Journal for Nature Conservation 32 (2016) 35–43

Contents lists available at ScienceDirect

Journal for Nature Conservation

journal homepage: www.elsevier.de/jnc

Review

Endangered wild yak (*Bos grunniens*) in the Tibetan plateau and adjacent regions: Population size, distribution, conservation perspectives and its relation to the domestic subspecies

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ARTICLE INFO

Article history:
Received 13 November 2015
Received in revised form 8 April 2016
Accepted 8 April 2016

Keywords:
Wild yak status
Tibetan plateau
Population size
Distribution
Conservation perspectives

ABSTRACT

The yak (*Bos grunniens*) is a long-haired bovid, endemic to the Tibetan Plateau and the adjacent high-altitude regions. The domesticated subspecies of yak (*B. grunniens grunniens*) are abundant and closely associated with the livelihoods of herders, while the wild subspecies of yak (*B. grunniens mutus*) are endangered due primarily to anthropogenic effects. The endangered status of wild yaks calls for consideration, if we are to secure its long term survival, hence this study. Here we hope to provide baseline information necessary for further research and protection of the wild yak resources. We use published data to discuss their evolution, their characteristics as well as their distribution in the Tibetan Plateau and the adjacent high-altitude regions. We were able to come up with a world wild yak distribution map, which may be useful for establishing protected areas, as well as updating the species IUCN Red List Status. From the data available, we were also able to provide an estimate of the wild yak population in China (~22,000 wild yaks living in China), corresponding to 90% of the total world population. We further discuss the major threats to yaks, and we give some suggestions for future and sustainable conservation.

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http://dx.doi.org/10.1016/j.jnc.2016.04.001
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1. Introduction

The yak (*Bos grunniens*), one of the Artiodactyla, is endemic to the Tibetan Plateau and the adjacent high-altitude regions (Wiener, Han, & Long, 2003). It is a species of the Bovini tribe (Bovidae, Bovinae). The wild yak branch appeared no more than 2 million years ago (Liang, Yao, & Yang, 2005; Liu, 2007). There are many different views about the wild yak's scientific name and to which taxonomic family it belongs, with some researchers classifying the wild yak in the genera *Bos*, *Poëphagus* or *Bison* (Feng, Cai, & Zheng, 1986; Yang, 2006; Zhang, Xia, & Yang, 2009). Linnaeus classified the domestic yak as *B. grunniens* in 1758. The wild yak was classified as *B. grunniens*, following Linnaeus classification of the domestic yak (Feng et al., 1986; Yang, 2006; Zhang et al., 2009).

However, yaks are quite different from other *Bos spp*., especially concerning their anatomy. There are 14 pairs of ribs in a yak, which is two more pairs than other *Bos* spp. (Liu, 2007; Mipam et al., 2012). Yaks have one more thoracic vertebra, one fewer lumbar vertebrae, and 0–4 fewer coccygeal vertebrae than other *Bos* spp. (Olsen, 1990). Yaks also differ from other *Bos* spp. in morphology, such as the length of hair. Although yaks and bison (*Bison bison* or *Bison bonasus*) are similar in spinal structure, they are different in skull structure (Olsen, 1990). Gray (1863) advocated for the classification of the wild yak as the sole species in the genus *Poëphagus*, which was widely endorsed (Feng et al., 1986; Liu, 2007; Zhang et al., 2009). Przhevalsky and Yule (1876) classified the wild yak as a distinct species, *Poëphagus mutus* (Feng et al., 1986; Yang, 2006; Zhang et al., 2009).

At the taxon level, IUCN considers the wild species of yak under *Bos mutus*, while the domestic form is considered under *B. grunniens* (IUCN, 2014), as the name for this wild species is not invalid by virtue of being antedated by the name based on the domestic form. However, the analysis of DNA fragments showed that the wild yak and the domestic yak have the same genotype, without any significant differences in chromosome number, chromosome morphology or chromosome size (Zhang et al., 2009). MtDNA analysis also confirmed that the domestic yak originated from the wild yak over a short historical period (Qi, Han, Blench, Rege, & Hanotte, 2008). Therefore, we accept the taxonomic classification of the wild yak and the domestic yak as two subspecies and consider the wild yak as the ancestor of the domestic yak. We used *B. grunniens* L. as the yak's scientific name, and the domestic and wild yak subspecies are *B. grunniens grunniens* and *B. grunniens mutus*, respectively (Zhang et al., 2009; Wilson & Reeder, 2005; Ma et al., 2009).

The wild yak is covered with black and brown or jet black hairs with some patches of white hair around the snout (Liang et al., 2005; Peng & Ou, 1999). Both sexes have horns (Leslie & Schaller, 2009). The domestic yak is smaller in size than the wild yak, but it is very important (economically and culturally) for the nomadic people in the plateau areas, being a cold tolerant mammal (Liang et al., 2005; Yang, 2006).

The ancestor of the modern wild yak used to live in China, Nepal, Siberia, Mongolia and Alaska (Liu, 2007). Nowadays, they are mostly found in the northwestern and southwestern parts of China, including Nanshan Mountain in the northwest of Gansu Province (35°33′N, 82°45′E) (Feng et al., 1986).

In the past 100 years, the world population of wild yaks has declined rapidly due to human activities (Yao et al., 2006), which lead to the species being under first class special state protection in China since 1980. On an international level, the yaks are, since 1985, in the Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). More recently, the yaks were assessed as vulnerable (VU) in the IUCN Red List of Threatened Species after 1996, and the yaks were assessed as Endangered in the China Species Red List (IUCN, 2014; Yang et al., 2007; Yang, 2006).

However, information about the wild yak is scattered and incomplete, and a detailed survey of *B. grunniens mutus* is needed (Leslie & Schaller, 2009). In this study, we use published data to discuss the yak's evolution, characteristics and distribution in detail. We produce a wild yak world distribution map, which may be useful for establishing protected areas. Since the hybridization between wild and domestic yaks may contribute to the wild yaks' decline, we also summarize the hybridization history of domestic yaks. The aim of this study is to provide a thorough review of the available information regarding wild yaks' ecology, distribution and population characteristics that will serve as a baseline for long-term conservation plans for the species.

2. Materials and methods

For this study, we did a Google Scholar search on the keywords Wild Yak, Yak (both in Chinese and English), *B. grunniens* and *B. mutus* and try to find out all possible published data available on the yak's evolution, characteristics and distribution, especially published data on the wild yak. Most of the available work was in Chines and Russians, which often required translation.

In order to generate the distribution of wild yak in the world, we noted down all the confirmed locations where wild yaks were found. Then we used Google Map to find latitude and longitude of those sites, and finally imported and plotted them into Arc GIS (ArcGIS10.1). Combining the reported distribution of wild yaks in different geographic areas, we draw a map of the distribution of wild yak in the world.

3. Results

3.1. Evolution and adaptations

After the Cretaceous mass extinction in the late Mesozoic era, the adaptive radiation of mammals occurred rapidly, and mammals became the dominant animals of terrestrial ecosystems during the Kainozoic era (Wang, Meng, & Ni, 2006). During the early age of the Eocene epoch (~50 million years ago), the Artiodactyla appeared (Tong & Wang, 1998; Wang et al., 2006). The Indian and the Eurasian plates collided during the Paleogene period (~30–40 million years ago), which resulted in tectonic plate movements and the formation