

NOTES ON THE ECOLOGY OF GORALS IN TWO AREAS OF SOUTHERN ASIA

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The Goral, *Nemorhaedus* spp., is a cliff-dwelling rupicaprine distributed from North-East Pakistan to North-West Thailand and South-East Siberia (Groves and Grubb, 1985). Its biology is still largely unknown and most information on the species comes from anecdotal reports of early hunters and travellers. Recently Green (1987) provided detailed data on Goral food habits in Uttar Pradesh, North India, and Heptner *et al.* (1989) gave a description of the biology of the Amur goral, Siberia, mainly based on Bromlei (1956, in Heptner *et al.*, 1989). Cavallini (*in press*) carried out a survey in Himachal Pradesh, North India, collecting some information on Goral group size, altitudinal distribution and activity.

The aims of our study were (1) to identify daily movements and the habitat attended; (2) to assess group size and structure; and (3) to describe activity rhythms.

We carried out our observations at a site in the Himalayan foothills and, by comparison, in another area of North-West Thailand whose climatic and other environmental features were different.

STUDY AREA

The Majathal Harsang Wildlife Sanctuary (henceforward MHWS) (31° 15'-77° 0'), HP, India, extends over 3 939 ha, at 650-1 985 m a.s.l. (Fig. 1). Its human population reaches 645 inhabitants whose main ways of subsistence are traditional agro-pastoralism and woodland exploitation; grass cutting is extensive. The arboreal vegetation includes oak woodlands (*Quercus incana*) on the northern slopes and in moist pockets, as well as sparse pinewoods (*Pinus roxburghii*) on relatively arid terrain. The upper slopes, and most of the southern slopes, were deforested and turned into rocky meadows. Sparsely vegetated cliffs are also present. The climate is monsoonal. The rainy season lasts from July to September,

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and snowfalls are scarce. The mean air temperatures during our study period are shown on Fig. 2. The Grey goral *Nemorhaedus goral bedfordi* is the species found at MHWS (Groves and Grubb, 1985).

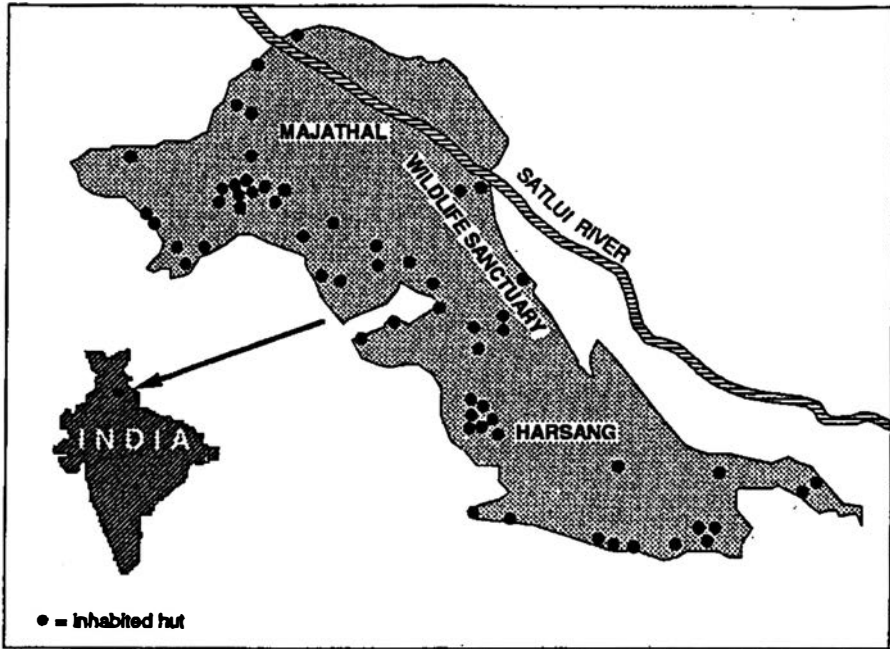


Figure 1. — Map showing the study area and village locations at MHWS.

The study area in Thailand, the Doi Mon Jong Mountain, North-East slope, is located in the Om-Koi Wildlife Sanctuary (henceforward OKWS) ($17^{\circ} 14' - 98^{\circ} 26'$), Chiang Mai Province. OKWS extends over 122 000 ha, in a hilly area covered by mixed deciduous and dry dipterocarp forests in the lowlands, whereas evergreen forest is found at higher altitudes. Several hill tribe villages are located within the Sanctuary. The hills create a rainfall gradient which moderates the South-West monsoon. Precipitation in the region declines from 1 200-1 400 mm per annum to less than 1 000 mm in the East. The Long-tailed goral *Nemorhaedus caudatus evansi* is the species living at OKWS (Groves and Grubb, 1985).

Mean temperatures, measured during the observation sessions, were 17°C in the morning at both MHWS and OKWS, whereas they were 15°C and 22°C respectively in the afternoon. In both study areas, potential predators of the gorals were leopards (*Panthera pardus*) and Himalayan black bears (*Selenarctos tibetanus*). Tigers (*Panthera tigris*) were reported to visit the OKWS during the rainy season (May to October).

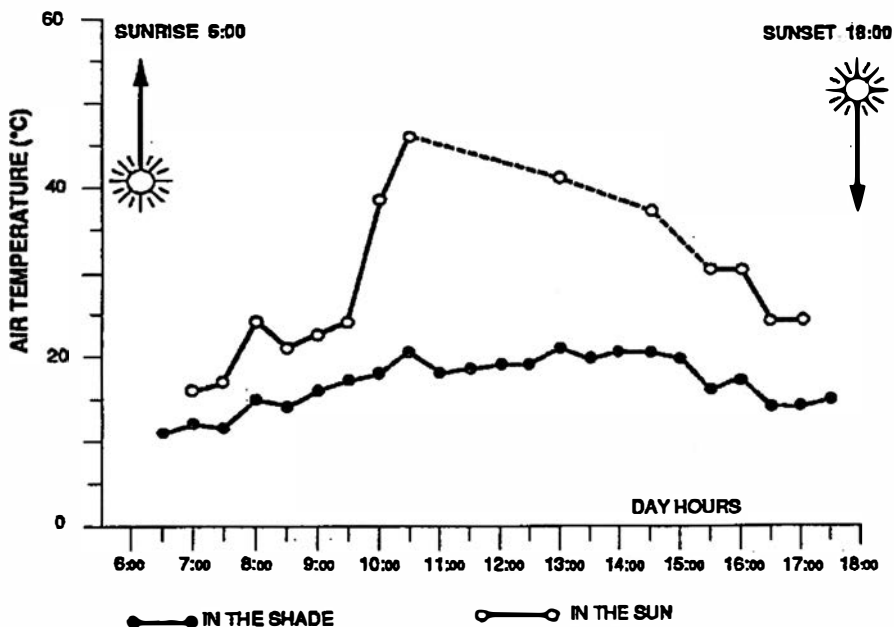


Figure 2. — Mean air temperature at MHWS during the study period.

MATERIAL AND METHODS

At MHWS, observations ($N = 113$) were made with 10×40 fieldglasses and a 30×75 telescope, at a mean distance of 388 m (range: 60-1 500 m), in two ecologically similar hills (Fig. 1): the Harsang (1 985 m a.s.l.), from Oct. 7 to 12, and the Majathal (1 883 m a.s.l.), from Oct. 13 to 25, 1989. At the beginning of the study four surveys (for a total of 18 km) were made on foot to estimate the relative Goral density in different areas through pellet group counts. Data on group sizes, structure and use of slope gradient were based on the independent sightings made in the course of such surveys.

Pellet group counts suggested that the upper slopes (i.e. above 1 600 m a.s.l.) of both the Harsang and the Majathal were heavily used by gorals (respectively, 54.1 and 44.6 pellet groups/km of transect) whereas the lower slopes, i.e. below 1 600 m a.s.l., were almost unattended (1.8-3.6 pellet groups/km of transect). Thus, we concentrated our observations on activity rhythms in an area (ca. 10 ha) of the Majathal hill, where Goral density was the greatest (92 ind./100 ha) and where watching conditions were optimal. Data were recorded on a pocket recorder, for a total of 47 animal hours.

At OKWS, observations were made at a mean distance of 300 m (range: 100-400 m), for a total of 78 animal hours (29 animal hours in April 1985, the dry warm season, and 49 animal hours in January 1986, the dry cold season). The data recording method was the same as above.

For both study areas, data on Goral time budgets were collected by 5-min. scan sampling (Altmann, 1974).

RESULTS

MOVEMENTS AND HABITAT USE

The gorals used steep slopes in both study areas (in either cases all sightings were made in terrain over 30° steep). While at OKWS 39 % of sightings (N = 18) concerned slopes over 60°, these were 23 % (N = 31) at MHWS. A comparison between the availability of slope gradients at MHWS (N = 12) and those used by gorals (N = 16) did not prove significant (Mann-Whitney U-test, Siegel, 1956).

TABLE I

Goral use of open habitat in MHWS, and temperature.

Hour	T °C (\bar{X})	Open habitat	
		n.	%
6 : 00	23	32	61.5
10 : 00			
10 : 00	41.3	5	9.6
14 : 00			
14 : 00	27	15	28.9
18 : 00			

TABLE II

Sightings of gorals in open habitat (meadow with sparse trees/bushes) in daytime.

Morning watch session :	6.30-9.30
Last sighting time :	7.15-8.44
*T °C :	20
N. mornings :	10
Afternoon watch session :	15.00-18.00
First sighting time :	15.15-15.56
**T °C :	20
N. afternoons :	8

* Measured in full sun, since the goral terrain was sunny (9.00 hour).

** Measured in the shade, since the goral terrain was not sunny (15.30 hour).

In MHVS gorals attended open habitat in the first 4 hours following dawn, to gradually disappear in the oak forest of the lower half of the slope (Table I ; Table II). They remained there till early afternoon, when they moved upwards again to re-appear in the meadows, where they remained until nightfall. Apparently, gorals avoided open habitats when temperature raised over 20 °C (Table I ; Table II). At sunrise, we always found them there or arriving from the hill top, where they most likely spent the night. While in the meadows, they fed extensively on large leaves of *Clerodendron infortunatum*, together with other grass species. The diet at OKWS was mostly made up of grass species, although shrubs followed up closely (Lovari, 1986).

GROUP SIZE AND STRUCTURE

At MHWS adult males were mainly solitary, whereas females tended to live in groups (Table III and IV). Most groups contained one or more individuals whose sex and age could not be assessed ; up to eleven individuals were seen together. Mixed groups, i.e. inclusive of females, yearlings, kids and at least one adult male, were as common as female groups (Table IV). Goral density was much greater at MHWS than at OKWS, but no significant difference in group size could be assessed (Table V).

TABLE III

Proportion of solitary individuals in the two sexes.

Females				Males			
In group		Solitary		In group		Solitary	
n.	%	n.	%	n.	%	n.	%
11	72.7	3	27.3	13	30.8	9	69.2

TABLE IV

Group size and grouping categories among gorals.

Group* types	Size			n.
	\bar{X}	median	range	
Females (with yearlings and/or kids)	2.2	2	2-3	10
Mixed	2.9	2.5	2-5	10
C.O.M.U.	3.5	2.5	2-11	34

* No male group was observed (only solitary individuals).
C.O.M.U. : containing one or more unidentified individuals.

TABLE V

Goral populations and study area parameters at MHWS and OKWS.

	MHWS	OKWS
N. sightings	136	18
Density in study area	ca. 4.6-10.5 ind.*/100 ha	ca. 5 ind./100 ha
Mean group size	1.9	1.6**
Median group size	1	1
Modal group size	1	1
Range	1-11	1-4
Season	October	January ; April
Altitude m a.s.l.	1 500-1 950	1 600-1 970

* Densities in Harsang and Majathal hills, respectively.

** Not significant ($P = 0.56$; Mann-Whitney U-test, two tailed).

TIME BUDGET

In the early morning, time budgets were remarkably similar in both study areas (Fig. 3). Feeding dominated (ca. 50 %) over all other activities, whereas standing and moving ranged around 17 % and 10 % respectively. Social behaviour was the only difference between MHWS and OKWS, being observed only in the former, at the expense of lying down (Fig. 3).

Our afternoon data showed important differences between the two study areas (Fig. 3). At OKWS feeding fell down, whereas moving and lying down rose sharply. On the contrary, feeding and standing did not change at MHWS, lying

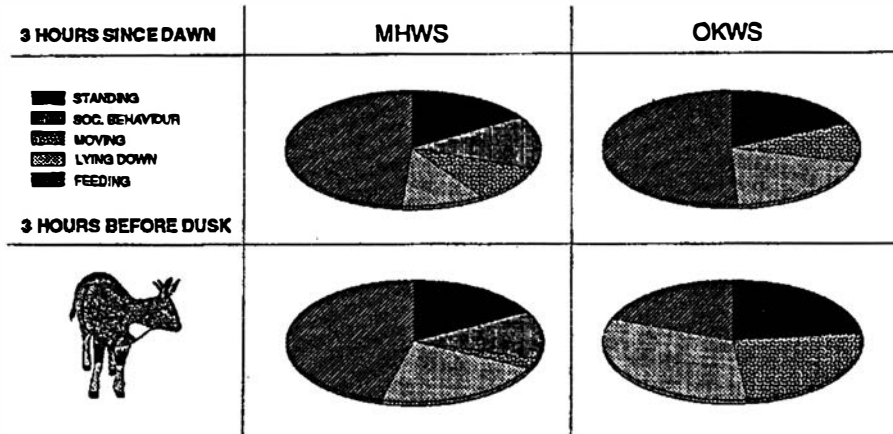


Figure 3. — Time budgets of gorals at MHWS and OKWS.

down doubled, while moving was reduced to about 1/3 of the morning data. As in the morning, social behaviour was only observed at MHWS, and its percentage was nearly unchanged.

Hourly behavioural transitions were studied at MHWS (Fig. 4). Standing decreased from the early morning to the time when goral disappeared in the mid-morning. Afternoon data showed the opposite trend. Feeding ranged around 45 % during all observation hours, but for late afternoon (ca. 30 %). No Goral was seen lying down between 8.00 and 9.00 a.m., when social behaviour reached its peak (Fig. 4).

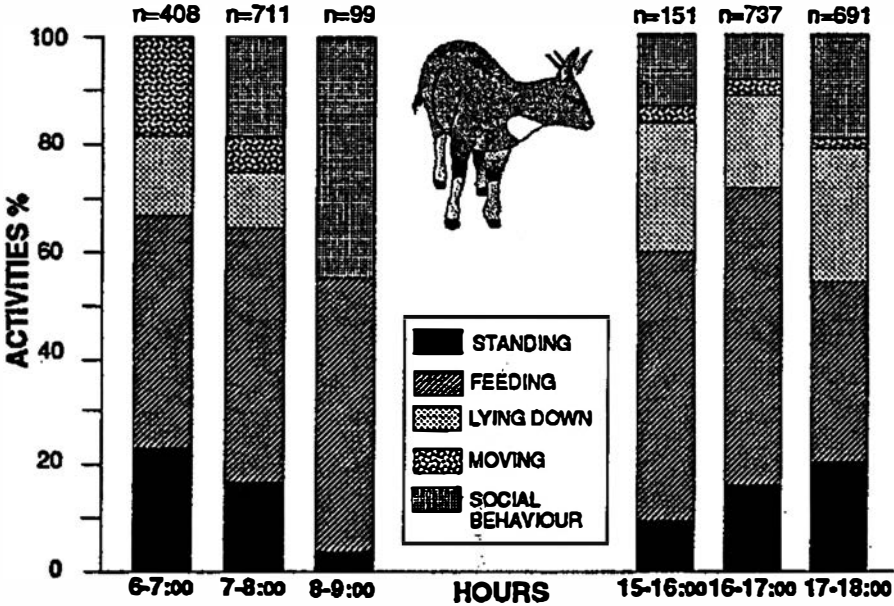


Figure 4. — Hourly time budget of gorals at MHWS.

DISCUSSION

We agree with other authors (e.g. Heptner *et al.*, 1989 ; Mead, 1989) on considering the Goral as a typical cliff-dweller. In particular, our information on slope use is consistent with what Green (1987) reported for Uttar Pradesh — a median slope gradient of 30°-40° (range 10°-65°). The altitudinal range of our study areas lies in the lower half of the species range (0-4 000 m a.s.l., Schaller, 1977 ; Heptner *et al.*, 1989 ; Mead, 1989) (Table V). Schaller (1977) stated that « the goral's choice of habitats is liberal as long as the terrain is steep, rocky and provides some cover ». The Goral avoidance of open habitat we have reported for the hottest part of the day (Table I ; Table II) suggests that temperature is an important factor. This is further supported by the fact that, where gorals occur at the lowest end of their altitudinal range, at 45° N. lat., snowfalls are heavy in winter and temperatures quite cold (Heptner *et al.*, 1989).

Gorals tend to live in small groups throughout their distribution range (Engelmann, 1938 ; Green, 1981 and 1987 ; Heptner *et al.*, 1989 ; Cavallini, *in press*). However, our data suggest that the two sexes show different degrees of sociability, adult males tending to lead a solitary life (Table III ; cf. also Engelmann, 1938). This is not surprising in a rupicaprine (e.g. Hamr, 1984, for *Rupicapra rupicapra* ; Lovari and Cosentino, 1986, for *Rupicapra pyrenaica* ; Chadwick, 1977, for *Oreamnos americanus*). The proportion of solitary individuals in our study area was intermediate between those given by Green (1981 ; 1987) for Nepal and India, as to males. On the contrary, the females we observed were much more often grouped than in Green's data (1981 ; 1987). Mean group size is congruent with that reported by Green (1981 : 2.2 ; 1987 : 1.3), and did not vary significantly between MHWS and OKWS in spite of the different local densities (Table V). In the Indian study, mixed groups were consistently larger than those reported by Green (1981 ; 1987). Maximum group size in the Majathal hill (MHWS) was close to the upper values known for gorals (i.e. 12 : Engelmann, 1938 ; 10 : Heptner *et al.*, 1989 ; 9 : Cavallini, *in press*), whereas the opposite was found for OKWS. This may be related to the very different densities in our two study areas. While the density recorded for the Harsang hill (MHWS) and the Doi Mon Jong (OKWS) approximated those reported for other ranges (2.6/100 ha, Green, 1987 3.5-4/100 ha, Heptner *et al.*, 1989), the Majathal area appeared exceptionally populated by gorals, perhaps because of a low human interference (people were not cutting grass on goral's range).

The differences in monsoonal regimes and vegetation between MHWS and OKWS are obvious. Therefore, the similarity of the morning time budgets of the gorals in the two areas is surprising. It might be explained by the identical mean temperatures of the two sites.

The gorals were rutting when we carried out our observations at MHWS. This could explain the only difference found between the two areas, i.e. the presence of social behaviour in the Indian population. In fact, social interactions apparently took place very seldom at OKWS (only four interactions observed in 78 animal hours). The afternoon time budgets also differed greatly : again social behaviour was present at MHWS only. The greatest difference between the two Goral groups was in their feeding activities which were very reduced at OKWS, and replaced by lying down and moving ; this could be due to the afternoon temperature which was much warmer at OKWS than at MHWS. Actually, gorals at OKWS kept in the shade of caves or among stunted trees in the middle of the day, before moving to grassy ledges and steep meadow patches as soon as sunshine diminished.

At sunrise, when we started our observations at MHWS, gorals were moving downhill from the meadows and the cultivated fields of the mountains top, where they presumably spent the night. In the early morning, upon reaching the intermediate slope belt, they engaged in behavioural interactions. The sharp rise of temperature at mid-morning (Fig. 2) coincided with their disappearance in the oakwood. Only when the temperature started cooling down in the afternoon did they show up again, lingering around and interacting in the intermediate slope belt, as well as intermittently moving uphill.

Most likely, temperature is a very important environmental factor regulating Goral's activity and habitat use.

SUMMARY

Some aspects of the ecology of gorals were studied in North India and North-West Thailand. In both areas gorals used steep ($> 30^\circ$) to very steep ($> 60^\circ$) slopes. In the Indian area, open habitat was avoided when temperature raised over 20°C . Adult males were mainly solitary, whereas females tended to live in small groups : up to 11 individuals could be seen together. Mean group size (1.6-1.9 individuals) appeared independent of local goral density. In the morning, feeding dominated (ca. 50 %) over all other activities at both study sites, followed by standing and moving. In the afternoon, in Thailand, lying down and moving rose sharply to the expense of feeding, while in India lying down doubled, along with a strong decrease of moving. These behavioural differences were probably dependent on local temperature variations. Social behaviour was scarcely observed in Thailand during our visit, whereas it was noticeable in India (rutting season). Temperature seems to be a factor of primary importance to regulate overall Goral activity and habitat use.

RÉSUMÉ

Les auteurs comparent certains aspects de l'écologie des gorals (genre *Nemorhaedus*) dans le nord-est de l'Inde (*N. goral bedfordi*) et le nord-ouest de la Thaïlande (*N. caudatus evansi*). Dans les deux cas, ces Ruplicapriini habitent des pentes raides ($> 30\%$) à très raides ($> 60\%$). En Inde, les milieux ouverts sont évités quand la température dépasse 20°C . Les mâles adultes sont surtout solitaires, alors que les femelles tendent à former de petits groupes pouvant atteindre 11 individus. La taille moyenne des groupes est indépendante de la densité de la population locale. Dans les deux localités, l'alimentation est l'activité dominante (environ 50 % du budget-temps) de la matinée, aux dépens de la station debout et des déplacements. En Thaïlande, le repos couché et les déplacements s'observent surtout l'après-midi, aux dépens de l'alimentation. En Inde, par contre, le repos couché est associé à une forte diminution des déplacements. De telles différences comportementales dépendent probablement des variations locales de température. Nous n'avons pratiquement pas observé de comportements sociaux en Thaïlande pendant notre séjour, contrairement à l'Inde (13 à 15 % du budget-temps) où les gorals étaient en rut lors de notre séjour.

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