

RESEARCH ON DISTRIBUTION, LIVING ENVIRONMENT AND PROTECTION OF WILD BACTRIAN CAMEL (*Camelus bactrianus ferus*)

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ABSTRACT

Wild bactrian camel (*Camelus bactrianus ferus*) estimated is one of the rare and endangered species in the world. Methods of field investigation, experimental analysis and data collection were used in the paper. The distribution region, population quantity and population status of wild bactrian camel were researched. The living environment of wild bactrian camel including topographic feature, climate environment, edible vegetation and drinking condition were studied, and the adaptability of wild bactrian camel in severe environment was analysed. Based on the difference analysis of morphological characteristics and ecological habit between wild bactrian camel and domestic bactrian camel, the environmental adaptation and evolvement of local morphological structure of wild bactrian camel and domestic bactrian camel were discussed. For the quick decrease of habitat and population quantity, the impacts of human activities, environmental conditions and natural enemies on wild bactrian camel, was evaluated quantitatively and recommended the feasible protection measures.

Key words: Distribution area, environmental adaptation, living environment, population status, protection, wild bactrian camel

Since Russian explorer Przewalski collected the specimen of wild bactrian camel (*Camelus bactrianus ferus*) in the north of Lob-Nor region at Xinjiang in China in 1877, many scholars have carried out the investigations (Gu *et al*, 1991; Olsen, 1988; Yuan, 1988; Chen, 1984; Tulgat and Schaller, 1992). Wild bactrian camel is the only one wild species of *Camelus*, which is rare and endangered. Its agnate brother wild dromedary camel (*Camelus dromedarius*) has died out several hundred years ago. In the past 60 years, the quantity of wild bactrian camel sharply decreased, and now it is close to extinction, IUCN (International Union for the Conservation of Nature and Natural Resources) and CITES (The Convention on International Trade in Endangered Species of Wild Fauna and Flora) have taken wild bactrian camel as the endangered species and listed in the red book. So the rare species wild bactrian camel has important value at the heredity of species and scientific research.

CAS (Chinese Academy of Sciences) organised some field investigations of wild bactrian camel from 1959 (Gu and Gao, 1987). Bannikov (1976) and Dash *et al* (1977) studied wild bactrian camel in Mongolia. Wen (1990) reported the distribution and transition of

wild bactrian camel in China. Hare (1996) investigated wild bactrian camel of China and Mongolia. Luzhang *et al* (2005) reported the distribution and population characters of wild bactrian camel in Gansu Province. UNEP (United Nations Environment Programme), Xinjiang Environmental Protection Institute and Xinjiang Environmental Monitoring Centre, jointly investigated the population quantity and distribution range of wild bactrian camel from 1995 to 1997, and achieved many results (Yuan *et al*, 1999a), discussed in paper. Zhao *et al* (1999) studied ecological habitat and behaviour of wild bactrian camel. Li *et al* (1998) reported the distribution and survival environment of wild bactrian camel in the south of Lob-Nor. The purpose of this paper is to research the distribution, population status, living environment, ecological habit, environmental adaptation, impact of human activities and feasible protection measures of wild bactrian camel.

Materials and Methods

Living environment factors of wild bactrian camel including topographic feature, climate environment, edible vegetation, drinking condition and soil were integrated surveyed at the distribution

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of wild bactrian camel area located at the EjinQi, Mazong mountain, Anxi, Dunhuang, Akesai and Huahai in the southwest and north of Hexi corridor from 2005 to 2006.

The differences of morphological characteristic and ecological habit between wild bactrian camel and domestic bactrian camel were analysed. Seven heads of adult domestic bactrian camel with average weight 480 ± 23.8 Kg were collected in Alxa youqi which is the main distribution area of domestic bactrian camel, and morphometry and topographic anatomy by using computerised tomography were studied the research results combined with the morphometrics results of 7 heads of wild bactrian camel at Gansu endangered Animal Species Research Centre, the differences of morphological characteristics and ecological habit between wild bactrian camel and domestic bactrian camel were summarised. The environmental adaptation and evolvement of local morphological structure of wild bactrian camel and domestic bactrian camel were researched.

Climatic elements data of representative weather stations at wild bactrian camel distribution area near 50 years were analysed, the eco-climatic adaptation of wild bactrian camel and climate difference of 4 distribution areas were studied. The edible vegetation and food habit characteristics of wild bactrian camel were studied by using directory of 117 vegetation species and the method of microscopic examination for 86 excrement samples of wild bactrian camel from 4 main distribution regions (Zhang and Yuan, 1997). The adaptability of wild bactrian camel to brine water was analysed by chemical analysis of the drinking saline spring. Impacts of human activities, environmental conditions and natural enemies on wild bactrian camel was evaluated quantitatively using the method of experts point rating (Yuan *et al*, 1999a), the feasible protection measures for wild bactrian camel were proposed. SPSS13.0 software was used in the paper.

Results and Discussion

Distribution and quantity of wild bactrian camel in the world

Distribution and quantity in historical periods

In historical periods, the wild bactrian camel was distributed at the low altitude hills and plain terrain of the whole central Asia and the east of western Asia and the population quantity was great. Wild bactrian camels appeared at the west of Qaidam basin, the west of Hexi corridor, and the southeast

of Xinjiang in the 1950s (Wang, 2004). With the development of the human activity territory and intensity, population quantity was continuously decreasing from about 10000 heads before 100 years ago to 2500-3000 heads at the end of 1970s (Gu and Gao, 1987). Yuan (1996) considered that wild bactrian camel mainly existed at the centre of Lob-Nor, the quantity was few and decreased to 730-880 heads. Presently, the number is lower than giant panda.

Distribution and quantity of wild bactrian camel at present

Wild bactrian camel is mainly distributed in 4 unmanned regions at present, including the northern margin of Altyn mountains, Taklimakan desert, Goshun gobi and Altay gobi (Yuan *et al*, 1999). Through our analysis, distribution area from high to low is Taklimakan desert, Goshun gobi, the northern margin of Altyn mountains and Altay gobi, respectively. The quantity and population density of wild bactrian camel showed inverse trend. The distribution region, area, quantity and population density of wild bactrian camel in the world are presented in table 1. It obviously shows that the quantity and population density of Altay gobi is relatively high among 4 regions, area of Taklimakan desert is the maximum, but the quantity and population density is the lowest. At present, the population quantity and distribution region of wild bactrian camel have been affected severely by many factors. At the northern margin of Altyn mountains, increase of the nomadic population and grazing intensity becomes the main influencing factors; at Taklimakan desert, hunting makes the population quantity decreasing quickly; at Altay gobi, population quantity showed an obvious declining trend with survival rate of the young by very low due to wolf harm (Tulgat and Schaller, 1992).

Living environment of wild bactrian camel

Living environment of wild bactrian camel, perhaps is the worst in the world. It is a miracle that wild bactrian camel can survive under the worst environment like Mars, and it is the only one large

Table 1. Distribution region and population quantity of wild bactrian camel in the world.

Distribution region	Area (km ²)	Quantity (head)	Population density (head/1000 km ²)
Altyn mountains	43 000	250-300	6-7
Taklimakan desert	46 400	50-80	1-2
Goshun gobi	45 000	80-100	2
Altay gobi	28 000	350-400	13-14

sized mammal depend on the high salt water to survive.

Topographic feature

Wild bactrian camel lives in the desert and half-desert region where altitude ranges from 1700 to 3800 m in the continental hinterland of Asia. There are etched hill, gobi desert, salt desert, low valley, bare rock land and Yardang Landform at distribution area. The residual hill and age-old dry river bed with an altitude of 780 m in the middle of dry Lob-Nor basin which is the main protection region of wild bactrian camel.

Climate

Wild bactrian camel distributes at the driest hinterland of Asian continent. Table 2 shows the climatic data of the representative weather stations at the distribution area of wild bactrian camel. High-temperature drying in summer, cold and strong wind in winter, low precipitation and high evaporation rates are the main climatic characteristics. Maximum temperature reaches 43.1°C and minimum temperature reaches -35.4°C. Daily temperature difference ranges from 10 to 20°C, and annual temperature difference exceeds 30°C. Minimum annual precipitation is only 29 mm, but annual evaporation capacity is about 3000 mm. The dust storm is frequent. It is obvious that the adaptation capacity of wild bactrian camel for atrocious weather is very strong.

Food habit analysis

Vegetation of the distribution area of wild bactrian camel is very scarce. There are 117 vegetation species including 72 woody species and 45 herbage species according to first-hand investigation and statistical analysis for 4 areas (Li *et al*, 1996), Floristics holds 3.3% of Xinjiang higher plants and 0.43 percent of nation. Zhang and Yuan (1997) found that the preferred foods of wild bactrian camel

have commonality by microscopic examination and statistical analysis for 86 excrements samples of wild bactrian camels from 4 distribution areas. The favourable edible vegetation of wild bactrian camel includes *Phragmites communis*, *Alhagi pseudalhagi*, *Nitraria sibirica*, *Nuraria sphaerocarpa*, *Calamagrostis pseudophragmites*, *Calligonum mongolicum*, *Halostachys caspica*, *Halogeton glomeratus*, *Achnatherum splendens*, *Populus diversifolia* and the unfavourable vegetation includes *Reaumuria soongorica*, *Atraphaxis pungens*, *Haloxylon ammoderon*, *Sympegma regelii*, *Ephedra przewalskii*, *Zygophyllum xanthoxylum*, *Anabasis aphylla*. Distribution range and population quantity of wild bactrian camel have no significant correlation with vegetation species and abundance, but have significant correlation with intensity of human activity.

Drinking condition

Annual precipitation at the distribution area ranges from 30 to 70 mm, the area is the driest region in the middle of Asia. Most organisms depends on the underground water to live. There is no fresh water, only the saline spring with high minerals. Zhao *et al* (1999) made chemical analysis of the spring water which wild bactrian camels drink and proved that the salt content and minerals of water were high. For example, in water of Gazelle spring at Goshun gobi, total salt content was 30.97g/l and Cl⁻, SO₄²⁻, CO₃²⁻, HCO₃⁻, Ca²⁺, Mg²⁺, Na⁺ and K⁺ contents were 13.75 g/l, 5.91 g/l, 0.01 g/l, 0.61 g/l, 0.89 g/l, 0.12 g/l, 10.41 g/l and 10.41 g/l, respectively. In water of Camel spring, total salt content was 19.46 g/l and Cl⁻, SO₄²⁻, CO₃²⁻, HCO₃⁻, Ca²⁺, Mg²⁺, Na⁺ and K⁺ contents were 7.53 g/l, 4.79 g/l, 0.01 g/l, 0.11 g/l, 0.71 g/l, 0.10 g/l, 6.21 g/l, 6.21 g/l, respectively. Wild bactrian camel was the only one large sized mammal who depend on the high salt water to live. As yet, it is an enigma that how the high salt water intake kills other animals, but not the wild bactrian camel.

Table 2. Climatic data statistics of the representative weather stations at the distribution area of wild bactrian camel.

Parameters	Ruoqiang	Luntai	Korla	Yiwu	Mazong mountain	Ejinqi
Annual mean temperature (°C)	11.7	11.0	11.7	3.9	4.6	8.9
Temperature annual range (°C)	34.9	33.0	33.4	30.3	32.6	37.6
Max temperature of the warmest month (°C)	43.1	41.4	40.0	33.2	35.4	42.5
Min temperature of the coldest month (°C)	-23.3	-25.5	-25.3	-30.7	-35.4	-31.3
Annual average relative humidity (%)	40	50	46	43	39	33
Annual evaporation capacity (mm)	2881	2000	2713	2177	3306	3400
Annual average wind velocity (m/s)	2.5	1.2	2.3	3.6	4.4	3.2
Annual days of sand storm (day)	13	1.2	1.1	0.1	1.3	10.7
Annual precipitation (mm)	29.0	72.0	57.4	103.4	63.4	35.2

Impacts of human activities and natural enemies on wild bactrian camel

It was found that 61% death of wild bactrian camels in Mongolia gobi park was by wolves. Additionally, mining activities destroy vegetation and pollute drinking water of wild bactrian camel. The famous Silk Road passed through the distribution area in history, the tourism, exploration and archeological activities are frequent at present, so wild bactrian camels are interfered, and environment is further destroyed. Roads and pipe laying interferes migration and foraging routes of wild bactrian camel (Gao *et al*, 2006). Many domestic bactrian camels invade the distribution region of wild bactrian camels, and hybridisation occurs which makes the quantity of pure breed of wild bactrian camel on a decrease. Yuan *et al* (1999b) deeply investigated survival environment of wild bactrian camel. Investigation experts chose 8 influencing factors including concealment, food, natural enemy, water source, grazing, hunting, mining and traffic. Every influencing factor was divided into 10 grades. The region with good environment condition and weak effect of human activity had high grade, but had low grade inversely. Living environment of wild bactrian camel at 4 distribution regions was evaluated (Fig 1). According to comparison of 4 regions, survival was suitable at Goshun gobi and Altyn mountains from the aspect of environment condition. The effects of human activities were relatively little at Goshun gobi, so it was an optimal survivally region of wild bactrian camel out of 4 distribution areas.

Differences between wild bactrian camel and domestic bactrian camel

Differences of the genetic gene

Wild bactrian camel (*Camelus bactrianus ferus*) is the only one wild species of *Camelus* lived on the earth at present. The wild species of dromedary camel (*Camelus dromedarius*) has disappeared several hundred years ago. Someone thinks that wild bactrian camel is the ancestor of the domestic bactrian camel (*Camelus bactrianus*), they all belong to the same species. According to analysis of the blood samples of wild bactrian camel and domestic bactrian camel, it is found that difference of the gene between wild bactrian camel and domestic bactrian camel reaches 2.6% which exceeds the 1.6% difference between human being and chimp, this testifies that wild bactrian camel and domestic bactrian camel belong to 2 branch species separately before 800 thousand years.

Differences of morphological characteristics and habit

Many observations and investigations prove that differences of morphological characteristic and habit exist in two species. Body and limbs of wild bactrian camel are generally thin and high. The shoulder height of adult wild bactrian camel was about 180-200 cm, and body weight ranges from 450 to 690 kg. Head was relative small and face is narrow. Ear was small and its length is about 10 cm. The hump was small and peaked, the height was about

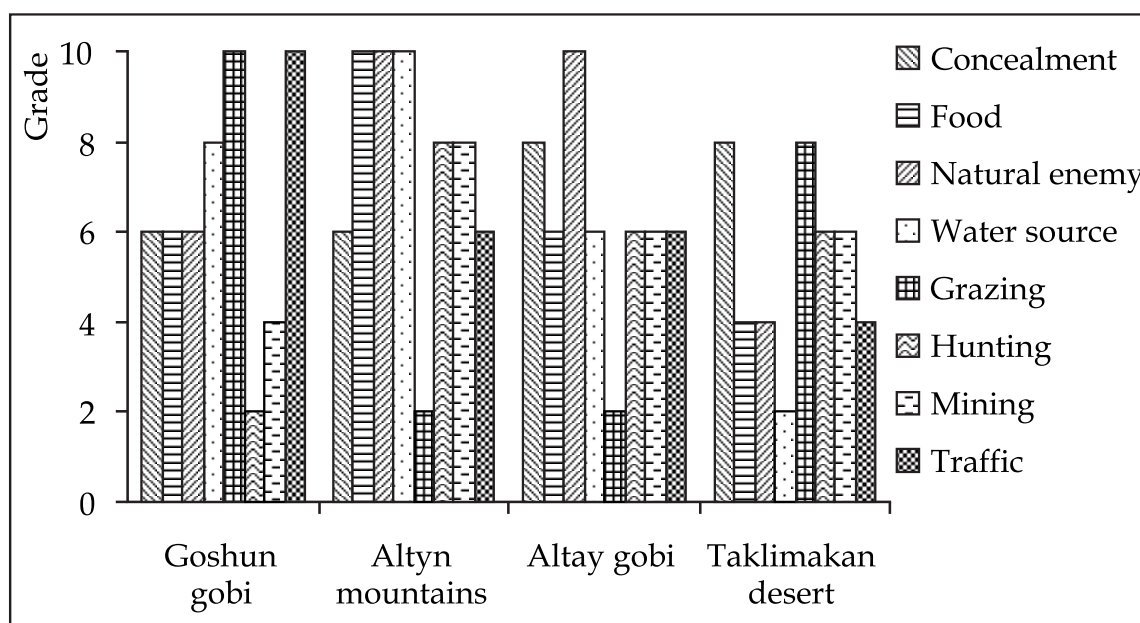


Fig 1. Evaluation of living environment of wild bactrian camel at 4 distribution regions.

20-25 cm, and space of two humps was relatively wide, the hump was always straight and without drooping. Its tail was short and length was about 40 cm (Li, 2002). The hair was short and the colour was only fulvous. The toe nails were peaked. The hoof was relatively small, which was a benefit for rapid run. The wild bactrian camel showed timorous temperament and were afraid of human beings. The running speed reached 40 km/h. Wild bactrian camel was able to endure aridity, high temperature, chillness and high salt water. The hearing and vision sense of wild bactrian camel was remarkable as they would run and escape rapidly in exceptional and dangerous conditions.

Body and limbs of domestic bactrian camel were fatty and short. She *et al* (2007) and Xie *et al* (2006) studied the morphometry and topographic anatomy of the domestic bactrian camel. Head of domestic bactrian camel was relatively big and face was broad. Ear was relative big and its length was about 12 cm. The hump was relatively big and was similar in shape to dune, the height was about 40-50 cm, and the space of the 2 humps was narrow, the hump was drooping while the nutrition was scarce. Tail was relatively long with a length of 50 cm. The hair colour was complex and yellow, brown, white, ashy, black or red in colour. The sole of foot was round, the toe nails were blunt, the hoof was relatively large and was considered fit for burden. The temperament was docile and fearless of the human being. The running speed was slow and could reach 15-20 km/h.

Gansu Endangered Animal Research Centre has bred 7 heads of wild bactrian camels, and it has been the largest wild bactrian camel population in pen at home and abroad (Li and Zhao, 2002). Xu (1989) reported that domestic bactrian camel in China was divided into 6 varieties according to living place: Chaidamu bactrian camel, Beijianguo bactrian camel, Nanjiang bactrian camel, Sunite bactrian camel,

Alxa bactrian camel, and Hexi bactrian camel and morphological characteristic of every variety was analysed. Seven heads of adult domestic bactrian camel were collected from Alxa youq. Morphometry and topographic anatomy were studied by authors using computerised tomography (CT). The above results were integrated. Body size characteristics of adult wild bactrian camel and adult domestic bactrian camel were compared (Table 3). The results showed that the body length and body height of wild bactrian camel were higher than those of domestic bactrian camel, and ratio of body length to body height of wild bactrian camel was higher than that of domestic bactrian camel. The difference between body height and body length was significantly higher between wild bactrian camel and domestic bactrian camel.

Environmental adaptation analysis of wild bactrian camel and domestic bactrian camel

Morphological characteristic and habit of wild bactrian camel and domestic bactrian camel have evolved gradually in order to adapt for different survival environment. The domestic bactrian camel generally lives in the pasture with fresh water and fine grass along with the human being. The limbs become strong and powerful, and hoof is large for the reason of long burden (Zhang, 2004). The hump evolves as the energy storage, it becomes straight while food is enough, but it becomes drooping while food is scarce. Under the threat of human being and natural enemy, wild bactrian camel gradually shrinks back the desert where human and other animal can't live. The slim leg and small hoof are helpful to run fast and escape. Sensitive olfaction can help them to find the water source or locate the position of natural enemy away from several kilometres distance by little odour. Wild bactrian camel has a set of gregious digestive system, it is the only one large sized mammal depending on the high salt water to survive, it can make the most of the coarse desert food

Table 3. Comparison of body size measurement between adult wild bactrian camel and adult domestic bactrian camel.

Adult wild bactrian camel					Adult domestic bactrian camel				
Number	Body height (cm)	Body length (cm)	Ratio of length to height	Difference between height and length	Number	Body height (cm)	Body length (cm)	Ratio of length to height	Difference between height and length
1	182	150	1:1.22	32	A	168	143	1:1.17	25
2	181	156	1:1.16	25	B	168	147	1:1.14	21
3	183	150	1:1.22	33	N	176	144	1:1.22	32
4	175	155	1:1.13	20	S	173	153	1:1.13	20
5	185	157	1:1.18	28	C	169	148	1:1.14	21
6	168	140	1:1.20	28	H	167	142	1:1.18	25

and adapt the brine under the adverse environment, where they are forced to adapt in order to survive.

Protection measures of wild bactrian camel

For the impacts of the human activities, the distribution area of wild bactrian camel shrinks gradually and the rate of habitat decay is increasing. Compared with the investigation results in the 1980s, the population quantity of wild bactrian camel has reduced to approximate half. So the feasible protection measures must be taken in order to prevent the shrink and extinction of population.

Wild bactrian camel is the rare, endangered and national key protected species, its amount is lower than giant panda at present. In recent years, IUCN has taken wild bactrian camel as the endangered species and listed in the red book, CITES has taken it as the grade I endangered species. China government also has taken it as the national key protected species. In 2002, the Altyn mountains natural reserve has been expanded into the Lob-Nor National Natural Reserve, it is one of the largest natural reserves in the world, the area is about $7.8 \times 10^4 \text{ km}^2$, the amount of wild bactrian camel is about 400-500 heads in natural reserve. A multinational protected area of wild bactrian camel will be built on the border between China and Mongolia.

Human activities, environmental degradation and natural enemies threaten severely the survival of wild bactrian camel which needs attention to protect the endangered species. The excessive chopping and denudation must be forbidden, it is necessary to strengthen the ecological environment protection and the desert vegetation recovery. Grazing should be controlled in the reasonable bearing capacity of the environment, rotation grazing and prohibited grazing have been strictly executed at protected area (Yuan *et al.*, 2004). The poachers must be punished with a heavy hand, more checking stations should be built. Mining activities of the core area must be forbidden. The quantity of natural enemy, wolf should be controlled designedly. In order to protect the pure blood of wild bactrian camel, the hybridisation between wild bactrian camel and domestic bactrian camel should be prevented and controlled. Breed and reproduction of wild bactrian camel are important research projects, Gansu Endangered Animal Research Centre has bred 7 heads of wild bactrian camel, one head of female wild bactrian camel has successful reproduced young one, this was also the only successful case of man made reproduction in pen in the world, it has been the largest wild bactrian camel population in pen at home and abroad at present. Finally, it is important

that an awareness for protection of wild bactrian camel should be created.

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