



Phylogenetic position of the takin (*Budorcas taxicolor*) and the yak (*Bos grunniens*) within the family Bovidae

SHAOBIN WU^{1,2}, XIUYUE ZHANG¹, BISONG YUE¹, BO ZENG¹, JIANGHONG RAN³

¹Sichuan Key Laboratory of Conservation Biology on Endangered Wildlife, College of Life Sciences, Sichuan University, Chengdu, Sichuan 610064, P.R. China

²Department of Life Science, Yangtze Normal University, Chongqing 408003, P.R. China

Shaobin Wu, Xiuyue Zhang contributed equally to this work

³Corresponding author. E-mail: rjhong-01@163.com

Abstract

The takin (*Budorcas taxicolor*) is a rare mammal endemic to the Asian Continent, with differing opinions regarding its taxonomic status. In order to clarify its evolutionary position within Bovidae, we sequenced the complete mitochondrial genome of a takin (*B.t. bedfordi*) sampled from Tangjiahe Nature Reserve in Sichuan Province, China, and reconstructed the phylogenetic relationships of eleven species within Bovidae based on 12 heavy-strand encoded protein-coding genes. The results indicated that (a) the takin shared a close relationship with the aoudad (*Ammotragus lervia*) and sheep (*Ovis aries*), and was most closely related to caprines; (b) the *Bos* genus did not exhibit a monophyletic structure, in which the yak (*Bos grunniens*) was closely linked to American bison (*Bison bison*). Combined with other DNA data, morphological evidence and paleontological data, we strongly support the designation of *Poephagus* for the yak, and yak should be nominated as *Poephagus mutus* or *Poephagus grunniens*.

Key words: systematics, phylogenetic relationship, *Poephagus*, mitochondrial genome

Introduction

The takin (*Budorcas taxicolor*) is a rare mammal species endemic to Asia. Originating from the north of Asia (Neas & Hoffmann, 1987), it is now mainly distributed in China, Burma, India, Nepal and Bhutan. Based on morphological observations, physiological characteristics and geographical distribution, it is classified into Bovidae in Cetartiodactyla and includes four subspecies: *B.t. taxicolor*, *B.t. bedfordi*, *B.t. tibetana*, *B.t. whitei*. At present the takin is a national protected species (Class I) of China and Vulnerable (VU) species in Red Data Book of IUCN (<http://www.iucnredlist.org/apps/redlist/details/3160/0>), and listed in appendix II of CITES (Wang, 1998).

Taxonomic status for the takin has been proposed primarily based on morphology, ecology and behavior. Due to its peculiar morphological characteristics, such as the yak-like horn and large body size (Wu, 1986), different conclusions for its classification have been made. Lydekker (1916) deemed that it belonged to the subfamily Antilopinae, but other researchers suggested that the takin should be placed into Caprinae (Allen, 1940; Simpson, 1945; Ellerman & Morrison-Scott, 1966; Schaller, 1977). Based on morphological and behavioral similarities, Wu (1986) considered it to be closer to the musk ox *Ovibos moschatus* (Caprinae). However, based on Cytochrome b sequence analyses, Groves and Shields (1996, 1997) thought that the similarities of the takin and musk ox in behavior and morphology might be attributed to convergent evolution, and that the takin and all sheep could be considered a clade. Determined from Cytochrome b sequences, Hassanin *et al.* (1998) inferred that *Budorcas* (takins) was the sister-group of *Ovis* (sheep and mouflons), which is in contradiction with subsequent investigations based on cytochrome b, 12S rRNA and exon 4 of the κ -casein gene (Ropiquet & Hassanin, 2005). Recently the phylogenetic position of takin has been elucidated