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THE DISTRIBUTION, POPULATION STATUS, AND WILDLIFE PRODUCT TRADE OF HIMALAYAN MUSK DEER IN GILGIT-BALTISTAN, PAKISTAN

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ABSTRACT

Himalayan musk deer (*Moschus chrysogaste leucogaster*) is an IUCN Red List Endangered species that reaches its western range limit in Pakistan, although its distribution or population size is unknown. Here, we mapped its distribution, described habitat preferences, estimated population sizes, recruitment and mortality, and reported the market values of musk deer wildlife products. We used two approaches: analyzing local wisdom (traditional ecological knowledge) through the use of questionnaires, and conducting confirmatory field surveys of selected areas. Questionnaire respondents indicated musk deer sightings in 28 of 84 localities; mainly in Himalayan dry temperate forests with >20% forest cover. There were an estimated 224-363individuals. When females were observed with offspring, there were often two fawns present, suggesting twinning. Hunting appears largely opportunistic, with approximately 20% of the population killed each year. Musk, skins and canine teeth are sold in markets. Future threats include future human population growth, growing awareness about musk deer product values and political instability.

Keywords: Density, population size, overexploitation, habitat, musk pods, wildlife trade, poaching, traditional ecological knowledge.

INTRODUCTION

Himalayan musk deer (*Moschus chrysogaster* Hodgson subsp. *leucogaster*, Artiodactyla: Moschidae) is a small (10 kg), stocky built, primitive deer-like ruminant. Males lack antlers, and females have a single pair of teats. It possesses well-developed canine teeth. Musk deer once persisted in sizeable populations, inhabiting scrub at 2,100-4,000 m above sea level (asl) in Himalayas from Chitral through Gilgit, Baltistan, Indus Kohistan, western China and Kashmir up to Tibet (Scully, 1881; Stockly, 1928; Groves, 1975; Green, 1986; Roberts, 1997; Timmins and Duckworth, 2008). There are indications of a decline in musk deer populations throughout its geographic range. The musk pod, present in males at rut, is harvested for extraction of musk use in the perfume and medicine industries (Homes, 1999). Musk deer is considered Endangered by the IUCN (Timmins and Duckworth, 2008) and is listed on CITES Appendix I. Musk pods are illegally sold in the wildlife trade (Khan *et al.*, 2006). Japan, for example, imported 170 kg of musk per year, mainly of the Himalayan origin (Green, 1986). The price of musk exceeds that of an equal weight of gold

(Khan *et al.,* 2006). An IUCN-sponsored workshop of wildlife researchers, naturalists and wildlife technicians ascribed the Critically Endangered status to musk deer in Pakistan, noting that there is no reliable information on its distribution or population levels (Sheikh and Molur, 2004). In this study, we estimate musk deer population size, distribution and threats in Gilgit-Baltistan (GB).

There are few population studies on this species in Pakistan. Schaller (1980) recorded the Raja of Gupus recalling that musk deer was present in all ravines south of the Gilgit River until 1947. Roberts (1997) reported musk deer from Astor (Gilgit), Hushe and Drosh (Baltistan), while Rasool (1998) suggested a much wider distribution of musk deer in GB. Population estimates in areas adjacent to GB suggested 120 musk deer in 2002 for Neelum valley (Azad Jammu and Kashmir, Pakistan, AJK), with the largest population of 22 animals in Machiara National Park (Qureshi *et al.,* 2004). Later estimates suggested 64 musk deer in the Machiara National Park (Qamar *et al.,* 2008). A small population was reported for Palas valley of Indus Kohistan (Kyber Pukhtunkhwa, KPK), where though no animals was sighted, yet musk deer presence was confirmed from indirect signs (Khalid *et al.,* 1993).

We surveyed the most inaccessible ridges at upper limits of tree line (Roberts, 1997), believing that large areas of steep mountain tracts, with favourable musk deer habitat and limited human population, may still hold viable populations of musk deer despite increasing hunting pressure. Our specific objectives include: a) mapping its present distribution, b) describing musk deer habitat preferences, c) estimating present population size, d) estimating present recruitment and mortality, and e) reporting the market value of musk deer parts. We used two approaches: analyzing local wisdom (traditional ecological knowledge) through the use of questionnaires; and conducting confirmatory field surveys of selected tracts.

MATERIAL AND METHODS

Study Area

GB (71-75^{o}N; 32-37^{o}E; 70,332 km^{2}, 1,000-8,000 m asl) consists of towering snow-covered mountains, deep gorges and narrow valleys. The fast running streams ultimately drain into the River Indus (Figure 1). The Karakorum, Hindu Kush and Himalaya ranges knot in the centre of GB and diverge in different directions. The Karakorum and Hindu Kush have northwestern and southwestern orientations, respectively. The east-west oriented Himalayas occupy southern parts of GB. The Himalayas receive more liberal precipitation during the summer and winter monsoon (mean annual precipitation = 180 cm). They are therefore greener, supporting Himalayan dry temperate mountain forest, sub-alpine and alpine forest (Champion *et al.,* 1965). Northern parts (Karakorum and Hindu Kush) have scanty summer rains, thinner vegetation and greater wind and water erosion. Climatically, GB falls in temperate zone. Winter temperatures remain below freezing for most of the year. The human population (0.7 million) is concentrated in major towns along streams. Small human settlements, groups of family houses and nomadic camps are scattered throughout GB.

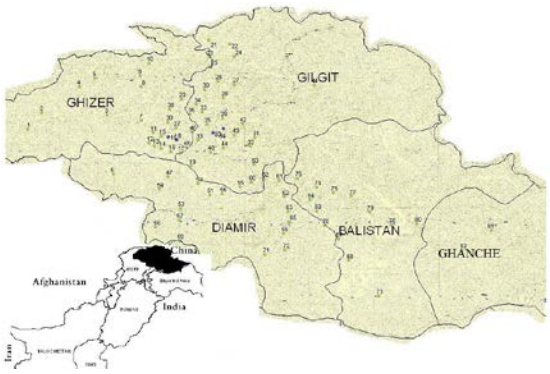

Figure 1: Location of GB and tentative location of different study localities used for questionnaire analysis.

Roads and walkways mostly run along streams (Rasool, 1998). The people depend on livestock grazing and are highly attuned to populations of wild animals. Growth in the human population and the development of communication links is leading to intensified agriculture, grazing and wild resource extraction.

Data collection and analysis

Following techniques successfully used by Abbas *et al.* (2013), we used both questionnaires and field surveys to gather data on musk deer. Our questionnaire contained questions about musk deer population size, herd size, lambing patterns and hunting pressure; the market for musk and musk deer parts; and public awareness about conservation. Trained field assistants administered the questionnaire in early 2006, using a structured interview process. After obtaining informed consent, field assistants interviewed hunters, herders and wildlife enthusiasts throughout GB.

We conducted field surveys in 8 randomly-selected broad localities of GB during later half of 2006. Group of 3-5 trained field assistants walked independently through suitable musk deer habitat using available shepherd walkways, generally following the musk deer survey methodology of Qamar *et al.* (2008). Surveys were carried out at dawn (one hour before and two hours after sunrise) and dusk (two hours before and one hour after sunset) to match the crepuscular habit of musk deer. Field assistants were spaced 500 m from one another. They counted the number of musk deer flushed during the survey. They also recorded musk deer signs in the form of recent communal latrines, footprints and bedding areas. The GPS locations of the beginning and end points of each transect was recorded, along with the survey duration.

Responses to 150 questionnaires were grouped into 82 localities (Figure 1). Responses to each question were analyzed individually (odd information edited and questions left un-responded ignored) and generalizations developed for broad area and total GB tract.

The field survey area was calculated by multiplying transect length traveled by all the workers in the group by the transect width (500 m). Numbers of the animals flushed or indirectly recorded (tracks around latrines, resting places, etc.) were divided by transect area to calculate musk deer population density. Transect densities were pooled for calculation of densities for the 8 broad localities and for GB. Population estimates were calculated by multiplying density with area of potential musk deer tract in GB using Google Earth Contour maps, after adjusting for possible disturbances. Information on habitat and vegetative cover was recorded as general observations and used for

inferring musk deer habitat preferences.

RESULTS

Questionnaire respondents indicated musk deer sightings from 28 of 84 localities sampled in GB, giving constancy of 33% for musk deer presence. No musk deer population was reported over some two-thirds of GB. Musk deer were recorded in southwardly located mountains, with no populations in northwardly placed mountains (Figure 2).

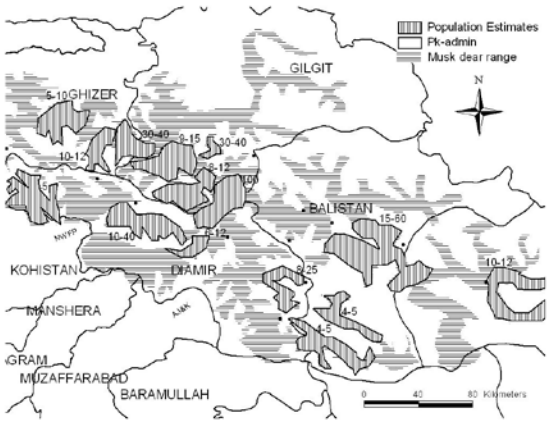

Figure 2: Distribution of potential musk deer tracts and estimated populations for different localities of GB, as suggested by questionnaire analysis.

Musk deer is distributed in the Himalayan dry temperate forests, dominated by juniper (*Juniperus* spp.), Himalayan birch (*Betula utilis*) and morinda spruce (*Picea smithiana*). Our sample sizes are too small to develop a robust wildlife-habitat association model for musk deer. However, we observed the lowest musk deer densities in the areas having <20% forest cover. Areas with more forest cover appeared to have the potential to support higher deer population densities. Musk deer in GB co-occurs with many charismatic species, including: snow leopard (*Uncia uncia*), leopard (*Panthra pardus*), lynx (*Felis lynx*), fox (*Vulpus* spp.), wolf (*Canis lupus*), stone martin (*Martes foina*), ibex (*Capra ibex*), Astor markhor or flare-horned markhor (*Capra falconeri falconeri*), chukar (*Alectoris chukar*) and ram chukar or snow partridge (*Lerwa lerwa*).

Data received from the questionnaire respondents suggests a musk deer population of 224-363individuals for GB during 2006 (Table 1; Figure 2). The largest musk deer population occurred in Dumot. Smaller populations occurred in Randu, Jutial and Jagot. Populations with fewer than 25 individuals occurred in Astor, Singul, Hanzal, Haramosh, Chilas and Khaplu. All other localities held very small populations (<10 heads). Transect surveys yielded a mean population density 4.97±3.47 SEM per 100 km^2 for favourable musk deer tracts of GB (Table 2). Population density estimates for different broad localities ranged between 3.39 and 12.97 musk deer per 100 km^2.

Questionnaire respondents collectively reported 57 recent musk deer sightings between 2004 and 2005. Group size ranged from 1-12 individuals, with an average of 2.14 ±0.43 SEM (Figure 3). Herds of 8 and 12 individuals were reported in two separate sightings. We do not know whether these sightings represent unusually large herds, or were multiple herds grazing fairly close to one another. Average herd size was the highest in Astor (2.42±0.61 SEM, n=15), followed by Gilgit (1.65±0.15 SEM, n=22), Diamer (1.50±0.22 SEM, n=9), Ghizer (1.25±0.50 SEM, n=9) and the smallest in Ghanche (1.00, n=

Table 1: Summary of the information received on musk deer population, hunting and market prices of musk deer parts in GB through questionnaire analysis. For locality Ref. Nos. refer to Figure 1.

Locality		Population (#)		Hunting claims (#)	Market Price (in thousands Pak Rs.)		
Name	Ref. Nos.	Min	Max		Musk (per 10 g)	Skin	Tooth
Darel	**6**	**5**	**5**	**2**	**10**		
Singul	**11, 12**	**5**	**10**	**1**	**5-8**		
Hanzal	**17**	**10**	**12**	**1**	**10**		
Jutial	**39**	**30**	**40**	**2-3**	**6-8**		
Haramosh	**43, 44, 47**	**9**	**15**	**1-5**	**5-12**		
Sakwar	**48, 49, 50**	**8**	**12**	**4-8**	**5-10**	**0.5-10**	**0.5-4**
Jaglot	**51,53,54**	**10**	**40**	**5-8**	**9-10**		
Dumot	**55, 56**	**100**	**100**	**1-4**	**5-10**		
Chilas	**57, 60**	**6**	**12**	**2-5**	**8-10**		
Astor	**62-64**	**8**	**25**	**1**	**5-10**		
Gudai	**67**	**4**	**5**	**1**	**8-10**		
Ratu	**71,72**	**4**	**15**	**1**	**5-10**		
Rondu	**74,77,80**	**15**	**60**	**3**	**8-10**		
Khaplu	**82**	**10**	**12**	**0**	**-**		
		224	**363**	**25-43**			

Table 2: Transect data on distribution of musk deer population in different localities of GB surveyed in 2006. Densities having common letters are not significantly different at the 0.05 level.

Locality		Transect		Sightings (#)			Density (per 100 km^2)
Name	Ref. No.	#	Area (km^2)	Direct	Indirect	Total	
Jutial	39	3	43.5	3	1	4	12.76±10.11 a
Haramosh	43,44,47	3	23.5	2	1	3	9.20±2.41ab
Sakwar	48,49,50	2	38.5	1	1	2	5.26±1.55a
Astor	62,64	2	47.5	1	2	3	6.31±5.52abc
Gudai	67	3	48.0	-	2	2	4.17±0.50ac
Ratu	71-72	2	25.0	-	1	1	4.0±3.51abc
Rondu	74,77,80	3	39.0	-	2	2	5.13±1.50ac
Khaplu	82	5	206.5	2	5	7	3.39±0.54abc
		23	463.0	9	15	23	4.97±3.47

1). Very large herds were reported for Skardu (6.50 ± 5.52, n=2). Of the 8 sightings documented during 2006 field surveys, a single musk deer was

observed in 88% (7 of 8) of cases, and only one group (of 2) was seen.

Questionnaire respondents recalled herd sizes being larger in the past. They reported seeing mean herd sizes of 3.2±1.28 SEM (n =18) prior to 1990. This declined to1.38±0.26 SEM (n=22) during 1990-95. Herd size increased slightly to 1.45±0.18 SEM (n=29) during 1996-2000 and 1.76±0.18 SEM (n=57) during 2001-05.

We were not able to directly obtain data on the number of fawns born per female or the proportion of breeding females in the population. However, questionnaire respondents provided data for 27 family groups. They indicated that 7.4% (n=2) groups contained one fawn, 85.1% (n=23) had two and 7.4% (n=2) had three (average=2.00 ± 0.075 SEM) fawns per female. No report contained sighting of more than 3 fawns. Fawns were more frequently (86.6%, n=27) seen with the female. Both males and females accompanied fawns on two occasions (7.4%).

Questionnaire respondents reported a total kill of 25-43 musk deer during 2005 (Table 1). They reported that most of this hunting is for bush meat. Musk pods, skins and tooth (canine) are considered as by-products of such hunting and are taken to the market, where these are sold. Firearms are used for most hunting, though live traps/snares are also sometimes used (especially in Dumot) for musk deer trapping.

Musk is available in all market places of the central and southern parts of GB. Prices vary with quoted prices ranging between Pak Rs. 5,000-10,000 ($USD 83-166, based on 2006 exchange rates) per 10 g. The average musk pod weighs approximately 30 g (Roberts, 1997). People in the region believe that musk has aphrodisiac properties and effectively treats arthritis.

Deer skin is also available in some market places, especially in Gor, Harchu, Ramkha, Randu, Tormik, Shigar, Jaglot and Sakwar. The market price of skin was not readily available for many areas, but was reported fetch Pak Rs. 500-10,000 ($USD 8-166). Musk deer tooth (canine) is also available in different markets for Pak Rs. 500-4,000 ($USD 8-66) per tooth. It is believed to have some spiritual value.

Questionnaire respondents indicated that the general public of GB has a high level of awareness about the environmental issues. All the respondents conveyed their concern over the declining trends in wildlife species, including musk deer. They regarded wildlife and natural vegetation of the area as important natural resources, both for their aesthetic value and for supporting livestock.

DISCUSSION

Distribution

Musk deer are widely distributed over the southern mountains of GB in areas with adequate forest cover. Within this area, it is absent in the northern drier mountains where forest cover is limited. The distribution of musk deer reflects the habitat requirements identified by Roberts (1997). However, the distribution of musk deer in GB is wider than suggested by previous authors (Roberts 1997, Schaller, 1980).

We have identified populations in the Astor, Hushe and Drosh Valleys, and in the south-eastern mountain valleys south of the Gilgit River. Our report partly confirms the suggestion of Rasool (1998), indicating a wider distribution of musk deer in a number of valleys of southern GB. This extends the western-most range limit (Timmins and Duckworth, 2008).

Contour mapping of mountains slopes actually occupied by musk deer in GB proved difficult, and needs further investigation. GIS mapping of the southern mountains slopes of GB falling at 2,000-4,000 m asl suggests that some 12,000 km^2 can possibly be exploited by musk deer in GB. However, about half of this area is not directly exploitable by musk deer. Northern slopes have limited forested growth and higher human exploitation. We therefore infer that the total area of potential musk deer habitat in GB is around 6,000 km^2. Similar contour mapping of adjacent areas suggest that some 3,762 km^2 is available for musk deer in KPK (2,411 km^2) and AJK (1,351 km^2).

This study provides the first estimate of musk deer population size and density for GB. Our data suggests a population of around 300 musk deer present over some 6,000 km^2 of favourable habitat tract available in GB (5 musk deer/100 km^2). These estimates are independently derived from two procedures, i.e., the survey of local wisdom and direct field survey. The estimates derived from two independent sources were in reasonable agreement. Future population size monitoring could be questionnaire-based. This would be a great advantage, as musk deer is challenging to study using direct field studies. It lives on steep slopes, is crepuscular in habit, and avoids humans. Herders living in GB with a passion for wildlife make ideal informants, as they have a keen field observation for their area. Musk deer population studies could make use of transect surveys to cross-validate data from local observers.

Musk deer have a home range of 13-22 ha (Harris and Cai, 1993), so the observed musk deer population size of some 300 is a small fraction of what could be supported in GB. With some 50,000 km^2 of musk deer habitat available on the southern slopes of the Himalayas, the area is capable of supporting >200,000 individuals (Green, 1985). GB falls in the western extremity of summer monsoons. At this limit, limited precipitation does not support the rich forested vegetation that musk deer require.

Small populations of musk deer are reported elsewhere in Pakistan. A population of 120 has been suggested for some 1,400 km^2 of musk deer tract of adjacent areas of AJK (8.6 musk deer/ 100 km^2; Qureshi *et al*., 2004). No estimates are available for some 2,400 km^2 of musk deer tract in KPK, and a study carried out in best musk deer habitat of Kabkot Nullah (Palas Valley, District Kohistan, KPK) indicated presence of a small population (Khalid *et al.,* 1993).

The Dumot Valley (100 musk deer) and Randu, Jutial and Jagot (each with 40-60 musk deer) are the priority areas for future conservation of musk deer in GB. Astor, Harmosh and Drosh were areas that supported high musk deer populations in recent decades (Roberts 1997). However, these valleys now support smaller musk deer populations (<25 musk deer). Our study suggested relatively medium-

high densities and smaller populations for Astor and Harmosh, which we believe is due to the limited available musk deer habitat tracts in these valleys. No previous population size or density estimates are available for these localities. It is therefore difficult to say whether there has been a recent habitat contraction, a decline in the population, or both factors occurring together.

Our data indicate that musk deer is essentially a solitary species in GB, possibly exhibiting territorial behaviour (Figure 3: Kirchshofer, 1972; Roberts, 1997). The reported decrease in herd size from 3.2±1.3 SEM (prior to 1990) to 1.8 ±0.2 SEM (2001-2005) might indicate a recent decline in musk deer population of GB. This trend equally persisted in 2006 physical sightings (average herd size = 1.2).

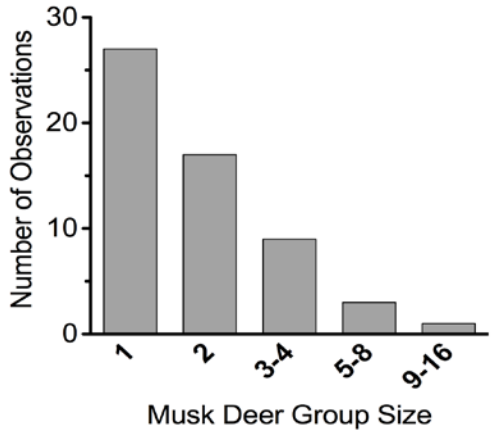

Figure 3: Frequency of sightings of herds of different size for musk deer population in GB as indicated by respondents of questionnaire.

The number of fawns accompanying each female or family group can provide an indirect estimate on the reproductive potentials of musk deer. Questionnaire respondents indicated that 85% of family groups had two fawns present. This suggests twin births are frequent. This is in contrasts with Prater (1965) suggesting that single births are more common in musk deer. Moreover, we can infer females play an important role in fawn rearing and protection. The occasional sightings of fawns with both males and females together suggest an absence of agonistic male-fawn interactions. The presence of 2 fawns per female indicates high natality and early fawn survival. This might be due to low intra-specific competition given the low musk deer densities and low predation pressure.

We do not know the natural mortality schedule for musk deer in this population. Our results indicate that 25-43 musk deer faced human predation in GB during 2005, which constitutes 8-14% of musk deer population of some 300. Human-caused mortality is likely additive instead of compensatory. However, further research is needed to assess the impact of hunting on the musk deer population, as present level of hunting pressure alone probably cannot solely account for the decline in musk deer population in GB (Prater, 1965).

Musk deer is not in direct conflict with man. It neither competes with livestock for food, nor is it a pest for agricultural crops. Local populations have no special passion for hunting musk deer, and foreign hunters seldom come to hunt in this remote, difficult terrain. Instead, most musk deer hunting is opportunistic and conducted by herders using firearms. Bush meat provides the primary motivation. Musk pods, skin and canine teeth are then sold in local market, either directly or through

middlemen. We do not know what prices middlemen offer, other than these are adjusted depending on the sophistication of the seller.

There are some positive signs for the future of wildlife and musk deer conservation in GB. There is a high public awareness about wildlife conservation, an appreciation for wildlife and natural resources, and a desire for developing eco-tourism. There is also an absence of organized market hunting for musk deer in this region. However, challenges remain. The future growth and expansion of the human population into the musk deer habitat, the growing awareness of market trends facilitated by new communication links and mass media, and political instability will expose musk deer to increased hunting pressure and negatively impact habitat potentials. A well-managed, carefully handled awareness campaign, combined with equitable use of wild resources will be needed to engage local communities with musk deer conservation efforts in GB.

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REFERENCES

Fakhar-i-Abbas, Rooney TP, Mian A (2013). Gray wolf (*Canis lupus* L.) in Gilgit-Baltistan, Pakistan: distribution, abundance, and persecution. Canid Biology & Conservation, 16, 18-24.

Champion HG, Seth SK, Khattak, GM (1965). Forest Types of Pakistan. Pakistan Forest Institute, Peshwar, Pakistan.

Green MJB (1986). Distribution, status, and conservation of the Himalayan musk deer (*Moschus chrysogaster*). Biol Cons, 35, 347-375.

Groves CP (1975). The taxonomy of *Moschu*s (Mammalia, Artiodactyla) with particular reference to the Indian region. J Bombay Nat Hist Soc, 72, 662-676.

Harris RB, Cai GQ (1993). Autumn home range of musk deer in Baizha Forest, Tibetan Plateau. J Bombay Nat Hist Soc, 90, 430-436.

Homes V (1999). On the scent: conserving musk deer – the uses of musk and Europe's role in its trade. TRAFFIC Europe, Brussels, Belgium.

Khan AA, Qureshi B, Awan MS (2006). Impact of musk trade on the decline of Himalayan musk deer *Mochus chrysogaster* population in Neelum Valley, Pakistan. Curr Sci, 91, 696-699.

Khalid U, Ghafoor A, Raja NA (1993). Musk deer survey in Kabkot Nullah, Palas Valley, District Kohistan, NWFP, Pakistan. J For, 45, 125-128.

Kirchoshofer R (1972). The Musk Deer, Dragoco Report, Gerberding, West Germany.

Prater SH (1965). The Book of Indian Animals, 2nd ed. Bombay Nat Hist Soc Mombay, India

Qamar Q, Anwar M, Minhas RA (2008). Distribution and population status of Himalayan musk deer (*Moschus chryogaster*) in the Machiara National Park, AJ&K. Pak J Zool, 40, 159-163.

Qureshi B, Awan MS (2004). Distribution of Himalayan musk deer (*Mochus chrsogaster*) in Neelum Valley, District Muzaffarabad, Azad Jammu and Kashmir. J Biol Sci, 4, 258-261.

Rasool G (1998). Animals of the Northern Areas of Pakistan, BASDO, Gilgit, Pakistan.

Roberts TJ (1997). The Mammals of Pakistan. Ernest Benn Ltd., London, UK.

Schaller GB (1980). Stones of Silence. Viking Adult, New York, USA.

Scully J (1881). On the mammals of Gilgit. Proc Zool Soc Lond, 49, 197-209.

Sheikh M K, Molur S (2004). Status and red list of Pakistan Mammals based on Pakistan's Conservation assessment and management plan for mammals. IUCN, Pakistan, Islamabad.

Stockly CH (1928). Big Game Shooting in the Indian Empire. Constable, London, UK.

Timmins RJ, Duckworth JW (2008). *Moschus leucogaster*. The IUCN Red List of Threatened Species. Version 2014.3. www.iucnredlist.org Downloaded: 16 April 2015.