Population Features of Barking Deer (*Muntiacus muntjak*) in Margalla Hills National Park, Pakistan

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Abstract.- Belt transect (71 km) sampling of population of barking deer (*Muntiacus muntjak*) in Margalla Hills National Park, Pakistan (western extremities of Lesser Himalayas), conducted during winter March-April 2005 suggested a population of 86 individuals distributed in southern slopes with an average density of 1.21±0.14/ km^2 (range 0.80 - 1.45). The population exhibited a growth rate of 4.14% per annum between 1971 and 1990 and 1.94% between 1991 and 2005. Sex ratio of 1.45 (female/ male) and fawn/ female ratio of 0.25 was exhibited. The majority of the sightings (64.29%) were as singles or in groups of two (total = 35.71%: two females = 3.57%, male-female = 7.14%, female-fawn = 25.0%). The deer habitat had reasonably good plant diversity (35 species). Population density of barking deer was 1.57/ km^2 at > 1,200 m above sea level, whereas it was 1.07 – 1.21/ km^2 at <1,200 m above sea level. The maximum density appears at medium tree cover (19%), and increasing or decreasing tree cover beyond the cover optima decreased the deer density. Shrub cover had no direct effect on deer density, while increasing herb cover directly increased muntjak density.

Key words: Age structure, density, habitat, population estimates, sex structure, vegetation cover.

INTRODUCTION

The barking deer or Indian muntjak (*Muntiacus muntjak*) has been regarded as endangered in Pakistan with isolated populations present in Margalla Hills National Park (MHNP), Khanpur Range and Lathrar (Sheikh and Molur, 2005). The Margalla Hills (Pakistan) used to hold a good population of the species, which had declined to some 20-30 heads by the 1970's (Roberts, 1977). The creation of MHNP provided protection to the habitat and the population grew to 67 individuals by 1990 (Ali, 1991). The continued survival of the species in the country depends in part on a better understanding of distribution and structure of its population in the MHNP, as very limited numbers of deer probably survive in the unprotected areas of the country. The objective of this study is to provide a current census of barking deer in MHNP with attention to sex and social structure and habitat associations. Its confirmed density in its world distribution which is confined in south Asia is unknown; however the major threats according to IUCN criteria are habitat encroachment, poaching, competition with free grazing livestock, feral dogs and hunting (Timmins *et al.*, 2008).

MATERIALS AND METHODS

Margalla Hills National Park (33°40 – 33°44 N, 72°55 – 73°20 E; 465 -1,600 m above sea line, established in 1980) is spread over 126.05 km^2 in the Margalla Hills Range, falling in the western extremities of the Lesser Himalayas. The park has a rugged topography of steep slopes and gullies, with predominance of limestone rocks. Deforestation and grazing have caused soil erosion, leaving shallow residual soil or parent rocks (Shinwari *et al.*, 2001). Average temperature ranges between 16.9 and 40.1 °C during summer and 3.1 to 24.7 °C during winter. The major part of the precipitation (annual average 120 cm) is received during July – August, and the snowfall is occasional (Masud, 1977). The south-facing slopes of the hills are green and provide habitat for muntjak, while the north-facing slopes are dry and barren. A total of 608 plants species has been recorded from the park, including *Acacia modesta*, *Bauhinia variegata*, *Cassia fistula*, *Bombax ceiba* (trees), *Dodonea viscosa*, *Woodfordia fruticosa*, *Adhatoda vesica* and *Zizyphus mauritiana* (shrubs). These provide the dominant cover. Some 30 species of mammals, including rhesus monkey (*Macaca mulata),* jackal (*Canis aureus),* wild boar (*Sus scrofa),* grey goral (*Naemorhedus goral),* common leopard (*Panthera pardus)* and barking deer; 250 species of birds, 17

species of reptiles, 6 species of amphibians and 27 species of fish have been reported from the park area (Anjum *et al.*, 1984; Rafique *et al.*, 2005).
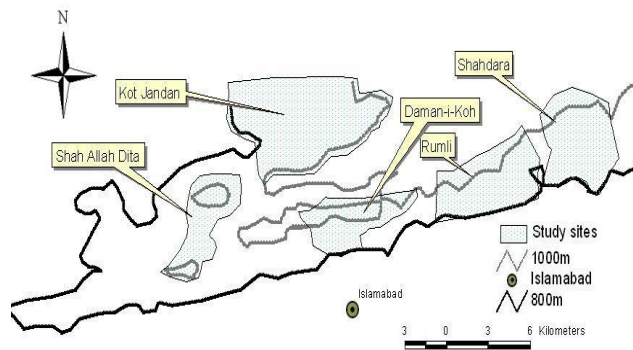

Fig. 1. Map of Margalla Hills National Park showing different zones, created for ecological studies on barking.

We divided the potential barking deer habitat of MHNP into five zones, *viz.* Shahdara, Rumli, Daman-i-Koh, Shah Allah Dita and Kot Jandan (Fig. 1). Each zone was separately sampled for deer populations, using a belt transect method during March-April, 2005 after breeding season. For this purpose, 3-4 parties of 3 observers each walked along randomly selected predefined shepherd tracks, during morning and evening sessions, to count the total number of deer. The distance traveled by each party (length of transect) was worked out using topographic sheets   (1:63,360), while distance of each sighted individual(s) from the walking line and altitude of such places were recorded by using a Global Positioning System (MAGELLAN SporTrak COLOR). Average of the distances of different sightings was calculated, which was doubled and used as average width of transect. The transect area was calculated by multiplying the transect length by the average width. Population density was calculated by dividing the number of deer observed by the respective transect area. The total population in each zone was estimated by multiplying the density with the potential habitat area, calculated using detailed maps.

Each of the sighted animals was classified as adult male, adult female or fawn, and these data were used to work out sex and fawn-to-female ratios. A group of individuals seen together (in one sight) was regarded as a herd.

Records were noted down of fresh foot tracks, faecal pellets, hairs, etc., seen during field visits. Information on number of barking deer present in different valleys was also collected from shepherds/ prominent peoples of the area. This information was used to countercheck the transect sampling.

A line transect method was used for vegetation analysis. A total of eight transects, 50 m each, was randomly laid in each zone, taking care to sample all possible habitat variation. The length of the transect line directly touching or expected to be passing through the plant canopy was recorded. The cover of each species was calculated by dividing the total length of a transect line under a species by 50 m (transect length) and represented as a percentile. The community structure, for each zone, was developed by pooling the individual transect data. The altitude of the localities giving the muntjak sightings was recorded using a GPS.

Sokal and Rolf (1969) was followed for statistical analysis.

RESULTS

Population biology

The present study suggested that barking deer were distributed over a fairly continuous range, occupying the southern slopes of the park, at an altitude up to 1200 m above sea line (asl), with an overall density of $1.21\pm0.14/km^2$. Different localities exhibited different densities, yet these were not significantly different (p > 0.05). The estimates generated from density figures suggested a population of 86 head (range 76 − 96) distributed over some 71 km^2 of favorable deer habitat in MHNP (Table I).

The data on sex structure (Table II) suggested a male-to-female ratio of 1:1.45, not significantly different ($\chi^2_{(1)}$ = 1.6531, p > 0.05) from 1:1 sex ratio. However, females were consistently in higher numbers than males in all the pockets. The available data on the population structure (Table II) suggested that there were 0.25 fawns to a female in the total deer population of MHNP.

Table I.- Population density and estimates on barking deer in different localities of Margalla Hills National Park, during March-April, 2005.

Localities	Transect sampling			Population estimation	
	Area (km^2)	Number	Density (per km^2±SE)	Total Area (km^2)	Number
Shahdara	10.50	14	1.33±0.34	15	20
Rumli	5.00	6	1.20±0.46	12	14
Daman-i-Koh	13.75	20	1.45±0.23	20	29
Kot Jandan	7.50	6	0.80±0.29	12	9
Shah Allah Dita	9.50	10	1.05±0.31	12	12
Total	46.25	56	1.21±0.14	71	86

Table II.- Sex and age structure of barking deer population in different localities of Margalla Hills National Park, during March-April 2005.

Localities	Male	Female	Fawn	Sex ratio (Female/Male)	Age structure (Fawn/Female)
Shahdara	6	8	0	1.33	-
Rumli	2	3	1	1.50	0.33
Daman-i-Koh	6	10	4	1.66	0.40
Kot Jadan	2	3	1	1.50	0.33
Shah Allah Dita	4	5	1	1.25	0.20
Total	**20**	**29**	**7**	**1.45**	**0.25**

The analysis on the herd composition suggested that 64.3% of the population was dispersed as singles (males or females) and 35.7% in groups of two (Table III). In 10% of these groups female grazed with a female, while in 20% the female was accompanied by a male and in rest (70%) the female was accompanied by a single fawn. There was no record of more than one fawn with a female or groups of more than two individuals.

Habitat

Vegetation analysis (Table IV) suggested the presence of a minimum of 35 plant species (9 trees, 13 shrubs and 13 herbs) in favourable deer habitat. The major part of the absolute cover was contributed by shrubs (30.3- 68.7%), followed by herbs and grasses (21.3 – 36.0%) and trees (7.5 and 36.0%).

The density of barking deer showed a positive correlation ($R^2_{(3)}$ = 0.8611, p = 0.05 – 0.10) with plant diversity, as indicated by the number of plant species in each stand area. The analysis of association of barking deer density with vegetation

Table III.- Sighting frequencies of groups of different compositions in the barking deer population in MHNP during 2005.

Group Size	Group Composition	Frequency	
		Sightings (#)	% population
1	Male	18	33.6
	Female	18	33.6
	Total		**64.29**
2	Male+Male	2	7.14
	Female+Fawn	7	25.00
	Female+Female	1	3.57
	Total		**35.71**

cover (curvilinear $R^2_{(3)}$ = 0.978, p < 0.05 level) suggested that the maximum deer density was present in the habitat having a medium tree cover (around 19%), while both the increase or decrease in trees cover beyond/below this optimal cover resulted in gradually decreasing deer density. The changes in shrub cover did not suggest a regular pattern of change in deer density ($R^2_{(3)}$ = 0.346, p > 0.05). The herb cover showed a high curvilinear correlation coefficient ($R^2_{(3)}$ = 0.834, p=0.05 - 0.10),

Table IV.- **Distribution of absolute vegetative cover amongst different species in different locations of Margalla Hills National Park during spring 2005.**

Plant Species	Rumli	Shahdra	Shah Allah Dita	Kot Jandan	Daman Koh
Trees					
Acacia modesta	0	0.5	0	0	0.48
Acacia nilotica	0	4.5	1.92	1.92	1.92
Bauhinia variegata	0	3.85	2.52	3.52	2.52
Ehretia aspara	0	0	3.25	4.63	3.63
Grewia optiva	1.91	0	2.91	0	1.05
Grewia tenax	1.57	1.5	1.57	0	1.91
Olea ferruginea	0	0	2	0	4.59
Pinus roxburghii	4	3.5	17	25.94	2
Ziziphus nimularia	0	1.14	0	0	1.36
Total Tree Cover	**7.48**	**14.99**	**31.17**	**36.01**	**19.46**
Shrubs					
Adhatoda vesica	1.57	1.5	1.5	0	1.07
Buxus sempervirens	0	0	3.5	4.02	3.02
Carissa opaca	3.14	3.25	3	3.33	2.2
Cassia alata	0.69	0.69	4.9	8.91	4.91
Dodonaea viscose	28.79	28.75	9.79	12.75	8.75
Flacourtia romntchi	2.75	1	1	0	0.69
Gymnosporea royleana	2.44	2.44	2.44	2.44	1.57
Jasminum humile	3.57	3.57	4.57	0	0.52
Mallotus philippensis	8.8	0	1	0	0.35
Myrsine Africana	10.48	9.3	4.5	6.59	2.11
Rosa brunonii	6	4.76	5.75	0	0.19
Rubus ellipticus	0.5	0.5	0	4.35	4.76
Wood fordia fruticosa	0	1.36	2.25	0	0.17
Total Shrub Cover	**68.73**	**57.12**	**44.2**	**42.39**	**30.31**
Herbs/grasses					
Alpuda cristata	0	0	3	0	3
Calatropi procera	0	1.16	1.25	0	1.16
Chrysopogon aucheri	7.69	10.48	3.25	4.18	3.18
Digitaria decumbens	4.71	4.75	5.25	5.36	4.36
Eulaliopsis binata	0	0	0	4.52	3.52
Ephedra gerardiana	0	0	0	0.58	0.58
Heteropogon contortus	3.32	6.25	4.25	0	2.44
Lamium amplexicaule	0.25	0.35	0	0	3.57
Mimosa rubicaulis	1.25	1.25	3.11	0	1.38
Polygonum plebium	0.46	0.25	0	0	17.7
Rhus cotinus	2	0.19	0	0	0.35
Themeda anathera	3.65	1.66	5.3	6.63	0
Trifolium repens	0.5	0.15	0	0	4.63
Total Herb Cover	**23.83**	**26.49**	**25.41**	**21.27**	**45.87**
Total Plant Cover	**100.04**	**98.6**	**100.78**	**99.67**	**95.64**
Deer Density	**1.33±0.46**	**1.20±0.46**	**1.45±0.23**	**0.80±0.29**	**1.05±0.31**

suggesting that the barking deer population density gradually increased with increasing herbal/grass cover.

Distribution of muntjak densities at different altitudes (Table V) and a reasonably high value of the curvilinear correlation coefficient between

density with increasing altitude ($R^2_{(3)}$ = 0.754, p > 0.05) suggested a trend of increase in density with the altitude. The altitudinal variation between 800 and 1,100 m asl did not affect density, while a further rise in altitude showed a steep rise in deer density.

Table V.- **Population density of barking deer at different altitude in Margalla Hills National Park, during March-April, 2005.**

Altitude (m)	Area Sampled (km^2)	Deer Observed	Density (per km^2±SE)
800-899	10.25	11	1.07±0.27
900-999	11.50	14	1.21±0.28
1000-1099	9.25	10	1.08±0.29
1100-1199	7.00	8	1.14±0.45
1200-1299	8.25	13	1.57±0.35

DISCUSSION

The muntjak population was distributed in the southern slopes of the hills. The northern slopes of the Himalayas, including the Margalla Hills, are generally dry and barren and hence do not provide a suitable habitat for barking deer, as they tend to live in habitat with denser vegetation cover (Roberts, 1977).

No previous reliable densities for barking deer are available for the MHNP to compare with. The species has been reported to be present in high densities in Wilpattu National Park, Sri Lanka (0.5 - 7.0/ km^2; Barrette, 1977) and Nepal (6.7 – 7.0/ km^2; Seidensticker, 1976; Dinerstein, 1980). MHNP holds a reasonably good density (1.21± 0.14/ km^2) of this deer species. Chaplin (1977) reported the presence of more than 200 muntjaks distributed over a few hundred hectares in the whole region.

The present estimates (86, range 76 – 96) are the first appearing on the barking deer population of MHNP (65% of the favourable habitat sampled). Three previous population estimates are available for the area, suggesting a population of 20-30 (based upon information from local villagers; Roberts, 1977), 67 (an approximation developed through the number of animals seen, fresh faecal pellets observed and number of barks recorded; Ali, 1991) and 112 (an approximation through counting

number of footprints on water points; Anwar, 1997). The estimates of Roberts (1977) appear as underestimations (based on records of 10 deer in a day in 1971, flushed during wild boar hunting) and those of Anwar (1997) as overestimations, as water points located in close proximity (44 water points over 70 km^2) can be visited by the same animal/ group of animals and hence there are high chances of a double count. The present estimates need confirmation, yet these may be considered reliable estimates of the existing population and can work as benchmark information for future reference on population growth and survival.

Most sightings concerned solitary individuals, followed by groups of two, mostly females with a single fawn. The barking deer is basically a solitary animal (Lekagul and McNeely, 1977; Roberts, 1977) and 93-94% (Nepal: Seidensticker, 1976; Dinerstein, 1979) and 64.5% (Sri Lanka: Barrette, 1977) of sightings have been reported as singles.

Fawn-to-female ratio was low for all the localities. A comparatively high fawn to female ratio (76 fawn:100 females) has been suggested for the muntjak population in Wilpattu National Park, Sri Lanka (Barrette, 1977). The low fawn-to-female ratio may indicate a low population recruitment rate of the MHNP population. This species is a slow breeder and single birth is believed frequent, while twins are very rare (Barrette, 1977, Lekagul and McNeely, 1977, Roberts, 1977). A higher predation on fawns may also result in a low fawn-to-female ratio, and there are indications of a recent increase in the local population of leopard (*Panthra pardus*) in MHNP.

The barking deer is known to be predominantly a browser (Lekagul and McNeely, 1977) and shrubs are expected to build the major part of its diet. The presence of a greater shrub cover in the park ensures the continued availability of diet to this species. No previous study is available on the effect of different plant communities on density of the barking deer. A direct positive correlation of vegetation diversity is expected, as it ensures the survival of a herbivore species. A direct correlation with grass cover tends to suggest that this deer depends more on grazing than on browsing (Dinerstein, 1979). The initial increase of tree cover may increase protection/ availability of food (deer

may eat fallen fruits and fleshy flowers: Roberts, 1977), but increasing tree cover beyond the optimal level (20%) can hinder the free movement of these deer, who mainly depends upon escape from predators for its survival.

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