Tibetan antelope migration during mass calving as parasite avoidance strategy

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The Tibetan antelope (*Pantholops hodgsonii*), or chiru, is an endemic animal of the Qinghai-Tibet Plateau that lives in alpine meadow, grassland, and desert habitats at altitudes ranging from 4,100 to 5,200 m above sea level.[1] Following near extinction toward the end of last century, the population has grown rapidly over the last couple decades and now is estimated at nearly 300,000 individuals (https://english.www.gov.cn/202108/23/content_WS6122f504c6d0df57f98deff8.html). The rapid recovery of Tibetan antelope populations is due in large part to the Chinese government's strong emphasis on ecological protection and associated environmental policies and programs. For example, the Sanjiangyuan ecoprotection comprehensive experimental region, Hoh Xil World Heritage Site, and Sanjiangyuan National Park have all recently been established on the Qinghai-Tibet Plateau (in 2000, 2017, and 2021, respectively)—each covering, in turn, 395,000, 60,265, and 190,700 km^2 (these areas are partially overlapping) and collectively encompassing the largest contiguous area of formally protected land in China (https://epaper.chinadaily.com.cn/a/202110/14/WS616758e4a31019b029ba0f93.html). Furthermore, within the Sanjiangyuan National Park, each family has a designated "ecological steward" to whom government pays 1,800 Yuan per month (approx. $260 USD), simultaneously seeking to strengthen the regional conservation workforce and to reduce local (mainly Tibetan) herders' dependence on grasslands and animal husbandry. Construction of wildlife passages under the Qinghai-Tibet Railway and removal of fences in core areas have ensured the connectivity of key wildlife habitats and the Tibetan antelope's migration routes. Female antelope are migratory: more than 20,000 travel each year across the vast Changtang (Qiangtang), Aljin (A'erjin), and Yushu grasslands in Tibet (Xizang), Xinjiang, and Qinghai provinces to their calving grounds in the Hoh Xil (Kekexili) steppe and desert wilderness.[1,2] The densest aggregation is around Zhuonai Lake (N 35°29.2′, E 91°58.3′, average elevation 4,773 m above sea level).

The driving purpose or benefits accrued from such long-distance migrations have long remained a scientific mystery. Escape from parasites is proposed as an evolutionary driver of seasonal migrations, as migratory hosts can have lower levels of parasitism than year-round residents.[3] One recent comprehensive study of the Tibetan antelope identified 12 genera of gastrointestinal parasite eggs/oocysts present in their feces. From field expeditions to Zhuonai Lake during two consecutive breeding seasons, we found that the dominant nematode eggs were *Trichostrongylus*, *Marshallagia*, and *Nematodirus* spp., which also are found in Svalbard reindeers and muskoxen in the cold northern Arctic[4] and in Saiga antelope in temperate regions of Central Asia.[5] Female Tibetan antelope travel

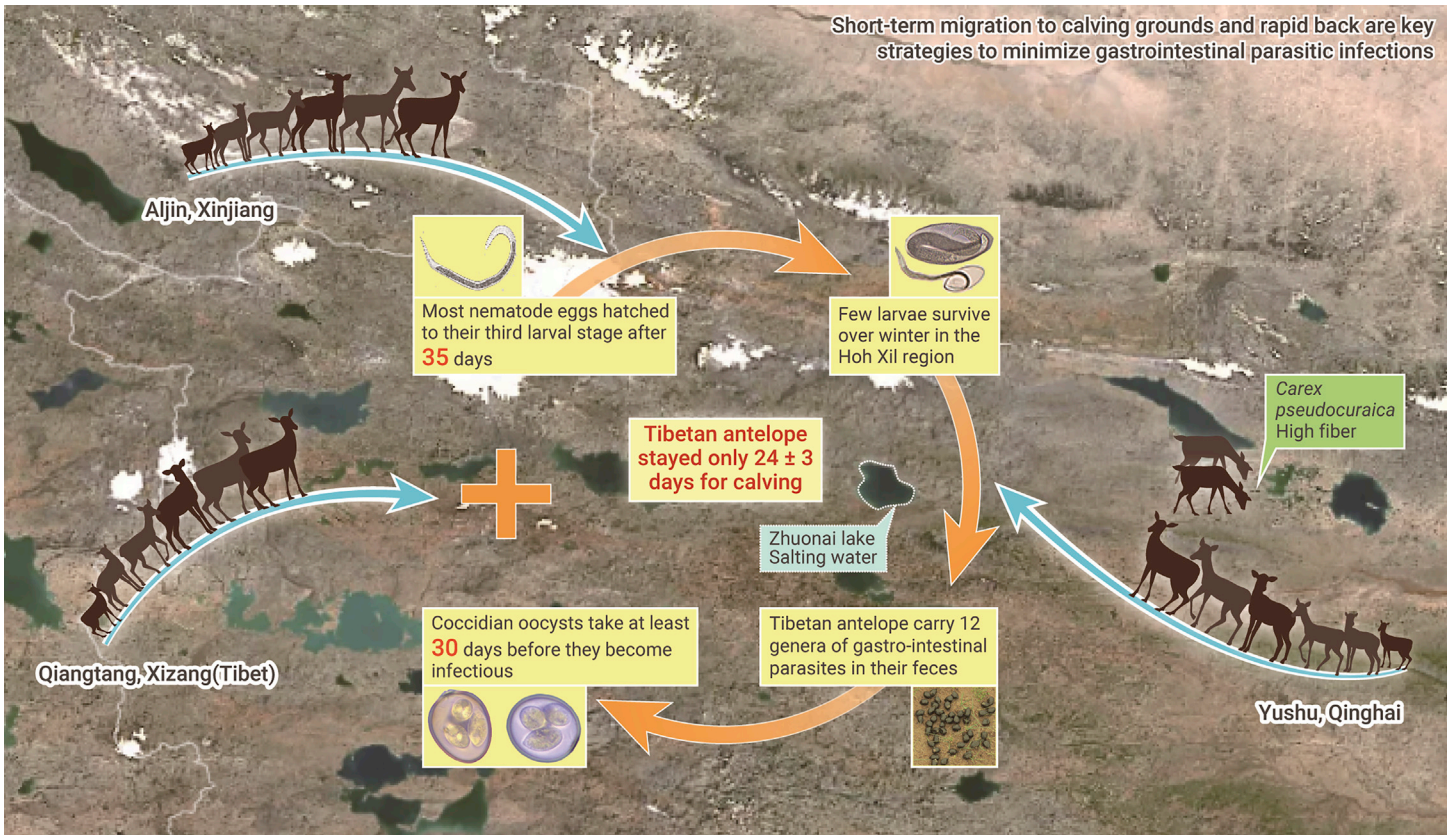

Figure 1. A visual overview of Tibetan antelope migration patterns that reduce risk of parasitic infection

around 300–400 km to Zhuonai Lake and stay only around 24 ± 3 days.[2] However, eggs of Tibetan antelope feces only developed to their first larval stage after 30 days, and the sporulation rates of the two dominant coccidian species were 0%, 18.9%, and 54.0% for *Eimeria pantholopensis* and 0%, 13.5%, and 30.4% for *E. wudaoliangensis*, respectively, on their 25th, 30th, and 35th days of development. Thus, the dominant parasite eggs/oocysts in the feces could not develop to the infective stage (i.e., third larvae stage, or sporulated oocysts) in the calving ground of Zhuonai Lake. Being extremely cold and dry in winter, very few larvae of the *Marshallagia* and *Nematodirus* spp. survived in feces left for nearly 1 year (over winter) in the calving grounds near Zhuonai Lake. The overall risk of gastrointestinal parasite transmission and infection is therefore deemed low during the aggregating period of Tibetan antelope. Short-term utilization of the calving grounds and optimally timed rapid back migration (see Figure 1) are postulated as important behavioral strategies for the Tibetan antelope to mitigate the risk of gastrointestinal parasitic infection.

Based on observations over many years, it also has been found that the seasonal shift in the Tibetan antelope migration caused by global warming (now occurring earlier in the year) has not extended the duration of their calving period. Likewise, local desertification and sandstorms caused by the shrinking of Zhuonai Lake (from 270 km^2 in April 2011 to 147 km^2 in April 2020) did not appear to affect their migration patterns. In fact, the number of Tibetan antelope migrating through (under) the Wubei Railway Bridge enroute to the traditional Zhuonai Lake calving area increased from 3,100 individuals in 2008 to 4,522 and 6,377 individuals in 2018 and 2019, respectively. These monitoring results reflect the significant increase in the number of migratory Tibetan antelope across the Sanjiangyuan region. Sandy habitats and high cellulose content of vegetation in these calving grounds also ruled out the likelihood of further migration in search of high-quality food. Parasites, therefore, appear to be an important mediating factor in the growth of wild mammal populations, with one of the key benefits of the Tibetan antelope's extraordinary annual migration being—despite obvious trade-offs—a reduction in the risk of gastrointestinal parasitic transmission and infection, thereby enhancing the pups' early survival and increasing overall population.

Based on the above, we suggest that effective protection of the ecological characteristics and integrity of the "vast delivery room" (calving grounds) around Zhuonai Lake and along the entire migration route of this endemic ungulate, supplemented by interventions to ensure that its behavior is not disturbed in these areas, is the most important way to ensure the species' survival and to restore/maintain the healthy development of the Tibetan antelope population. The ungulate's total population is still low compared with their former population, which was in the millions around a hundred years ago, often with 1,500–2,000 individuals being visible at one time.[1] In contrast, the population of domestic livestock on the Qinghai-Tibet Plateau, mostly sheep and yak, has increased around 3–5 times since the mid-20th century. Livestock and wild ungulate populations in the Sanjiangyuan National Park are currently estimated at 1,684,000 and 314,000 sheep unit equivalents, respectively; the effective number of livestock is thus 5.3 times greater than wild ungulates. Together, the large livestock numbers and recovering populations of wild ungulates have led to an overstocking and consequent degradation in some parts of the Tibetan grasslands. While it may be impossible to fully restore the original authenticity of the grassland ecosystem, we nonetheless must now commit our collective efforts to protect the emblematic Tibetan antelope in the Sanjiangyuan region—and through the conservation of this iconic species, also maintain and conserve the wider socio-ecological system. The best and most sustainable solutions will be found when co-created and implemented through partnerships including protected area authorities and local communities jointly committed to synergistic human-nature relationships, with space for wildlife through co-existence as part of the rich, integrated social-ecological grassland landscape that has developed over generations.

REFERENCES

1. Schaller, G., Kang, A., Cai, X., et al. (2006). Migratory and calving behavior of Tibetan antelope population. Acta Theriol. Sin. ***26***, 105–113.
2. Karina, M., Buho, H., Hiromasa, L., et al. (2017). Seasonal migration and home ranges of Tibetan antelopes (*Pantholops hodgsonii*) based on satellite tracking. Int. J. Zool. Res. ***13***, 26–27.
3. Folstad, I., Nilssen, A.C., Halvorsen, O., and Andersen, J. (1991). Parasite avoidance: the cause of post-calving migrations in Rangifer? Can. J. Zool. ***69***, 2423–2429.
4. Cao, Y., Shang, G., Li, W., et al. (2022). The risk of transmission and infection of gastrointestinal-parasites in the Tibetan antelope (*Pantholops hodgsonii*) aggregation at Zhuonai Lake, Hoh Xil. Acta Theriol. Sin. https://doi.org/10.16829/j.slxb.150556.
5. Khanyari, M., Milner-Gulland, E., Oyanedel, R., et al. (2022). Investigating parasite dynamics of migratory ungulates for sustaining healthy populations: application to critically-endangered Saiga antelopes (*Saiga tatarica*). Biol. Conserv. ***266***, 109465.

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DECLARATION OF INTERESTS

The authors declare no competing interests.