Summer food habits of brown bears in Kekexili Nature Reserve, Qinghai–Tibetan plateau, China

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Abstract: We documented food habits of brown bear (*Ursus arctos*) during summer 2005 in an important calving area for Tibetan antelope (*Pantholops hodgsonii*) in the Kekexili Nature Reserve, Qinghai province, China. Fecal analysis ($n = 83$) revealed that the plateau pika (*Ochotona curzoniae*) was the primary prey (78% occurrence, 46% dry weight), and that wild yak (*Bos grunniens*; 39%, 31%) and Tibetan antelope (35%, 17%) were important alternative prey. Vegetation also occurred in bear feces (17% occurrence). Brown bears in this region were evidently primarily carnivorous, a survival tactic adapted to the special environment of Qinghai–Tibetan plateau.

Key words: *Bos grunniens*, brown bear, diet, *Ochotona curzoniae*, *Pantholops hodgsonii*, pika, scavenge, Tibetan antelope, *Ursus arctos*, wild yak

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The brown bear (*Ursus arctos*) has a Holarctic distribution that stretches from Eurasia to North America. With such a wide geographic distribution, food habits of brown bears differ substantially in different geographic areas, and seasonal variation in food selection is common (Welch et al. 1997, Hilderbrand et al. 1999*b*, Rode and Robbins 2000, MacHutchon and Wellwood 2003). Food habits of brown bears living on the high-elevation Qinghai–Tibetan plateau (>4,000 m) are poorly documented, having been briefly described by Kozlov (1899, quoted in Schaller 1998), Schaller (1998), Harris and Loggers (2004), Liu (2004), and Smith and Harris (2004).

The subspecies on the Qinghai–Tibet plateau in China is considered *U. a. pruinosus*, a second-class key protected species in China (Ma et al. 1994). Wang (1998) estimated a density of *U. a. pruinosus* was 0.003/km^2 and Ma et al. (1994) estimated a population of 5,000–6,000 brown bears on the Qinghai–Tibet plateau.

Understanding food habits is important for understanding bear distribution and habitat use (MacHutchon and Wellwood 2003). Brown bears living on the Qinghai–Tibet plateau must contend with a short growing season of vegetation, lack of protective cover, and extremes in weather. They may be particularly vulnerable to changes in food availability because of the short time they have to acquire energy necessary for maintenance, growth, and reproduction prior to winter denning. Understanding food habits of brown bears on the plateau may provide insights into how they adapt to this environment, and be critical for effectively managing habitat for brown bears and their prey.

Our objective was to provide baseline documentation of brown bear food habits to better understand its ecology on the Qinghai–Tibet Plateau, which may be useful given increasing encroachment of human development (Harris and Loggers 2004). Because we found it difficult to collect data based on direct observations, we used fecal analysis to assess food habits.

Study area

The study was conducted in a ~300 km^2 region centered at 92°00′E, 35°29′N, near Zhuonai Lake (ZNL) in Kekexili (sometimes referred to as Hoh Xil) Nature Reserve (KNR), Qinghai Province, China (Fig. 1). KNR is in the central part of the Qinghai–Tibetan plateau, and

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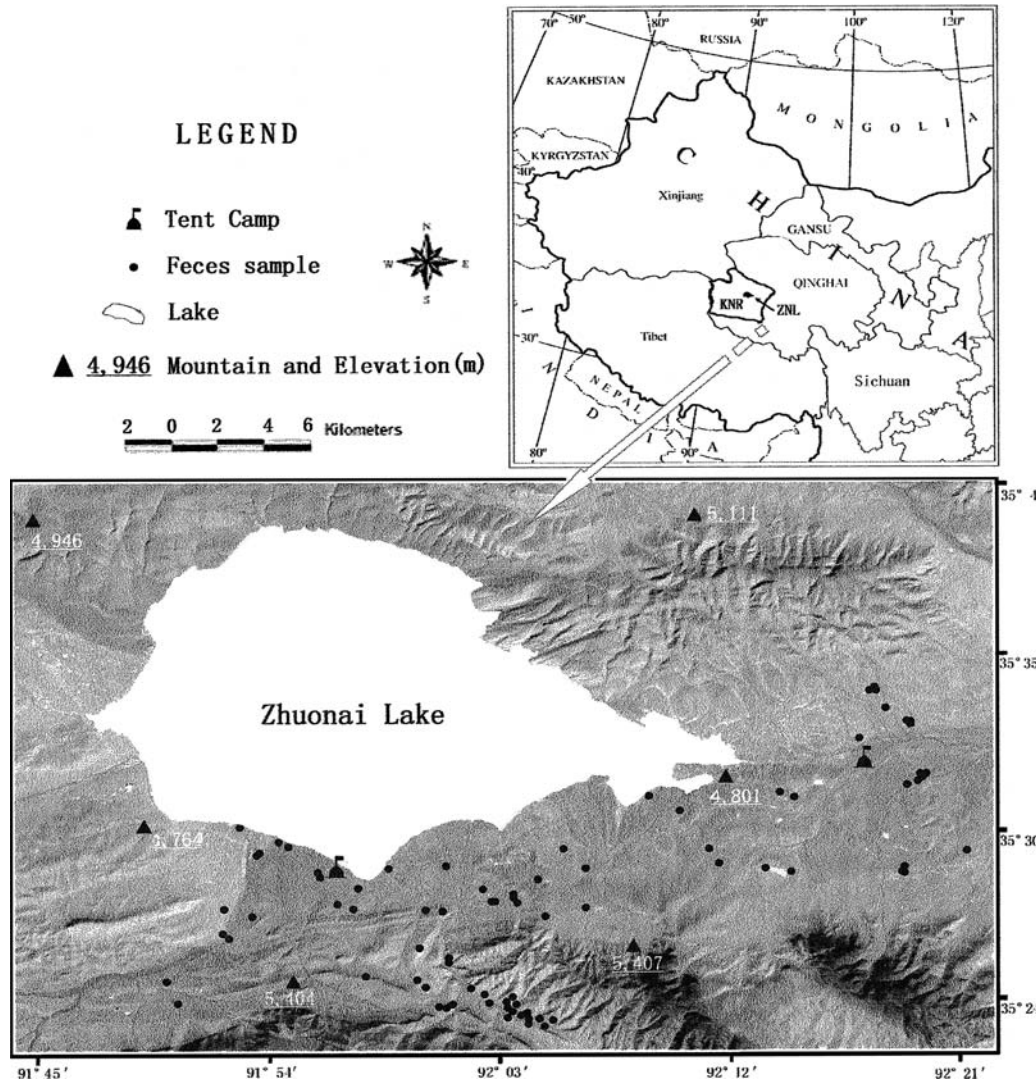

Fig. 1. Study area for 2005 study of summer food habits of brown bear near Zhuonai Lake, Kekexili Nature Reserve, Qinghai Province, China.

Zhuonai Lake, an alpine half-saline lake with a mean elevation >4,700 m, is in the central part of the KNR (Guo 1993).

The climate of the region is continental, characterized by dry, cold winters, frequent winds, strong solar radiation, and a short frost-free period. Mean annual temperature is below –5°C, varying from <6°C in the warmest months (Jun–Aug), to below –20°C in the coldest months (Nov–Feb). Plant growth lasts <100 days. Mean annual precipitation varies from 240 to 300 mm, and about 69% of total precipitation falls during June–August (Guo 1993, Li et al. 1996). Zhuonai Lake is one of the most important lambing concentration areas for Tibetan antelope (*Pantholops hodgsonii*). Thousands of female Tibetan antelope migrate annually to this area for lambing from adjacent Tibet, Xinjiang, and other areas of Qinghai in June and return to their jumping-off place in mid-July.

Vegetation types around Zhuonai Lake include alpine steppe, alpine meadow, and cushion plants; trees are absent (Guo 1993). Alpine steppe is dominated by *Stipa purpurea* and *Carex moorcroftii*, and alpine meadow by *Kobresia pygmae*, *K. tibetica*, and cushion plants (e.g., *Androsace tapete*, *Arenaria gerzeensis*). Although the vegetative cover is sparse, vegetation is high in protein (13%), fat, and low in fiber (Guo 1993, Wu and Feng

Table 1. Frequency of occurrence and percent dry weight composition of food items in feces of brown bear, summer 2005 in Kekexili Nature Reserve, Qinghai Province, China ($n = 83$). Total dry weight of the mud and sand in feces was 2,324 g, average = 28 g; total dry weight of all feces was 7,387 g, average = 89 g.

Food items	Occurrence in feces (%)	Fecal dry weight (%)
Burrowing mammals		
plateau pika	78	44
Himalayan marmot	13	2
Other mammals		
wild yak	39	31
Tibetan antelope	35	17
Tibetan wild ass	8	3
wooly hare	6	1
Insects		
bumblebees	11	trace
Plants	17	2
Birds	4	trace
Unknown matter	3	trace

1996). Potential prey for bears in the Zhuonai Lake region include Tibetan wild ass (*Equus kiang*), wild yak (*Bos grunniens*), Tibetan gazelle (*Procapra picticaudata*), Tibetan antelope, Himalayan marmot (*Marmota himalayana*), wooly hare (*Lepus oiostolus*), and plateau pika (*Ochotona curzoniae*), 54 bird species, and 6 fish species (Wu and Feng 1996).

During this study (8 Jun–27 Jul 2005), we found no evidence of feces or tracks from other predators, although we suspect that fox (*Vulpes vulpes*, *V. ferrilata*), lynx (*Lynx lynx*), and wolves (*Canis lupus*) inhabit the area (Wu and Feng 1996). *U. arctos* are undoubtedly the only species of bear in this region. The area is uninhabited by people because of its extreme elevation, harsh climate, and inaccessibility.

Methods

Fecal collection

Feces were collected when encountered, incidental to transect surveys for calving Tibetan antelope in the area. Eighteen linear transects of 5–30 km each were placed within the study area, running through each vegetation type near Zhuonai Lake. In the study area, brown bears are the largest carnivore, so its feces are easily identified on the basis of shape (cylindrical feces tapered at one end), diameter (mean diameter 3.2 cm, <2.0 cm abandoned), odor, and color. We only collected fresh, whole feces. Fresh feces were determined to have been deposited within a week based on a dark but relatively lustered color, moist interior (although the exterior was often dry), and strong odor upon breaking. Prior to analysis, collected feces were measured, sealed in paper envelopes, and labeled with GPS readings (Fig. 1), date, and other information. The samples were sun-dried and stored until analysis.

Fecal analysis

Feces were analyzed following the method of MacHutchon (1989) and Bargali et al. (2004). Feces were weighed separately and soaked in water 10–15 hrs, then washed in running water to remove mud and fine digested materials using 0.7 and 0.4 mm sieves. Sieve contents were mixed with water and distributed evenly in an enamel pan. A random 10-ml sample was removed from the pan, mixed with 30 ml of water, then put into a Petri dish and spread over a 25-square grid (each square = 4%). The percent volume of each item in the sample was estimated. Three to five samples were examined from each feces.

Undigested food remains were identified to species using reference collections from animals in the study area and from museum specimens at the Qinghai–Tibet Plateau Wildlife Rescue Center, Xining. We identified food items by verifying guard hairs microscopically. We did not quantify bear hairs or debris such as stones and soil particles, which we assumed were ingested incidentally (Hwang et al. 2002). All inseparable, unidentifiable crushed matter was considered waste and discarded (Bargali et al. 2004).

We categorized prey items into 5 types: burrowing mammals (plateau pika and Himalayan marmot), other mammals, insects, birds, and plant material (grouped together). Samples were oven dried at 75°C for 24 hrs. Very small fragments (<0.5 cm) of plant found in feces with pika remains were considered secondary prey from the pikas and not counted.

We quantified importance in diets by percent of occurrence (number occurrences of prey type x 100/number of occurrences of all prey types), and dry weight of remains of prey types (dry weight of remains of prey type x 100/dry weight of total feces).

Results

We analyzed a total of 83 feces. We identified 6 herbivores as well as bumblebees (*Bombus* spp.), birds, plants, and unknown animal matter (Table 1). We also found 3 indumentum segments (average length = 0.6

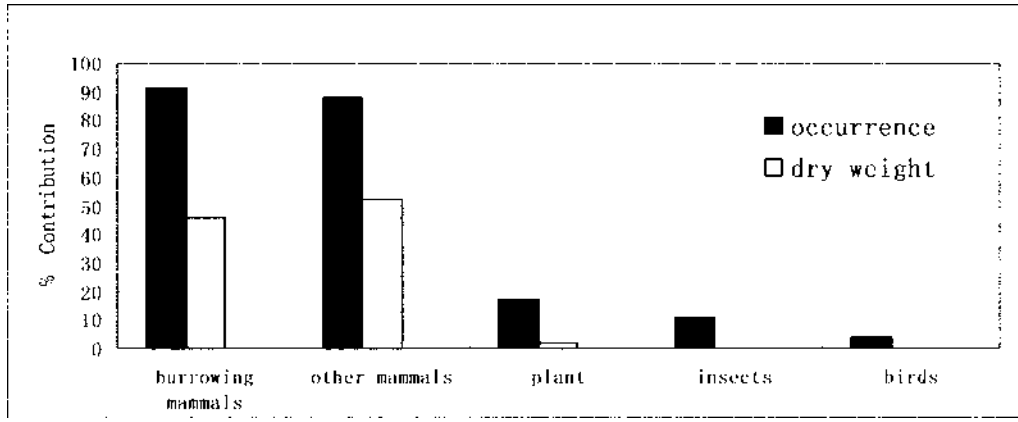

Fig. 2. Frequency occurrence and dry weight of 5 food items in feces of brown bears during summer 2005 in Kekexili Nature Reserve, Qinghai Province, China.

cm) in the feces, but these could not be identified to species.

Among the 8 animal food items identified, plateau pika occurred in feces most often (78%); wild yaks (39%) and Tibetan antelope (35%) occurred in similar proportions (Table 1). Plateau pika also ranked highest in percent composition (44%) on a dry-weight basis, followed closely by wild yak (31%) and Tibetan antelope (17%) (Table 1). Twenty-two feces consisted entirely of pika contents, 4 feces were entirely Tibetan antelope, and 3 feces were entirely wild yak. Himalayan marmot, Tibetan wild ass, wooly hare, and birds had smaller occurrences (13%, 11%, 6%, and 4%) and contributed negligibly to total dry-weight (2%, 3%, 1%, and trace). Bumblebees were found in 11% of feces, but they made up only a trace of the dry weight. Burrowing mammals had higher proportions in occurrence and dry weight than any other category (Table 1). Animal matter was 98% of total dry weight (Fig. 2). Plants occurred in 17% of bear feces and contributed negligibly to dry weight (2%).

Discussion

Plateau pikas were the primary prey for brown bear in KNR. Wild yak and Tibetan antelope were important alternative food items. Although fecal analysis has shortcomings (McLellan and Hovey 1995), it has the advantage of yielding substantial data without locating or disturbing free-ranging animals. The method has been used on a wide range of bear species to infer dietary composition (Schaller 1967, Hamer and Herrero 1987, Mattson et al. 1991, McLellan and Hovey 1995, Bargali et al. 2004). We acknowledge that our sample size was small and our methods prevented us from differentiating food habits on the basis of sex and age. However, we believe our results reflect the general trend in brown bear food habits in this region. Because little is known about the ecology of brown bears on the Qinghai–Tibet plateau, the description of any aspect of its biology is an important step toward proper management of the species and the plateau ecosystem.

Most predatory animals on the Qinghai–Tibetan plateau rely heavily on pikas in their diet (Smith et al. 1990, Schaller 1998). During his 1893–96 expedition to the Qinghai–Tibetan plateau, Kozlov found 25 pikas in the stomach of one bear (Smith and Foggin 1999). Schaller (1998) presented data showing that almost 60% of the diet of brown bears in the Chang Tang Nature Reserve, Tibet, which borders the KNR to the south, were pikas (Schaller 1998). Similarly, our study revealed that brown bear prey heavily on pikas in the KNR.

In KNR, we suspect that brown bear are opportunistic omnivores in summer. Pikas are distributed widely on the alpine steppe and alpine meadow on the Qinghai–Tibetan plateau (Wu and Feng [1996] reported an average density of >120 pikas/ha). Pikas have relatively simple burrow systems (Schaller 1998, Smith and Harris 2004). Rain softens the soil in summer, making pikas a relatively easily hunted food item. We also noted extensive digging for pikas by bears (Fig. 3).

Jiang and Xia (1985, 1987) determined that pikas also play an important role in the stabilization of the alpine meadow community. The pika's role as a primary prey closely resembles the prairie black-tailed dog (*Cynomys ludovicianus*) in the North American prairie ecosystem

Fig. 3. A brown bear in the Qinghai–Tibetan Plateau digging for pikas (photo by Milo Burcham), approximately 120 km east–northeast of the study area.

(Schaller 1985, Hoogland 1995, Smith and Foggin 1999). Plateau pikas are currently subject to extensive poisoning programs on the plateau and are considered by most government planners a rangeland pest (Smith and Foggin 1999). If pikas are extirpated from the plateau, it could have a major negative effect for brown bears. We suggest that the pika should be considered a positive element, and widespread poisoning activities to kill pikas should be halted.

Pikas in KNR appeared relatively stable and consistently available to bears, but wild yak and Tibetan wild ass were less predictable prey items. In the transect surveys we found 2 carcasses of wild yak. One had been consumed, with almost no meat remaining on the skeleton; the other was relatively fresh. Around the carcasses, we found fresh bear tracks and feces. We documented a similar instance involving a Tibetan wild ass carcass. Neither we nor the managers of KNR observed bears preying actively on ungulates in Kekexili. We believe that brown bears scavenged the carcasses of large ungulates.

A number of Tibetan antelope lambs died from the extreme, harsh climate. Dead antelope lambs are another plentiful resource for scavenging bears (although we do not know if bears preyed on them). Himalayan marmots, wooly hares, birds, and insects contributed negligibly to bear feces.

Brown bears are clearly more carnivorous than vegetarian in KNR during summer (Fig. 2). Mammals are likely the highest quality foods throughout the year (McLellan and Hovey 1995, Hilderbrand et al. 1999*a*). Bunnell and Hamilton (1983) suggested that brown bears change food items with seasons in response to changes in digestibility to optimize their energy and protein intake. Abundant meat resources positively affect body size, reproductive success, and population density of brown bears and therefore positively influence habitat quality (Hilderbrand et al. 1999*a*). It is interesting that bears in this high-elevation plateau appear to be more carnivorous than vegetarian. However, the opposite is found on the Deosai plateau in the northern Territories of Pakistan for a different subspecies of brown bear in a similar environment. Brown bears feed according to opportunity and availability of food. They tend to prefer vegetable matter but use other organisms depending upon conditions and time of the year. During summers, they are reported to feed on insects and small crustaceans lying under or on the surface of rocky fields. In the spring and summer, they mostly feed on alpine bulbs and roots of the plants. They are occasionally reported to kill domestic sheep and goats; rodents are also in their diets, but they probably do this only when they are really desperate. Although the diet of the brown bears consists mostly of roots and grasses, a small amount of animal matter occurred in recent studies on the invertebrates of Deosai Plateau (Kashif Sheikh, University of Alberta, 2006); thus, brown bears are opportunistic omnivores.

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