Pilot study on musk deer (*Moschus* spp.) at Langdu, Diqing Prefecture, Northwest Yunnan China: Estimating distribution of musk deer from sign survey and camera trap data*

Report to: China Exploration and Research Society (CERS)

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Executive summary

The expense and effort required to estimate true population size is usually prohibitive, but a number of methodologies have been developed to estimate population size and/or relative abundance in wild ungulates. The purpose of this study was to apply two methodologies: camera trap and sign survey on the musk deer population study, to compare the two methodologies for musk deer study, to obtain a better understanding of the distribution and habitat preference of musk deer at Langdu, and evaluate the suitability of the two methodologies for musk deer survey.

Nine transects totaling 20.1 km in length were surveyed within forest, grassland and flowstone habitats. A total of 5 camera traps were set. Results showed signs of the animal in the study site were significantly variable between species. It might be a practical measure using sign survey for musk deer distribution study. But it was difficult to estimate the population density for the quantitative relationship between the indirect index and the number of musk deer it represents in a certain period was difficult to establish in the field. Study revealed that there was only one species of musk deer – the Alpine musk deer (*Moschus sifanicus*) in the study area. Results from the sign survey showed the Alpine musk deer were rare in the study area and have an aggregated distribution. The pattern of distribution appeared to be affected by human disturbance. The defecation sites of the Alpine musk deer often overlapped with Tufted Deer (*Elaphodus cephalophus*). It might be the results of coevolution and adaptability in a limited habitat. Results also showed the Alpine musk deer preferred areas from 4180 to 4520 m in altitude. And the preferred habitat type was rhododendron forest, with a gradual decrease in preference for rock.

Due to some sudden agency, the pilot study only set up 23 camera days and didn't capture any photos of wildlife. The camera days were too short to capture the photo of the animals for the home range of the musk deer was large. It was grazing season during our study, musk deer suffered the most human disturbance in this season and they might change their course and defecation place which made more difficult to get their photos. Additionally, the camera traps were checked every day which might disturb the animal. How to hide the cameras in a long period in the study site avoiding stolen by hunters or herders is a challenge for using camera traps. The cameras would be camouflaged with bark of the trees in the future study. Also it is necessary to conduct biodiversity awareness promotion for local people. Then the cameras could be set up in the forest safely and do not need to cheek every day. It might be increase the chance to capture the photos of the animal. Although we didn't get any photos of the animals, might be a promising method for estimating the density of the musk deer by capture and recapture the photos of the animals.

Hunting and over grazing were the most serious threat to musk deer in the study area. Local minority especially Lisu and Tibetan who have no religion had the custom to hound. Along our transects, 23 traps made by steel cable were found. This was ruinously destructive for wildlife. Musk deer would be extinct if this kind of hunting couldn't be forbidden.

Introduction

Musk deer, *Moschus* spp., are relatively small deer species from a unique taxonomic family, the Moschidae, with a head to body length of 70-100 cm, a height at the shoulder of 50-61 cm and a weight 7-17 kg (Nowak, 1991). Musk deer do not have antlers, but both males and

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females possess clearly elongated upper canine teeth that project far below the lower lip and are visible when the mouth is closed. A musk gland or *pod* between the naval and genitals of the male (three years of age or older) secretes a brownish wax-like substance known as musk. Musk deer are distributed from the Arctic Circle in Russia to north Mongolia and the Korean peninsula, around the Gobi desert to China, the Himalayan region, Afghanistan, Pakistan, Nepal, Bhutan and south to India, Myanmar and Viet Nam. The population status of musk deer is largely incomplete and there is a paucity of reliable survey data. Populations of musk deer are declining significantly throughout their distribution (Wemmer, 1998). All species of musk deer have been listed as 'Vulnerable' or 'Lower Risk-Near Threatened' on the IUCN Red List of Threatened Species. There are primarily two reasons for the depletion of musk deer populations - loss of habitat and the hunting of musk deer to obtain musk (Wemmer, 1998). Though laws to protect musk deer and their habitat exist throughout their range, wild populations in all range countries in Asia and the Russian Federation continue to decline, due mainly to the high demand for musk (Homes, 1999).

China is one of the most important range countries of musk deer distribution. The annual musk production in China in the 1960's was 2,000-3,000 kg (Zhou et al. 2004). Five species of musk deer (Forest musk deer *Moschus berezovskii*, Alpine musk deer *M. sifanicus*, Black musk deer *M. fuscus*, Himalayan musk deer *M. chrysogaste*r and Siberian musk deer *M. moschiferus*) occur throughout 17 provinces in China, from Heilongjiang and Jilin in the north to Guizhou and Guangxi in the south, from Anhui and Hunan in the east to Sichuan, Yunnan and Tibet in the west (Yang et al., 2004). The total number of musk deer in China was estimated to be between 220,000 and 320,000 (Zhou et al., 2004). The species were listed in the second category of the Chinese State Key Protected Wildlife List in 1998.
Farming of musk deer started in 1958 in China the production of musk, and to protect declining populations. Since then, efforts have been made to expand musk deer farming, and many state farms have been established. The most commonly farmed species was the forest musk deer, and to some extent also the alpine musk deer, with the other three species being kept rarely (Yang et al., 2003). At present, there are several farms (called Musk Deer Breeding Centers) where musk deer are kept. The farm located in Dujiangyan, Sichuan Province, holds the largest captive population in China, about 1300 head. In addition, about 250 alpine musk deer are kept at a Breeding Center in Xinglong Mountain Nature Reserve in Gansu Province. In total, some 1,900 animals are being farmed in China (Zhou et al., 2004).

There are three species of musk deer (Forest musk deer *Moschus berezovskii*, Alpine musk deer *M. sifanicus*, Black musk deer *M. fuscus*) in Yunnan (Yang et al., 2003). The exact distribution area and population abundance of the species in Yunnan are still unknown. As one of the biodiversity richness areas in the world, Yunnan Province is very important for conservation and recovery for the species. Our study aims at clarifying the distribution, status and conservation of musk deer in Yunnan. In this pilot study, we try to practice two methodologies: camera trap and sign survey on the musk deer population study. Camera trap is a promising new method for conducting distribution studies of musk deer, with no studies of musk deer distribution based on camera trap published before. The purpose of this study was to compare the two methodologies for musk deer study, to obtain a better understanding of the distribution and habitat preference of musk deer at Langdu, and evaluate the suitability of the two methodologies for musk deer survey.

Material and method

Study area: The study was conducted at langdu, Zhongdian County, Diqing Tibetan Autonomous Prefecture. Langdu is located in northwest Yunnan border on Sichuan (28°14′52.2″ N, 99°58′28.3″ E) (Fig. 1).

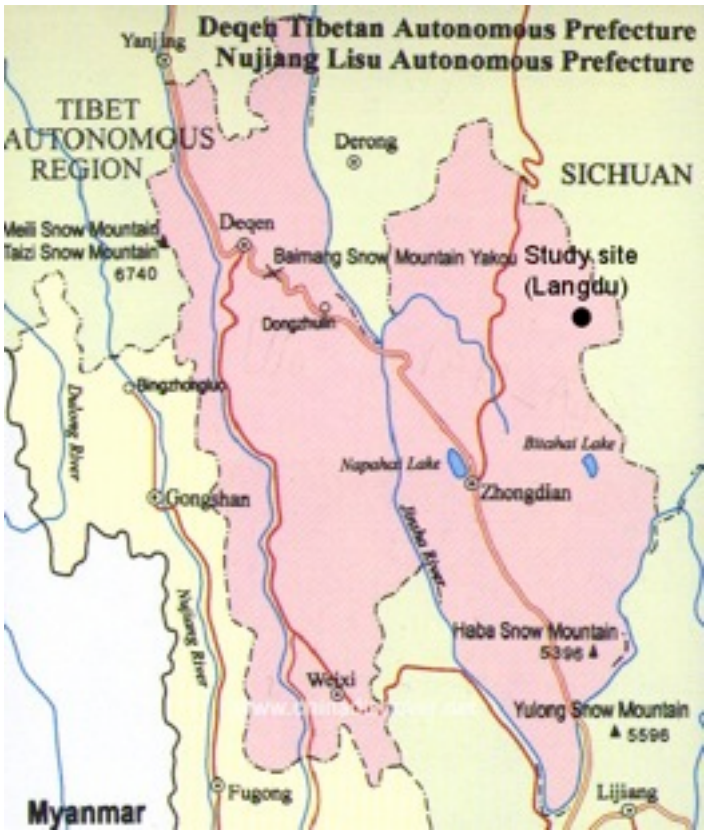


Fig. 1. Map of the study site

The study site ranges in elevation from its lowest point of 3, 841 m at Wudihu Lake to 4, 600 m at the summit of the mountain. Most of the study area is rugged and steep. Different plants and animal signs were found in the area at different altitudes. Nomadic groups graze their livestock here from June to August.

In the lower forested zone, birch, juniper, firs and rhododendron grow. Above this zone, all existing plants are dwarfed or shrubs. As the altitude increases, plant life is restricted to lichens and mosses. Plants cease to grow at about 4560 m, as this is the flowstone line in the area. Forests of sliver fir cover the lower elevations of the site. At elevations of around 4, 050 m and above, forests of rhododendron, juniper trees and grassland were found. The forests provide habitat for rare species including musk deer (*Moschus* sp.), serow (*Capricornis sumatraensis*) and Tufted Deer (*Elaphodus cephalophus*) and black bear (*Selenarctos thibetanus*).

The field information was collected from August 2010.

Population and distribution: Preliminary information on the distribution of musk deer was gathered through informal interviews with hunters, villagers, and herders. Additionally, signs (hair, footprints, pellets etc.) of different ungulate recorded in the field work were identified with the help of a local experienced hunter. Straight transects in the forest were used to survey the distribution of musk deer. The transects were designed to be 10 m wide and two person walk abreast with 5 m interval to search the signs left by musk deer. Differences in topographic relief and vegetation density prevented us from walking at the same velocity; therefore, transects were of variable length ranging from 0.9 to 4.2 km. Nine transects totaling 20.1 km in length were surveyed within forest, grassland and flowstone habitats. Ten pellets were selected at random from each pellet group. Using callipers, the length, maximum diameter, and the minimum diameter (defined as the smallest width which was measured at the same cross-section of the pellet as the maximum width) were also recorded for each pellet. Ten fresh fecal pellets were collected using plastic gloves and preserved in alcohol for DNA bar-coding. Furthermore, other parameters such as slope, altitude, crown cover, ground cover, and land features were recorded from same plots.

Bushnell Trophy camera-trap equipment was used for the surveys. A total of 5 camera traps were set, one in each of the fir forest, rhododendron forest, barren lands (rock), grassland, and flowstone (Fig. 2). Traps were preferentially set up along animal trails and covered all major habitats. The cameras were fixed on plants or rocks at a height of 1 m. 2 were left to function 7 days in a row, other 3 were left 3 days in a row. During this interval of time, we visited the areas every day only to make sure they were still there at a distance at least 20 m to the traps.

Fig.2. Set up the camera traps

Results

Signs identification: In the study we found that pellet size and shape were significantly variable between species. There were three species of ungulates distributing in the study area: musk deer (*Moschus* sp.), serow (*Capricornis sumatraensis*) and Tufted Deer (*Elaphodus cephalophus*). Pellets were classified into three shape categories: cylinder (serow), pear (Tufted Deer) and egg (musk deer) (Fig. 3). The musk deer pellets were the smallest, only about a quarter of serows' and a third of Tufted Deer's pellets. The pellets were 8 mm long and 6 mm wide in average. The pellet looked like an egg with smooth surface. The color of the pellet was dark, unlike the serow and Tufted Deer deer. The pellet group was 24 cm long and 16 cm wide in average (n=5).

a. serow **b. Chinese muntjac deer** **c. musk deer**

Fig. 3. Shapes of faecal pellets from three ungulates at Langdu. Pellet group a, b, c represent the serow, Tufted Deer and musk deer pellet group, respectively. Letters above pellets refer to shape categories: *a*= cylinder, b=pear, c=egg.

The hair of the musk deer was easier to drop out than other two ungulates. Thus, the hair of the musk deer was often found together near their pellet groups. The hair of the musk deer was very special: the hair shafts were hollow, fragile, having small curls, waves or rappels (Fig. 4). The hair of three species (Forest musk deer *Moschus berezovskii*, Alpine musk deer *M. sifanicus*, Black musk deer *M. fuscus*) in genera *Moschus* from the specimens collected by Kunming Institute of Zoology, Chinese Academy of Science were tested. Results showed the hair of the Forest musk deer was shorter than Alpine musk deer and Black musk deer with a average length of 2.8 cm and a maximum length of 4.6 cm (n=9). While the average length of the hair of Alpine musk deer was 4.3 cm with a maximum length of 6.4 cm (n=7). In the field study, the average length of the hair was 5.1 cm (n=34). From informal interview, the musk deer distributing in the area had blond body hair, a white band in the neck and tan-tipped ears. This was in accordance with the characteristics of Alpine musk deer documented by Sheng (Sheng, 2007). Thereafter, the musk deer distributing in the study area could be inferred to be Alpine musk deer.

Fig. 4. Show the hair of the musk deer dropped in a bed site

Due to their small body size, the weight of the musk deer only had 7-17 kg. Therefore, their footprints were difficult to detect in forest and grassland where the grounds were covered by dwarfed plants or grass. In a flowstone habitat, several fresh tracks of the deer were detected. The footprints had a pointed, triangular shape. The front feet was 34 mm in long and 30 mm in wide, while the hind feet was 36 mm in long and 32 mm in wide (Fig. 3)

Fig. 3. Footprint of the musk deer

Population and distribution: Unfortunately, the camera traps didn't capture any photos of the animal. Along with the transect sum of 28 fresh signs of animal were found. They are related to three ungulates that include Tufted Deer (12 pellet groups and three footprints), serow (7) and musk deer (5 pellet groups and one footprint). Out of 9 transects only 6 signs of the musk deer were found and they were distributed as shown in Table 1.

Table 1. Frequency distribution of musk deer signs in the sampling transects

Number of pellet group	0	1	2	3
Number of sampling transects	5	2	1	1

We used C_A index to study the spatial distribution of the musk deer (Guo *et al*., 2004). $C_A = (S^2\text{-}m)/m^2$ (m is the mean of the density, S^2 is the variance of the density), where $C_A < 0$ indicates an even distribution, $C_A = 0$ indicates a random distribution, and $C_A > 0$ indicates an aggregated distribution and larger value of C_A imply greater aggregation.
From the data in Table 1 we can calculate the index as follows:

$$\sum x = 9\ ,\ m = \frac{3}{9} = 0.33$$

$$s^2 = \frac{\sum x - \frac{\sum x^2}{n}}{n-1} = 0.42\ ,\ C_A = 0.82$$

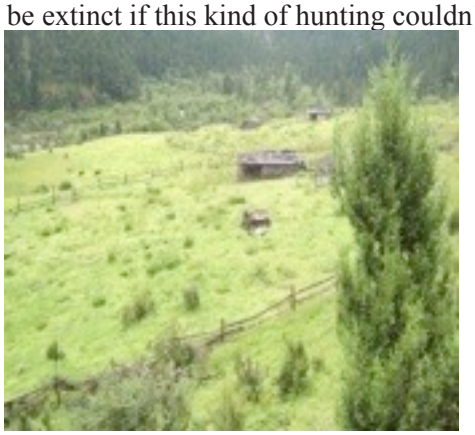
As $C_A = 0.82 > 0$, the pellet groups of musk deer in the study area have an aggregated distribution.

Our study showed musk deer avoided areas at an altitude of $<$4030 m in the study area and mostly preferred areas from 4180 to 4520 m in altitude. Musk deer preferred the cover canopy range of 0-30%, the slope range of 35º - 45º. They avoided areas with a slope below 35º. Musk deer preferred rhododendron forested areas (with 4 fresh signs), with a gradual decrease in preference for rock (1 fresh sign) and flowstone (1 fresh track). The defecation places of the musk deer often overlap with Tufted Deer (Fig. 5). Of these 21 fresh signs of musk deer and Tufted Deer, musk deer signs were found in 3, Tufted Deer signs were found in 12, and both musk deer and Tufted Deer pellets were found in three of the signs.

Fig. 5. Show latrine overlap of musk deer and Tufted Deer. The red circle showed the Tufted Deer pellets, while the dark square showed the musk deer pellets.

Human disturbance: Hunting and over grazing were the most serious threat to musk deer. Along with the field visit sum of 4 herders were informally interviewed. Study revealed that nomadic groups graze their livestock here from June to August in the study area. Grazing here was organized and collective. Yak farm was built by several households together (Fig. 6 a). The farmers often set fire to the shrub in low gradient ridge in dry season for grazing in the coming year (Fig. 6 b). These behaviors cause habitat loss and fragment. Local minority especially Lisu and Tibetan who have no religion had the custom to hound. The breeding scale of local herdsmen ranged from 60 to more than 300. Most of the herders had guns to prevent their livestock stolen by other people (Fig. 6 c). But the real purpose of the guns was doubtful. The gun was made by local blacksmiths and it was very easy to get a gun and

bullets in this area at a price about RMB 1, 700.
Along our transects, 23 traps made by steel cable were found (Fig. 6 d). These traps were set up in the altitude between 4, 200 to 4, 400 m where musk deer preferred to active. Some of the traps had been set up recently, no more than two days. Both sides of the traps were block by branches, no matter young or mature, male or female, the deer were going to be lassoed in case they pass away the traps. This was ruinously destructive for wildlife. Musk deer would be extinct if this kind of hunting couldn't be forbidden.



a. a collective yak farm (4, 050 m asl)

b. a tract of burned bush forest (4, 460 m asl)

c. a gun of a herder

d. a trap for musk deer (4, 230 m asl)

Fig. 6. Human disturbance

Discuss

Population and distribution: The population survey of musk deer is largely incomplete due to a paucity of reliable survey data. Our results showed the musk deer was rare in the area, and was endangered because of illegal hunting and human disturbance. It is an imminent task for the government to conserve the musk deer. In order to know the exact population of musk deer, detailed population surveys should be carried out in the area.
In our study, $C_A = 0.82 > 0$, which indicate the musk deer population was aggregated. The pattern of distribution appeared to be affected by human disturbance. Because of the grazing in the low elevation and moderate slope forests, the dogs often appear in these areas. Musk deer usually were found on high level of the forests, far from human disturbance. Musk deer is a solitary animal, overlap of the defection sites between musk deer and Tufted Deer might be due to habitat loss and human disturbance. And it might be the results of coevolution and adaptability in a limited habitat. More study need to be done to reveal the tolerant mechanism between the two species.
Poaching is the main threat to the survival of musk deer. The main reason for the intense hunting of musk deer has always been the demand for musk. The price of musk deer in the international market is skyrocketing, leading to an increase in poaching. Evidence of poaching is frequently observed in this area, and this is a likely cause of the disappearance of musk deer from Langdu.

Methodology: As musk deer is a solitary animal and is usually active in the morning and at dusk, it is difficult to investigate this animal directly in the field. So an indirect index, such as footprints, droppings, or dens was used to estimate its population density. But, the quantitative relationship between the indirect index and the number of animals it represents in a certain period was difficult to establish in the field. Our study might prove sign survey for musk deer distribution was function. But it is difficult to estimate the density of the deer. The population density estimate relies on an accurate knowledge of defecation rates, pellet decay rates, the age of pellets in a given deposit, and the rate of pellet loss through insect attack or rain. We try to use camera trap in musk deer population survey, and this was a novel attempt using camera traps for musk deer study. It might be a useful method for estimating the density of the musk deer for the following reasons: (1) since the ability to detect the species is not subject to seasonal differences, there is no question as to the identification of the animals; (2) the animals do not suffer any harm; (3) not a lot of time is needed to train the sampling staff; (4) it is not necessary to put in long hours checking the trapping stations, as is the case in live trapping; and (5) it might be effective to estimate the population density by capture and recapture the photos of musk deer. Due to some sudden agency, the pilot study only set up 23 camera days and didn't capture any photos of wildlife. The musk deer is a medium size mammal and has a large hunting area. If the number of the camera traps is too few, it is not possible to capture the photo of the animals. It was grazing season during our study, although the livestock couldn't reach to the steep forest, but the herdsmen always went into the forest with their dogs to search Chinese medicine or hunting. Musk deer suffered the most human disturbance in this season and they might change their course and defecation place which made more difficult to get their photos. Additionally, we checked the camera traps every day to make sure the traps were still there. This might disturb the animal. How to hide the cameras in a long period in the study site avoiding stolen by hunters or herders is a challenge for using camera traps. The cameras would be camouflaged with bark of the trees in the future study. Also it is necessary to conduct biodiversity awareness promotion for local people. Then the cameras could be set up in the forest safely and do not need to cheek every day. It might be increase the chance to capture the photos of the animal.

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