“The Qinling natural habitat of the Panda” (English Summary)

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This English language summary in this document is extracted from the book:

Pan Wenshi (Ed.) (1988). *The Qinling natural habitat of the Panda*, Beijing University, Shaanxi Province Evergreen Forestry Bureau, Union of Panda Researchers, Beijing University Press, 1988.

Pan Wenshi (潘文石, born 1937) is well-known internationally for his work on the ecology of the Giant Panda. Much of the early work was carried out in a high mountainous area on the southern slopes of the Qinling Range, through which the ancient Tangluo Qin Shu Road passed. The following English Summary from his early book provides useful information on the Qinling Pandas as well as information of the geomorphology and natural environment of the Tangluo Road. The general area involved is well illustrated in the map from the book following this introduction.

At the bottom of the map about 1/3 of the way from the left is a town called Maoping (茅坪) which is a large township and the Headquarters of the Changqing (Evergreen) Wildlife Reserve (长青自然保护区). A road shown through Maoping continues to the old township of Huayang (华阳). The road on this map comes from Yangxian, a County seat to the east of Hanzhong and the Han River. A bit more than half way from the left of the map to the right at the bottom is another road going all the way north through the area shown. The first town is (modern) Foping (佛坪) which is the county seat of Foping County. It is the Headquarters of the well-known Foping Wildlife Reserve (佛坪自然保护区) and is now the location of a Panda Breeding Centre. The road it is on continues north over the mountains to Zhouzhi on the Wei River to the west of Xi’an. The horizontal watershed boundary at the north west corner of the map is the main Qinling (秦岭) boundary that includes Taibai Mountain (太白山) and is the water divide between the Yellow River and the Yangtze River. The boundaries and terrain of the Panda reserves will be made available as a Google Earth presentation in the future.

In 2005, the Qinling Panda was recognised as a subspecies of *Ailuropoda melanoleuca* (Wan, 2005) called *Ailuropoda melanoleuca qinlingensis*. The recent paper referenced here estimates there were still about 200-300 Qinling pandas in the wild in 2005. The full reference to the paper is:

Wan Qiuhong, Wu Hua & Fang Shengguo (2005). A new subspecies of giant panda (*Ailuropoda melanoleuca*) from Shaanxi, China. *Journal of Mammalogy* **86** (2): 397–402.

For some other recent work and additional information, the following two papers are useful and accessible through the web.

The first is a paper published in "China Online Papers" (中国科技论文在线, http://www.paper.edu.cn). This paper is about the Qinling area conservation and has been published cooperatively by the WWF and the “Giant Panda Conservation and Research Centre” at Beijing University. Two additional areas noted in addition to the original Foping and Changqing Reserves are the Laoxiancheng (老县城) Reserve (covering the area where the original Qing Period “Ting” called Foping (佛坪厅) was located) and another called the Zhouzhi Reserve in the upper catchments of the Black River. The full paper reference is:

Louks, C.J., Lu, Z., Dinerstein, E., Wang, D., Fu, D. and Wang H. (2003). The Giant Pandas of the Qinling Mountains, China: a Case Study in Designing Conservation Landscapes for Elevational Migrants. *Conservation Biology*, **17**(2), 558-565.

Louks *et al*. (2003) provide an estimate for the Panda population as being approximately 220 pandas. It outlines proposals to improve them by extending boundaries and filling in linkage areas. The areas mapped below in the original work by Pan Wenshi and others can still be seen as the base conservation area in this paper.

A Thesis describing the use of remote sensing to map areas of the Laoxiancheng reserve in the Qinling area is also available. It describes remote sensing and GIS methods as well as very useful background information about the Laoxiancheng Reserve.

Wang, Tiejun (2003). *Habitat analysis for the Giant Panda in Laoxiancheng nature reserve in the Qinling Mountains China*. Thesis submitted for the degree of Master of Science in Geo-information Science and Earth Observation (Rural Land Ecology), ITC, Enschede, The Netherlands.

You can access a PDF copy of this Thesis HERE.

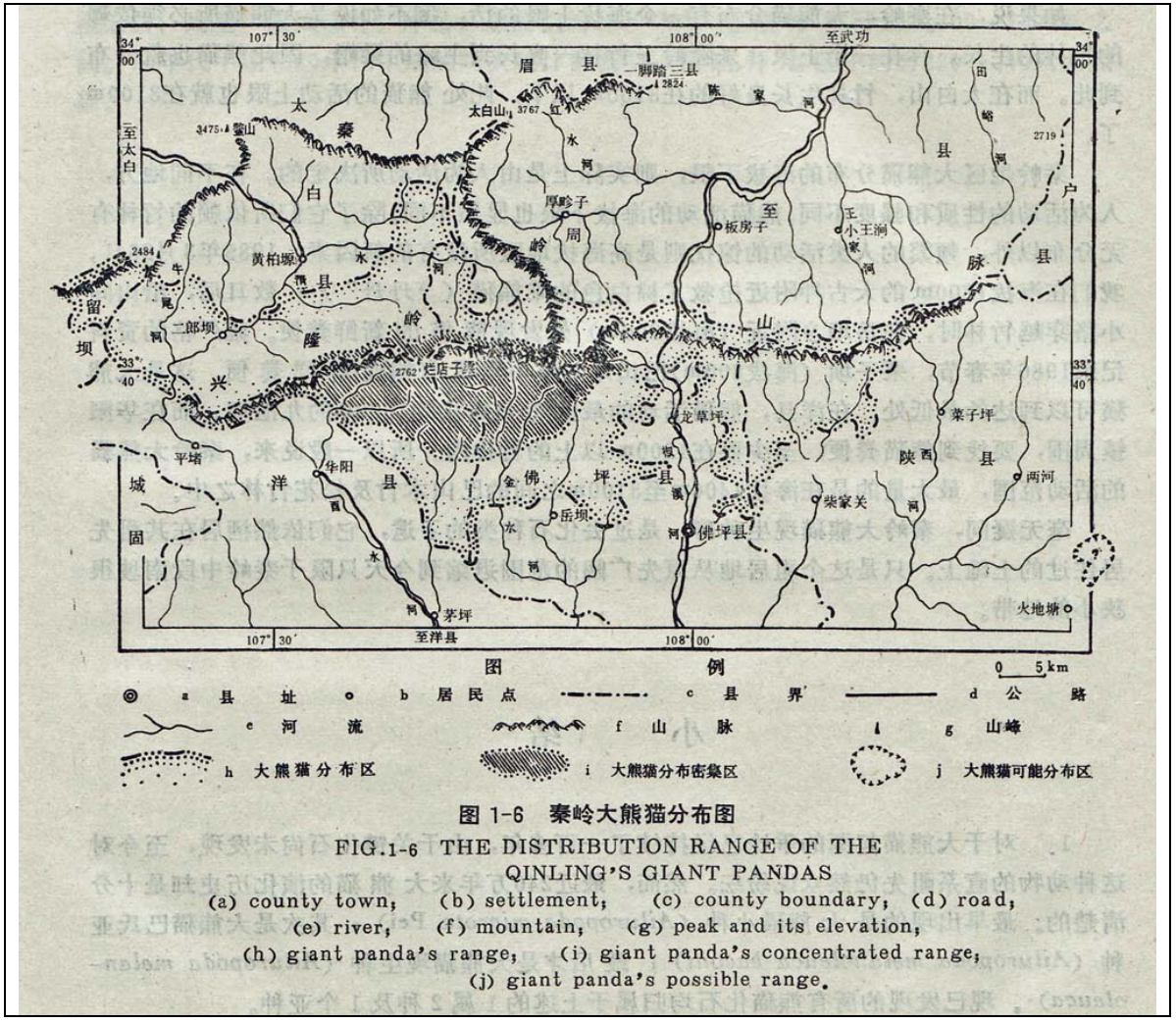

图 1-6 秦岭大熊猫分布图

FIG.1-6 THE DISTRIBUTION RANGE OF THE QINLING'S GIANT PANDAS

(a) county town; (b) settlement; (c) county boundary; (d) road; (e) river; (f) mountain; (g) peak and its elevation; (h) giant panda's range; (i) giant panda's concentrated range; (j) giant panda's possible range.

CHAPTER 1

GIANT PANDAS IN THE QINLING MOUNTAINS

1. The origin of the giant panda has been a controversy for over 100 years. To date, panda's direct ancestor has not been identified because some key fossils have not been found. However, the last 240 million years of the panda's evolutionary history is clear. The first species of pandas appeared was *Ailuropoda microta* Pei, a small body panda; then come: *Ailuropoda melanoleuca baconi*, a large body panda; followed lastly by *Ailuropoda melanoleuca*, today's panda.

2. In the fossil record, *Ailuropoda microta* Pei appeared in the early Pleistocene Period. The companion fossil animal group has significant traits of the Oriental realm. This shows that *Ailuropoda microta* Pei lived in the rainy lower mountain forests of a tropical-subtropical zone. *Ailuropoda melanoleuca baconi* appeared in the middle Pleistocene Period, it ranged from the tropical-subtropical forest of southeast China to the warm temperate forest around present day Peking, which suggests that it lived on lower mountains and hilly land. The fossils from the Holocene Period show that the panda's bodily form was then as large as today's panda. For this reason, it is judged that the panda we have seen for last 10 thousand years is *Ailuropoda melanoleuca*. During that time its environment has changed from subtropical mountain forest to warm temperate mountain forest.

3. Pandas have had a long history in the Qinling Mountains. Both *A. microta Pei* and *A.m. baconi* appeared there during the early middle Pleistocene Period, about 700,000 years ago. From fossil and historical records it has been shown that pandas lived on both slopes of the Qinling Mountains up to a few thousand years ago. At that time, the pandas quickly vanished from most of their ranges because their habitat had been damaged by people. Though local people and local chronicles indicate that there have been giant pandas, or "Hua Bear" ("Flower Bear", 花熊) as they are locally known, on the south slope of the Qinling Mountains [for a long time], the first specimen was not collected until 1964.

4. Today, pandas living in the Qinling Mountains are located on the south slope, including six counties and covering about 1650 km^2. Within this area the pandas live at elevations ranging from 800m to 3100m. There are [were] about 220-240 pandas living there according to calculations done both in the 1970s and the 1980s.

CHAPTER2

GEOMORPHOLOGIC FEATURES AND ITS HISTORY OF THE QINLING MOUNTAINS

1. The Qinling Mountains, an important borderline area of the physical geography, are situated in the middle of China. They extend for some 400-500 km. in an E-W direction and are about 140-200 km. wide. The peaks range in elevation from 2000m to 3000m with the highest peak reaching 3767m (Taibai Mountain).

2. The Qinling Mountains are asymmetric fault-block mountains. The north slope is a steep fault scarp, while the south slope is a gentle incline. On the mountains there are three planation surfaces. The highest one (Taibai epoch) reaches to about 3300-3500m, the middle one (Qinling epoch) to 2500-3000m and the lowest one (Hanjiang epoch) to 1500-l800m. The Qinling Mountains are a product of tectonic movement. Though their history began in the Tertiary Period, the present form was largely determined by Neotectonic movement beginning in the Pleistocene Period, when the Qinling Mountains were quickly uplifted under the influence of the Himalayan movement. Because of later erosion, the range-valley relief developed gradually. Glaciation played an important part in the areas evolution during the late Pleistocene Period. Glacial landform deposits and erosional effects have been clearly identified on the mountain peaks. Based on this, it is estimated that the snow-line during the late Pleistocene Period was situated at a height of 3350m above sea level and the lower boundary of the exposed ancient preglacial-material is situated at an elevation of 2500m. Thus recent preglacial material is found at elevations between 2500 and 3400m.

3. Because of endogenic and exogenic processes, there are six geomorphic types; (l) Ancient glacial highly undulating alpine; (2) Ancient preglacial highly undulating medium mountains; (3) Erosional-denudational moderately undulating medium mountains; (4) Erosional-denudational low mountains; (5) erosional-accumulational hills and (6) Alluvial plains.

4. Currently giant pandas generally live in the moderately undulating medium mountains and ancient preglacial highly undulating medium mountains. These geomorphic types provide a good environment for pandas because: (1) The highest peak of the Qinling Mountains (Taibai Mountain), located to the north of the panda's habitat, is a natural screen against the northern cold and dry air currents, so the local climate is warm and wet; (2) The mountains have a remarkable vertical zonation which favours giant pandas because it allows the pandas to choose the most suitable environment for each season of the year; (3) The range-valley relief keeps the effect of people's activity to a minimum, preserving the natural landscape; (4) The many small flat areas found in the highly undulating Qinling Mountains, for example, the planation surfaces, terraces, fans and abandoned river channels, provide pandas with good living environments; (5) Although the Qinling Mountains were subjected to glaciation during the Pleistocene Period, it was limited to peaks over 3350m. Since the medium mountain area was not affected, it is now an area that is suitable for giant pandas.

CHAPTER 3

CLIMATIC CONDITIONS ON THE QINLING MOUNTAINS

1. During the Quaternary Period, the average world temperature varied with long periods of cold followed by long warm periods. Throughout this period however, the global climate was gradually cooling. This affected the lives of two species of giant panda - *Ailuropoda microta* Pei and *Ailuropoda melanoleuca baconi*, *Ailuropoda microta* Pei eventually became extinct as they could not adapt to the drastic climatological changes. *Ailuropoda melanoleuca baconi* migrated with the changes from low to high latitudes during the warm periods and from high to low latitudes during the cold periods. In the process of their north-south migrations, they became accustomed to subtropical ever-green forest and warmer temperate summer-green forest environments.

2. During the last 5000 years the climate in the Qinling area has alternated between cold and warm many times. From the 3000 B.C. to 1400 A.D. there were 4 warm and 4 cold periods. The temperature changed following a wave-curve profile. However, the trend was toward a warm period that was shorter and shorter and a cold period that was longer and longer. The last has a cold period lasted from the 13th century to the 20th century. The Qinling Mountains were originally in a subtropical zone and are now in a warmer temperate zone. The north slopes original subtropical vegetation with its associated animal populations including giant pandas gradually died out because of the changes in the climate. This shows that climate is one of important factors influencing the giant panda's range.

3. If the elements of climate, i.e. temperature and humidity, of the south and north slopes of the Qinling Mountains are compared, significant differences are observed. On the south slope, the average yearly temperature is 2°C higher than that on the north slope, the winter average temperature is 4-5°C higher, the non-fog period is 40-50 days longer, the relative humidity is 10% higher and the average rainfall is 200-400 mm greater. Because of these differences, the north slope has a warm and semi humid climate while the south slope has a warmer and more humid climate particularly, a northern subtropical climate.

4. Based on meteorological data, the south slope of the Qinling Mountains can be divided vertically into three climatic zones: an alpine cooler temperate zone (above 2400m); a mountainous warmer temperate zone (between 800m-2400m) and a northern subtropical zone (below 800m). The south slopes of the Qinling Mountains are located within the east Asia monsoon area which has the following characteristics: breezy and warm in winter, humid and rainy in summer.

5. The giant pandas presently living in the Qinling Mountains move vertically with the season. They live in the mountainous warmer temperate zone between 1400m and 2400m during autumn, winter and spring. In the summer they move to the alpine cooler temperate zone between 2400m and 3000m where the average temperature is about 15º C. This is in contrast with the giant pandas of the Qionglai Mountains [邛崃山 in Sichuan] which live in the mountainous cooler temperate zone between 2l00m and 3000m during all four seasons.

CHAPTER 4

THE VEGETATION

1. There are about 2500-3000 species of plant living on the south slope of the middle part of the Qinling Mountains, it is a region where plants from southern and northern China coexist. The vegetation is rich in plant species, includes diverse types of vegetation with some primary forest in certain areas. It also has a spectrum of vertical zones that more complete than the adjacent areas. All of these conditions are required for the panda's habitat required to exist.

2. The primary vegetation on the Qinling Mountains as noted varies with elevations and can be divided into the following zones: a northern-subtropical evergreen deciduous broadleaf forest zone; a temperate deciduous broadleaf forest zone; a mid-mountain theropencedrymion zone; a subalpine needle leaf forest zone and an alpine scrub-meadow zone. But the present vegetation, which has been damaged by people, differs greatly from the primary vegetation.

3. The present vegetation includes many types of tree including larch, fir, birch as well as some pines and oaks. The presence of these favours the presence of the giant pandas.

4. The human population has often moved onto the southern slope of the Qinling Mountains. The high tide occurred during the middle and late Qing Dynasty. The increase in the human population greatly decreased the forest cover, and changed the nature of the vegetation. The changes are less at higher elevations and therefore at these higher altitudes the pandas can still live.

5. There are 5 genera and 9 species of bamboo on the south slope of the Qinling Mountains. *Bashania fargesii* and *Fargesia spathacea* are the most important for the giant pandas living there, *Bashania*, which is distributed primarily between 1400m and 1800m of elevation, is the panda's major food source in the winter and spring, *Fargesia* is found between 1700m and 3000m of elevation and is the panda's summer food source. Both these species of bamboo are in good supply, and cover about 40 percent of the total area.

CHAPTER 5

TERRESTRIAL ANIMAL FAUNA

1. Various terrestrial Vertebrate live on the Qinling Mountains. To date 87 species and 7 subspecies of mammals have been identified. They represent slightly more than 20 % of the Chinese total and belong to 7 orders, 25 families and 67 genera. There are 338 species and 14 subspecies of birds, representing 30 % of the Chinese total. They belong to 17 orders, 52 families and 162 genera. There are 16 species and one subspecies of amphibian, representing 8% of the Chinese total. They belong to 2 orders, 7 families and 10 genera. Twenty-six of these animals are protected by law.

2. The Qinling Mountains are a line between the Oriental realm and Palaearctic[1] realm. Animals of both realms are found there. 30.2 % of the Oriental mammals' range extends from the mountains' south slope to the North Slope. 71.0 % of the Palaearctic mammals' range extends from the North Slope to the south slope. As with the mammals, 74.1 % of the Oriental birds' breeding region reaches the south slope and 81.1 % of the Palaearctic birds' breeding regions reach the south slope.

3. The mountains are a partial screen for animal movement. They confine the breeding regions of 69.8% of the Oriental mammals and 26% of the Oriental birds to the south slope. This shows that the mountains are more of a screen to mammals than birds.

4. The composition of the Qinling mammal fauna is quite complicated. It consists of Palaearctic European-Siberian fauna, China-North Eastern fauna, Middle Asian fauna, Qinghai-Tibetan fauna and the Oriental China-Burma fauna. There are many insectivorous animals which indicate that the Qinling mammal fauna is primary. 34 species of stegoden-giant panda fauna from the Pleistocene Period are still found in the Qinling Mountains. Thus it was seen that the present Qinling fauna are a continuation of the local ancient fauna,

5. Different subspecies of 6 species of mammals, 14 species of birds and 3 species of moth exist simultaneously in the Qinling Mountains. This shows the complexity but relative stability of the environment.

6. The vertical distribution of mammals and birds on the northern slope is clearer than on the south slope. On the northern slope, the higher the mountain is, the fewer Oriental birds there are and the more Palaearctic birds there are. Most Oriental mammals are found at elevations between 1350m and 3400m. On the south slope, Oriental mammals live in the mid-mountain northern subtropical and temperate zones. Palaearctic animals live in the sub-alpine needle-leaf forest zone and the alpine scrub-meadow zone.

7. In the last 15 years, the amount of tufted deer and common muntjac fur purchased from a village on the mountains' south slope has not decreased. The amount of fur of other animals that has been purchased from this region has been stable for the last 20 years. This shows that the quantity of animals has been relatively stable in recent decades.

[1] Palaearctic – being from Europe, North Africa or Asia north of the Himalayas.

CHAPTER 6

HUMAN DEVELOPMENT IN THE XINGLONGLING AREA

1. The development of the Xinglongling Mountain District, located at the centre of the Qinling panda's range, can trace a history of over 1000 years. Its central town (Huayang) was an important ancient strategic point and has been of political importance. During the Tang Dynasty (730 A.D.), it was established as a county and then later redefined as a town when it declined. It has been a district since 1950. The half-closed natural geographic environment and severe natural conditions in the area have restricted the area invaded by human beings. The primitive developmental forest provides a natural shelter for giant pandas and other wild animals.

2. Population change is a basic indicator of social and economic activity. Historically, the population has increased slowly with fluctuations up and down. The major factors influencing the local population are:

1. Social political changes;
2. Improvement or deterioration of access to the region;
3. Natural disasters;
4. Decline of population quality due to inbreeding; and
5. The influence of government social policy.

Due to all of the above factors, the population of the developmental district can be characterized as follows:

1. The population density is relatively low and people are concentrated in the town centres and along roads;
2. The population distribution is inversely related to the distribution of forest resources; and
3. The population's social composition is complicated and changes extensively from time to time.

When a high percentage of the local population is temporary workers, these natural and social changes to the local population influence the range and quality of human developmental activities as well as the ecological environment of the Xinglongling Mountain forest.

3. Development of agriculture is the first economic activity of human's fighting for survival. Although the system of cultivating areas by turn and opening up virgin land provide considerable amounts of arable land for crops, the system endangers the forest, the wild animals and the living conditions of human beings. The development of modern communication and transportation system has accelerated political, economic and cultural development and enlarged the range of social economic association. When the importance of protecting the forest and the wild animals is not fully recognized, the speed at which forest environments are being destroyed has also accelerated. The development and utilization of forest products provide society with a great deal of lumber and improve people's living conditions in the mountain area. Unfortunately however, unplanned lumbering has harmed and is harming the forest and endangering the wild animals that live in the forest.

CHAPTER 7

THE SOUTH SLOPE OF THE QINLING MOUNTAINS A NATURAL REFUGE FOR GIANT PANDAS

The giant panda originally appeared in the early Pleistocene Period as the *Ailuropoda microta* Pei then evoluted to the *Ailuropoda melanoleuca baconi* which appeared in the middle Pleistocene Period and finally to the present day *Ailuropoda melanolenca*. A comprehensive survey of the appropriate fossil records show that the panda's living environment has gradually changed. Generally the pandas preferred forest home has changed from lower mountainous tropic-subtropic forest to lower mountainous subtropic and temperate forest, and finally to medium and higher mountainous temperate forest. This last change only occurred in specific areas, and, was caused by the human invasion into the panda's original range. Because of these changes pandas have become more and more tolerant of cold climates.

Giant Pandas appeared on the Qinling Mountains at the beginning of the middle Pleistocene period and have continued to live there for some 7,000,000 years. These pandas are unique because they are still living on the southern slopes of the mountains, their original range, although other pandas living in their original ranges have generally died out. The ways in which the southern slopes of the Qinling Mountains shelter these pandas are as follows:

(1) The distinctive landform is a climatic screen. The highest sector of the Qinling Mountains topped by Taibai Mountain effectively blocks cold air currents from the north. Even during the last glacial epoch, the snow line on Taibai Mountain,was at about 3350m.The southern slopes of the mountains are gentle and broad, and the South-eastern Monsoon rain can easily reach there along the Hanjiang River. Thus the climate on the southern slopes has generally been warm and wet, allowing the giant pandas to survive through the glacial period.

(2) With this favourable climate, a diversity of vegetation grows quickly on the south slope. The mountains' great range of elevation provides a large variety of vegetation that can be divided vertically into many zones. Among the existing vegetation zones the mid-mountain coniferous-deciduous broadleaf mixed forest (theropencedrymion[2]) combined with *Bashania* Bamboo forest and the subalpine dark coniferous combined with *Fargesia* Bamboo forest are both suitable for present day giant pandas. In addition, the micro-climate resulting from the varied topography causes plants in different locations to be at different phases of their growth at any given time. This is of benefit to the pandas as not all the bamboo blossoms and dies at the same time.

(3) On the southern slopes of the Qinling Mountains, the dividing line between the mountainous warmer temperate zone and the temperate zone is at an elevation of 1400m. For about 2000 years people have periodically cultivated above this line, but they have always moved away because the natural conditions are too unfavourable for long term cultivation. Thus 1400m of elevation is the upper limit of continuous agriculture. People are presently distributed as follows, there are dense populations in the hills and the lower mountainous regions, where the forest has been replaced by

[2] Mixed predominantly coniferous forest type mapped commonly in mountain areas of China

farms; there are fewer people (about 2 per sq-km) living on the lower mid-mountain regions; and above 1400m there are no permanent human settlements. Thus people have unconsciously left the region above 1400m to the giant pandas. This factor has favoured the panda's survival especially in the last 200 years.

(4) On the gently sloping southern slopes, the soil is nourishing, the weather is pleasant and therefore vegetation damaged by people recovers quickly. For the above reasons the southern slopes of the Qinling Mountains is a superb natural refuge for the giant panda. It is one of the last natural refuges left to them.

CHAPTER 8

POPULATION DENSITY, A STATISTICAL MODEL AND ESTIMATES

1. When pandas are living among the *Bashania* every winter and spring, they are easily observed because the bamboo is sparse. This situation provides a chance to effectively investigate the number of pandas in the area. To investigate the number of pandas, a population density model was developed for the theropen-cedrymion-*Bashania*-giant panda ecosystem of the Qinling Mountains as follows:

$$P = \frac{V}{\left(1-(1-T)^{K}\right)}$$

where:

P=population density of giant pandas per 1 km^2 of *Bashania* bamboo.
T= area proportion of a quadrat in the study area.
K=frequency with which each specific panda enters freely into a quadrat.
V=the number of pandas which visit a quadrat in a time unit (the time observers stay in each quadrat).

Three hypotheses about the model were also proposed. The model operates as follows: a large number of random quadrats of *Bashania* bamboo were defined; the number of pandas in every quadrat in a time unit (V) and the probability of a panda entering a quadrat $\left[1-(1-T)^{K}\right]$ during the time the unit was investigated. Then the panda's population density was calculated. In the model, T is determined by observers; K is determined by the ratio of each panda's moving into an area in a time unit T; V comes from direct field observations.
2. To test the model it was used in three areas where the number of pandas was already known. Densities determined by using the model were: 2.15/km^2 in Sanguanmiao, 1.91/km^2 in Baiyangping , and 1.88/km^2 in Shanshuping. Thus the total numbers of pandas in the three areas calculated by this method were 25-26, 7-8 and 7-8 respectively. These values agreed with the known values. Thus it is clear that the model works.
3. One of the advantages of the model is that it only requires simple field operations. In Sanguanmiao the field survey took 8 people 8 days and the result from the model was more correct than that from a crude route survey with the same surveying data. Therefore it is reasonable to use the model to calculate the number of pandas in various regions of the Qinling Mountains, where research has not yet begun. When using the model, the. quadrat area T is determined by forest visibility, it is the crucial factor.

4. Based on the calculated winter densities of 2.15, 1.91, 1.88 (av. 1.98) pandas per km2 of *Bashania,* it is estimated that our work area (346km^2) has a population of .about 121 pandas in *Bashania*. While there are also a few pandas in *Fargesia*, equal to 8.8% of the pandas in *Basania*. So the total number of pandas in our work area is about 132. The work area is the centre of concentration of the Qinling panda population.

CHAPTER 9

THE PANDA'S FOOD AND ITS .NUTRITIONAL VALUE

1. *Bashania fargesii* and *Fargesia spathacea* are the food bamboo of the pandas in the Qinling Mountains. From October to May they eat *Bashania* and from June to September they eat *Fargesia*. This obviously·seasonal food selection is characteristic of the Qinling pandas. The pandas eat selected parts of the bamboo; in *Bashania*, in addition to shoots, they consume more leaves than stem, young than old·and thick than thin, therefore young leaves of a thick bamboo are the favorite food; in *Fargesia*, in addition to shoots, they eat stems; for both types of bamboos, however, the thick shoots are the most tasty food during their growth period. (May for *Bashania* and June, July·and August for *Fargesia*).

2. The nutrient content of both bamboos was analysed. In *Bashania*, the protein and amino acid balance of the leaves, especially the young leaves, is far richer than that of the stem, which may explain the panda's preference for young leaves., In *Fargesia*, the leave's protein content ,is higher than the stem's, but its leaves are fewer in number and smaller than·*Bashania*'s, To eat them would take a lot of time which may be one of the reasons why pandas eat the stem rather than the leaves. Through choosing their food, pandas get the most nutrients as quickly and efficiently as possible. This is a response to the pressures of limited time and energy. Bad taste caused by Si02 in some parts of the bamboo may he another reason for the choice.

3. The daily food intake of an adult panda was estimated at 17 kg fresh weight of leaves and stems or 23.7 kg fresh weight of new shoots. An adult consumes about 145-664 g of protein per day; the amount varying with the seasons, considerably more than needed for basic maintenance and growth. Dry matter digestibility is about 20. 7% for *Bashania* leaves, 18.19% for *Bashania* stem, -and 14.6% for *Fargesia* stem. The panda's daily energy intake is 6911 kcal in spring and winter, 5138 kcal in summer, more than the fundamental needed. In addition to digest the inner contents of each cell, pandas also digest some (about 21.7%) of the hemi-cellulose in the cell wall. This ability to digest hemi-cellulose is rare among carnivorous animals. It is a necessary energy resource for giant pandas. As with feeding habits, the ability to digest hemi-cellulose is an adaptation to subsisting on bamboo which is of low nutritional value.

4. In comparison with the panda, the bamboo rat, another animal which relies on bamboo for its nutrition, utilizes much ·more of the hemi-cellulose. The food, nutrition and energy intake of pandas in Qinling and Wolong was also compared and no significant difference was found.

CHAPTER 10

ADAPTATION OF THE GIANT PANDAS LIVING ON THE SOUTH SLOPE OF THE QINLING MOUNTAINS

1. Faced with an environment changed by people, the giant pandas living on the south slope of the Qinling Mountains have responded with special new adaptations, suitable to their habitat. Primary cultivation, which began 2000 years ago and continues today along with its environmental repercussions, were and still are the major pressure on the panda's adaptations. It should be noted that the cultivation has not been severe enough to eliminate the pandas. Today, forestry in the panda's range is another pressure on the giant pandas. A comparison of panda's movements in cut and uncut forest was made in the spring of 1987. It was found that pandas ranged through 69.5% of the uncut forest, 69.4% of the forest selectively cut in 1981-1982 and 70.5% of the forest selectively cut in 1983-1985. Thus it appears that selective cutting of a forest does not endanger the panda. In other words, pandas can tolerate a selectively cut forest. But pandas will seldom range through areas that have been overcut. In a cut forest there are no large trees. This deprives the pandas of the place (a hole dug at the base of a large tree) they usually bear their young. They have adapted by rearing their young in rock caves which they make into nests.

2. In the area where pandas are most concentrated there are about 132 pandas. They annually consume (1) 203.2t of *Bashania* bamboo shoot, 1.9% of its annual growth; (2) 854.2t of *Bashania* stem, 0.9% of the total stem biomass available; (3) 404.2t of *Bashania* fresh leaves, 1.8% of the total biomass available; (4) 403.9t of *Fargesia* bamboo shoot, 1.3% of annual growth; and (5) 619.3t of *Fargesia* stem, 0.1% of the total stem biomass available. Thus pandas consume very little of each year's new growth and very little of the existing bamboo stock.

3. The Qinling's giant pandas make a very obvious vertical movement with the seasons. From October to May they live in lower *Bashania* bamboo at elevations of 1400 to 1900m, and from June to September they live at higher elevations and live in *Fargesia* Bamboo. Every May, when the *Bashania* shoots are growing, some of the pandas eat it while most of them move to *Fargesia* bamboo, though the *Fargesia* shoots have not yet sprouted. This indicates that the pandas' spring move from *Bashania* to *Fargesia* can not be completely explained by their desire to eat shoots. The move to lower elevations in October may be caused by the decreasing temperature at the higher elevations where *Fargesia* bamboo is found. It has been suggested that both moves may be regulated by the seasonal change of climate.

4. The Qinling panda population is estimated at about 230-240 individuals. Among them, the effective population (that population capable of reproduction) is about 92 pandas, with the inbreeding rate increasing 0.5456% every generation. Thus after breeding 12 generations in this population, l/8 of each individual panda's genes will be completely the same. In other words, all of the individuals will be cousins, It will than be impossible to preserve this population from extinction without ingesting new genes into the gene pool.

5. One factor in favour of the panda population is that most of the pandas living on the south slope of the Qinling Mountains are gathering at the upper courses of two adjacent

rivers, the Jinshui and the Youshui. This concentration of pandas, promoted by the suitable environmental conditions and the positive role of the panda's seasonal movement, makes it convenient for panda groups to exchange individuals.

CHAPTER 11

PROBLEMS OF AND SOLUTIONS FOR PRESERVING THE QINLING PANDA POPULATION

1. Both remote sensing technology and ground surveys were used to analyse the habitat of the Qinling giant pandas. On the mid-mountain planations surfaces, there are five "mountainous islands" ranged from east to west, which are covered by dense vegetation. Among them, the Xing Longling "mountainous island" is the largest with an area of 1168 km^2; Muotianling located to its west has an area of 460 km^2; Tianhuashan, Caopingliang and Huoditang are all located to its east and have areas of 384 km^2, 336 km^2 and 328 km^2 respectively. All of them are connected except for the Huoditang "mountainous island". The patterns of distribution of the islands, and their fingered outline, indicates that the present distribution of pandas in the area has survived from ancient times.

2. In the early 1980's, about 20% of the *Fargesia* bamboo located at the elevations between 1900 m and 2350 m blossomed and then died. Giant pandas, however, were not affected because the amount of blossomed bamboo is small and another bamboo - *Bashania*, which did not blossom, was available. In the blossomed area the seedlings are now growing, the bamboo is recovering and the pandas are already eating it.

3. Preserving genetic variety is one of the most urgent problems for the Qinling pandas. To help preserve this genetic variety the natural connections between the "mountainous islands", at mid-mountains should be preserved. This can be done by eliminating the harvesting of timber in wooded areas and the planting of trees in the non-wooded areas. Agriculture, hunting and the harvesting of bamboo should be effectively restricted above an elevation of 1400 m. The possibility of exchanging male pandas between China's different local populations was discussed. It was concluded that this would increase the genetic fitness of all populations.

4. The establishment of a region where pandas are protected but human activity is not completely restricted located outside the natural reserve was also suggested. The cooperation with Changqing (Evergreen) Forestry Products in Shanxi Province has been providing us with good experience with such a conservation district since 1981. When harvesting the forest they take less than the forest's natural replacement rate and they also plant young trees.

5. We suggest that a man-made forest community on the south slope of the Qinling Mountains with a complex arbour tree-bamboo forest be set up. The planting of arbour trees will be combined tightly with recovering bamboo, so that pandas and people will be able to successfully coexist.

Pan Wenshi (Ed)
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