Figure 2. (top) *Site plan of Zabid, Yemen.*

Figure 3. (bottom, left) *At Zabid Northeast, the underground clay pipes were glazed inside and out.*

Figure 4. (bottom, right) *Zabid East kiln site. Before the 12th century, this was a well. Centuries later, the same ground was used for a graveyard.*

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lead inserted into the mouth. Two of the pipes had been deliberately blocked with a pack of lime plaster. There was little sediment inside the 2 sealed pipes, perhaps an indication that the distribution drum was an effective way of settling the sediment before it entered the pipes.

A short distance upstream, 2 parallel pieces of brick masonry could be seen exposed on the surface of the ground where a bulldozer had been brought to level a new field. The masonry represents the remnant of an underground conduit, which it had been necessary to build higher over time as the sediments rose, a phenomenon now familiar to our project. Since the conduit appears to run directly toward the exposed distribution drum now surrounded by fruit trees, it seems logical to connect the 2. On the other hand, the drum may belong to an entirely different system, but just happens to be in the same area because this is a natural flood course with a reliable supply of seasonal water. The pottery found inside the abandoned drum chamber implies that the system had already fallen into decay well before the 16th century.

These conduits, then, hold the promise of being remnants of Zabid's famous water systems of the 12th to 15th centuries. Clearly, a future season has to be directed toward tracing the course of these conduits underground, both toward their planned destinations, as well as from their respective sources. But, already, their discovery underlines the effectiveness of the ongoing archaeological program.

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Dietary Seasonality among Tibetan Nomads

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MANY TRADITIONAL societies have a single annual harvest that yields insufficient food to last until the following harvest. When this happens, caloric intake exhibits a marked seasonal fluctuation. It results in an involuntary "lean" or "hungry" season to which people adapt by means such as seasonal emigration or weight loss. This dietary seasonality has been seen as a social and health problem to solve.[1] During research in Tibet we identified another type of seasonality of diet. In this type, the seasonal fluctuation in caloric intake is generated by cultural norms and values about ideal diet and effective use of animal resources rather than by food shortages.

The study was conducted in a community of traditional pastoral nomads living in Phala, a harsh, high-altitude (4850 to 5450 m) environment on the Northern Plateau of Tibet (Xizang Daoyuan, in Chinese; Chang Tang, in Tibetan). For centuries these nomads have subsisted by harvesting products from their yak, sheep, and goats, directly consuming some (eg, yogurt, butter, meat, wool) and trading others for goods they do not produce themselves (eg, barley, tea, metalware).[3]

To evaluate the Phala nomads' diet, a sample of 78 person-days of weighed dietary intake was collected in 4 of 10 Phala home-base campsites in 3 seasons during 1987 and 1988. Food weights were converted into caloric values for analysis by age (5 to 14 years, 15 to 59 years) and sex. The food weights attained in individual households accurately reflect total consumption because there are no other sources of food such as shops, restaurants, or forage.

The Phala nomad diet consists of just 16 foods in 4 major categories (Table 1). How much and which foods the nomads choose to eat vary markedly by season (Figure 5). Median total caloric intakes are lowest in all age and sex groups in summer and early fall, intermediate in spring, and highest in winter (Figure 5). Winter medians are higher than summer by 105% for girls, 47% for boys, 248% for women, and 148% for men.

The increase in winter caloric intake is due to an increase in meat calories (Figure 6). Three of the 4 age and sex groups (boys excepted) consume more calories from meat during the winter than from all sources in the summer. Meat consumption in summer derives mainly from animal fat stored since fall that is used to flavor the evening soup. The very high winter meat consumption derives from multiple, daily servings of boiled mutton or yak meat plus stews containing chunks of meat.

Table 1. Foods Consumed by Phala Nomads, Tibet

PRODUCED BY NOMADS THEMSELVES FROM SHEEP, GOATS, & YAK

ANIMAL PRODUCTS
meat
organs
blood
fat

DAIRY PRODUCTS
yogurt
buttermilk & cream
cheese & butter

OBTAINED THROUGH TRADE AND BARTER

MAJOR ITEMS
barley
tea

MINOR ITEMS
rice
flour
dried radish
oil
sugar

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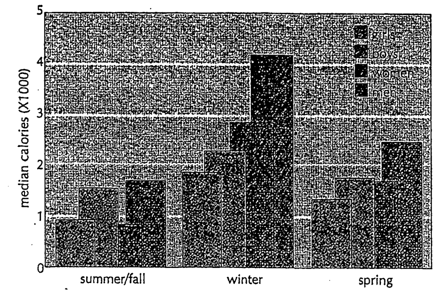

Figure 5. *Seasonal variation in median total caloric intake.*

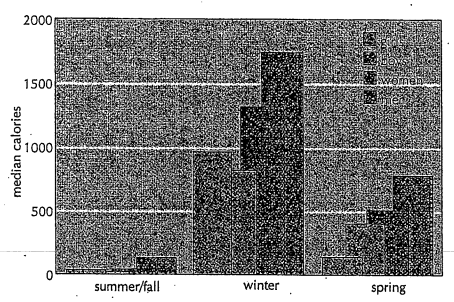

Figure 6. *Seasonal variation in median caloric intake from meat.*

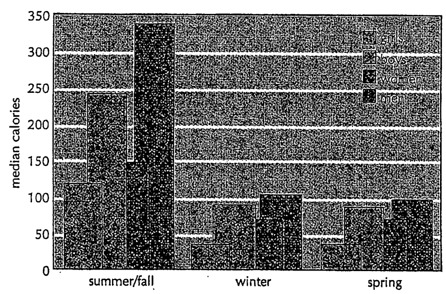

Figure 7. *Seasonal variation in median caloric intake from dairy products.*

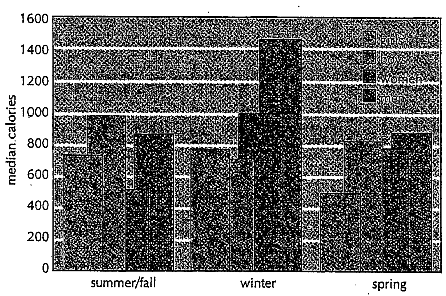

Figure 8. *Seasonal variation in median caloric intake from* tsamba.

Meat calories contribute a median of 36 to 53% (depending upon age and sex) of the caloric intake in winter and are equivalent to 200 to 500 g of boiled mutton daily. By comparison, meat calories contribute only 4 to 8% in summer and 10 to 33% in spring.

Dairy products are abundant during the summer when sheep, goats, and yak all give milk but they do not equal the caloric value of winter meat (Figure 7). Yogurt, cheese, and butter contribute only 12 to 19% of the total daily summer calories. Throughout the rest of the year, Tibetan-style tea prepared with butter and salt contributes nearly all the dairy calories (2 to 5% of the median intake).

Tsamba, roasted barley flour, is a staple food throughout the year (Figure 8). Made from barley obtained through trade (Phala nomads cultivate no crops), it provides a median of 51 to 73% of caloric intake in the summer, 30 to 40% of the caloric intake in winter and 34 to 51% in spring.

Summer caloric intake was below the estimated basal metabolism rate (based on age, sex, and weight)[2] for 17 of the 38 nomads measured in summer 1987. It is not surprising, therefore, that nomads lose body fat during summer, although it is noteworthy that this occurs without signs of undernutrition as measured by upper arm circumference for children under 5 years and by body-mass index for adults.

This marked seasonal variation in diet does not appear to be explained by lower caloric requirements in summer. Subsistence activity is higher in summer than winter because the active day is several hours longer and because milking and milk-processing work peaks then. Depending upon herd size and the family's labor force, women and adolescent girls spend 5 to 8 hours a day milking, and processing yogurt, butter, and cheese. Their workload is lightened when sheep and goats go dry in September and yak milk production decreases. Thus, caloric intake in Phala is lowest when essential subsistence activity is highest.

Similarly, the seasonal variation in diet does not appear to be explained by higher caloric requirements in winter. Energy expenditure for themoregulation (keeping the body warm) is undoubtedly higher during winter than summer, since Phala nomads sleep in unheated tents when winter overnight lows are in the −20 to −40°C range and report feeling cold while herding during winter. However, the observed winter increase in body fat reveals that the high caloric intake more than offsets any increase in caloric expenditure for thermoregulation.

Thus, the Phala nomads' seasonal variation in caloric intake appears to be larger than seasonal variation in caloric requirements and appears to vary inversely with caloric requirements for subsistence, suggesting that there must be another explanation for the low summer intake.

The nomads' own explanation for their high winter meat intake has cultural and economic elements. They consider lean meat to be tasteless, inferior food. They also believe that consuming large quantities of meat and fat is necessary in winter to keep warm. For example, they say they need "thick stews" with plenty of meat and barley flour in winter. Since livestock are fattest (and taste best) in late fall to early winter after the growth of summer and before the deterioration of winter, they slaughter nearly all the animals they plan to use as food at this time. This maximizes the caloric value obtained from each animal and yields the best quality fleece for winter clothes and trading. The system of a single slaughter in late November to early December also facilitates storage because the meat freezes immediately.

The nomads' explanation for their low summer meat intake also has cultural and economic elements. Most nomads have enough livestock to increase their caloric intake by conducting an additional small summer slaughter or simply rescheduling their meat intake by killing fewer animals in winter and more in summer. However, they do not do this because they believe that slaughtering animals in May, June, or early July is wasteful—the livestock are emaciated after the winter and have little meat and fat, and poor quality skins. Most households will slaughter an animal or 2 only after sheep shearing in late July and August. Thus, they consciously decide to consume enormous amounts of fat and meat in winter and virtually none in summer due to cultural conceptions of taste and economic productivity.

The nomads' low summer caloric consumption could be augmented by substituting more grain and dairy products (which they have) for absent meat calories. They do not do this, because they perceive that they are already eating what they need. Summer, for example, is not considered a season of hunger. To the contrary, they perceive that, like winter, it has its own special tasty foods—fresh yogurt and cheese—and they look forward to the abundance of dairy products. They say, in fact, that they eat the same amount in summer and winter. In other words, they do not eat few calories in summer simply because there are fewer calories available to eat.

Several lines of evidence support this contention. First, there is no summer shortage of barley flour. During the summers of 1990 and 1993, we asked numerous males and females of all ages in several campsites whether they were hungry. All responded negatively and said that they could eat more barley flour if they were hungry. Second, rich nomads with hundreds of head of livestock had the same seasonal pattern of low summer consumption of total calories as poor households with just a few dozen livestock (Figure 8). These households could easily afford to eat more meat in summer if they were hungry. Similarly, these households could easily afford to increase barley consumption. However, they too eat fewer barley calories in summer. Men and women from the higher socioeconomic status households have summer median barley calorie intakes that are just 69% and 51% of their winter barley intakes, respectively. Third, there was no summer emigration of nomads to earn income and food elsewhere as is found in many instances of seasonality of diet driven by food shortages. To the contrary, Phala nomads hire dozens of villagers to come from 20 days' trek away to tan skins each summer, even though they know how to do this work. The Phala nomads pay villagers in the form of live sheep and goats which could be used for food if they did their own tanning. This behavior is not consistent with the hypothesis that the Phala community has too few animal resources to eat meat in summer. These multiple lines of evidence argue that the diet of the Phala nomad is not dictated by seasonal poverty or lack of food.

The usual explanation for seasonal variation in diet reasons that food shortages produce "lean seasons" which force reduced caloric intake and that this is an unhealthy situation caused by poverty. The Phala case suggests another model in which a marked seasonality of diet is based on cultural notions of appropriate diet for different seasons and on strategies of herd management and harvest.

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Sable Ecology in Chinese Taiga Forests

Steven W Buskirk, Ma Yiqing, and Xu Li

The sable (*Martes zibellina*), a forest carnivore of boreal and taiga Asia, is best known in the Western world for its precious fur, the quest for which stimulated eastward expansion of the Russian Empire to the Pacific Ocean. But, while the sable seems exotic and unique to Westerners, it actually belongs to a closely related group of species, the boreal forest martens. The 4 species in this group extend from Ireland eastward across the Eurasian and North American boreal zones to Newfoundland.[1] The sable occupies coniferous forest habitats thought to be like those used by the other members of the group.[2]

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Sable populations in many areas of the former Soviet Union have recovered from the severe overexploitation of the 19th century, but those of China have not. This is in part because of the extensive conversion of Chinese coniferous forests to other land uses. As a result, the sable is endangered in China, and classified as a Category I protected species.[5]

In October 1991, we began studying sable ecology in the Daxinganling Mountains of northern Heilongjiang, People's Republic of China (51° 52'N, 123° 12'E; Figure 9). Our aim was to understand better the habitat similarities among the boreal forest martens, and how human uses, especially timber cutting, of coniferous forests may influence sable behavior and populations. Our understanding of other martens, especially the American marten,[3] enabled us to predict specific ways that sables should respond to habitat attributes and habitat disturbance. We expected that sables would prefer old stands with large standing trees; that they would associate with high densities and diameters of coarse woody debris (logs, branches, and root balls); that they would forage mostly where logs and other woody debris penetrated the snow surface; and that human cutting of trees and