

## EFFECTS OF A SNOWSTORM ON TIBETAN ANTELOPE

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The Tibetan antelope or chiru (*Pantholops hodgsoni*) is medium-sized; males weigh 36–55 kg (Engelmann, 1938; Kinloch, 1892) and females 25–30 kg. The lyre-shaped horns of males are distinctive, rising almost vertically from the head for about 50–65 cm (Fig. 1). It survives now primarily in the north-central and northwestern parts of China's Tibetan Plateau, the Qian Tang, an area of >600,000 km<sup>2</sup> uninhabited except for a sparse population of pastoralists near the periphery (Feng et al., 1986). The Qian Tang consists of broad valleys and rolling plains (elev. 4,300–5,000 m) with hills and ranges breaking the expanses (Fig. 2). Drainage is primarily internal, with streams ending in soda lakes. The Qian Tang is arid, high, and cold, and supports only sparse grasses, forbs, and an occasional procumbent shrub such as *Myricaria prostrata*. Yet, a distinct ungulate fauna is adapted to this bleak habitat, including wild yaks (*Bos grunniens*), kiangs (*Equus hemionus kiang*), Tibetan gazelles (*Procapra plecticaudata*) and chirus (Schaller, 1977). Large herds of chirus have been observed; for example, Rawling (1905:85) noted "15,000–20,000 visible at one time."

In the late 1950's a north-south road was built through the eastern edge of the Qian Tang to connect Golmud town in Qinghai Province, with Lhasa in Tibet. Road access soon attracted sheep and yak herders to this previously uninhabited area. On 17 October 1985, a blizzard deposited about 30 cm of snow on the region, the heaviest such fall on record. As part of a project to assess the status of wildlife on the Tibetan Plateau, we visited the area from 22 October to 10 November 1985, during which time we observed the effects of the blizzard on chirus and other ungulates. We returned to the area the next year (18–29 November) to census and assess the condition of wildlife populations.

Most work was done along about 250 km of road from just south of Kunlun Pass to the community of Totohe (Fig. 2). Snow confined us to the road in 1985, except for a 9-day cross-country survey covering 400 km on a tractor-pulled wagon. Wildlife was censused by tallying all ungulates in a 300-m strip on each side of our route.

There was no snow in 1986 and it was possible to travel off the road by car. Stratified sampling was used to census chirus in a 20,000-km<sup>2</sup> area. By scanning the open terrain with 20-power telescopes and driving transects along the road and cross-country, it was apparent that chirus avoided hills and sandy valleys at that season. They favored undulating plains of silt and limestone pebbles, a barren habitat with an estimated vegetation coverage of 10–15% consisting mainly of grasses (*Festuca rubra*, *Poa* sp., and *Littledalea tibetica*).

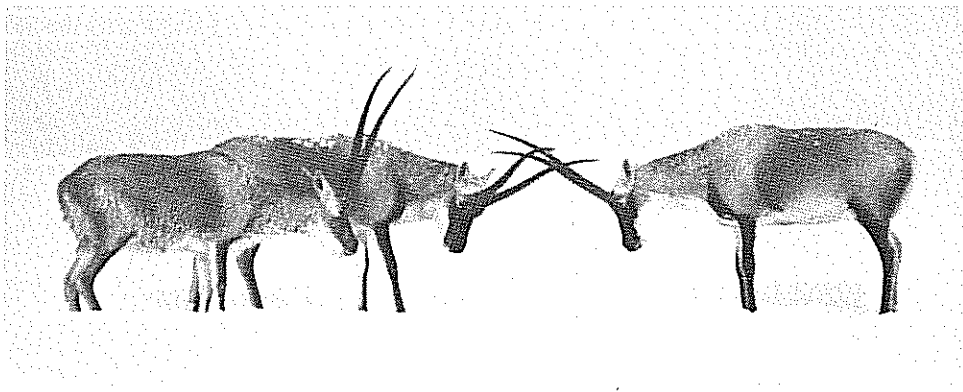


FIG. 1.—Two adult male chirus spar gently while a third stands by with neck held low, a submissive posture.

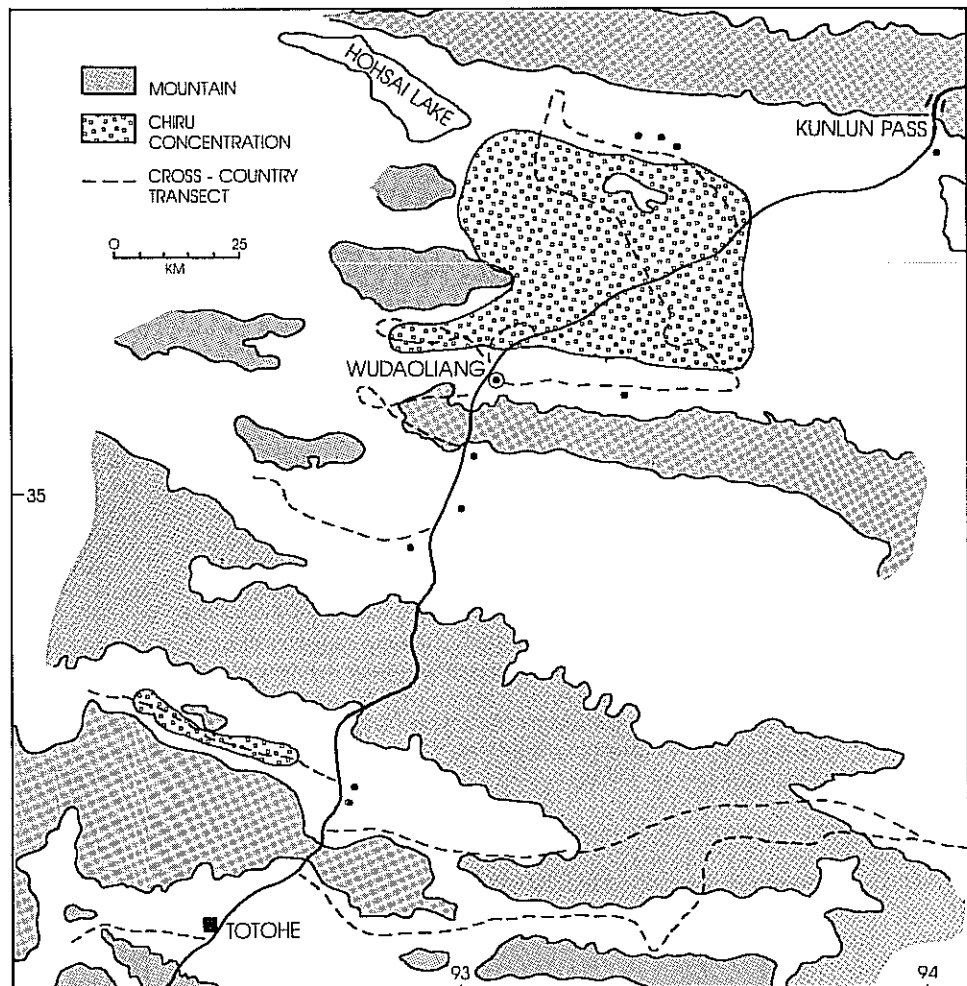


FIG. 2.—Distribution of chirus in the study area, southwestern Qinghai Province, China, November 1986. Each block dot represents a sighting of one-six chirus outside the two population concentrations. The contour line of hills around Totohe is at 4,500 m and farther north at 4,800 m. The long cross-country transect to the east was done in 1985, all others in 1986.

The transects revealed that, except for a few individuals, chirus were concentrated in two areas, a small one N of Totohe and one of about 2,100 km<sup>2</sup> N of Wudaoliang (Fig. 2). Two census-strip widths (600 m and 2,000 m) were used along the road within the latter area for comparative purposes; off the road only the wider strip was used because nearby animals fled from the vehicle.

Animals were classified by sex and age class when possible: adult male, yearling male (horns about 25 cm long), female, and young. Yearling and adult females were nearly the same size and could not be distinguished readily. Young, born in late June (Rawling, 1905), were smaller than adult females and weighed less (young  $15.5 \pm 0.8$  kg,  $n = 3$ ; female  $25.8 \pm 2.6$  kg,  $n = 6$ ).

A total of 267 chirus was counted in the concentration area N of Totohe, a count that probably included most animals in that valley. Road transects of 224 km in the concentration area near Wudaoliang gave a density of 0.8 chirus/km<sup>2</sup> with a 600-m census strip and 0.9/km<sup>2</sup> with a 2,000-m strip. Cross-country transects there totalled 150 km and revealed densities ranging from 0.7 to 4.8/km<sup>2</sup>. Mean density based on all transects was 1.47/km<sup>2</sup>, or about 3,087 chirus in 2,100 km<sup>2</sup>. An estimated 3,500–4,000 chirus occupied the 20,000-km<sup>2</sup> survey area in November 1986. Because size, range, and movement patterns of the chiru population remain unknown, we cannot judge if this density also is typical of other parts of its range. Among other

TABLE 1.—Sex and age composition of the chiru populations in the Totohe and Wudaoliang areas, southwestern Qinghai Province, China, 1985 and 1986.

Area and year	Sample size	Adult ♂ : 100 ♀	Yearling ♂ : 100 ♀	Young : 100 ♀
Totohe				
1985	1,528	31:100	8:100	50:100
1986	274	117:100	2:100	0:100
Wudaoliang				
1985	198	41:100	19:100	58:100
1986	968	61:100	22:100	17:100

species tallied within the transect strips were 90 Tibetan gazelles, 413 kiangs, 9 wild yaks, and 14 wolves (*Canis lupus*).

Chirus were distributed somewhat differently in 1985 than in 1986. As in 1986, there were many animals N of Wudaoliang, but, in addition, they were common in broad sandy valleys where grass (*Agropyron cristatum*, *Trisetum spicatum* and *Stipa purpurea*) is more abundant than on the high plains. Concentrations of chirus occurred just south of Kunlun Pass and in all valleys between Wudaoliang and Totohe. Animals were especially plentiful near Totohe where not one individual was seen in 1986. Their forage covered with snow, animals were moving extensively, and we were unable to estimate numbers beyond noting that several thousand were near the road. About 700 chirus were seen between Kunlun Pass and Wudaoliang on 22 October, and road transects there gave an estimate of 2.3/km<sup>2</sup>. Between Wudaoliang and Totohe the density along the road was 1.2/km<sup>2</sup>. At least 1,000 chirus moved northeast past Totohe on 24 October. There were few chirus along 100 km of road S of Totohe (0.2/km<sup>2</sup>), and along a 400-km cross-country transect E of Totohe (0.4/km<sup>2</sup>).

Excluding lone individuals, generally adult males, mean herd size was 16.9 ± 32.1 in 1985 (*n* = 137 herds) and 9.2 ± 9.7 in 1986 (*n* = 147 herds). Most herds (71%) had two–20 members and some as many as 40. In 1985, 13 herds, usually migrating ones, contained >40 individuals, the three largest numbering 108, 157, and 279; in 1986 only two herds with >40 individuals (44, 74) were observed.

Snowfalls on the plateau tend to be light, seldom more than 10 cm accumulating at a time. Sun and wind normally clear snow away from exposed sites within days, but the heavy October 1985 storm was followed by unseasonal calm and low temperature (to -40°C and lower) and the snow remained. Unable to obtain grass except by digging craters in snow with sweeps of a foreleg, chirus had to expend much energy to obtain little nourishment. By the end of October some animals had died of malnutrition. Weakened physically and hampered in their movements by snow, animals near herders' tents, road maintenance camps, and other habitations were killed by dogs and shot by people. We found 31 carcasses: 19 dog kills, 9 dead of malnutrition, and 3 dead of unknown causes. The bone marrow of all 22 chirus examined (15 of them dog kills) was like soft, reddish gelatin, wholly depleted of fat. The dead included 1 adult male, 6 yearling males, 11 females, and 13 young. There was a disproportionately small number of adult males and large number of subadults in this sample compared to the composition of the living population (Table 1). The results were verified in 1986 when skeletons and partially mummified bodies of 193 chirus were found in one valley W of Totohe; sex and age classes deviated significantly from the expected number based on sex and age classes in the living population (Table 2). Judging by tooth eruption and wear in a sample of 88 lower jaws, females of all ages died: 11 yearlings (second molar erupted), 13 2½-year-olds (third molar erupted), 28 prime animals (some tooth wear but infundibuli persisted on all molars), 20 somewhat past prime (one or both infundibuli off first molar), and 16 old animals (one or both infundibuli off second molar).

A large animal has a lower metabolic rate and lower food requirements per unit weight than a small animal (Moen, 1973), and it requires proportionally less energy to travel through snow and dig for food. It is, therefore, not surprising that heavy and tall adult males with a shoulder height of 94 cm (Engelmann, 1938) survived better than yearling males (shoulder height, 76.8 ± 0.9, *n* = 3), females (73.4 ± 2.7, *n* = 6) and young (63.4 ± 2.2, *n* = 7). Furthermore, adult males probably were in good condition with ample fat deposits just before the rut, whereas females and young may have had low energy reserves, the former after rearing offspring (at least five of nine adults were lactating at time of death), and the latter because of rapid body growth. Dead animals usually had grass in the rumen, indicating that malnutrition rather than just lack of food caused death. Among other species in the area, many gazelles died but relatively few kiangs; the 127 families of the Totohe commune lost two-thirds of 86,000 sheep and half of 8,200 yaks.

The rut of chirus is in late November and December (Rawling, 1905), yet there was no indication of its approach in November 1985. By contrast, a year later a pre-rut was evident. An adult male then often

TABLE 2.—Actual and expected number of deaths due to malnutrition among 193 chiru carcasses examined at Totohe, southwestern Qinghai Province, China, 1986.

Age and sex class	Actual number <sup>1</sup>	Expected number <sup>2</sup>
Adult male	3	32
Yearling male	20	8
Female	89	102
Young	81	51

<sup>1</sup> Chi-square test indicated significant difference from expected ( $\chi^2 = 300.54$ ,  $df = 3$ ,  $P < 0.001$ ).

<sup>2</sup> Based on proportion of each sex and age class represented among 1,726 living animals classified in 1985 (Table 1).

associated with several females, tried to herd back any female that strayed, and trotted with lowered horns at nearby males, displacing them, as if attempting to maintain a harem. A walnut-sized nasal sac bulged from the side of each nostril of males, a unique anatomical feature in this species that was not as prominent in 1985 as in 1986. These sacs may function as resonators for the "deep-toned roar" (Rawling, 1905:311) given by males at that season. With animals in poor physical condition, the 1985 rut may have been delayed and of low intensity as females failed to enter estrus. For females that mated, conception and fetal survival rates may have been low, judging by the small crop of young in 1986. Of 125 females observed in the Totohe area, none had young and in the Wudaoliang area the ratio was only 17 young:100 females, in contrast to 1985 when about half the females were accompanied by young (Table 1).

With the death of relatively few adult males but many females and young, the proportion of adult males in the population increased. Although chirus in both Totohe and Wudaoliang areas probably represent segments of a single population with a center of activity west of the road, each segment may have its traditional wintering grounds. The die-off in the Wudaoliang area did not seem as severe (Table 1). Totohe was still deep in snow in mid-November 1985, whereas Wudaoliang had patches of exposed grass by that time. Consequently, relatively few females and yearling males may have died there, and some young were born there in 1986.

Male and female chirus are partially segregated in summer, each sex sometimes concentrating in different areas. Such behavior may skew sample counts. Because we surveyed a large region just before the rut, the sexes probably were represented in their true proportions. The sex ratio in 1985 markedly favored females, suggesting high mortality of males in previous years. Rawling (1905:312) noted fights during the rut "in which blood flows freely," possibly a mortality factor in males. Among North American ungulates, adult males may succumb in disproportionate numbers during severe winters after having their energy reserves reduced by the rigors of the rut, as, for example, reported for moose (*Alces alces*; Lent, 1974) and pronghorns (*Antilocapra americana*; Martinka, 1967). Chiru males may be affected similarly if adverse conditions occur after rather than, as we observed, before the rut.

A minor vagary in weather not only caused the death of an unknown but large number of chirus, but also had a major effect on the structure of the population. Reproductive success was greatly reduced for a 2-year period and the sex ratio of adults was altered markedly. The single 1985 snowfall will affect the dynamics of the population for years.

This work represents a collaborative effort between Wildlife Conservation International of the New York Zoological Society, the China Wildlife Conservation Association, the Ministry of Forestry in Beijing, and the Forest Bureau of Qinghai Province. Guo Geiting and Qiu Mingjiang helped us in the field in 1985, and Zheng Jie and Wang Haibin did so in 1986. Liu Shangwu, Academia Sinica, Xining, kindly identified the plants.

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