

Status of Tibetan plateau mammals in Yeniugou, China

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During September 2002, we conducted surveys focussing on the Tibetan plateau ungulate species in Yeniugou, Qinghai province, China, to compare abundance estimates with those from 1997 and the early 1990s. Wild yaks *Bos grunniens*, for which the area is named, evidently increased in number from about 1,200 to almost 1,700 animals. White-lipped deer *Cervus albirostris*, formerly quite rare in Yeniugou, also increased in number. Blue sheep *Pseudois nayaur*, Tibetan gazelle *Procapra picticaudata* and Tibetan wild ass *Equus kiang* remained almost steady or may have declined slightly. Tibetan antelope *Pantholops hodgsoni* which were historically resident in Yeniugou, but suffered a dramatic reduction during the 1990s, were completely absent in 2002. Argali *Ovis ammon* evidently continued to decline from their early 1990s level of approximately 250; we accounted for only 94 animals in 2002. We are uncertain of the causes for the argali decline, but the best supported hypothesis is that the recent increase in year-round presence of specific pastoral encampments has displaced argali groups from preferred seasonal foraging areas, causing permanent emigration, lower reproduction, higher mortality or some combination of the three. Poaching and disturbance from itinerant gold miners have declined in recent years, and most remaining species are fairing relatively well. The rapid development associated with the adjacent Qinghai-Tibet railroad has not yet affected the wildlife populations. Yeniugou contains probably the densest population of wild yaks in existence. Unfortunately, despite its obvious importance for Tibetan plateau fauna, Yeniugou still has no conservation-oriented management. Thus, wildlife populations are controlled indirectly by social and economic forces. Most Tibetan plateau mammals have limited tolerance for human activity; they persist in Yeniugou because people are still sparse. With the continued rapid economic development of nearby areas, the future of Yeniugou's wildlife will not be secure until incentives are created for pastoralists, county officials and higher government authorities to favour maintaining its essentially wild and undeveloped character.

Key words: *Bos grunniens*, *Cervus albirostris*, *China*, *Ovis ammon*, *pastoralism*, *Pantholops hodgsoni*, *Pseudois nayaur*, *Qinghai*, *Tibetan plateau*

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For an area of low primary productivity, the Tibetan plateau contains a surprising diversity of large mammal species. Although detailed ecological studies are still lacking, it appears that most large mammals compensate for paucity of resources by occasional migratory movements or by having large home ranges. Thus, long-term persistence of these species requires that human alterations of, or disturbances to, their wild habitat be either restricted geographically or of limited intensity. It is not surprising that all species of Tibetan plateau ungulates are listed on either Appendix I or II of CITES, and under various classifications in the IUCN Red List (Wilson & Reeder 1993, Hilton-Taylor 2000). Nomadic pastoralism has been the predominant land-use of the Tibetan plateau for centuries, and most wild species have long since accommodated to such low-intensity use. With the recent push to 'exploit' China's western regions (China Daily 2001, Glantz, Ye & Ge 2001), socio-economic conditions on the Tibetan plateau are undergoing rapid fluxes, and thus the future of this unique fauna is in question.

Although situated in the neighbouring province of Qinghai rather than in the Tibetan Autonomous Prefecture itself, a portion of the Kunlun Mountains colloquially named Yeniuogou (literally 'wild yak valley') has for years been recognized by Chinese scientists and authorities as a stronghold of Tibetan plateau ungulates (Cai 1997, Cai, Liu & O'Gara 1990), particularly the wild yak *Bos grunniens*. Although not completely clear, we suspect that the principle reason for the relatively high densities of large mammals in Yeniuogou is geographical: relatively high amounts of precipitation have produced glaciers and permanent snow fields along the north-facing slopes of the Kunlun Mountains, whereas much drier and somewhat lower slopes characterize the mountains just a few kilometres to the north. The diversity of habitats caused by the proximity of lush, snow-fed meadows and dry, desert conditions evidently allows for high reproduction to offset the inevitable human-caused mortality. Despite its importance, Yeniuogou has never been accorded any official conservation status, and land use continues to be dominated by pastoralism. In 1995, approximately 45,000 km² of lands directly to the south and west of Yeniuogou were designated as the Kekexili Nature Reserve, which was elevated to 'national level' status in 1997 in an attempt to protect the declining herds of Tibetan antelope *Pantholops hodgsoni* (also called chiru). However, Yeniuogou was not included within Kekexili, and thus wildlife congregating there is protected only by the national wildlife law that bans poaching.

Beginning in 1990, collaborative surveys by the Chi-

nese Academy of Sciences and the University of Montana (UM), USA, have documented the status and conservation prospects of wildlife in Yeniuogou (Harris 1993, Harris 1995, Harris & Miller 1995, Harris, Miller, Cai & Pletscher 1996, Miller, Harris & Cai 1994). In 1997, a group from UM returned to Yeniuogou to assess trends during the 1990s (Harris, Pletscher, Loggers & Miller 1999). The major finding of that survey was that resident Tibetan antelope, which had been numerically dominant in the early 1990s, had been decimated by poaching. Most other species had evidently remained relatively stable, although we noted troubling declines in both blue sheep *Pseudois nayaur* and argali *Ovis ammon* (Harris et al. 1999). Here, we report on an additional follow-up survey we conducted in 2002.

Study area

Yeniuogou is an interior valley within the Kunlun Mountains in Haixi Mongolian People's Autonomous Prefecture, situated in Qinghai Province at approximately 35° 50'N, 91-93° E (Fig. 1). Elevations on the valley floor vary roughly within 3,800-4,200 m a.s.l.. The main Kunlun range (elevations up to 5,921 m a.s.l.) lies to the south of the Yeniuogou River, and isolated massifs of up to 5,521 m a.s.l. in the north. The valley totals an area of approximately 3,900 km², although studies were conducted only within a smaller, core area of approximately 1,200 km². Yeniuogou is characterized by high



Figure 1. Location of the Yeniuogou study area within the province of Qinghai, China with inset showing the location of Qinghai within China.

elevations, low annual precipitation and shallow soils. Vegetation consists predominately of graminoids (notably *Stipa*, *Kobresia* and *Carex* spp.) and forbs. Trees do not grow at these elevations. Height of vegetation ground cover tends to be low (5-25 cm; Zhou 1990, Harris & Miller 1995), and parts of the area at higher elevations are devoid of all vegetation. Further information on vegetation in Yeniugou can be found in Harris (1993) and Miller & Bedunah (1994).

Yeniugou is situated in a transition zone between traditionally Mongol and Tibetan ethnic areas. During the 1930s, a group of Kazaks seeking refuge from persecution in Xinjiang also began settling in the area. Tibetans were the original inhabitants of Yeniugou, but they were removed in the early 1950s, and their grazing rights revoked. From the early 1950s through 1983, grazing rights belonged to the Kazaks. In 1984, the area was officially handed over to a group of Mongol pastoralists when the majority of Kazaks moved back to Xinjiang (Qinghai Bianjizu 1985). Thus, three different ethnic groups have occupied Yeniugou in the past 45 years.

Mongol pastoralists initially used Yeniugou only during summer returning to winter pastures near the town of Golmud each year. There appeared to be little systematic allocation of pastures among pastoral groups in the early 1990s, and drainages occupied by an encampment in a given summer would not necessarily be occupied by the same, or indeed any, pastoralist the following summer (Harris 1993). In recent years, government policies have increasingly stressed a clarification of grazing boundaries and fixing of grazing seasons. The number of Mongol pastoralists using the valley has evidently remained approximately stable, but resident pastoralists have adopted a more sedentary style of animal husbandry. These pastoralists now spend all year within Yeniugou, and boundaries of both summer and winter pastures are defined and allocated to specific families. According to Kazak informants, who witnessed both periods, two phenomena characterized the transition from Kazak to Mongol occupancy of Yeniugou: 1) the movement of gold miners, based in eastern Qinghai, through Yeniugou to suspected deposits to the west, and 2) commercial hunting of wildlife by outsiders, primarily of yaks and argali, and primarily in winter. Both of these activities were illegal; in practice, both were virtually uncontrolled. Further information on the cultural history of the area is reported in Harris (1993).

Since the adoption by national authorities of the 'Great Western Development Strategy' in 1999 (Crisp & Tang 2000), remote areas such as Haixi Prefecture in west-

ern Qinghai (in which Yeniugou lies) have been the focus of considerable economic development activity. The economic centre of Haixi, Golmud, doubled in population between 1984 and 2001 (Wu & Li 2001). However, China's extensive rail transportation network had never penetrated onto the Tibetan plateau (despite failed efforts to do so in the 1950s), and it was in the context of the greater, regional strategy that the central government announced in February 2001 the initiation of work on a rail line connecting Golmud in western Qinghai with Lhasa in the Tibetan Autonomous Regions (Economist 2001). Construction teams were quickly mobilized, and by July 2001 a massive construction project involving an estimated 400,000 workers was underway along the present route of the motorway connecting the two cities (Wu & Li 2001). The railroad under construction passes approximately 50 km from the nearest part of the study area.

Methods

We spent the period 3-22 September 2002 in Yeniugou. We interviewed local pastoralists encountered, as well as county officials in Golmud and Xining, Qinghai's provincial capital. We observed wildlife during foot-surveys along predetermined routes (vehicles were used to transport base camps along the main river valley). To maximize the validity of comparisons, we used the same methods as during our 1997 surveys and surveyed the same subdrainages on approximately the same calendar date (Fig. 2). We documented all travel routes on 1:100,000 topographic maps and later calculated distances travelled. Most observations were aided by binoculars or 20-42x zoom spotting scopes. We focused our attention on Yeniugou's wild ungulate fauna, particularly the three species we believed most susceptible to recent declines at the hands of humans: wild yak, Tibetan antelope and argali. Time constraints did not allow us to conduct distance sampling surveys for Tibetan wild ass *Equus kiang*, Tibetan gazelle *Procapra picticaudata* and Tibetan antelope *Pantholops hodgsoni* as we had during 1991; violation of critical assumptions rendered distance sampling inappropriate for wild yak, blue sheep and argali in any case (Harris 1993, 1996). When appropriate, we estimated the probability that multiple sightings in the same general area represented duplicate counts and adjusted our counts accordingly (Harris 1993, 1994). We make no claim that the number of animals observed during any of the four survey periods represent fully unbiased population estimates as we can not account for animals that may nev-

er have been observed, and only have qualitative means to assess varying detectability. However, by replicating observations under similar conditions (Table 1), we believe that gross population changes were unlikely to be confounded with counting inaccuracies.

Results

Wild yak

Our best estimate of the number of wild yaks observed during September 2002 is 1,697; about 400 more than we observed in the same area during September 1997 (see Table 1). Yak groups often move among subdrainages, particularly during the transition from summer to autumn foraging sites (Harris & Miller 1995), which makes assessment of possible duplicate counts difficult. However, in September 2002 most yaks occurred in large, reasonably distinguishable maternal groups (including all sex/age classes) that were relatively sedentary during the survey period, and on a number of occasions we were able to document what appeared to be the same group in approximately the same location during intervals as long as 17 days. Thus, we believe that any duplicate counting of individuals was negligible.

As in earlier surveys, most large yak groups occurred along the north-facing slopes characterized by moist, *Kobresia*-dominated sedge meadows, typically at 4,500-4,800 m a.s.l. (Fig. 3). Also as in previous years, we noted scattered individual adult males throughout the study

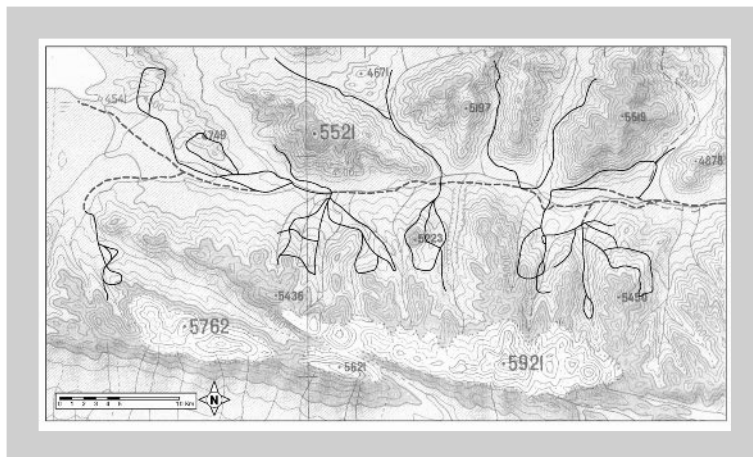


Figure 2. Study area within Yeniugou, showing routes walked (—) and driven (- -) during the September 2002 survey. The main crest of the Kunlun Mountains (elevation markers 5762 and 5921 m) bounded our surveys to the south, the Yeniugou river flows west to east through the middle of the map and the blank area in upper left corner is the Black Lake.

area, especially in the drier, south-facing slopes north of the Yeniugou River. However, unlike in previous years, we also noted large maternal groups north of the river. In contrast to the north-facing slopes fed by glaciers and snow-fields, these drier valleys have only small, scattered sedge meadows, but most of these were occupied by large groups of yaks. In 2002, we tallied 379 of the total 1,697 animals counted north of the river, whereas in 1997, only 120 of the estimated 1,297 animals were observed north of the river.

Prior to this survey, we had no reason to suspect a history of hybridization between wild and domestic yaks. However, in 2002 we observed a single white-faced yak. No domestic yaks were present in Yeniugou during 2002, but a herd of about 25 had been kept by a Mongol pastoralist during 1996-1997.

Table 1. Survey conditions and estimated number of animals of each species observed in the large mammal surveys conducted in Yeniugou, Qinghai Province, China, during 1991-2002. Confidence limits (given in parentheses) apply to number of animals observed, not necessarily to animals present.

Survey conditions	1991 ¹	1992 ¹	1997 ²	2002 ³
Time period	18 Sep-5 Oct	6-29 August	2-23 September	3-22 September
Weather conditions	always clear	almost always cloudy	always clear	usually cloudy
Vehicle only route (km)	33	69	85	79
Foot/horseback route (km)	319 ⁴	232	255	267
Species				
<i>Equus kiang</i>	843 (618-1052)	<100	418	506
<i>Cervus albirostris</i>	10	16	85 (80-89)	119 (111-127)
<i>Bos grunniens</i>	1223 (1014-1494)	841	1297	1697
<i>Procapra picticaudata</i>	1511 (1037-1985)	not estimated	not estimated	not estimated
<i>Pantholops hodgsoni</i>	2076 (927-3247)	not estimated ⁵	2	0
<i>Pseudois nayaur</i>	1200 (1150-1261)	1060 (1053-1077)	839	701
<i>Ovis ammon</i>	245 (238-256)	191 (188-218)	141	94

¹ Harris 1993;

² Harris et al. 1999;

³ Present study;

⁴ Includes 52 km of line-transect surveys (Harris 1996) and survey routes conducted in July 1991;

⁵ Unstructured observations suggested *P. hodgsoni* to be present in similar areas and densities to those documented in 1991.

day. Our uncertainty arises because of a group of 15 animals that appeared similar in composition to a group of 16 seen nine days earlier at a position 21.5 km away.

Our best estimate of the number of blue sheep observed during September 2002 was 701, somewhat fewer than the 839 estimated observed during 1997 (Harris et al. 1999) and the 1,150-1,261 estimated observed in 1991 (see Table 1). Blue sheep groups were found in most, but not all of the previous locations, but, when found, group size was generally similar to those documented in previous surveys. Weather conditions often made observing blue sheep difficult; thus we suspect under-counting was more pronounced for blue sheep than other species.

We estimate that we observed 506 individual Tibetan wild ass during September 2002, which is similar to the total of 418 seen in 1997 (Harris et al. 1999), fewer than our 1991 estimate of 843 wild ass (95% CI = 618-1,052), but more than we observed during 1992 when < 100 were documented (see Table 1). We believe that the wide disparity in counts of wild ass reflects their mobility and variable choice of location for resource availability rather than true changes in abundance.

Inability to conduct distance sampling (line-transect estimates) during 2002 precluded us from quantifying the number of Tibetan gazelle. However, frequency of observation, group size and group distribution suggested that gazelle abundance was roughly similar to the 1,511 (95% CI = 1,037-1,985) estimated in 1991.

Distance sampling was unnecessary to quantify Tibetan antelope, numerically the most abundant ungulate in Yeniuogou during the early 1990s, with an estimated 2,076 (95% CI = 927-3,247) present in 1991. Despite extensive searching all calving and wintering areas which we had documented antelope inhabiting during the same time period in the early 1990s, we did not record a single Tibetan antelope in Yeniuogou during September 2002.

As during earlier surveys, we made opportunistic observations of carnivores, including wolves *Canis lupus*, brown bears *Ursus arctos*, lynx *Felis lynx*, red and Tibetan foxes *Vulpes vulpes* and *V. ferrilata* and Altai weasels *Mustela altaica*. During our September 2002 survey, we documented the presence of Eurasian badger *Meles meles* for the first time in Yeniuogou. We accounted for at least six individual brown bears during our 2002 survey (five observed directly including a female with two cubs, and one inferred from footprints which could be reliably dated and, from their location, were unlikely to have been made by any of the five bears observed). Although we hesitate to impute much meaning to such a small sample, the relative ease with which

we encountered bears struck us as noteworthy (one of our observed bears was encountered independently on three separate occasions). Bears on the Tibetan plateau are extremely wary of people, so our observations suggested to us that human disturbance in Yeniuogou had remained low.

Numbers of Himalayan marmots *Marmota himalayana*, Tibetan hares *Lepus oiostolus* and Mongolian five-toed jerboa *Allactaga sibirica* appeared unchanged from the early 1990s. Plateau pikas *Ochotona curzoniae*, the subject of considerable reduction efforts elsewhere on the Tibetan plateau, were abundant. We noted that brown bears, Tibetan foxes, Saker falcons *Falco cherrug* and Hume's groundpeckers *Pseudopodoces humilis* were always associated with habitats containing high pika densities (Smith & Foggin 1999). In one case, a Tibetan fox was seen closely following the movements of a brown bear that was excavating pikas. The fox appeared to be attempting to benefit from capturing pikas disturbed (but not captured) by the bear.

Management

We observed 22 pastoralist camps in Yeniuogou during September 2002, compared to 19 in 1997, 29 in 1992 and 15 in 1991. Of these 22 camps, nine were located within the study area in close proximity to wild ungulates. Pastoralists we interviewed told us that livestock herd sizes averaged about 650, suggesting that there may have been about 14,300 domestic sheep (including roughly 20% goats) in Yeniuogou, of which some 5,850 were located near wild ungulates. We were informed by resident Mongol pastoralists that winter trespassing by Tibetans (who raise domestic yaks) living to the south had stopped, and we saw no field evidence to challenge that assertion. In accordance with general policies throughout pastoral western China in recent years, all guns had been confiscated from pastoralists during the previous year.

In contrast to earlier surveys, we observed no itinerant gold miners in Yeniuogou in 2002, nor did we encounter any along the highways leading toward it from eastern Qinghai province (from which most originated during the 1990s). Provincial and county officials informed us that enforcement of bans on placer gold mining had recently been strengthened, and our observations tend to corroborate this. Activity associated with the construction of the Golmud-Lhasa railway was considerable along the existing highway, and we occasionally heard blasting from gravel operations from a distance of some 40-50 km while observing

wildlife. However, we saw no evidence that construction or related impacts had yet affected wildlife within the study area. Authorities in Golmud had begun promoting small-scale tourism in Yeniugou, focussing not on wildlife, but instead on the Black Lake and various Daoist religious shrines built in recent years. Tourists, mostly from Taiwan, travelled along the main valley road in jeeps, staying overnight in Yeniugou.

As of September 2002, no government-sponsored wildlife conservation or management activities had yet been implemented in Yeniugou. A tentative proposal designating Yeniugou (as well as a similar valley called Xiu-gou further to the east in the Kunlun Mountains) as a nature reserve had been drafted, but provincial authorities in Xining viewed it (probably correctly) as primarily an attempt to direct government funds toward Golmud. Plans for nature reserves in remote areas of western China often call for an intensity of construction, staffing, access development, research and monitoring that is inconsistent with the conservation of the species that are sensitive to human disturbance. Officials in Golmud had not yet visited Yeniugou, and information available to them came primarily from our own, earlier surveys.

Discussion

As its name suggests, Yeniugou has long been associated with wild yaks. Our interest in the area began in the late 1980s, when reports of substantial poaching of yaks prompted concerns about their status. Commercial poaching of wild yaks appears not to have occurred since that time, and subsistence poaching by pastoralists has evidently occurred at a low-enough level to allow for a population increase. The proximity of moist sedge meadows, favoured during summer, with lower elevation *Stipa*-dominated grasslands used during winter, evidently provides high quality habitats for wild yaks. Wild yaks are still very vulnerable to human disturbance, but are evidently able to tolerate low density pastoralism in the area. Yeniugou probably contains the densest congregation of wild yaks anywhere in the world, and clearly represents an important component of their entire range (Schaller & Liu 1996).

We considered two hypotheses regarding the continuing, slow decline of argali observed in Yeniugou (from approximately 250 to < 100 within 10 years): 1) poaching and 2) displacement by pastoralists, resulting in either permanent migration, or lowered reproduction incapable of balancing the mortality. We lack evidence that would conclusively reject poaching as a principal factor, but although we do not doubt that some occurred,

we are sceptical that it alone caused the observed decline. With the increased awareness of the poaching problem in recent years (largely generated by publicity about declining numbers of Tibetan antelope), we believe that commercial poaching (and associated marketing of meat or other products) would have become known to law enforcement authorities (none was reported). Small-scale subsistence poaching could well have occurred, but pastoralists are no longer armed, do not lack meat and our experience in the neighbouring province of Gansu suggests that pastoralists rarely have easy access to argali because their own activity displaces the animals to more distant slopes (Harris & Pletscher 2002). We observed no field evidence of argali poaching.

Documenting displacement of wildlife by human activity is always difficult, to say nothing of linking displacement with demographic responses. Thus, we can not be entirely confident that pastoralism is to blame for the argali decline. However, changes in the patterns of pastoralism and of argali distribution (see Fig. 4), together with indications from work in nearby Gansu (Harris & Pletscher 2002) form a pattern consistent with this explanation. Although pastoral encampments remained few in 2002, they had become more sedentary than during earlier decades. Perhaps more importantly, they were located in precisely the areas that argali had preferred during late summer and early autumn of earlier years, as well as in areas we inferred were important for argali during winter. These areas, in which we observed the majority of argali during the 1990s, held no argali in 2002. Instead, the majority of the argali we observed were located in the most remote places in the valley system, where forage production appeared to be lower.

Unlike the related blue sheep, argali appear unable to obtain the quantity and quality of forage they need from sparse, high-elevation sedges and forbs. Argali depend on availability of a substantial quantity of grass in summer (Harris & Miller 1995) supplemented with shrubs in winter (Harris & Bedunah 2001). Among Tibetan plateau ungulates, argali also appear to be the most intolerant to human disturbance, moving to alternate areas when people are present.

In contrast to the situation with argali, widespread poaching of Tibetan antelope during the 1990s was documented by county-level officials in Golmud, and was observed personally by a Kazak pastoralist whom we knew to be a reliable observer. We doubt that domestic livestock were implicated in the disappearance of Tibetan antelope because we have no evidence that domestic herds had used areas formerly frequented by the Tibetan antelope. Because Tibetan antelope are capa-

ble of long-distance movements, we can not definitively dismiss the possibility that what appeared to be a dramatic population reduction was, instead, a redistribution or alteration in timing of movements. However, our previous surveys and information from pastoralists present from the 1950s through the early 1980s suggest that our study area encompassed the year-round distribution of Tibetan antelope within Yeniugou (Harris et al. 1999). Additionally, we noted a complete lack of skulls, tracks and droppings from Tibetan antelope in 2002, all of which we commonly encountered prior to our 1997 survey. Thus we interpret the absence of antelope in 2002 as confirming our earlier interpretation that the species is now extirpated from Yeniugou. Its future in this valley system will require recolonisation from nearby herds.

The fact that white-lipped deer and brown bears had persisted in Yeniugou suggests that, with the exception of antelope poachers in the mid-1990s, human disturbance had remained relatively low. White-lipped deer and brown bears (along with wild yaks and argali) are likely to disappear when human presence increases. For example, local respondents and officials were unanimous in reporting that these four species were very rare or had been eliminated from the central and eastern Qilian Mountains in Sunan County, Gansu, whereas blue sheep, Tibetan wild ass and Tibetan gazelle numbers remained locally high (R.B. Harris, unpubl. report to the World Bank Gansu and Xinjiang Pastoral Development Project, 2002). The reduction in traffic and poaching from gold miners no doubt had a beneficial effect on these sensitive species.

However, whether the relatively undisturbed nature of Yeniugou can continue in the face of the rapid development in western China (and lacking specific management plans to prioritize wildlife) is unclear. We conclude that the long-term persistence of Yeniugou's unique wildlife requires a government policy favouring the maintenance of it in a primitive state, a direction that is contrary to the general thrust of development, exploitation and modernization in western China.

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