

SYSTEMATIC REVIEW AND ANALYSIS OF THE TAXONOMY OF MUSK DEER IN KASHMIR

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ABSTRACT

Elucidating the taxonomy of species is important for conservation purposes, but unfortunately musk deer in Kashmir have not been studied extensively. Examination of the museum specimens of musk deer from the Kashmir region indicated that in Kashmir there are possibly two species. Field studies in Jammu and Kashmir revealed that the musk deer occurring in the Wardwan – Kishtwar belt are apparently different from those that occur in the main part of Kashmir. This study is based on a systematic review of the literature on the taxonomy of musk deer in Kashmir along with some personal field observations. The species most predominantly occurring in Kashmir is the Kashmir musk deer (*Moschus cupreus*). The other possible species is Himalayan musk deer (*Moschus leucogaster*) occurring mostly in the Wardwan – Kishtwar belt of Jammu and Kashmir. The affinities of musk deer in Kashmir with other species of musk deer are also studied.

Keywords: Himalayan musk deer; Jammu Kashmir; Kashmir musk deer; *Moschus cupreus*; *Moschus leucogaster*; taxonomy

Introduction

Taxonomy is the foundation of biodiversity conservation and validating the genetic distinctness of extant sub-species and isolated populations remains an important goal, with implications for conservation (Grubb and Gardner 1998). The basic premises of taxonomy, the science of biological classification, is still undergoing a wide-ranging rethink (Groves 2003).

Musk deer are evolutionarily primitive (Fig. 1) and not included in the Cervidae (Groves and Grubb 1987). The taxonomy of *Moschus* is unrefined (Flerov 1952; Groves 1975; Groves 1980; Groves and Grubb 1987; Groves et al. 1995; Grubb and Gardner 1998; Groves 2003). Further, the taxonomy of musk deer in India and some of its ad-

joining areas is further confused by giving too much emphasis to the species *Moschus chrysogaster* (Green 1979, 1985, 1986, 1987, 1989, 2002, etc.).

In the absence of detailed scientific and biological studies, is it possible to establish how many species of musk deer there are in Kashmir? To address this question, the present study compiled the morphological and other observations on the musk deer found in Kashmir. The details presented below may initially appear fuzzy, but succeeding elaboration will throw more light on the taxonomy of musk deer in Kashmir and reveal its similarities and differences from other species of musk deer.

Methods

Literature on musk deer was analysed with particular emphasis on those occurring in Jammu Kashmir. Some of the personal field observations made during various studies on musk deer relevant to their taxonomic status are also presented.

Results and Discussion

In cladistic terms, *Moschus moschiferus* is probably the sister-taxon of all other species (Groves et al. 1995). Kao's (1963) description of *Moschus moschiferus*, which perhaps is a modification of that of Flerov's (1952), according to Groves (1975), is as follows: "a large species; dark brown, usually spotted; two white stripes on lower part of neck, extending to shoulder. Ear-backs dark. Individual hairs are grey white for two-thirds of their length, then brown-grey, with a darker brown tip; commonly there are whitish rings near the tips, which, when clumped, give the overall spotted effect. The fur is soft

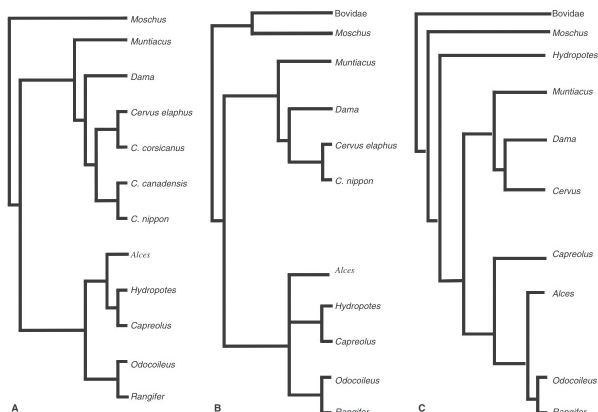


Fig. 1 Cladograms (maximum parsimony) of the phylogenetic relationships of Cervids based on: (A) Cytochrome b mtDNA gene data (Randi et al. 1998; Pitra et al. 2004); (B) Cytochrome b and CO₂ mtDNA and nuclear fragments: exon 2 of alpha-lactalbumin and intron 1 of the gene encoding protein kinase C iota data (Gilbert et al. 2006); (C) morphological data (Groves and Grubb 1987) (Source: Cap et al. 2008).

compared to that of the other two species, 45–60 mm long on the withers, 65–75 mm on the rump (in the Siberian race; but in Korean skins these lengths are only 34–37 mm and 45–62 mm respectively). Only the Siberian musk-deer (provisionally called *Moschus moschiferus*) has white rings on its hair; in both other species the rings tend to be yellowish to some degree (Groves 1975).

On the basis of museum samples, Groves (1975) states that “there exist two colour types from the Indian region: a dark type with dark ears, indistinguishable from the Chinese *berezovskii*, and a light type with yellow-rimmed ears, recalling *sifanicus*, but not identical with it (ears only rimmed with yellow, not broadly tipped; colour perhaps greyer and less yellow); and as such there are certainly two species represented”. Two of the museum samples at the British Museum (Natural History) pertaining to the Kashmir region have been described by Groves (1975) as:

“London, BM (NH): Skull only”;

“91.8.7.221. Kashmir. Length 150 mm; lacrimal somewhat longer than broad; midpoint in orbit; arches not much elevated.”

“91.8.7.222. Kashmir. Incomplete; lacrimal longer than broad; arches somewhat elevated.”

Codes 91.8.7.221 and 91.8.7.222 mentioned above refer to the museum cataloguing of specimens and numbers for locating the samples within the museum.

The additional specimens examined by Groves (1980) are described as:

“1. *Moschus sifanicus*

Two skins, one skull and a head skin in the Powell-Cotton Museum, Birchington, Kent, England. T.31.2 is skin and skull; the skin is light tobacco brown, fading to off-white on head, shoulders and again on rump. The ears are yellow-rimmed. Skull broken, but its length is approximately 160 mm, lacrimal 21×14; mid-point of skull probably in orbit. Locality is Baltal, Kashmir. The other complete skin (no number) and head skin (M.46.99) have no locality beyond ‘Kashmir’ but are clearly of this species.”

“2. *Moschus chrysogaster chrysogaster*

The Powell-Cotton Museum possesses an incomplete skull that is probably of this form, number T.31.3, from Srinagar, which (if it is the actual locality rather than a base camp) is in the forest zone. The length would have been about 145 mm; lacrimal 23×20; mid-point would have been approximately at the front edge of the orbit.”

Since both specimens are from Kashmir, it is possible that there are two species of musk deer in Kashmir. During the present study it was apparent that the musk deer occurring in the Wardwan – Kishtwar belt differ from those that occur in the Kashmir division. The musk fragrance and the form of the musk pods (and musk grains) differ in the musk deer in these two areas. According to Ali (2016), “The musk pods of the musk deer in Wardwan and Marwah are larger and differ in appearance from those of the deer in Kashmir. The outer skin covering the musk glands of those in the Wardwan-Marwah

range is more delicate than that covering the musk pods of those in Kashmir. The musk from Wardwan and Marwah deer is highly granular and reddish brown in colour, similar to the colour of dried dates, and musk grains are wood-like in consistency. By comparison, the musk from Kashmir is powdery in appearance with a predominantly brownish tinge. Kashmir musk is not so fragrant; the fragrance of the musk from the Wardwan-Marwah range is well developed, breath taking and pleasing to the mind.”

The earliest name for musk-deer from the Indian region is Hodgson’s *Moschus chrysogaster* (1839). According to Groves (1980), two species of musk deer are found in India and Nepal: *M. sifanicus* has light brown fur, the backs of the ears are rimmed with pure yellow, the skull length averages about 160 mm, and the lacrimal bone is long and low; *M. chrysogaster* has dark brown fur, the ear-backs are wholly dark, the skull length is about 150 mm, and the lacrimal is relatively short and high. The former, which lives above the tree-line, is represented in China by a race in which the whole tip of the ear, not just the rim, is yellow, but which is otherwise poorly distinguished and is in any case unnamed; the latter species, which lives in forest and is represented in India and Nepal by its nominate form, is smaller and short-faced, whereas in China there are probably two subspecies.

Further, Grubb (1982, cited in Groves and Grubb 1987) describe *Moschus chrysogaster* as, “*M. chrysogaster* [= *M. sifanicus*] that occurs in the Alpine zone of the eastern and southern edge of the Tibetan Plateau, extending onto the southern side of the Himalayas. It is the largest of the musk deer, with a characteristic long-snouted skull. The pelage is a pale speckled yellow brown in colour, with yellow-tipped ears and a broad whitish band down the throat. These last two features are sometimes absent in the north Indian population, which apparently bridge the gap between nominate *chrysogaster* and a newly described subspecies, *cupreus*, from Kashmir.”

For the musk deer of Himalaya, the Kashmir form is described by Groves et al. (1995) as: “A Kashmir form, described as *Moschus chrysogaster cupreus* by Grubb (1982); apart from the specimens listed in the type description, Colin P. Groves has seen two in the Calcutta collection, from Gilgit (ZSI 19942) and from Peshawar (ZSI 9968). It is grey-brown, often vaguely spotted, distinguished by having a coppery-brown unspeckled dorsal saddle; it has a very dark, grizzled grey rump, light grey underparts, white throat, whitish lower limb segments, and dark brown ears white at the base, with frosted rims. The hairs have long white bases; their length is 33–38 mm. on the withers, 37–58 mm. on the rump.”

There are four, perhaps five distinct taxa in the Himalayan region; two of these (*Moschus cupreus* and the *Kulu form*) are allopatric to the others, whereas the other four occur close to each other in the Nepal / Sikkim / S.E. Tibet region. As three of them (*M. fuscus*, *M. leucogaster* and the true *M. chrysogaster*) are all said to occur in Sikkim, while *M. fuscus* and the enigmatic Zhangmu form

are both recorded from the Nepal side of Mt. Everest, it would appear that there are at least three species (Groves et al. 1995).

An analysis of skull morphology using craniometric characteristics in a multivariate analysis (Groves et al., 1995) indicates, as shown in Figs 2 and 3, the affinities of musk deer in Kashmir with other species of musk deer.

“The polygon for *M. moschiferus* overlaps those for *M. berezovskii* and *M. cupreus*; those for *M. berezovskii* and *M. fuscus* overlap somewhat and those for *M. cupreus*, *sifanicus* and the Zhangmu/ Khumjung sample are separate from all the others. When the *M. moschiferus* and *M. cupreus* polygons are omitted, *M. chrysogaster* is close to the *sifanicus* sample, which contains the reputed type of *M. saturates*; the *anhuiensis* specimen is close to the *berezovskii* sample; and the *M. fuscus* and *M. berezovskii* samples no longer overlap”, according to Groves et al. (1995). *Moschus chrysogaster* almost certainly includes *sifanicus* as a subspecies; there is no evidence that it occurs south of the Himalayas, but seems to be restricted to the alpine zone in the southeastern and eastern margins of the Tibetan plateau (Groves et al. 1995). Groves et al. (1995) conclude by proposing a taxonomy for *Moschus* in which *Moschus cupreus* is recorded as:

“? *M. cupreus* Grubb, 1982 (or as *Moschus leucogaster cupreus*)

Kashmir. Alt. over 3000 m.

Dorsal reddish; rump very dark, with grizzled grey bottom patch; limbs lighter. Rump usually dark or grizzled grey.”

The multivariate analysis of the craniometric data (Groves et al. 1995) indicates that there is no overlap of the polygons for *Moschus leucogaster* and *Moschus cupreus*; therefore, it is plausible to record the Kashmir musk deer as “*Moschus cupreus* Grubb, 1982”.

Groves (2003) raised six taxa, commonly regarded as subspecies, to specific rank, two of which are *Moschus cupreus* and *Cervus hanglu*. These species were earlier considered as subspecies and were named *Moschus leucogaster cupreus* and *Cervus elaphus hanglu*, respectively.

On the basis of Groves (2003) it can be inferred that *Moschus chrysogaster* does not occur in India and its distribution extends from eastern Nepal to Sikkim and Bhutan, entirely in the plateau zone.

Groves (2003) describes the Kashmir musk deer as:

“*Moschus cupreus* Grubb, 1982. Kashmir musk deer
From Kashmir, at over 3,000 m above m s. l.

Colour grey-brown, often vaguely spotted, with a copper-reddish dorsal saddle; rump dark, grizzled grey; underside light grey; throat white; lower segments of limbs whitish. Ears dark brown, white at base, with frosted rims. Large species.”

This description can be compared with the photographs of the Kashmir musk deer in Fig. 4. Further images of the deer are presented in Figs 5–8. The colour details of the individual hairs of musk deer (measuring 48 mm and 58 mm in length) collected from Dachigam National Park (Kash-

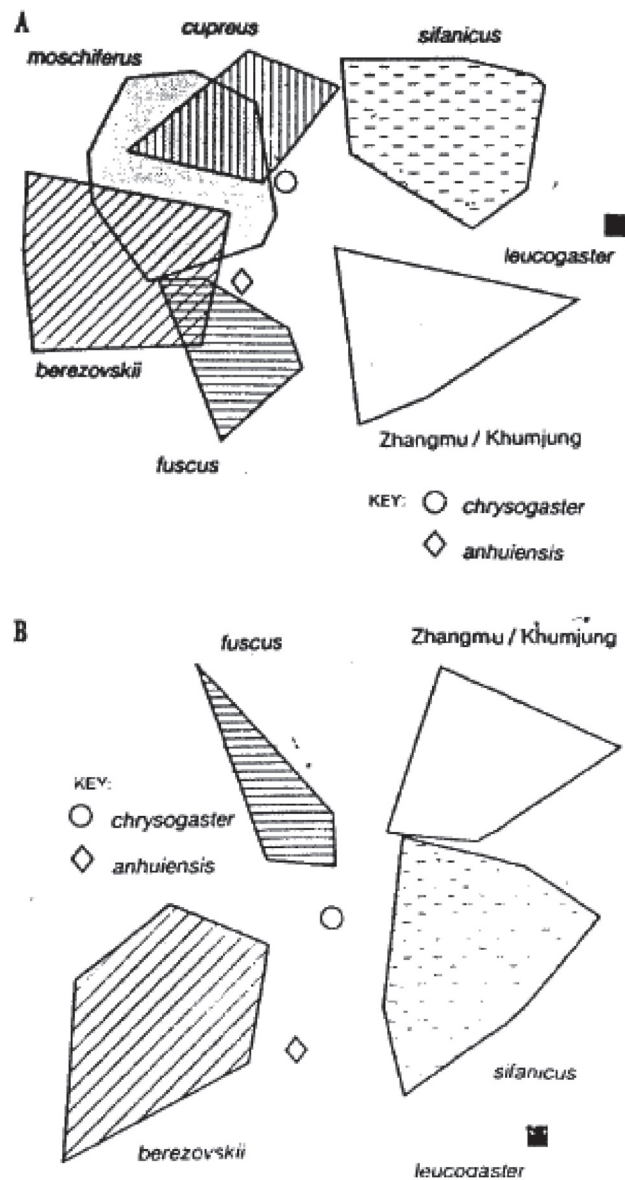


Fig. 2 Discriminant function plots; full variables (the *M. moschiferus* and *M. cupreus* dispersions are omitted); A – horizontal: Functions 1, vertical: Functions 2; B – horizontal: Functions 1, vertical: Functions 3 (Groves et al. 1995).

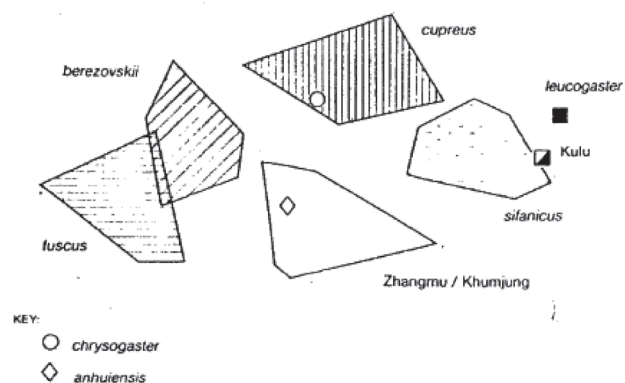


Fig. 3. Discriminant function plot of a reduced list of craniometric characteristics of *Moschus* (to enter the Kulu skull). Horizontal: Functions 1, Vertical: Functions 2 (Groves et al. 1995).

mir) during the present study are illustrated in Fig. 9 for comparison with the descriptions provided above. In Siberian musk deer, the hairs covering the body are reported to be 65 to 95 mm in length (Vaisman and Fomenko 2004) and the length of those of the Alpine musk deer (*Moschus chrysogaster*) in China is 38 mm (Sheng et al. 1993).



Fig 4. A sub-adult female musk deer photographed in Kashmir, 2005 (Ali 2009).



Fig 5 An approximately five-month-old musk deer fawn injured by stray dogs in a residential locality in Firdousabad (Batamaloo) in southern part of Srinagar City (Kashmir), which was rescued by locals and wildlife department officials.

Morphometric and morphological traits are frequently used by taxonomists for differentiating between species. The photographs in figs 4 to 8 provide first-hand information on the musk deer in Kashmir that can be compared with the descriptions of the specimens of musk deer in Kashmir in various museums and described above.



Fig. 6 Photograph of a male musk deer that was probably driven by a predator from the Dachigam National Park or its adjoining hills, which was caught by people in Merakshah Colony Habak (Srinagar, Kashmir) and handed over to Nigeen Police, 2007.

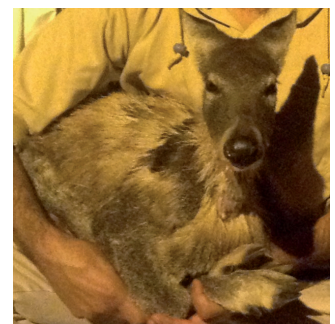


Fig. 7 Photographs of a female musk deer rescued by locals from a stream in Pethpora Nallah Bramsar locality of Chatergul (Kangan, Kashmir) on July 25, 2019. It had a bruised neck and was suffering from skin disease and infested with small wingless bloodsucking insects; and died after a few days in a rescue hut in the Dachigam National Park.

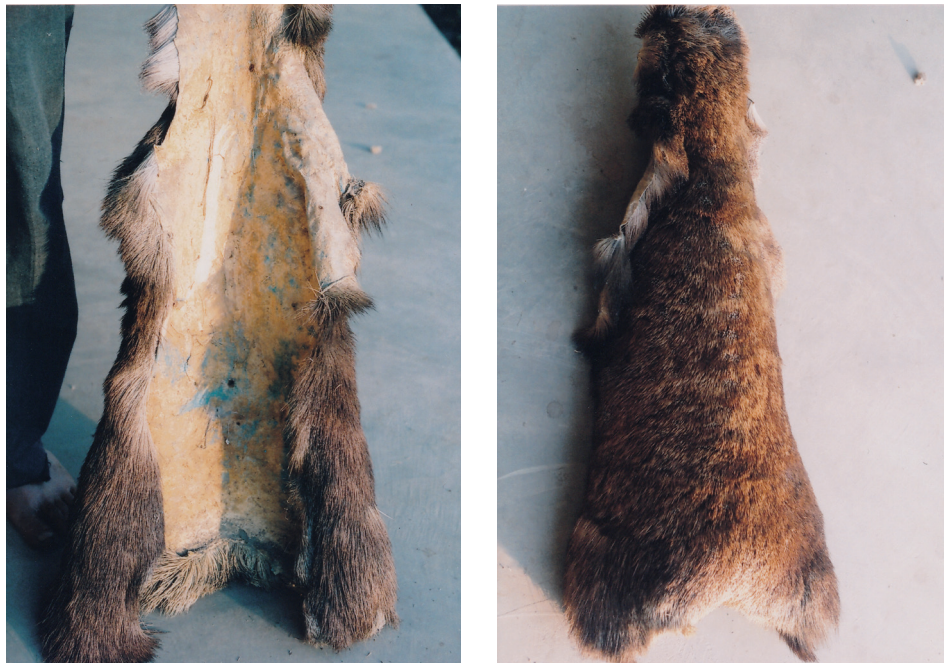


Fig. 8. An old skin of musk deer photographed in 2005 (type locality for the above skin is Yamhur Nai (~≥3000 m), northeast of Dachigam) (Ali 2016).

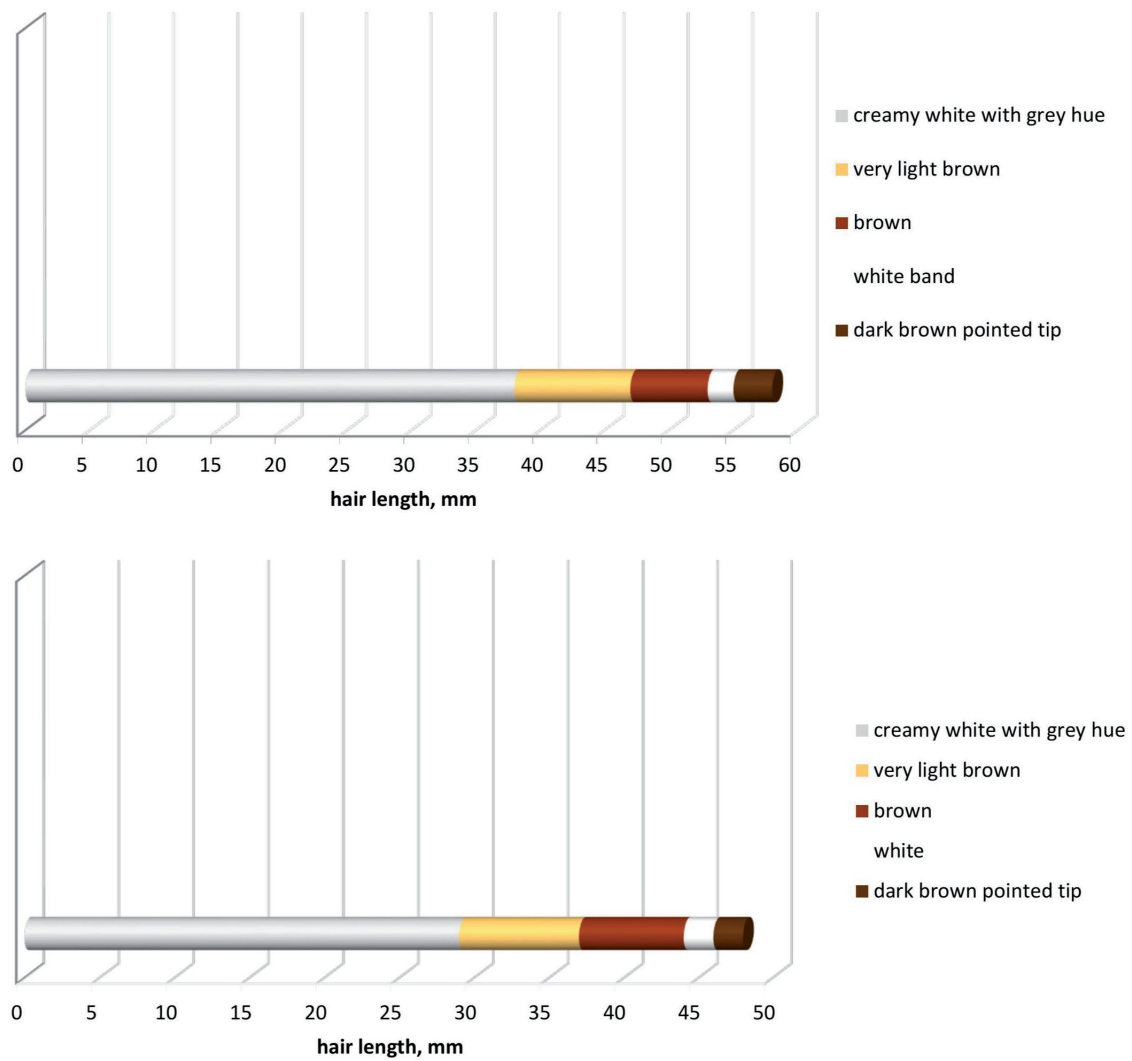


Fig. 9 Colouration of two hairs of different lengths collected from Kashmir musk deer in Dachigam National Park, Kashmir.

Gergan (1962) reports the height of musk deer at the shoulders is about 50 cm and at the rump about 55 cm. Colonel A. Ward, a well-known authority on Kashmir and mountain sports reports that musk deer are 22 inches (56 cm) in height at the croup and weigh 20 to 25 pounds (9 to 12 kg) (Lawrence 1895). The young are spotted on the back and sides (Lawrence 1895).

The updated IUCN Red List of threatened species (2008) recognizes the specific rank of the Kashmir musk deer and lists it as endangered. The status and global distribution of musk deer is shown in Figs 10 and 11. The most recent study on the habitat of Kashmir musk deer in Kashmir is that of Ali (2014).

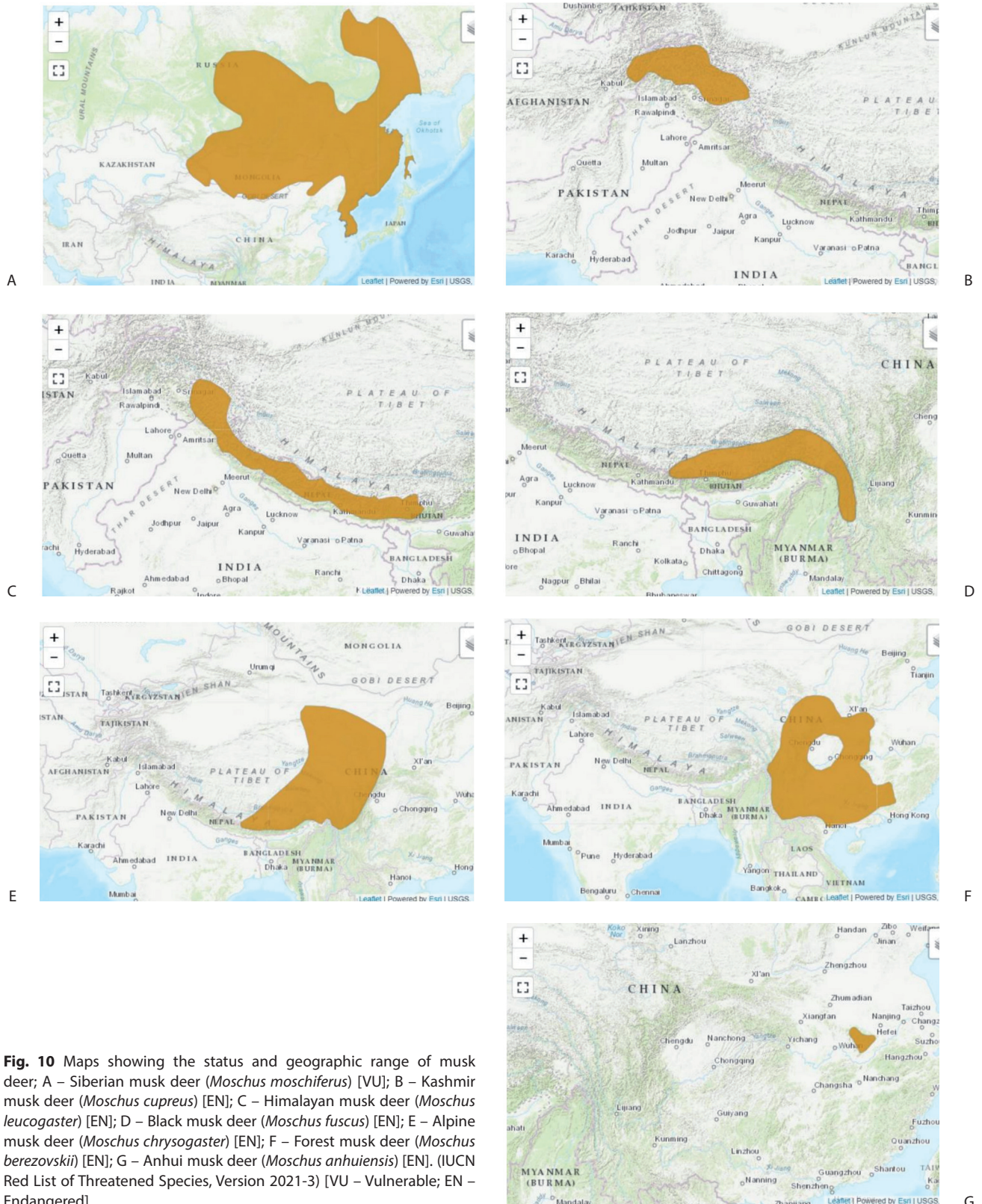


Fig. 10 Maps showing the status and geographic range of musk deer; A – Siberian musk deer (*Moschus moschiferus*) [VU]; B – Kashmir musk deer (*Moschus cupreus*) [EN]; C – Himalayan musk deer (*Moschus leucogaster*) [EN]; D – Black musk deer (*Moschus fuscus*) [EN]; E – Alpine musk deer (*Moschus chrysogaster*) [EN]; F – Forest musk deer (*Moschus berezovskii*) [EN]; G – Anhui musk deer (*Moschus anhuiensis*) [EN]. (IUCN Red List of Threatened Species, Version 2021-3) [VU – Vulnerable; EN – Endangered].

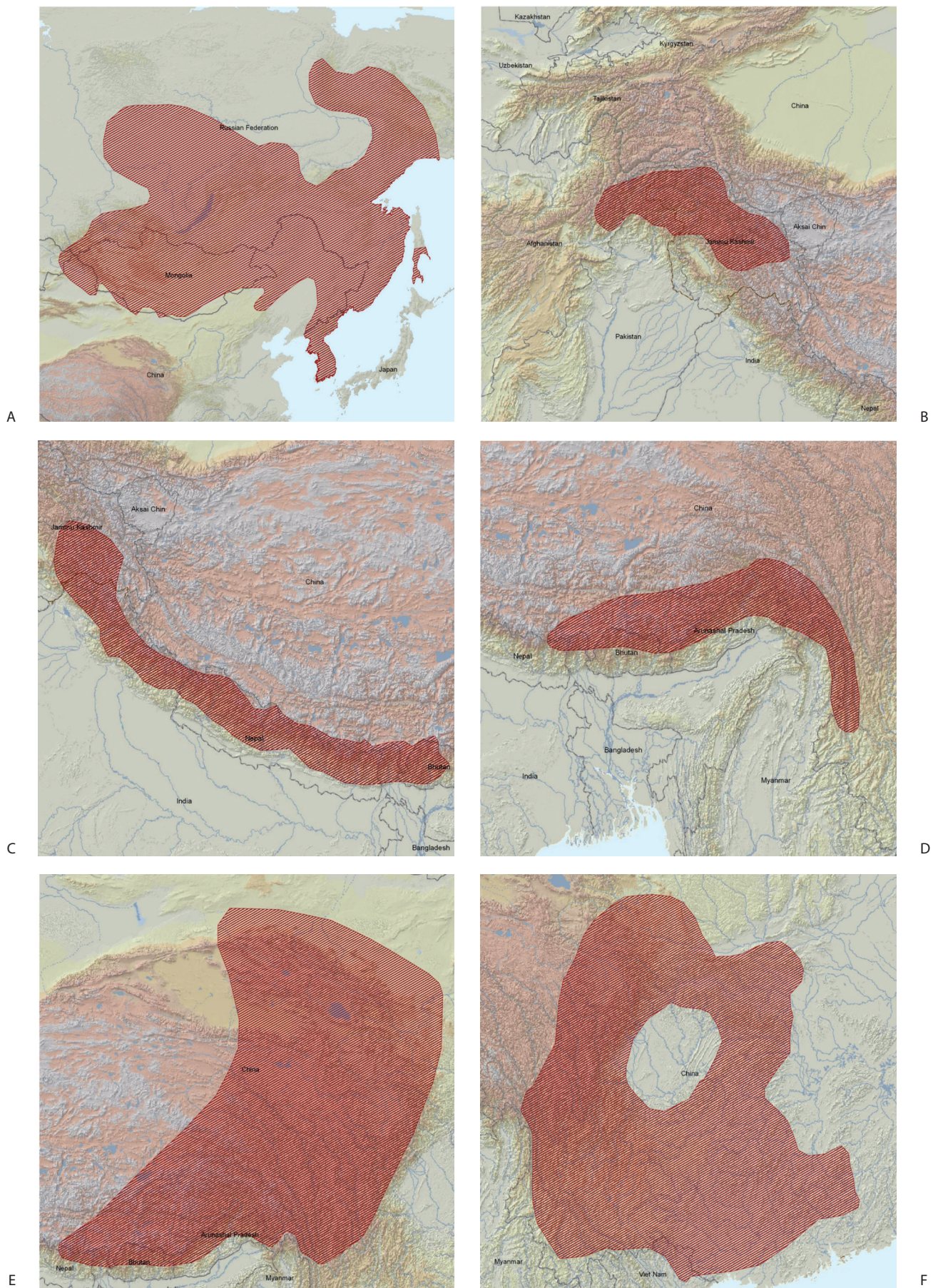


Fig. 11 Maps showing in cross hatched red the geographical distribution of musk deer; A – Siberian musk deer (*Moschus moschiferus*); B – Kashmir musk deer (*Moschus cupreus*); C – Himalayan musk deer (*Moschus leucogaster*); D – Black musk deer (*Moschus fuscus*); E – Alpine musk deer (*Moschus chrysogaster*); F – Forest musk deer (*Moschus berezovskii*). (IUCN Red List of Threatened Species, 2008/2022).

Conclusion and Recommendations

On the basis of an analysis of data and field observations it is tentatively concluded that in Jammu and Kashmir there are two different species of musk deer: Kashmir musk deer (*Moschus cupreus*) and Himalayan musk deer (*Moschus leucogaster*). Thus, it is recommended that a DNA study should be used to elucidate the taxonomic diversity of musk deer in this region.

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