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ECOLOGY OF THE GORAL *(NAEMORHEDUS GORAL)* IN OM KOI WILDLIFE SANCTUARY, THAILAND

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ABSTRACT

A study on the ecology of goral *(Naemorhedus goral)* was conducted from May 1996 through July 1997 in Om Koi Wildlife Sanctuary. Goral occupied the western portion of the Doi Mon Jong granite. They mainly utilized select grasslands along a rock base area and forest along a deep valley. Fecal analysis indicate that goral in the Doi Mon Jong area utilized at least 14 forage plant species from 6 families. The Age ratio between adults and infants indicate that the population is in equilibrium. Potential food competition with other ungulates was noted (i.e., serow, barking deer and domestic cattle), and goral were potential prey of tigers, but no evidence of predation was observed. The goral population is at present on the verge of becomming critically endangered because of hunting. As such, appropriate conservation measures are recommended to ensure the survival of goral populations.

INTRODUCTION

Goral (*Naemorhedus goral*) are one of fifteen protected animals under the Wild Animal Reservation and Protection Act. B.E. 2535 of Thailand. The IUCN (1996) lists goral as a Threatened Species. Their distribution extends from Kashmir, down the Himalayas to Assam, southern China, and Burma to northern Thailand (KLOSS, 1923).

Goral are endangered through loss of habitat, poaching, disease and competition with domestic cattle. The objectives of this study were to aid goral conservation through the determination of its distribution, ecological characteristics, habitat preference and population demography. It is believed that these criteria must be known in order to manage goral. Thus, the purpose of this research was to investigate the ecology of goral as pertains to population demography and habitat relationships.

In Thailand, surveys indicate that goral are distributed in seven reserve areas. These areas are briefly decribed below:

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Mae Lao-Mae Sae Wildlife Sanctuary. The habitat site of goral is at Doi Mon Lium (19°14'0.5" north latitude, 98°43'58.5" east longitude approximately 1,265 m MSL), in Amphoe Mae Tang, Chiang Mai Province. The vegetation is dry dipterocarp and pine forest. This area is hunted by hill tribe (Hmong) people who live beside the wildlife sanctuary.

Doi Chiang Dao Wildlife Sanctuary. The habitat site of goral is on Doi Luang limestone (19°22'55.4" north latitude, 98°51'12.8" east longitude approximately 2,100 m MSL), in Amphoe Chiang Dao, Chiang Mai Province. The vegetative cover is <6–7 m in height. There is hunting and shifting cultivation in this area.

Lum Nam Pai Wildlife Sanctuary. The habitat site of goral is on Doi Laung limestone (19°31'12.7" north latitude, 98°0.5'11.8" east longitude approximately about 850 m MSL), in Amphoe Muang, Mae Hong Son Province. The vegetative cover is mixed deciduous forest. Hunting, habitat degradation for agriculture and illegal harvesting all occur.

Mae Tuan Wildlife Sanctuary and Mae Ping National Park. Goral occur on clefts along the Ping River above the Bhumibol Dam (17°27'32.6" north latitude, 98°45'25.0" east longitude approximately 600 m MSL), in Mae Ping National Park. They also occur in Mae Tuan Wildlife Sanctuary, Amphoe Sam Ngao, Tak Province (17°18'0.3" N, 98°53'43.9" E) at about 645 m MSL. The vegetative cover is mixed deciduous forest. Hunting by spotlight and competition for forage with domestic animals occur.

Doi Inthanon National Park. The habitat of goral is grassland on Kiw Mae Pan (18°33'37.4" N, 98°26'46.8" E, approximately 2,300 m MSL), in Amphoe Mae Jam, Chiang Mai Province. A negative influence in this area is destructive tourism.

Om Koi Wildlife Sanctuary. The ecology of goral in this area is described below.

STUDY AREA

Om Koi Wildlife Sanctuary is located in the north-western part of Thailand between 17°17' and 19°45' N, and 98°27' and 98°45' E (approximately 1,580 m MSL) in Amphoe Om Koi, Chiang Mai Province, and Amphoe Sam Ngao, Tak Province. Om Koi Wildlife Sanctuary has an area of approximately 765,000 rai or 1,224 km^2 (Faculty of Forestry, 1992) (Figure 1). The predominant geology of the habitat of goral in the west of Doi Mon Jong is granite (Figures 2 and 3).

The climate of this sanctuary is classified as subtropical with daily rainfall occurring nearly every day throughout the rainy season (May to October) (Faculty of Forestry, 1992). The average maximum and minimum temperatures over a 30 year period were 36°C and 22°C (Meteorological Division, 1987). Average temperature and relative humidity of Doi Mon Jong from 0600 h to 1800 h during the rainy season (May to October) and dry season (November to April) showed marked fluctuations. Temperatures from 0600 h through 1200 h were lower during the dry season and higher than in the wet season, but from 1200 h through 1800 h were higher than in the wet season. Humidity from 0600 h

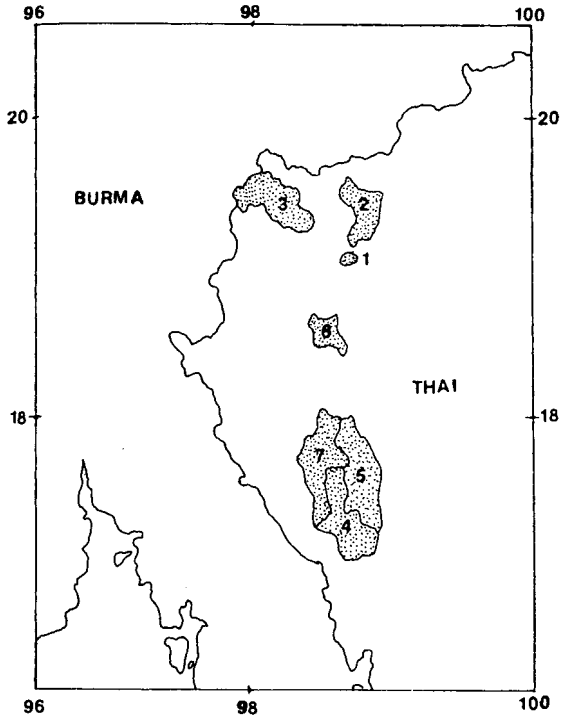

Figure 1. Protected area with goral in Northwest Thailand: 1. Mae Lao–Mae Sae Wildlife Sanctuary; 2. Doi Chiang Dao Wildlife Sanctuary; 3. Lum Nam Pai Wildlife Sanctuary; 4. Mae Tuan Wildlife Sanctuary; 5. Mae Ping National Park; 6. Doi Inthanon National Park; 7. Om Koi Wildlife Sanctuary.

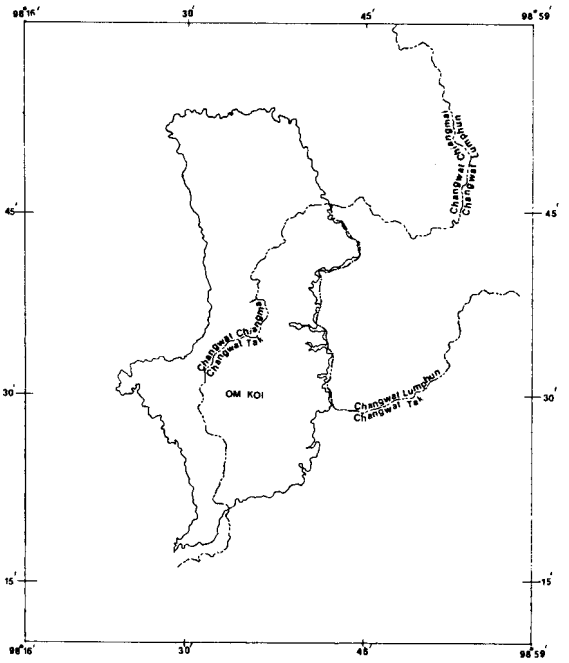

Figure 2. Map of Om Koi Wildlife Sanctuary, Chiang Mai and Tak provinces.

Table 1 Comparision of vegetative characteristics at different elevations of the forest along a deep valley, Doi Mon Jong (All trees over 4.5 cm diameter at breat height (dbh)).

Characteristics	Mean sea level		
	1,400	1,600	1,800
1. Plot size (m^2)	400	400	400
2. Slope (degrees)	30	45	70
3. Density (trees/ha)	625	900	700
4. No. of species	19	16	8
5. Diameter and height			
- Average dhh (cm)	22.62	18.48	12.79
- Average height (m)	14.04	10.50	5.97
6. No. of canopy levels	3	3	3

through 1300 h during the dry season was higher than in the rainy season but from 1300 h through 1800 h, was lower in the dry season.

The vegetative cover within this sanctuary consists of hill evergreen forest, rock base areas, dry evergreen forest, mixed deciduous forest, dry dipterocarp forest and successional forest (FACULTY OF FORESTRY, 1992). Goral in Doi Mon Jong inhabited various vegetation types found along the mountain ridge. The characteristics of the vegetation types were compared and the relationship of each type with goral described.

Rock base area. Large rock area which lacks vegetative cover, or has some grass or annual herbs (about 60% of the western side of Doi Mon Jong).

Forest along a deep valley. Hill evergreen forest which occurs in a deep valley and rolling plain (Table 1). Dominant tree species included *Ostodes paniculata* Bl., *Canarium bengalense* Roxb. and *Gordonia axilleris* Dietr.

Grassland. Grass occuring on ridges which was subjected to burning by wild fires. Dominant vegetation included *Heteropogon cantortus* Beauv. ex Roem. et Schult., *Eulalia siamensis* Bor and *Cyperus esculenlus* Linn. (unburned), while dominant vegetation that burned in February 1997 included *H. cantortus* Beauv. ex Roem. et Schult., *E. siamensis* Bor and *C. esculentus* Linn. (See Appendices 1 and 2 for importance value).

At least 43 species of mammals, 181 species of birds, 31 species of reptiles and 13 species of amphibians occur within Om Koi (FACULTY OF FORESTRY, 1992).

METHODS

Habitat description

The plant community study involved three main parts: (1) vegetative mapping and data collection, (2) vegetation analysis, and (3) community description.

Figure 3. Doi Mon Jong, habitat of the goral.

Figure 4. Habitat site of goral in western Doi Mon Jong.

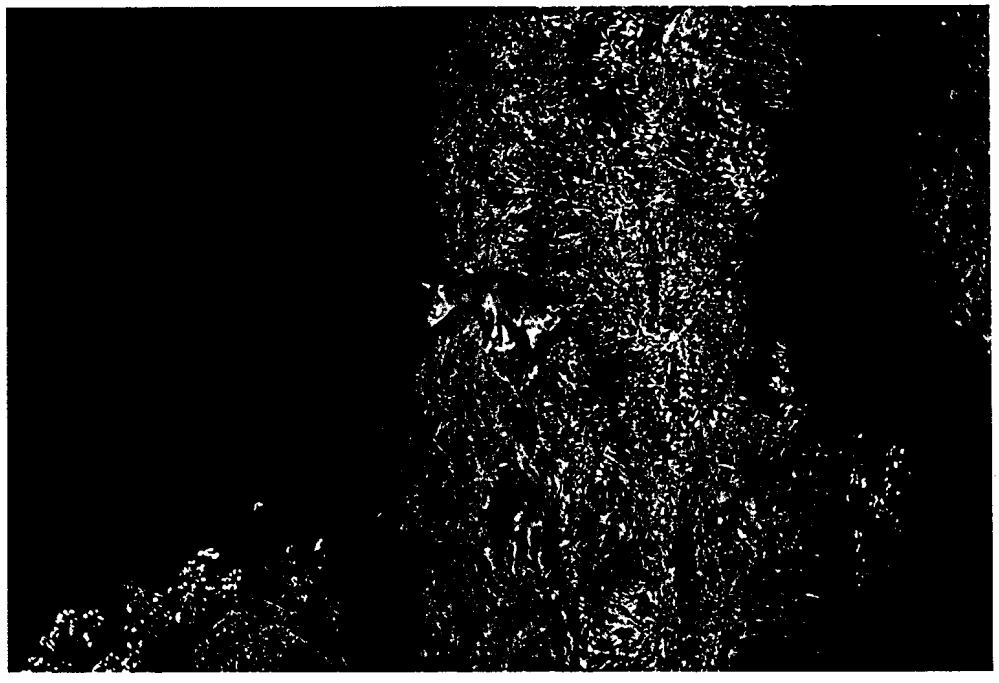

Figure 5. Female goral and its infant.

Figure 6. General characteristics of goral.

Quadrants of varying size were marked off for the purpose of detailed study of vegetation. Three nested square plots of 1 m^2, 16 m^2, and 100 m^2 were established at each sample point using the same corner. All trees over 4.5 cm diameter at breast height (dbh) within the 100 m^2 plot were measured for diameter and height. Trees or woody plants taller than 1.3 m with dbh smaller than 4.5 cm were measured in the 16 m^2 plot, and seedlings smaller than 1.3 m in height and 4.5 cm dbh were counted within the 1 m^2 plots. A plot of 400 m^2 in area for each forest level along the deep valley was established at each of three elevations: 1,400 m, 1,600 m, and 1,800 m MSL.

Dominant tree species of each vegetation type were determined by their Importance Value Indices (IVI) = Relative density + Relative dominance + Relative frequency (MUELLER-DOMBOIS AND ELLENBERG, 1974).

For grasslands, floral species were counted and number and biomass of each species were tallied from 1-m^2 plots located at 50-m intervals along the study area. Importance Value Indices (IVI) consisting of Relative frequency + Relative biomass were determined for all species.

Forage species

Forage species of goral were studied by the analysis of fecal material. Plant cuticle fragments in fecal samples were identified through microscopic analysis.

Feces were collected in the field from May through October 1996 (N=30), and November, 1996 through April 1997 (N=30). Microscopic slides for each fecal sample were prepared as described by ANTHONY & SMITH (1974). Ten microscopic slides were prepared for each fecal sample. Each plant fragment was classified by its characteristics and matched with a reference slide of the same species made from plants in the study area. Forage species in the feces were determined by relative frequency (KREBS, 1972):

$$\text{Relative frequency} = \frac{\text{frequency of species x} \times 100}{\text{sum of frequency values for all species}}$$

Population structure

Population structure was determined by counting the total number of individuals from the campground (approximately 1,800 m MSL) to the heighest elevation of Doi Mon Jong (approximately 2,000 m). Two fixed stations were used to count goral at the same time in the early morning. These stations were about 1 km apart, and enabled observation of roughly half of Doi Mon Jong.

Two age classes were assigned based on size and presence of horns were recognized: (1) Infants and juveniles (small size, lacking horn). (2) Adults (larger size and presence of horn).

Interspecific relationships

Interspecific competition occurs when individuals of different species utilize common resources that are in short supply; or if the resources are not in short supply, competition occurs when the organisms seeking those resources harm one another in the process (BIRCH, 1957). Interspecific relationships were investigated by direct observation between goral and another ungulates.

RESULTS

Vegetative cover and goral

From May, 1996, through April, 1997, goral were located 501 times. In the rainy season (May to October, 1996), they were seen to utilizing grasslands 129 times (53%), rock base area 94 times (39%) and forest along a deep valley 19 times (8%). In the dry season (November, 1996 to April, 1997), they were shown to utilize grasslands 124 times (48%), rock base area 110 times (42%) and forest along a deep valley 25 times (10%). Goral mostly utilized grasslands for food, the rock base areas for resting, and the forest along the deep valley for cover and escape (Figs. 4, 5, 7).

Elevation

Goral were found at elevations ranging from 1,400 to 1,929 m MSL (Figure 4). During the rainy season (May to October 1996), they utilized all areas between 1,400 and 1,900 m. Goral were not found above 1,800 m during the dry season (November 1996 to April 1997), likely due to the presence of tourists and the die-off of vegetative cover. They resided mostly between 1,500 and 1,800 m.

Forage species

Goral are both grazers and browsers. They fed on broad leaf plants, grasses and herbaceous plants. Fourteen species from six families were utilized by goral (Table 2). The dominant forage species was *Paspalum longifolium* Roxb. (relative frequency = 35.9% in the rainy season (May to October 1996) and 31.4% in the dry season (November 1996 to April 1997).

Population structure

Goral were commonly solitary but were sometimes observed in pairs or larger groups, especially during the rutting season. A total count of goral from the campground to the highest point of Doi Mon Jong revealed 8 adults and 2 infants. This study could not classify juveniles and subadults from adults because 7-month old goral already had horns (data from Om Koi Wildlife Propagation Station). The age ratio between adults and infants indicated that the population was approximately in equilibrium.

Relationship between goral and other animals

Competition. Large mammals that possibly compete with goral such as serow (*Capricornis sumatraensis*), barking deer (*Muntiacus muntjak*) and domestic cattle were found in the study area. Potential competition between goral and other ungulates could be seen for living space, escape cover, water sources, salt licks and forage species. Competition among different ungulate species was higher for forage species than all other ecological factors.

Protocooperation. Two bird species, the lesser coucal (*Centropus bengalensis*) and the white-headed bulbul (*Hypsipetes thompsoni*) were found in the study area. They consumed parasites on the skin of goral.

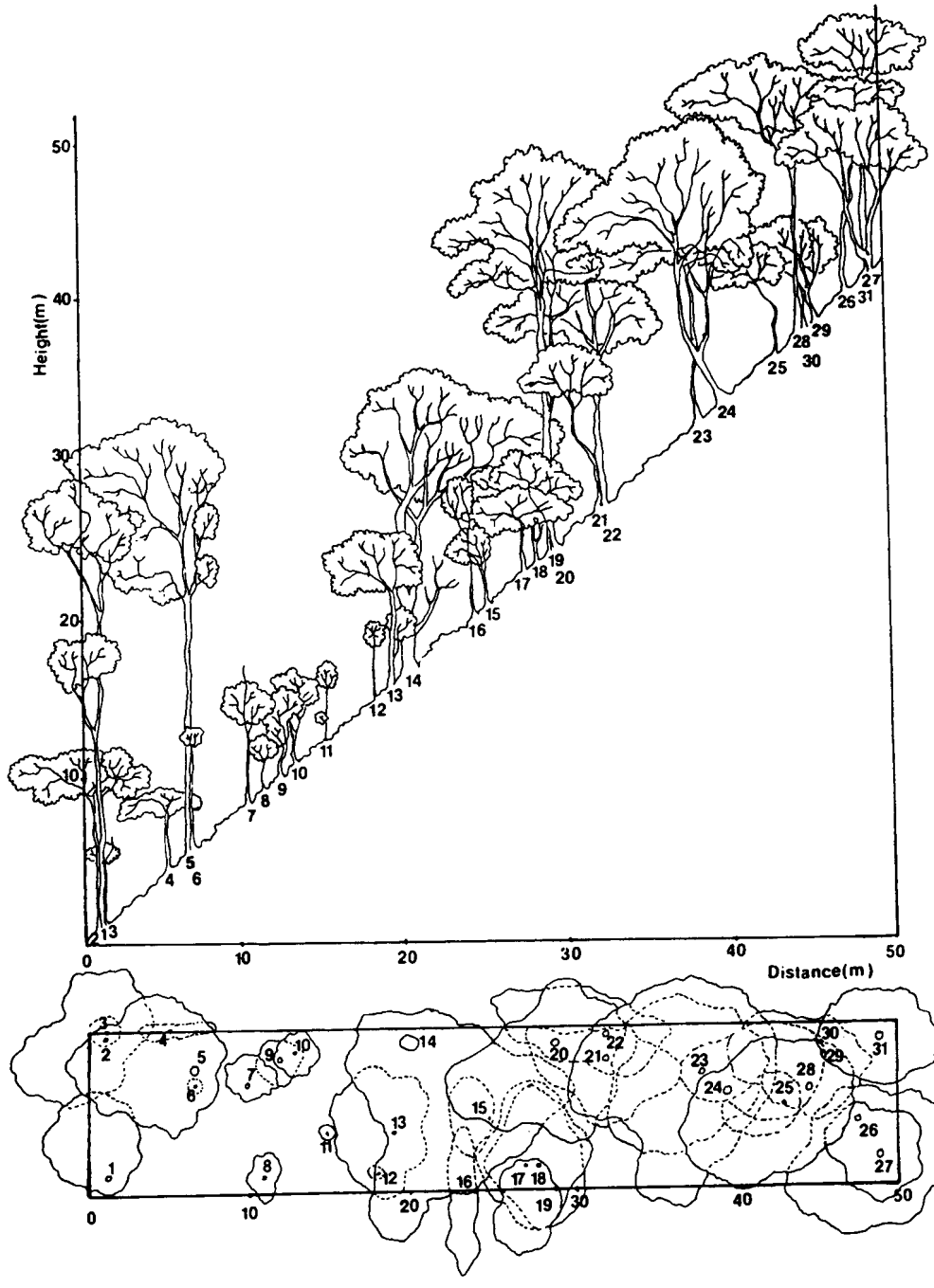

Figure 7. Profile diagram of forest along the deep valley.

Table 2. Relative frequency of forage species in the feces of goral.

Forage species	Relative frequency (%)	
	Rainy season	Dry season
Paspalum longifolium Roxb.	35.90	31.40
Gramineae	20.51	8.14
Heteropogon contortus Beauv. ex Roem. et Schult.	12.82	8.14
Thysanolaena maxima Ktze.	5.13	5.81
Cyperus esculentus Linn.	5.13	5.81
Zebrina pendula Schnizl.	3.85	18.60
Eulalia siamensis Bor	3.85	3.49
Orchidaceae	3.85	3.49
Setaria palmifolia Stapf	2.56	1.16
Saccharum spontaneum Linn.	2.56	1.16
Imperata cylindrica Beauv.	2.50	0.00
Ageratum conyzoides Linn.	1.28	5.81
Unknown	0.00	4.65
Heracleum burmanicum Kurz	0.00	2.33

Predation. In Doi Mon Jong, tiger (*Panthera tigris*) had opportunities to kill goral but success was likely rare due to the difficulty of traversing the rocky, high sloped terrain.

DISCUSSION

Vegetative cover and goral

In the rainy season (May to October, 1996) and dry season (November, 1996 to April, 1997) goral utilized the same vegetative cover. They predominantly utilized grasslands, followed by rock base areas and forest along a deep valley. Because the majority of the forage occurred in the grassland, goral utilized grasslands as their primary food source. The rock base areas lacked a substantial vegetative cover, and this, combined with a high slope was not conducive for use as a feeding area. However, goral did utilize this area for resting. In forest along a deep valley goral utilized this area for cover and escape. GEIST (1971) suggests that mountain sheep move to open slopes during conditions of deep, soft snow, where they are rarely seen, and to cliff terrain during late winter, where they are often hidden or hard to spot.

Elevation

Goral utilized elevations ranging from 1,400 to 1,929 m MSL during the rainy season (May to October, 1996), but were not found above 1,800 m during the dry season (November, 1996 to April, 1997), possibly due to the die-off of vegetative cover on the

cliff of Doi Mon Jong. NIEVERGELT (1981) and GEIST (1971) suggest that sheep, ibex, or mountain goats move where forage is most easily available at that time. The presence of tourists at Doi Mon Jong likely disrupted the behavior of goral. Human disturbances have degraded the landscape and driven goral bellow 1,800 m. PRIMACK (1993) suggested that even when human activity does not directly eliminate a species, the population size of a species may become so small that the species is no longer viable and may eventually go extinct. In addition, at the foot of the mountain domestic cattle consumed most of the forage, thus forcing goral to go higher to feed above 1,400 m: thus, they remained mostly between 1,500 and 1,800 m.

Forage species

Goral mostly fed on grass, especially in the rainy season (May to October, 1996). During the dry season (November, 1996 to April, 1997) they fed on annual herbs more frequenctly than in the rainy season, because the quality of forage was lower with less water content than in the rainy season. In addition, some species of grass also died off. Thus, goral had to feed on high quality forage species that had more water content. CHIMCHOME (1990) comments that applying both fecal analysis and twig count methods provides more accuracy on animal's forage species eaten. From direct observations we found that goral fed on some forage species that were not found in the feces such as *Impatiens chinensis* Linn., one species of the family Aspaceae, *Emilia sonchifolia* DC., *Pteridium aquilinum* Kuhn var. *Wightianum* Tryon, and *Borreria sp.* Average feeding activity time of female gorals was higher than for male gorals. During gestation females spent more time feeding than during other periods (KANBUNJONG, 1993).

Population structure

LEKAGUL & MCNEELY (1997) state that goral are usually found in groups of 4–12, while serow are usually solitary. This study indicate that goral were solitary, but were sometimes observed in pairs or in larger groups, especially during the rutting season. Male and female goral could not be classified in the field, because of the lack of sexual dimorphism. In this study, we classify the population in equilibium.

Relationship between goral and other animals

We found that serow utilized grasslands (approximately 1,500 m MSL) which goral also utilized. Due to their larger size, serow often forced goral out of a sympatric area.

Barking deer usually utilized grasslands for feeding above 1,800 m and below 1,500 m MSL, but could not traverse the rocky, high sloped terrain.

Domestic cattle commonly utilized grasslands at below 1,500 m MSL on a flat plan. In Doi Mon Jong morethan 300 domestic cattle fed on grasses and annual herbs. During the dry season when the grass died off, cattle moved higher to feed on grasses and annual herbs in the habitat of goral. During this season, the water supply was lacated downhill which goral shared with domestic cattle. If the domestic cattle had disease, they could possibly be passed on to goral very easily.

Relationship between goral and humans

The observed relationship between goral and humans was negative. The hill tribes hunted goral for food and medicine and used their horns for decorating their homes. Occasionally they used fire to burn the grasslands on Doi Mon Jong to hunt goral. The negative relationship affecting the goral population is at present on the verge of rendering goral critically endangered, thus appropriate conservation measures are needed to extend the survival of their population.

Conservation and management

To manage and conserve goral in Om Koi Wildlife Sanctuary and other protected areas is to ensure the long-term survival of the ecosystems. First, the core area (the sanctuary) must be protected and the local people should have use of the buffer zone area near the sanctuary boundary. Second, all domestic cattle must be moved out of the sanctuary. Third, habitat manipulation such as food management, small water source development, artificial saltlicks and corridor improvement must be undertaken to ensure that goral have adequate natural resources and can exchange between the gene pools. Finally, the promotion of wildlife and habitat conservation through training and exhibitions should be established for all levels of people, and especially among school students.

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REFERENCES

ANTHONY, R. G. AND N. S. SMITH. 1974. Comparison of rumen and fecal analysis to describe deer diets. *J. Wild. Manage.* 38 (3): 535–540.

BIRCH, L. C. 1957. The meanings of competition. *American Naturalist* 91: 5–18.

CHIMCHOME, V. 1990. Study on serow forage species by fecal analysis. M.Sc. Thesis, Kasetsart University. Bangkok (in Thai).

FACULTY of FORESTRY. 1992. Management plan for the Om Koi Wildlife Sanctuary (1993–1995). Faculty of Forestry, Kasetsart University, Bangkok (in Thai).

GEIST, V. 1971. *Mountain Sheep: A Study in Behavior and Evolution.* University of Chicago Press, Chicago. 383 p.

IUCN. 1996. 1996 IUCN red list of threatened animals. IUCN, Gland, Switzerland. 368 p.

KANBUNJONG, S. 1993. Behavior of goral (*Naemorhaedus griseus*) in captivity. M. S. Thesis, Chiang Mai University, Chiang Mai (in Thai).

KLOSS, C. B. 1923. The goral in Siam *J. Nat. Hist. Soc. Siam* 6 (1): 135–136.

KREBS, C. J. 1972. *Ecology: the Experimental Analysis of Distribution and Abundance.* Harper & Row, New York. 694 p.

LEKAGUL, B. AND J. A MCNEELY. 1977. *Mammals of Thailand.* Kurusapha Ladprao Press, Bangkok. 758 p.

METEOROLOGICAL DIVISION. 1987. The statistic of climatic in Thailand in previous 30 years (B.S. 2499–2528). Meteorological Division, Bangkok. (in Thai)

MUELLER-DOMBOIS, D. AND H. ELLENBERG. 1974. *Aims and Methods of Vegetation Ecology.* John Wiley & Sons, New York. 547 p.

NIEVERGELT, B. 1981. Ibexes in an African environment: Ecology and social system of the walia ibex in the Simen Mountains, Ethiopia. *Ecological Studies* 40: 1–189.

PRIMACK, R. B. 1993. *Essentials of Conservation Biology.* Sinauer Associates Inc., Sunderland., Mass. 564 p.

APPENDICES

Appendix 1. List of tree species and their Importance Value Indices in the forest along a deep valley at Doi Mon Jong from 12 10X10 m^2 plots.

Scientific Name	RD	RDo	RF	IVI
Ostodes paniculata Bl.	8.99	4.56	11.67	25.21
Canarium bengalense Roxb.	1.12	20.94	1.67	23.73
Gordonia axilleris Dietr.	11.24	6.97	5.00	23.01
Mallotus sp.	10.11	4.87	6.67	21.65
Unknown 3	2.25	13.07	1.67	16.98
Antidesma bunius Spreng.	2.25	9.94	3.33	15.52
Dehaasia sp.	2.25	9.69	3.33	15.27
Paranephelium longifoliolatum Lec.	3.37	5.87	5.00	14.24
Litsea sp.	6.74	1.37	5.00	13.11
Carpinus viminea Wall.	4.49	3.47	3.33	11.30
Castanopsis argyrophylla King	5.62	2.01	3.33	10.96
Phoebe grandis Merr.	5.62	1.48	3.33	10.43
Aphanamixis polystachya Parker	3.37	1.60	3.33	8.30
Beilschmiedia gammieana King ex Hook.f.	2.25	1.89	3.33	7.47
Quercus semiserrata Roxb.	2.25	1.37	3.33	6.95
Syzygium sp.	2.25	1.23	3.33	6.81
Aglaia pirifera Hance	1.12	3.46	1.67	6.25
Sapindaceae	2.25	1.98	1.67	5.89
Nyssa javanica Wang.	2.25	0.30	3.33	5.88
Diospyros sp.	2.25	0.16	3.33	5.74
Unknown 1	2.25	0.14	3.33	5.72
Camellia oleifera Abel. var. *confusa* Sealy	4.12	0.10	1.67	4.89
Ternstroemia gymnanthera Bedd.	2.25	0.49	1.67	4.41
Sterculiaceae	2.25	0.36	1.67	4.27
Mallotus philippensis Muell. Arg.	1.12	1.01	1.67	3.80
Unknown 2	1.12	0.87	1.67	3.66
Apocynaceae	1.12	0.36	1.67	3.15
Calophyllum polyanthum Wall.	1.12	0.17	1.67	2.96
Neolitsea siamensis Kostel.	1.12	0.09	1.67	2.88
Ficus fistulosa Reinw.	1.12	0.06	1.67	2.85
Ficus praetermissa Corner	1.12	0.05	1.67	2.84
Helicia nilagirica Bedd.	1.12	0.05	1.67	2.84
Toona ciliata M. Roem.	1.12	0.04	1.67	2.83
Total	100.00	100.00	100.00	300.00

Appendix 2. List of vegetative species and their Importance Value Indices of grasslands at Doi Mon Jong (about 1,750 m MSL) burned in February, 1997 (from 18 1 x 1 m^2 plots), and unburned (from 57 1 x 1 m^2 plots) (data in July, 1997).

Scientific Name	Unburned			Burned		
	Rf	RB	IVI	RF	RB	IVI
Heteropogon contortus Beauv. ex Roem. et Schult.	17.221	73.110	90.331	16.129	44.180	60.309
Eulalia siamensis Bor	8.761	15.164	23.926	12.903	30.432	43.335
Cyperus esculentus Linn.	13.595	3.191	16.786	13.978	5.616	19.595
Sauropus hirsutus Beille	8.459	1.937	10.396	7.527	5.543	13.070
Impatiens chinensis Linn.	6.344	0.580	6.924	2.151	0.089	2.240
Gramineae	4.532	1.610	6.142	2.151	0.386	2.536
Unknown 2	4.532	1.383	5.914	1.075	0.007	1.083
Aspaceae	5.136	0.388	5.524	3.226	0.054	3.279
Unknown 1	4.834	0.274	5.108	3.226	0.486	3.712
Curculigo orhidoides Gaertn.	3.625	0.152	3.778	4.301	0.631	4.932
Pedicularis rhynchodonta Bureau & Franch.	3.021	0.057	3.078	3.226	0.116	3.342
Anapahlis adnata DC.	2.719	0.062	2.781	1.075	0.007	1.083
Gerbera piloselloides Cass.	2.115	0.534	2.649	-	-	-
Murdannia gigantea Brueck.	2.115	0.088	2.203	1.075	0.042	1.117
Emilia sonchifolia DC.	1.510	0.309	1.819	5.376	0.348	5.725
Coleus sp.	1.511	0.280	1.790	1.075	0.221	1.296
Pteridium aquilinum Kuhn	1.208	0.413	1.622	1.075	0.016	1.092
Lindernia sp.	1.511	0.059	1.570	-	-	-
Habenaria dentata Schltr.	1.208	0.026	1.234	1.075	0.008	1.084
Xyris pauciflora Willd.	1.208	0.006	1.215	-	-	-
Hypericum garrettii Craib	0.906	0.040	0.947	-	-	-
Borreria sp.	0.604	10.800	0.717	1.075	0.663	1.738
Papilionaceae	0.604	0.039	0.643	2.151	0.474	2.625
Impatiens sp.	0.604	0.007	0.611	-	-	-
Crotalaria pallida Ait.	0.604	0.007	0.611	-	-	-
Orchidaceae	0.340	0.067	0.407	1.075	0.168	1.244
Seleria terrestris Fassett	0.302	0.055	0.357	-	-	-
Uraria crinita Desv.	0.302	0.006	0.308	-	-	-
Strobilanthes sp.	0.302	0.002	0.304	-	-	-
Ageratum conyzoides Linn.	0.302	0.002	0.304	-	-	-
Unknown 3	*	*	*	1.075	0.008	1.083
Borreria alata DC.	*	*	*	*	*	*
Drosera burmanii Vahl	*	*	*	*	*	*
Compositae	-	-	-	4.301	6.937	11.239
Iridaceae	-	-	-	1.075	2.714	3.789
Vernonia spirei Gand.	-	-	-	1.075	0.574	1.650
Byttneria pilosa Roxb.	-	-	-	1.075	0.074	1.149
Total	100.000	100.000	200.000	100.000	100.000	200.000

Note : *Relative biomass <0.001%
- no plants found