.

Our briefing on this area was limited. There is no logging in the reserve. The area receives 1200 mm of precipitation annually and the average temperature ranges from 5° to 25 °C. The small alluvial fans along the river bottom are almost all under cultivation. The lower canyon below 1400 m, where the slopes permit, shows signs of past farming or is now under cultivation. Between 1400 and 2000 m is a broadleaf forest with bamboo and shrub understorey (Fig. 6). Between 2000 and 3500 m are conifers with a bamboo understorey; between 3600–4000 m is a *Rhododendron* belt and above are open slopes. There is an interfingering of these broad vegetation zones according to slope and exposure but unlike Wanglang the forest is extensive and without grassland. Parent material is limestone; at the northern end of the reserve is a major marble quarry that provides stone for export.

We were told that there were seasonal movements of *Ailuropoda* and occasionally they were seen in winter along the river. We observed panda faeces and feeding signs in a number of locations in a stand of *Phyllostachys* bamboo, just above the road on the eastern exposure in an area surrounded by cultivation. In an interview with a local youth, the boy told of seeing six to eight giant pandas near the river in the last 18 months. Reserve officials told us that when food was in short supply in the Reserve *Ailuropoda* move to commune farms at the boundary and beyond to feed.

Giant pandas given as gifts by China to the people of UK, France, USA, Mexico, and Japan were taken from this area.

Fig. 6. Fengtongzhai Reserve (April 1981). A fine mixed mesophytic forest is found in this reserve.

WHAT IS ESSENTIAL GIANT PANDA HABITAT?

From the information now available to us, *Ailuropoda* has a patchy distribution along a narrow crescent extending through the Qinling Shan south of Xi'an in Shaanxi Province, the Min Shan and Qionglai Shan and the Daling Shan south of the Dadu Ho (Bi Feng-zhou, pers. comm.). This is the northern edge of the distribution of bamboo for this region of Asia (T. R. Soderstrom, pers. comm.) and the edge of the Sino-Japanese floristic region (Fig. 1: Sakai & Malla, 1981). Our current knowledge of *Ailuropoda* reproductive behaviour and physiology (summarized in Kleiman, 1983) has not enabled the establishment of a sustainable captive population. For the immediate future, the effectiveness of reserves as conservation units is all-important to *Ailuropoda* survival. The key to evaluating effectiveness of reserves is in understanding what is essential habitat and effective population size (Shaffer, 1981). Our first step in this analysis is to look for broad correlates to current distribution.

Zoogeographic position

Schafer (1938) for birds, Englemann (1938) and Schafer (1938) for mammals, and Wang (1961) for plants have noted how the contrast in relief at the edge of the Tibetan Plateau (Lee, 1939; Harland, 1945) and the consequent diversity and interspersion of habitats complicate the study of the biogeography of the region. Wang (1961) felt the relief resulted in the isolation of populations and accounted for the high proportion of endemic plant forms found there. Groves (1978) has described this process for blue sheep *Pseudois nayaur* and *P. schaeferi*, When one looks at groups such as the ungulates or carnivores, the diversity of species compared, for example, with mountain habitats in North or South America, is astounding. But the large mammal fauna is not unique to the plateau's edge; it is composed of species with wider distributions. *Ailuropoda* is the conspicuous restricted species now, but fossils have been recovered from numerous sites in southern and eastern China (Pei, 1974; Wang, 1974; see map in Zhu & Li, 1980). This blurring has made this region problematic in assigning it to any specific biogeographical province or in establishing boundaries for these (Udvardy, 1975; Zhang, 1979).

To clarify this, we scrutinized the reported distributions of selected groups of mammals and birds (Tables 2 & 3). Based on this and a consideration of topography and macroclimates, we believe that Sichuan can usefully be partitioned into six zoogeographic areas (Fig. 7): northwest montane, western escarpment, Tibetan, central basin, eastern hills and montane, and subtropical. As Schafer (1938) points out, some species usually associated with the western escarpment penetrate the Tibetan region via suitable habitats in the deep valleys; Tibetan forms predominate at the higher elevations in the western escarpment. This is expected and should not confuse the basic distinctions. The mammalian assemblages in the northwest montane and the western escarpment are more closely allied with the basin and subtropical than with the Tibetan. The major topographic features separating the western escarpment from

TABLE 2
Primates, Carnivores and Ungulates of Western and Central Sichuan

	Northwest Mountain	*Western Escarpment*	*Tibetan*	*Central Basin*	*Subtropical*
CARNIVORA					
Canidae					
Wolf *Canis lupus*	?	?	+	?	–
Red fox *Vulpes vulpes*	+	+	–	–	–
Raccoon dog *Nyctereutes procyonoides*	+	+	–	–	–
Red dog *Cuon alpinus*	+	+	+	+	+
Ursidae					
Brown bear *Ursus arctos*	+ ?	+	+	–	–
Asiatic black bear *U. thibetanus*	+	+	+	–	–
Brown bear *Helarctos malayanus*	–	–	–	–	+
Ailuridae					
Red panda *Ailurus fulgens*	+	+	–	+	+
Ailuropodidae					
Giant panda *Ailuropoda melanoleuca*	+	+	–	–	+
Mustelidae					
Beech marten *Martes foina*	–	– ?	+	–	–
Yellow-throated marten *M. flavigula*	+	+	+	+	+
Short-tailed weasel *Mustela nivalus*	+	–	–	–	–
Yellow-bellied weasel *M. kathiah*?					
Siberian weasel *M. sibirica*	+	+	+	–	–
Polecat *M. eversmanni*	+	+	+	–	–
Ferret-badger *Melogale moschata*	–	–	–	–	+
Badger *Meles meles*	+	+	–	+	–
Hog badger *Arctonyx collaris*	–	–	–	–	+
Common otter *Lutra lutra*	?	?	–	+	+

Viverridae					
Masked palm civet *Paguma larvata*	−	+	−	+	+
Large Indian civet *Viverra zibetha*	−	−	−	+	+
Small Indian civet *Viverricula indica*	−	−	−	+ ?	+
Banded linsang *Prionodon pardicolor*	−	−	−	−	+
Herpestidae					
Crab-eating mongoose *Herpestes urva*	−	−	−	−	+
Felidae					
Chinese cat *Felis bieti*	−	−	+	−	−
Jungle cat *F. chaus*	−	−	−	−	+
Pallas's cat *F. manul*	?	+	+	−	−
Temminck's cat *F. temmincki*	?	+	−	−	−
Leopard cat *F. bengalensis*	−	+	−	+	+
Lynx *Lynx lynx*	−	− ?	−	+	+
Clouded leopard *Neofelis nebulosa*	−	+	−	+	+
Leopard *Panthera pardus*	+	+	−	+	+
[a] Tiger *P. tigris*	+	+	−	+	+
Snow leopard *P. onca*	−	−	+	−	−
PERISSODACTYLA					
Equidae					
Kiang *Equus kiang*	−	−	+	−	−
ARTIODACTYLA					
Suidae					
Wild swine *Sus scrofa*	+	+	−	+	+
Cervidae					
Musk deer *Moschus moschiferus*	+	+	+	+	−
Muntjac *Muntiacus muntjak*	−	−	−	−	+ ?
Reeve's muntjac *M. reevesi*	−	−	−	+	+
Tufted deer *Elaphodus cephalophus*	+	+	+	+	−
Sambar *Cervus unicolor*	−	−	+	+	+

(continued)

TABLE 2—*Contd.*

	Northest Mountain	*Western Escarpment*	*Tibetan*	*Central Basin*	*Subtropical*
ARTIODACTYLA					
Cervidae					
Sitka deer *C. nippon*	+	–	–	–	–
White-lipped deer *C. albirostris*	–	–	+	–	–
Red deer *C. elaphus*	–	–	+	–	–
Roe deer *Capreolus capreolus*	+	?	+	–	–
Bovidae					
Argali *Ovis ammon*	–	–	+	–	–
Tibetan gazelle *Procapra picticandata*	–	–	+	–	–
Chiru *Pantholops hodgsoni*	–	–	+	–	–
Yak *Bos grunniens*	–	–	+	–	–
Takin *Bodorcas taxicolor*	+	+	+	–	–
Serow *Capricornis sumatrensis*	+	+	+	?	?
Goral *Nemorhaedus goral*	+	+	?	+	– ?
Blue sheep *Pseudois nayaur* including *P. schaeferi*	+	+	+	–	–
PRIMATES					
Cercopithecidae					
Rhesus macaque *Macaca mulatta*	–	–	–	+	+
Tibetan macaque *M. thibetana*	+	? +	–	+	–
Golden langur *Pygathrix* (= *Rhinopithecus*) *roxellana*	+	+	–	–	–
Min. totals 58	24	26	25	20	23

[a] Extinct in Sichuan.

Based on Allen (1938, 1940); Engelmann (1938); Schafer (1938); Sheldon (1975); Corbet (1978); Zhang *et al.* (1981); Wang Sung (pers. comm.).

Nomenclature follows Honacki *et al.* (1982); Eisenberg (1981) for Ailuridae and Ailuropodidae.

TABLE 3
Notes on the Distribution of Pheasants in Sichuan

Species	*Min Shan* *Tangjiahe/Wanglang*	*Western Escarpment* *Fengtongzhai*	*Habitat*
Chinese monal Lophophorus lhuysi	+	+	Highest elevation, above tree line, alpine meadows, scrub.
Blood pheasant *Ithagiais cruentus*	*I. c. berezowski*	*I. c. annae*	High elevations, subalpine forest and scrub.
Temminck's tragopan *Tragopan temmincki*	+	+	2 500–4 000 m. Cool damp forests, thick undergrowth.
Orange-collared koklass *Pucrasia macrolopha ruficollis*	+	+	2 500–4 000 m. Open forests, meadows.
Sichuan white-eared pheasant *Crossoptilon crossoptilon*	–	+	To 3 500 m. Open habitat.
Golden pheasant *Chrysolophus pictus*	+	+	2 500–4 000 m. Bamboo thickets, deep forest.
Lady Amherst's pheasant *Chrysolophus amherstiae*	+	+ ?	2 500–4 000 m. Bamboo thickets, deep forest.
Pheasant *Phasianus colchicus*	*P. c. strauchi*	*P. c. suehschanensis*	To 3 500 m. Open/brush slopes.

From Wilson (1913); Schafer (1938); Delacour (1977); Sheldon (1975).
Nomenclature follows Delacour (1977).

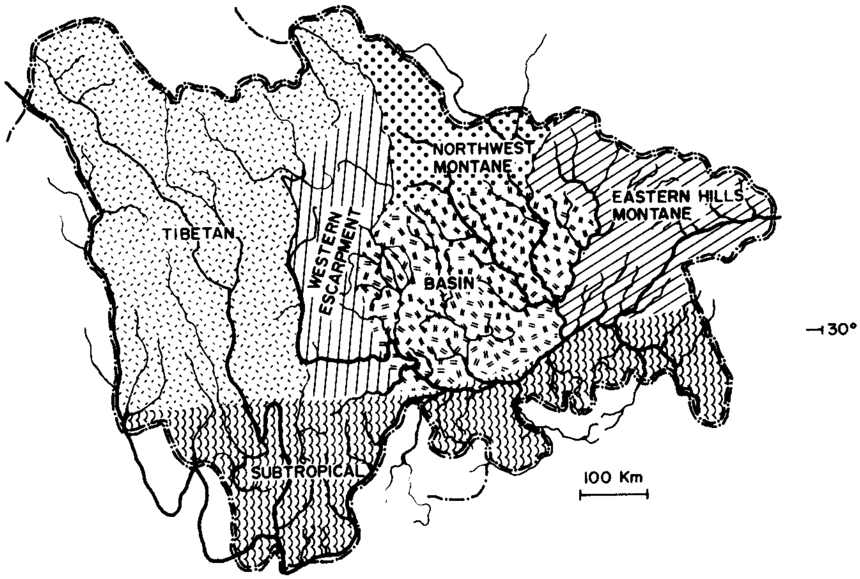

Fig. 7. Zoogeographic subdivisions of Sichuan.

the northwest montane is the tremendous valley of the Min. The Dadu-Dajin Valley separates the western escarpment from Tibetan.

In Sichuan, *Ailuropoda* is restricted to the western escarpment and northwest montane regions. We suspect that its distribution in the Daling Shan (subtropical) and the Qinling Shan has strong climatic and topographic affinities to this primary distributional area.

Macroclimate, topography, and vegetation types

The narrow crescent where *Ailuropoda* is found is at once uniquely exposed and protected at the juncture of China's two major climatic systems. There are no major mountain ranges in southeast China to deflect monsoon rains. There are major mountain barriers to the north and west that deflect the Asian continental weather system. The moisture-laden clouds are driven by the monsoon into the 'cul-de-sac' formed by the western escarpment and the Min Shan. The clouds rising against these steep slopes drop their moisture, resulting in a total annual precipitation budget well above that of surrounding regions. The same juxtaposition of mountains and weather systems appears to produce a certain stabilizing influence on what in some adjacent areas is a rather wide year-to-year shift in the convergent zone which results in considerable variation in annual precipitation (Watts, 1969).

The resulting climate in the mountains is cool, more so than would be expected at this latitude, but not in the extreme. Rainfall is heaviest in the summer; the area never seems without mist or drizzle, or snow in winter. Humidity is moderate to high throughout the year (Watts, 1969). Sakai & Malla (1981) have emphasized that the essence of the macroclimate in these mountains is maritime even though they are situated so far inland. Consequently, the plants that occur there do not have a low level of cold hardiness in contrast to congeners found in areas with continental climates to the north and west (Sakai & Malla, 1981).

We examined the new vegetation map of China produced by the Institute of Botany (1979) to see if there were any broad correlations of vegetation type(s) and *Ailuropoda* distribution. Within the range of *Ailuropoda* shown in Fig. 1, there are 18 vegetation types. Of these 18, only eight are found in the areas where the reserves we visited are located. Only two of these are shared between reserves (Table 4). Earlier classifications such as that by Hou *et al.* (1956) were too broad to be useful. We interpret a lack of any strong correlation to mean that the components in a vegetation association required by *Ailuropoda* are not sufficiently dominant and/or extensive to be recognized as distinct type(s) at the Institute's scale (1:4,000,000) of analysis.

Giant panda habitat and bamboo ecology

The altitudinal variations in soils and forest types have been graphically depicted for parts of the *Ailuropoda* range by Schafer (1938) and Wang (1961) and the influence of the distribution of these on *Ailuropoda* is described in general terms by Giant Panda Expedition (1974), Sheldon (1975), Zhu & Li (1980) and Schaller (1981). As is true in mountain environments generally, forest vegetation is a mosaic determined by macroclimate, microclimate, soil fertility, and drainage. Wang (1961) has provided a description of vegetation types in this area which are identified as basic, stable vegetation subdivisions, but the position of bamboo in these is not at all clear. (For a definition and the concept in the use of 'vegetation type', see Daubenmire & Daubenmire, 1968.)

Given the importance of bamboo in man's economy in so many areas, surprisingly little is known about its ecology (Janzen, 1976; Soderstrom & Calderon, 1979; Numata, 1979*a*, *b*). In a study of forest succession and

TABLE 4

Vegetation in the Tangjiahe, Wanglang and Fengtongzhai as Inferred from the *Vegetation Map of China*

Vegetation type	*Tangjiahe*	*Wanglang*	*Fengtongzhai*
Needleleaf forest			
Needleleaf forest on mountains in tropical or subtropical zone			
Abies-Picea forest with *Tsuga*			
15a: *P. asperata*, *P. purpurea*, *A. faxoniana*	+		
Broadleaf and woodland			
Broadleaf deciduous forest in temperate and subtropical zone			
Deciduous *Quercus* forest			
17c: *Q. variabilis*, *Q. acutedentata*, *Q. glandulifera*	+		
Mixed broadleaf deciduous and evergreen forest on acid yellow-brown soil in subtropical zone			
24: *Cyclobalanopsis*, *Castanopsis*, *Fagus*		+	+
25a: *Cyclobalanopsis glauca*, *Fagus longipetiolata*, *Tsuga*		+	+
25b: *Quercus aquifolioides*, *Acer* spp., *Betula* spp., *Tsuga*	+		
Broadleaf evergreen forest in subtropical zone			
26: *Cyclobalanopsis*, *Castanopsis*, *Lithocarpus*			+
Scrub and coppicewood			
Mixed evergreen and deciduous scrub on acid soil in subtropical or tropical zone			
40a: *Rhododendron simsii*, *Vaccinium bracteatum*, *Loropetalum chinense*, *Eurya nitida*, *Quercus fabri*	+		
Broadleaf evergreen semi-sclerophyllous thicket on mountain in temperate or subtropical zone			
46b: *Rhododendron* spp., *Sinarundinaria* spp.,		+	

Source: Institute of Botany, *Academia Sinica* (1979).

Phyllostachys bamboo in Japan, Numata (1979*a*,*b*) reported that flowering by the bamboo increases the predominance of hardwoods and pines in forest stands. Wang (1961) lists *Arundinaria* bamboo as an important fire succession species together with *Populus*, *Betula*, and *Salix*. It is apparent from our observations in Wanglang that there may be long delays (3–4 years) after bamboo flowering before new clones establish. In the interim seedlings of trees such as *Abies*, *Picea*, and *Tsuga* establish (see above). In some vegetation types bamboos may be suppressing seedling growth between flowering periods and thus stabilizing the structure of these associations. In Tangjiahe, *Sinarundinaria* was growing on rather open slopes where disturbance was apparently a factor. Earthquake-caused landslides are a major disturbance in these mountains and rates may be sufficiently high so that substantial areas of disturbed, non-climax vegetation may accumulate (see Garwood *et al.*, 1979). Janzen (1976) has pointed out that it is characteristic of mass-seeding bamboos to be extremely plastic and vigorous in vegetative growth and to have very broad geographic distributions (see Table 1).

What stands out to us in Table 1 is that the different bamboo genera known to be in these reserves have different growth periods and characteristics. While the giant panda has morphological adaption to fractionate bamboo culms rapidly and extract the highest tissues (Dierenfeld *et al.*, 1982), there is no *a prioria* reason that a single species or genus of bamboo is equally suitable as food throughout the year. Feeding selectively during periods of optimum nutritional suitability on bamboos with different, staggered growth periods and characteristics through the year could substantially improve the quality of *Ailuropoda's* diet. We speculate that it takes the proper 'mix' of bamboos in an area to provide the nutritional and energetic threshold necessary for *Ailuropoda* survival.

We were able to document the occurrence of more than one bamboo genus in some but not all of the reserves we visited (Table 1). Understanding the role of a bamboo mix as opposed to homogeneous stands and how different regimes or scales of intensity of stress and disturbance determine the structure and mix of vegetation types (Grime, 1979) is a central problem in *Ailuropoda* conservation. We think it would also be useful to examine the difference in nutritional quality between bamboo clones of the same species. In the Rocky Mountains (USA), elk *Cervus elaphus* selectively feed on different clones of *Populus tremuloides* growing next to each other and this has a basis in the chemistry of individual clones (McNamara, 1979). Growth forms of bamboo (McClure, 1966) make this a particularly difficult problem for ecologists and nutritionists to unravel, but *Ailuropoda* obviously has done so.

Ailuropoda as a bamboo specialist

We have focused our discussion thus far on bamboo because *Ailuropoda* is unique among the mammals in its ability to feed almost exclusively on bamboo culms. Drawing on the detailed anatonomical studies of *Ailuropoda* and *Ursus* by Davis (1964) and because the transferring immunological distance between *Ailuropoda* and the ursids is very small—comparable with that between dog and fox—Stanley (1979) concluded that '. . . a bear was transformed into a panda by very few genetic alterations, but the result is an enormous amount of adaptive change, not a little (p. 56).' With these genetic similarities Stanley felt that the basic shift could easily have been achieved by a quantum speciation event. 'I find it difficult to imagine that the drastic structural and ecological changes could have come about by slow, sequential fixation of the few genetic changes or that an entire species occupying a large geographic area could have made such a remarkable phenotypic transition. Far more likely would have been origin by way of a very small population occupying a local bamboo forest (p. 158).' Kleiman (1983), in reviewing *Ailuropoda* reproductive characteristics, which include the occurrence of a weak oestrus in the autumn in some females, variability in the duration of the gestation period, and survivorship of only one young despite litter sizes of one to three, suggested they have only recently undergone K-selection with dietary and habitat specialization.

With the climatic variations during the Pleistocene, habitats and faunal assemblages in the area that is now southeastern China were in flux. From the fossil record (Pei, 1974; Wang, 1974), we know there were times when *Ailuropoda* was rather widely distributed and that this happened more than once. Depending upon which competitors co-occurred with the forms of *Ailuropoda*, some populations may have been more relaxed in their dietary specialization and occurred over large areas where bamboo was not an extensive vegetation type. Or, competition from other large mammals may have restricted *Ailuropoda* to bamboo types but because of favourable conditions, bamboo was more widely distributed. The role of man in the distribution of *Ailuropoda* today is clear but the relationship may not always have been restrictive and negative. With fire, shifting agriculture, and bamboo plantings, early man may have enhanced *Ailuropoda* habitat and facilitated *Ailuropoda* distribution. However, expanding human populations have increasingly claimed more and more habitat until we see the pattern of distribution we have today.

There is no doubt that *Ailuropoda* can subsist on foods other than bamboo when available (Dierenfeld *et al.*, 1982) but within the mammalian assemblages where it is found today it is essentially 'locked-in' to bamboo. Other potential feeding niches are occupied by specialists. Obligate carnivores include *Panthera pardus*, *Cuon alpinus* and other canids, felids, and mustelids (Table 2). *Ursus arctos* and/or *U. thebetina*, and *Sus scrofa* are efficient, mobile omnivores which are specialists in finding dispersed patches of rich food. These competitors, and in some cases potential predators, very likely restrict *Ailuropoda* to thick bamboo cover, as all those who have tried to observe them have learned (Giant Panda Expedition, 1974; Sheldon, 1975; Zhu & Li, 1980; Schaller, 1981). Certainly if *Ailuropoda* comes across an alternative suitable food item it will eat it. But it is bamboo that is its predictable resource and that is where its foraging strategy must be targeted.

If the recent events in Wanglang are typical there is a tight flowering synchrony within both species and genera of bamboo in an area. This and other natural causes resulted in extensive *Ailuropoda* mortality (see above). Sixty kilometres southeast on the same ridge system the same bamboos were just beginning to flower five years later. The lifecycle of bamboo requires that a bamboo feeding specialist have good dispersal ability. Recolonizing areas where bamboo culms have regrown is dependent upon animals from areas where flowering is just taking place. Soderstrom (1979) has shown that flowering in these mass-seeding bamboos is restricted to a few years for the whole species worldwide. One can envisage, every century or so, an extensive shuffle of individual *Ailuropoda* within mountain ranges during the decade or so when bamboo flowering occurs.

We do not know how fragmented *Ailuropoda* habitat within the mountain ranges is today. This is a key element in understanding whether the established reserves will be effective conservation units for long-term *Ailuropoda* survival. Whether there is regular long-range dispersal independent of the bamboo cycle or a process of genetic mixing every century which is dependent on the bamboo cycle, *Ailuropoda* may be very sensitive to inbreeding depression and the profound, deleterious effects that Ralls *et al.* (1979) have found in so many small inbred populations.

Developing an effective conservation plan for a feeding specialist unique among the living mammals is an exciting and challenging task. The points we have discussed can be stated as working hypotheses, tested, accepted, modified, or rejected in light of additional information. It is from this process that a clear understanding can be obtained of the management actions that must be undertaken for *Ailuropoda* to survive.

SOME OBSERVATIONS ON BIOLOGICAL CONSERVATION IN CHINA

The impressive programme for the conservation of *Ailuropoda* that China has initiated can be explored to help us understand how biological conservation is viewed in China today and thus provide an improved basis for dialogue and cooperation. Biological conservation is not a subject that is usually treated in the information books available to Westerners, such as Xue (1981) or Qi (1979), or in the reviews by 'China watchers' (Hinton, 1979). The most complete statement of policy concerning the 'conservation of wildlife resources' available in the West was provided in 1979 by the Chinese delegation to the International Tiger Symposium held in New Delhi, India. Legal authority via the State Council is contained in the 'Instructions of Active Conservation and Rational Utilization of Wildlife Resources' (1962), 'Act of Forestry Conservation' (1963) and 'Act of Fishery Conservation' (1964), all of which are administered under the Ministry of Agriculture and Forestry. It was the 1962 Act that stipulated specifically '...that the giant panda is a rare and precious animal protected by the government and that nature reserves be established for its protection' (Zhu & Li, 1980). *Ailuropoda* is one of 19 species designated as category one. A second category includes 37 'valuable' species. Management activity is to be focused on these animals.

In the course of our discussions and travel, Chinese authorities outlined the components of the programme they have initiated to manage *Ailuropoda*: human-related mortality is reported to have been stopped and even the taking of relatively few animals for zoological parks has been terminated. Ten refuges with the principal objective of managing *Ailuropoda* have been designated and additional sites have been proposed. Habitat alterations and other potentially disturbing activities in these designated areas have been halted. Studies have been initiated to develop both a biomedical and ecological understanding of this specialized species. Public conservation education and professional training programmes have been initiated.

How do these actions compare with what would be considered a standard wildlife management action paradigm in the West? Summarizing the history of wildlife management, Leopold (1933) suggested the following sequence in nearly all such efforts: (1) restriction of hunting, (2) predator control, (3) reservation of lands as parks, forests, refuges etc., (4) artificial replenishment, and (5) environmental control of food cover, special factors, disease, etc. In the effort to conserve *Ailuropoda*, authorities in China have initially undertaken Nos. 1 and 3 and the breeding centre established at Wolong would appear to be the foundations for No. 4. As far as we were informed, no action has been taken regarding Nos. 2 and 5. (This is not criticism and we are not suggesting there should be action.) Public conservation education and professional training in wildlife management as well as the ability to organize and administer such programmes effectively have a relatively recent history in America (Lund, 1980; Tober, 1981). China is well on its way, and has included in the foundations of the management effort a broad-based research effort, an approach which places this conservation programme as one of the most comprehensive undertaken for any large mammal in Asia.

What is the economic basis for this effort? The reserves we visited in the Min Shan, Wanglang and Tangjiahe, are in the extreme upper watershed areas, and the Fengtongzhai, in the Qionglai Shan, protects a portion of an upper watershed. In the western press (Sterba, 1981) and in reports from China summarized in the World Bank's environmental report (World Bank, 1982) we are informed of the need to protect watersheds, particularly in Sichuan. In all our discussions we were never presented with watershed protection as a justification for the discontinuation of logging in the reserves we visited. Rather, our hosts continually emphasized that these management actions were undertaken to protect *Ailuropoda* as a 'rare and precious species'. This would seem an example of the protection of a non-resource and the Noah principle in action (Ehrenfeld, 1976).

This is quite different from the origins of conservation, at least as it was conceived and evolved in the 'progressive conservation movement' in North America (Hays, 1975). The main thrust early in the movement was soil conservation, watershed protection, and sustainable renewable resource management. Natural area preservation and endangered species have been an important part, the nonconsumptive part, but not the cornerstone of this conservation tradition. It is too early to tell how China will integrate the conservation programme they have initiated for *Ailuropoda* into a broad natural resource management framework. At the international level the World Wildlife Fund and the International Union for the Conservation of Nature and Natural Resources (IUCN) as well as the Man and Biosphere programme (di Castri & Robertson, 1982), while always emphasizing wise use of natural resources, focused early action plans on the protection of non- or limited-use areas and endangered species. It has only been recently with the 'World Conservation Strategy' that emphasis has been shifting to the more central position in the tradition.

Placement or 'design' (see Diamond, 1975) of nature reserves has recently received considerable emphasis in the conservation literature. A primary framework for placement of reserves in North America has been by physiographic or biotic provinces (Dasmann, 1972). Udvardy (1975) and the IUCN have encouraged this approach on an international scale. The publication by Wang (1980) which lists placement of reserves by vegetation province, and the use by Zhang *et al.* (1981) of the zoogeographical regions and subregions developed by Zhang (1979) in the review of the conservation status of primates, seem to be strong steps by China in this direction. But as we have reported above, the mountains around the Sichuan Basin blur the limits of these provinces and subdivisions and the reserves we visited were established in accord with *Ailuropoda* distribution (Bi Feng-zhou, pers. comm.; Sichuan Bureau of Forestry, 1977; Fig. 1). In discussions it was clear that other refuge sites had been similarly selected for other rare, large mammals.

The considerable cost of terminating logging in Tangjiahe was mentioned, but the short-term or long-term economic framework that Western park planners must always consider (Western & Henry, 1979) in shaping land-use decisions was not. Nor did we hear in discussion additional considerations for reserve site selection and management such as those proposed by UNESCO (1974) or IUCN (1980): representativeness, diversity, naturalness, potential effectiveness as a conservation unit or the host of other factors frequently employed in the West (Margules & Usher, 1981).

White (1967) and Galbraith (1979) have proposed hypotheses concerning the suppositions at the root of ecological and/or economic problems. For Galbraith, you accommodate a leopard killing your goats only if you cannot stop it. White's central point is the man-nature relationship: the occidental view imposes man's limitless rule of creation while the 'eastern view' emphasizes the equality of all creation, including man. One interpretation of the emphasis placed on the non-resource aspect of *Ailuropoda* conservation could be taken as support for White's view. From our long discussions a statement of the Chinese position might read: 'We have decided to increase the number of giant pandas and will do so.' This seems more in the mould of Galbraith's tenet where action can only occur within the constraints of a technological and organizational framework. Or stated another way: develop the organizational and technical capacity to accomplish a programme or accommodate the economic or ecologic consequences of failing to do so. This seems to us to account for the inclusion of a strong ecological and biomedical component in this giant panda conservation programme which is unique by most wildlife conservation standards.

All this is encouraging because the conservation of the biota in the mountains that rim the Sichuan Basin depends on an understanding of how these ecosystems work. The 100-year pulse of the flowering of bamboo in this system is a major ecological process which is unfamiliar to ecologists and managers in wildlife conservation of the West. To understand the consequences of this pulse will require creative thought and research to produce an effective conservation plan.

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