การสังเกตพฤติกรรมของกวางผา *(Naemorhedus griseus)* ในสภาพการเพาะเลี้ยง

นิธิดล บูรณพิมพ์*,*** และนริทธิ์ สีตะสุวรรณ**

บทคัดย่อ

การศึกษาพฤติกรรมของกวางผา *(Naemorhedus griseus)* ได้ทำการศึกษาที่ สถานีเพาะเลี้ยงสัตว์ป่าอมก๋อย ได้ทำการจัดกวางผาออกเป็น 3 กลุ่ม แต่ละกลุ่มประกอบด้วย ตัวเต็มวัยเพศผู้ ตัวเต็มวัยเพศเมีย และกวางผารุ่นเยาว์ (อายุประมาณ 1 ปี) กวางผาแต่ละครอบครัวจะถูกปล่อยอยู่ในคอกเลี้ยงในพื้นที่ 40 X 40 ตารางเมตร จากนั้นทำการบันทึกพฤติกรรมของกวางผาโดยวิธี Focal-Scan Sampling Method และ Descriptive Method ผลการศึกษาในสภาพการเลี้ยงกึ่งธรรมชาติพบ 6 รูปแบบพฤติกรรมที่พบเห็นได้บ่อย คือ พฤติกรรมการกินอาหาร การกินอาหารข้น การเคี้ยวเอื้อง การยืน การเดิน และ นอนพัก ซึ่งกวางผาเพศผู้มีค่าเท่ากับ 10.83% 4.24% 7.80% 42.42% 13.11% และ 11.97% ตามลำดับ ส่วนกวางผาเพศเมียมีค่าเท่ากับ 14.24% 9.39% 6.67% 42.05% 11.97% และ 7.73% ตามลำดับ และกวางผารุ่นเยาว์มีค่าเท่ากับ และ 9.85% 3.94% 5.53% 31.74% 14.02% และ15.05% ตามลำดับ ส่วนการพฤติกรรมของกวางผาก่อนปละหลังสวมปลอกคอวิทยุไม่มีความแตกต่างอย่างมีนัยสำคัญทางสถิติ ($p>0.05$) ซึ่งแสดงให้เห็นว่า สามารถนำปลอกคอวิทยุไปใช้ในการติดตามตำแหน่งของกวางผาในพื้นที่ขนาดใหญ่ได้ การศึกษาพฤติกรรมของกวางผาในครั้งนี้สามารถนำไปใช้ประโยชน์ในการจัดการด้านการอนุรักษ์และติดตาม เพื่อเพิ่มจำนวนประชากรของกวางผาได้อย่างมีประสิทธิภาพ นอกจากนี้ยังเป็นก้าวแรกของการอนุรักษ์กวางผาในป่าธรรมชาติอย่างมีประสิทธิภาพ

คำสำคัญ : การสังเกตพฤติกรรม *Naemorhedus griseus* สภาพการเพาะเลี้ยง

* สวนสัตว์เชียงใหม่ องค์การสวนสัตว์ในพระบรมราชูปถัมภ์
** ภาควิชาชีววิทยา คณะวิทยาศาสตร์ มหาวิทยาลัยเชียงใหม่

Behavioral Observations of Goral *(Naemorhedus griseus)* in Captivity

Nithidol Buranapim*,*** and Narit Sitasuwa**

Abstract

A study of goral *(Naemorhedus griseus)* behavior was conducted in Om Koi wildlife sanctuary (Om Koi wildlife breeding station). A group of nine gorals, consisting of 3 adult males, 3 adult females and 3 juveniles, were categorized into 3 groups. Each group was kept in a 40 x 40 m^2 enclosure. The behavioral patterns were observed using the focal-scan sampling method and/or descriptive method. The results included the six most common behavioral patterns that the animals typically displayed: viz. feeding (forage), feeding (concentrated), ruminating, standing, walking and resting at 0.83%, 4.24%, 7.80%, 42.42%, 13.11% and 11.97% for the male gorals and 14.58%, 9.39%, 6.67%, 42.05%, 11.97% and 7.73% for the female gorals, and 9.85% 3.94%, 5.53%, 31.74%, 14.02% and 15.05% for the juvenile gorals, respectively. Moreover, the goral behavior patterns were observed before and after the radio collars were put on and they did not differ significantly ($p > 0.05$). This indicates that the radio collars can be used to track the gorals over large areas. The observations made this study can provide new knowledge of goral behavior that can be used as a conservation management tool, especially for the re-establishment and monitoring of the goral population. An effective conservation program can be used as a first important step in an overall plan to conserve gorals in their natural habitats.

Keywords : Behavioral observation, *Naemorhedus griseus*, Captivity

* Chiang Mai Zoo, Zoological Park Organization under Royal Patronage.
** Department of Biology, Faculty of Science, Chiang Mai University.

INTRODUCTION

Gorals were first described in 1825 as living in the Himalayas of Nepal. The morphological characteristics of the goral are similar to those of antelopes or the black bucks of India. Gorals belong to the group Artiodactyla, thus they are closely related to bovids (cow, buffalo, goat, sheep, etc.). The genus *Naemorhedus* is presently represented by four species (IUCN, 2013)are *N*. *griseus* (chinese goral), *N*. baileyi (red goral), *N*. *caudatus* (long-tailed goral) (Zhang, 1987) and *N*. goral (himalayan goral) (Grove s and grubbv, 1985). They are characterized by broad and bell-shaped ears, small sub-orbital glands, slender and cylindrical horns, which are not divergent but curved backward and bear inconspicuous annulations or ridges, no beards exist among the males, and females posses four mammary glands (Roberts, 1997). The *N. goral* has been divided into two sub-species, which are the goral, *N. goral (Hardwickeii)* and the brown goral, *N. goral hodgsoni.* Additionally, Robert (1977) includes another subspecies in his research, the *N. goral bedfordi* (Roberts, 1997).

The chinese goral, *Naemorhedus griseus*, lives along the borders between northern Myanmar, southern China, North Korea and Manchuria. This species also is present in the forests of northern Thailand, where it is known to exist in Chiang Mai, Mae Hong Son, and Tak provinces (Chaiyarat, 1997). The goral populations in Thailand are concentrated in conservation areas, which are the Mae Ping National Park, Doi Inthanon National Park, Awp Luang National Park, Mae Surin Waterfall, Tham Pla Forest Park, PhaSua National park, Pha Dang National Park, Srisat Chanalai historical Park, Doi Chong National Park, Mae Fang National Park, Om Koi wildlife Sanctuary, Mae Lao-Mae Sae Wildlife Conservation area, Doi Luang Chiang Dao, Lum Nam Pai wildlife sanctury, San Pun Dan wildlife sauctuary, Doi Wiang La Wildlife Conservation and Salawin National Park. The problem with these conservation habitats is that these areas are considered to be very small in size, particularly those in high elevation areas, which are considered most suitable for gorals.

No thorough study has been conducted on populations of gorals in conservation areas. most of the important and healthy goral populations live in the forests between the Mae Ping national park and the Om Koi Wildlife Sanctuary. Other conservation areas, such as the forests along Pai-Salawin, also have goral populations, which are relatively small with a low rate of dispersion as a result of a limited amount of

suitable habitat areas. The limited dispersion of the goral population is also due to the use of the surrounding areas by local villages, which restrict the goral's access to available land (Chaitarat, 1997).

Narmorhedus griseus is listed as one of Thailand's endangered animal species (IUCN, 2013) and is also listed in appendix I of the convention of international trade on endangered species of wild fauna and flora (CITES) (IUCN, 2013). Goral prefer living in mountain areas with high elevation. In Thailand, they can only be found in the northern regions. Recently, their populations have been dramatically decreased due to habitat loss that can be associated with "development", as well as from the hunting for meat as food and for the market for horns. In 1993, there was an effort to reestablish a healthy population of gorals outside of their natural habitat *(ex situ)* at Om Koi Wildlife Breeding Station in Chiang Mai province, Thailand. The captive breeding program was deemed to be very successful (Kongprempoon, 2003), considering there were more than 80 gorals that had been born during the length of this program. The next important step for goral conservation is to reestablish a healthy population in their natural habitats *(in situ conservation).* A project to increase the number of gorals and to reintroduce captive-bred gorals back into their natural habitats is needed for the effective and long-term conservation of gorals in Thailand. In order to reintroduce gorals back into their natural habitat successfully, thorough and careful planning are needed (Department of National Park, wildlife and plant conservation, 2005).

In northern Thailand, shifting cultivation practices, hunting and "development" such as the building of roads and human settlements, as well as progress in commercial agriculture and forestry encroachment have been cited as major causes of the decline in biodiversity od numerous indigenous animal species, this is especially true in forested mountain areas (Cearden, 1996). The decline has been rapid. As late as the 1960s, anthropologists, travelers, and missionaries were still recording an abundance of wildlife in their travels (Young, 1967; Shrock, 1970; Wongsprasert, 1975), though there were few rigorous scientific studies that were undertaken at that time (Bruver, 1973). According to Chaiyarat *et al*. (1999), the *N. goral* is one of fifteen protected animals were listed under the wild animal reservation and protection Act, B.E. 2535 of Thailand (Chaiyarat, 1999). The IUCN (2008) has listed all goral species

as being threatened (IUCN, 2008). Gorals are endangered through loss of habitats, poaching, diseases, and competition with domestic cattle for land and food sources (Mead, 1989; Chaiyarat, 1999).

The red goral's behavior during the breeding season, September to November, has been presented in previous reports (Xie, 2006). Normally, gorals reach sexual maturity in their second or third year of life, but mating does not seem to to occur until the third year of life (Bromlei, 1956). Myslenkov and Voloshina (1997) reported that about 85% of the instances of goral copulation occurred in November, with estrus lasting 20-30 hours (Myslenkov and Voloshina, 1997). The gestation period is approximately 180 days. Normally, only one offspring is produced. During the rut, males will follow females closely, being in frequent naso-genital contact with them, often accompanied by smelling and licking, in order to determine the onset of estrus. Non-receptive females will either flee from the advances of the males or threaten them by butting the body of the male with their head. Receptive females tend to stand still when the males approach, and show the signaling of their estrus by raising their tail. Flehmen, lip curling, is mostly observed during the encounters between males and receptive females. Only one kid is normally born per pregnancy, however, two can occur, especially in captive populations (Dobroruka, 1968). Goral takes 2-3 years to grow to reach the reproductive age. The longevity of life is still unclear, though gorals probably live for around 8-10 years (Xie, 2006).

So far, previous behavioral reports on gorals indicated that gorals got into the habit of being particular about their food and mating habits in captivity (Schaulskaya, 1980; Zhang, 1987; Hofmann, 1988). Therefore, understanding fundamental behavioral patterns of the goral can be of help in designing appropriate conservation strategies.

Hence, this study is aimed at providing knowledge for the purpose of understanding goral behavior in captivity. This research included the study of appropriate radio collars for the purpose of monitoring the gorals in their natural habitat. This research project is very important for the conservation of gorals in the wild in the future. Furthermore, the results of this study can be used as a first important step in the conservation of gorals in their natural habitats or for the planning of an effective reintroduction program.

MATERIALS AND METHODS

Study Sites

A study of goral behavior under captive conditions was conducted in the Om Koi Wildlife Sanctuary Breeding Station located in Om Koi district, Chiang Mai province. Om Koi wildlife sanctuary consists of an area of approximately 1,224 km^2. The geographic coordinates of this area are 431800 and 1942400. The climate at the sanctuary is classified as sub-tropical. It rains almost every day during the rainy season, from May to October. The vegetation covering this sanctuary consists of hillside evergreen forests, rock-based areas, mixed deciduous forests, dry dipterocarp forests and successional forests (Chaiyarat, 1999). The 9 gorals selected for this study consisted of 3 adult males, 3 adult females, and 3 juveniles and were grouped into 3 groups (Figure 1) for the purposes of replicating

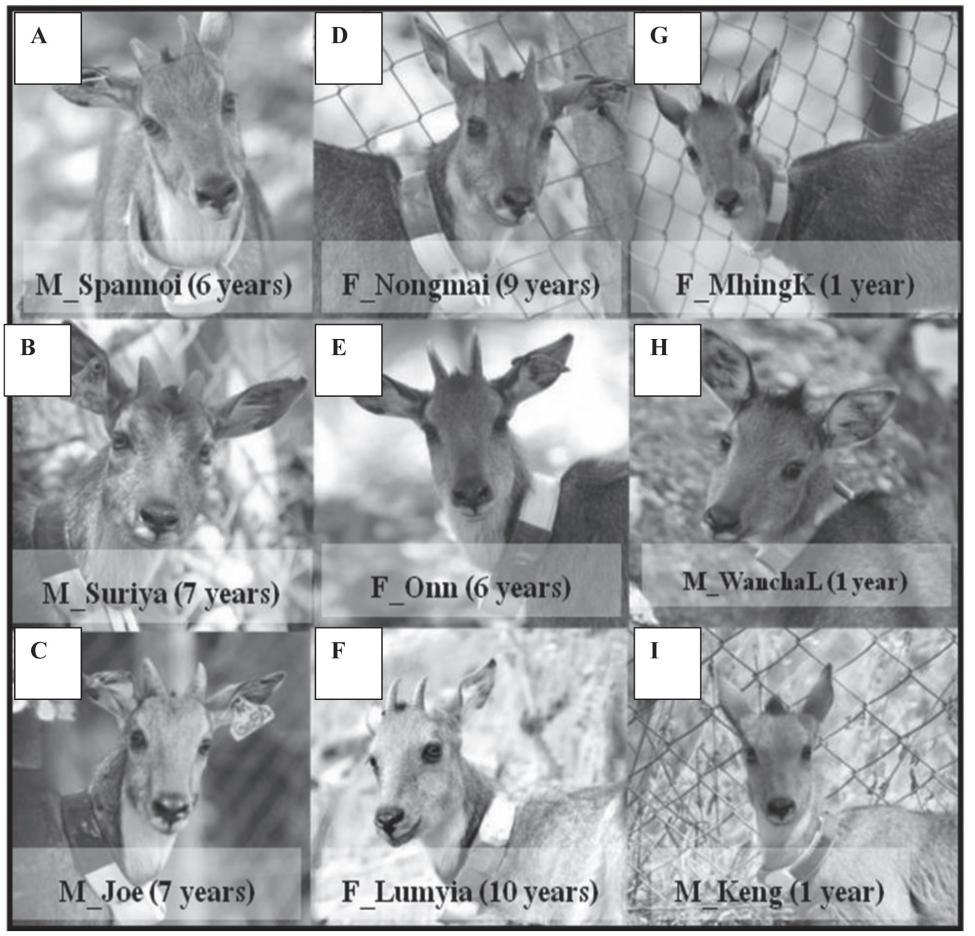

Figure 1. Nine healthy gorals were selected for this study: (A-C) adult males, (D-F) adult females, and (G-I) juveniles.

conditions that were similar to those found in nature and conducive for conservation. Moreover, the juvenile gorals require maternal care and milking. Each group was shepherded in 40 x 40 m^2 enclosures. This area consisted of a dry dipterocarp forest, the slope in each area was about 40 degrees and was covered with rocks and perennial plants. (Figure 2).

Figure 2. The 40 x 40 m2 goral plot at the Om Koi Wildlife Breeding Station

Behavioral observations

Nine healthy gorals, include 3 adult males, 3 adult females, and 3 juveniles, were observed for their behavioral patterns (Figure 2) during the rainy season within a 6-month period, from May to October 2012. The average value of the inbreeding coefficient of all gorals was 0.084. The selected gorals were checked for infectious diseases, i.e. tuberculosis, brucellosis, melioidosis and foot and mouth disease, to prevent the spread of diseases from reintroduced gorals back into the wild population. Each individual was then marked using an ear-tag. For the behavioral observation process, the focal-scan sampling and descriptive method (Gilby *et al*., 2010) were used to gather information on various aspects of goral behavior. Each observation session lasted an hour and the behavior of each family was observed every 10 minutes. Consequently, we obtained a total of 40 scans for

each observation session. The behavioral data in each family was recorded during every period (from 07.00 a.m. to 06.00 p.m.). In addition, the feeding of the goral was recorded based upon direct field observations.

The overall frequency of each behavioral act was calculated in terms of percentage value. Moreover, the daily behavioral activities of both sexes of the goral, and the effect of the radio collar on the behavioral patterns, were analyzed using Turkey's criteria in SPSS Version 17.

RESULTS

With regard to the study of the goral's behavior, twenty-two behavioral patterns were found, which included feeding (foraging), feeding (concentrated feed), ruminating, drinking, defecating, urinating, standing, walking, running, jumping, climbing, sleeping, resting, standing (sleep), grooming, scratching, aggressive posturing, guarding, social behavior, collar scratching, soil licking, and horn rubbing (Table 1). Six behavioral patterns were found to be common among all gorals, viz. feeding (foraging), feeding (concentrated), ruminating, standing, walking and resting with 10.83%, 4.24%, 7.80%, 42.42%, 13.11% and 11.97% for male gorals, respectively (Figure 3) and 14.24%, 9.39%, 6.67%, 42.05%, 11.97%, and 7.73% for female gorals, respectively (Figure 4) and 9.85% 3.94%, 5.53%, 31.74%, 14.02% and 15.05% for juvenile gorals, respectively (Figure 5). In addition, for the behavioral observations were recorded during each period of the day, the highest demonstrated behavior for all the times was the standing position. While feeding (foraging), feeding (concentrated feed), ruminating, walking, resting, grooming and scratching behaviors were shown at all times with rare frequencies. With regard to each behavioral pattern, resting and ruminating behaviors were demonstrated with the highest frequency in the morning (55.00 and 61.33 times), respectively. While feeding (foraging), standing and grooming behaviors were demonstrated at the highest rate in the afternoon (31.67%, 226.33%, and 51.67%, respectively). The feeding (concentrated feed), walking and scratching behaviors were demonstrated with the highest frequency in the evening were 55.00%, 27.00%, and 25.33% respectively. Moreover, the results showed that the feeding (foraging) behavior was also demonstrated at a higher frequency rate than feeding (concentrated feed).

Table 1 Percentage of each behavioral pattern displayed before and after putting on the collar

Behavior	Male				Female				Juvenile			
	Before	1st mt	2nd mt	3rd mt	Before	1st mt	2nd mt	3rd mt	Before	1st mt	2nd mt	3rd mt
Feeding (forage)	10.83	15.08	16.67	15.76	14.24	20.98	17.35	24.47	9.85	17.35	19.62	23.64
Feeding (con)	4.24	4.77	7.42	5.98	9.39	9.32	6.74	9.24	3.94	4.77	6.44	5.98
Ruminating	7.80	4.85	12.88	6.89	6.67	3.03	10.68	10.53	5.53	1.52	8.11	5.30
Drinking	0.45	0.45	0.68	0.15	0.30	0.91	0.15	0.45	0.68	0.98	0.68	0.45
Defecation	0.23	0.61	0.68	0.30	0.23	0.23	0.61	0.45	0.00	0.23	0.98	0.23
Urination	0.38	0.15	0.30	0.00	0.30	0.38	0.38	0.23	0.38	0.53	0.30	0.38
Standing	42.42	34.55	34.17	43.03	42.05	32.50	36.52	29.62	31.74	22.05	22.95	19.70
Walking	13.11	10.53	10.23	7.88	11.97	8.71	6.67	4.32	14.02	12.73	10.30	6.06
Running	0.45	0.83	0.61	1.21	0.45	0.38	0.30	0.45	1.21	1.21	0.76	0.76
Jumping	0.23	0.76	0.08	0.76	0.08	0.08	0.08	0.45	0.83	1.36	0.68	0.83
Climbing	0.68	0.15	0.00	0.15	0.08	0.00	0.00	0.00	1.44	0.15	0.38	0.53
Sleeping	0.76	3.48	0.08	0.83	0.00	1.44	0.38	1.06	4.47	5.45	1.74	5.83
Resting	11.97	14.55	7.73	10.98	7.73	11.21	8.94	10.83	15.08	20.45	18.79	22.12
Standing (sleep)	0.30	0.45	0.00	0.00	0.00	0.08	0.00	0.00	0.23	0.00	0.00	0.00
Grooming	1.89	3.03	2.88	1.97	2.95	3.11	4.09	3.11	4.02	5.61	2.58	2.42
Scratching	0.68	1.59	1.97	1.89	1.21	0.83	2.27	1.67	0.98	1.06	1.52	0.53
Aggressive	0.30	0.38	0.00	0.53	0.45	0.83	0.45	0.08	0.53	0.15	0.00	0.30
Guarding	0.61	0.15	0.23	0.00	0.38	0.15	0.23	0.00	0.23	0.08	0.15	0.00
Social behavior	0.68	0.23	0.83	0.61	0.00	0.61	0.30	0.30	0.76	1.51	1.21	0.98
Collar scratching	0.00	0.30	0.38	0.00	0.00	0.68	0.15	0.00	0.00	0.23	0.23	0.08
Soil lick	1.67	2.80	1.97	0.23	1.52	4.39	3.71	2.65	3.63	2.58	2.58	3.86
Horn rubbing	0.30	0.30	0.23	0.83	0.00	0.15	0.00	0.08	0.45	0.00	0.00	0.00

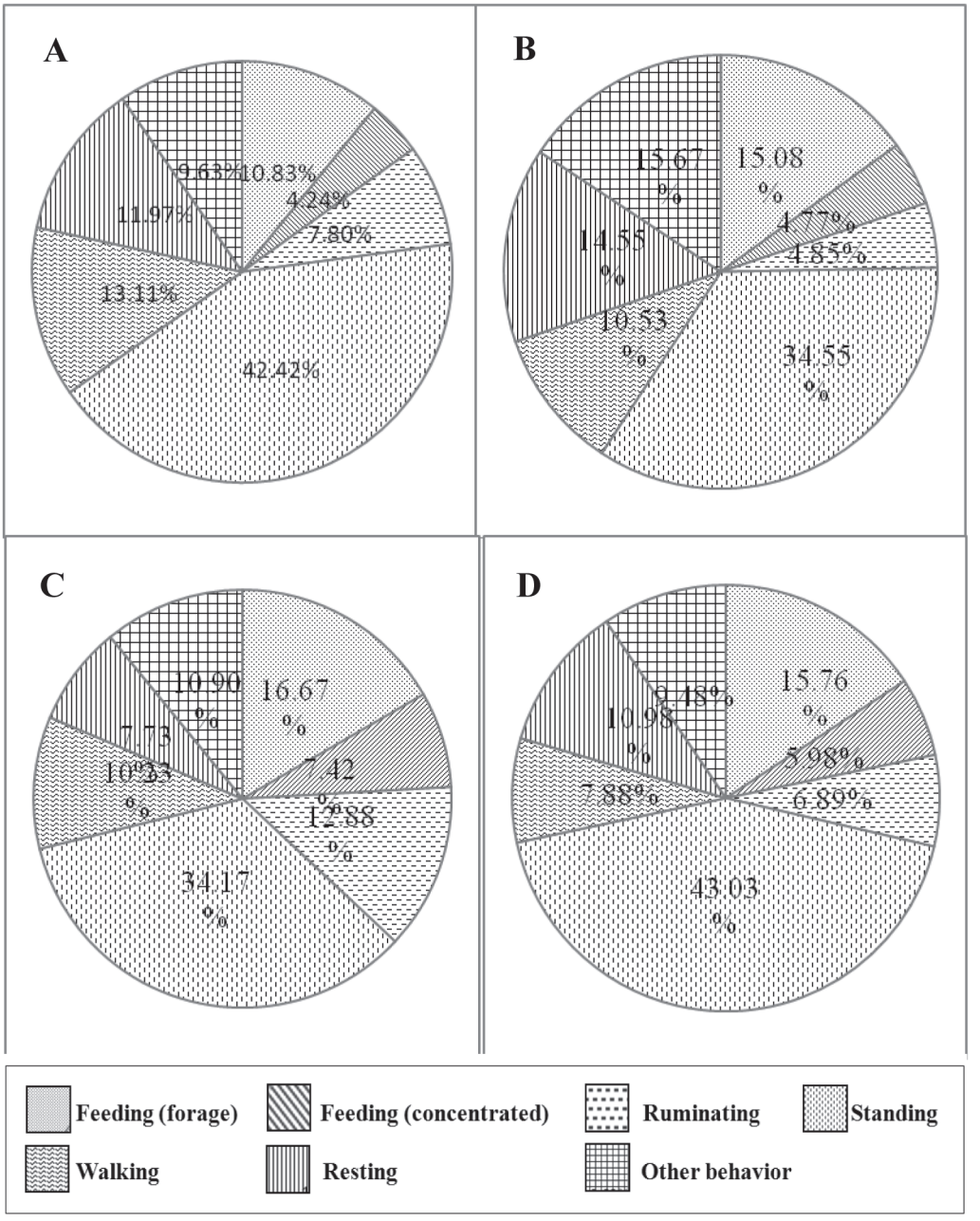

Figure 3. Proportion of the male goral's behavior under captive conditions before and after putting on the collar: (A) before putting on the collar, (B) after wearing the collar for 1 month, (C) after wearing the collar for 2 months, and (D) after wearing the collar for 3 months.

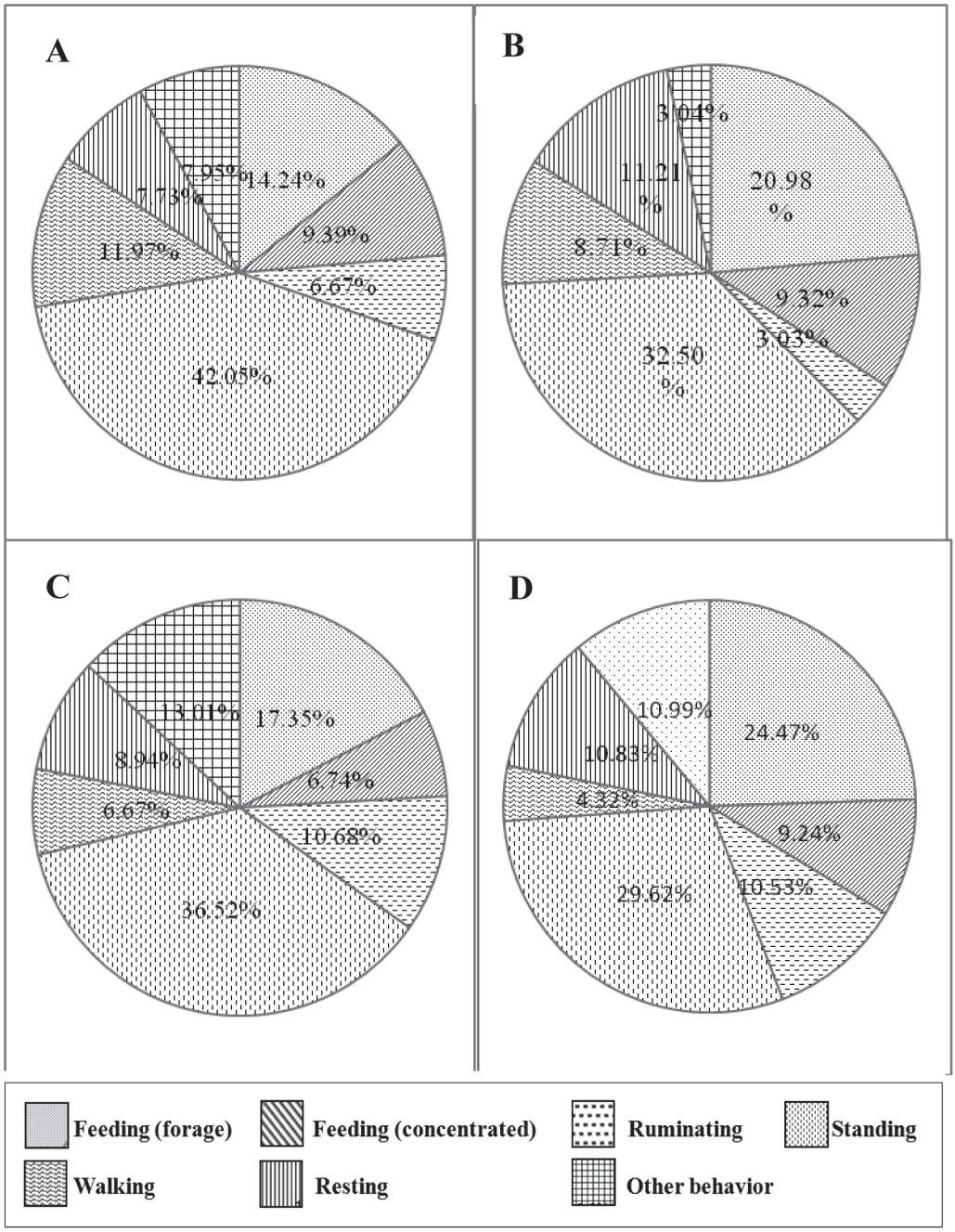

Figure 4. Proportion of female goral's behavioral actions under captive conditions before and after putting on the collar: (A) before putting on the collar, (B) after wearing the collar for 1 month, (C) after wearing the collar for 2 months, and (D) after wearing the collar for 3 months.

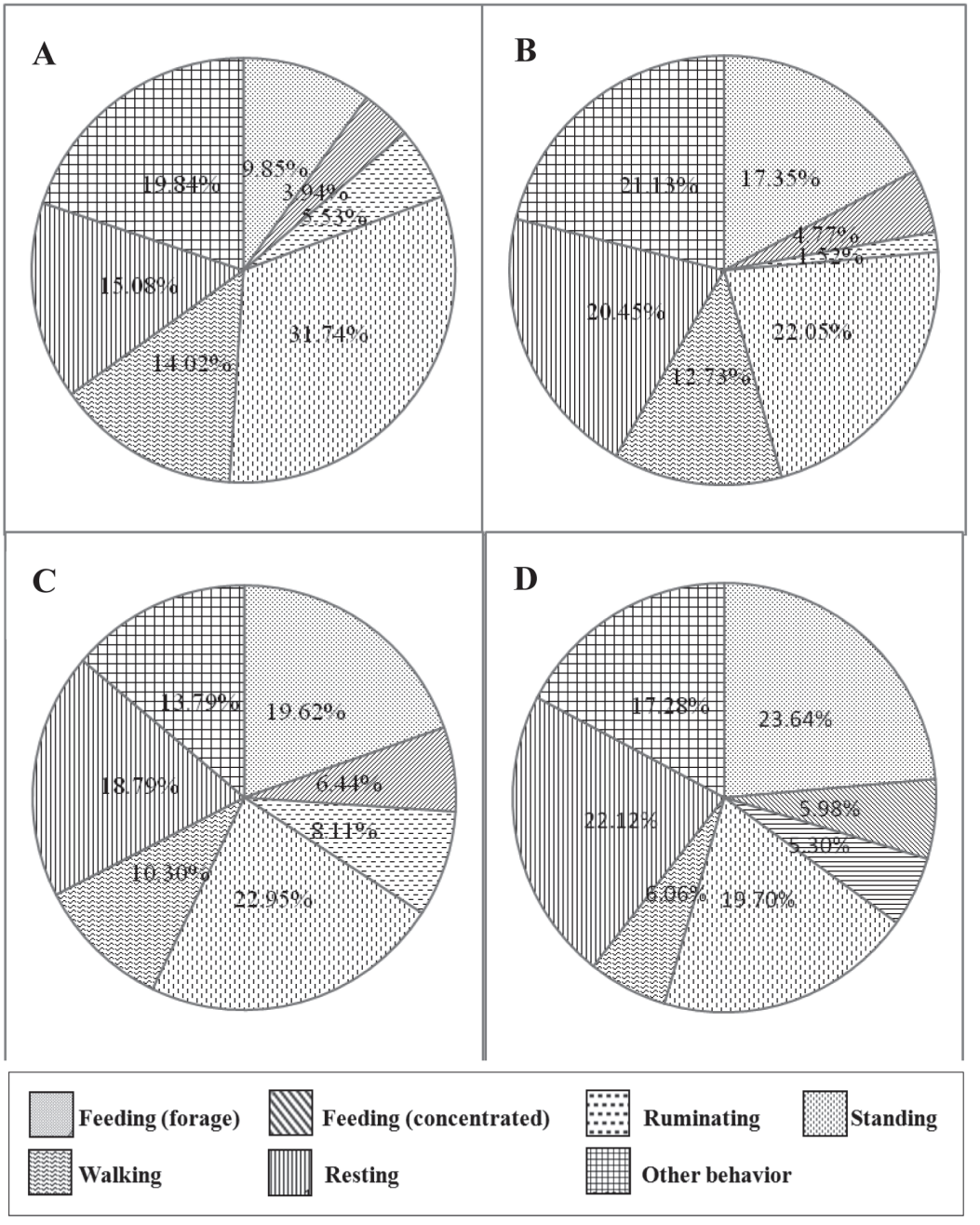

Figure 5. Proportion of juvenile goral's behavior under captive condition before and after putting on the collar: (A) before putting on the collar, (B) after wearing the collar for 1 month (C) after wearing the collar 2 months, and (D) after wearing the collar 3 months.

The descriptions of the dominant behavior were explained for a better understanding of the overall goral behavior, as follows:

1. Feeding (foraging): The goral smells the food first, then it uses its mouth and tongue flicks to eat the food. Its head is up while it is chewing and swallowing. The head is down again to smell and eat newly foraged food.
2. Feeding (concentrated feed): The goral brings its head down to eat and then looks up and around while chewing. When food is swallowed, the goral will bring its head down to eat again.
3. Ruminating: The goral can chew while both standing and lying down. The goral would regurgitate the roughage from the rumen to the mouth to chew it again. Rumination can be observed by watching the food moving from the throat to the mouth when the cheeks start bulging out. The cud is thoroughly chewed and swallowed for further digestion.
4. Standing: All four hooves are on the ground.
5. Walking: The animal moves slowly, first by using the front legs and the hind legs.
6. Resting: The goral selects a suitable location, which is commonly in the shady area under trees. The goral will then use one foot to scratch the ground surface, then crouch down on its knees, and then lay down.
7. Grooming: Gorals lick and scratch themselves and licking is accomplished by the turning of the head to the area that needs to be licked. Then, the tongue is used along the torso, shoulders, back, hips, legs, tail niche, and penis. For penis grooming, one hind leg of the male goral is raised up and swerved. The licking behavior can be observed both while they are standing or lying down. For the scratching behavior, the goral uses its hoof to scratch at its face, ears, neck, and shoulder. Grooming can be observed both while the goral is in the standing and resting positions.

The frequency of these six common behavioral acts in male and female gorals was significantly different ($p < 0.05$) (Table 2). Goral behavior before and after the radio collar was put on did not differ significantly ($p > 0.05$) (Table 3). In addition, in terms of the effect of the radio collars on the gorals, the behavior of the males, females, and juveniles were also observed both before and after the collar was put on

Table 2 The statistical analysis of the dominant behavioral patterns observed between male and female gorals using Tukey' s criteria

Dependent Variable: Data

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4811.959(a)	28	171.856	17.944	0.000
Intercept	613.211	1	613.211	64.027	0.000
Behavior	4811.830	27	178.216	18.608	0.000
Sex	0.129	1	0.129	0.013	0.908
Error	258.587	27	9.577		
Total	5683.757	56			
Corrected Total	5070.546	55			

a R Squared = 0.949 (Adjusted R Squared = 0.896)

Table 3 The statistical analysis of each behavioral pattern observed before and after putting the collar on the goral using Tukey' s criteria.

Period	N	Subset 1
After 2 months	23	4.3470
Before	23	4.3470
After 1 month	23	4.3474
After 3 months	23	4.3487
Sig.		1.000

The error term is Mean Square (Error) = 2.781.

a Uses Harmonic Mean Sample Size = 23.000.

b Alpha = 0.05.

(Figure 4-4). This was consistent with the frequency of collar scratching both before and 3 months after the collar was put on each goral. Moreover, this behavioral pattern was very rare when compared with the other behavioral patterns (Table 4).

Table 4. Percentage of collar scratching behavior observed before and after putting on the collar

	Duration			
	Before	**1st mt**	**2nd mt**	**3rd mt**
Male (n=3)	0.68	0.23	0.83	0.61
Female (n=3)	0.00	0.61	0.30	0.30
Juvenile (n=3)	0.76	1.51	1.21	0.98

DISCUSSION

From our investigation, the most common behavioral act observed was the standing behavior. This behavioral action was believed to be engaged in for the purposes of identifying any threats of potential predators. Chaiyarat (1997) also reported that the standing behavior of the goral might be so that it is ready to run to avoid predators and/or other threats. This posture is different from resting, walking, and other behaviors (Chaiyarat, 1997). In addition, the walking behavior was observed for the purposes of finding food under noted conditions. The other behavioral acts were rarely observed during the course of this study. There were lower percentages of all six of the common behavioral acts because of the amount of time needed for consumption. Therefore, it is suggested that further studies, the dominant behavioral acts should be observed because this will provide even clearer information on goral behavior which can be applied for goral conservation under natural conditions and for the assessment of their reintroduction.

The food which gorals typically consume consists of concentrated food and natural food, such as leaves, tree bark and the grasses which cover the ground in the stalls, as the goral must learn to live in its natural enviornment. Furthermore, this combination of food is a great source of energy, vitamins, and minerals needed for growth and reproductive functions (Lovari and Apollonio, 1994). Therefore, the results of this study

indicate that the frequency of forage feeding, which involves food of higher fiber content, was higher than the occurance of gorals feeding on concentrated feed. Moreover, gorals ingested food by chewing it several times before swallowing it. According to Chaiyarat (1997), the majority of the plant food, that the gorals ate, were grasses and high fiber plant species, such as *Spondias cytherea, Phyllanthus emblica, Eriochloa procera,* and *Terminalia alata* (Chaiyarat, 1997).

Standing behavior was observed with the highest frequency in this study. This observation results contrasted with previous reports on red gorals that were kept in captivity, and their rutting behavior might differ somewhat from those that are found in the wild (Xie, 2006). Compared to the Himalayan goral *(N. goral),* captive red gorals did not appear to show the body/head shaking behavior (Lovari and Apollonio, 1994), which was a male behavioral pattern and was thought to be a gentle display of dominance used in social interactions. The captive male red gorals that were previously mentioned, were raised in isolation; therefore, this behavior might not yet have been developed. However, the Amur goral *(N. caudatus raddeanus)* had a unique pattern of stroking the female's head (Xei, 2006).

To clarify, each main type of goral behavior is described, as follows;

1. Feeding (foraging): This behavior was occurred with the most frequency in May due to the high level of rainfall, which promoted a high biodiversity of plant species. Feeding (concentrated feed): This behavioral pattern was of the lowest frequency in May because this period took place during the rainy season, when there was a lot of forage material. However, during the dry season (January), which experienced a low level of rainfall, the frequeccy of this behavior rose.
2. Ruminating: This behavioral pattern occurred with the highest rate of frequency in July. because the rainy season produced a lot of forage food material. The results indicated that the ruminating behavior was usually observed in the morning.
3. Walking and standing: This behavioral act was observed in gorals when they were searching for food and/or avoiding disturbances and possible dangers from other animals. (Geist, 1971). For the walking behavior, they walked around the food stall or along the peripheral area for a long time.

This bevavior can be commonly obseved from December to Febuary because hunger drives the goral to a release in the foraging behavior (Archer, 1979) in their attempts to find food. However, the standing behavior is typically expressed for survival under the conditions mentioned above.

4. Resting: Habitually, this behavior occurs most frequently in May. When the rainy season begins, gorals take refuge under trees or huge rocks. This behavior can also occur in the morning or after eating when gorals look for places to rest which are usually shaded. Gorals like resting in groups, which provides greater security than being isolated (Yimbergen, 1972). This behavior remains constant throughout most of the year, except during the period of February – April, when this specific behavior decreases in frequency due to the higher temperatures that occur during that time, when compared to the temperatures that are typically seen in other months.
5. Grooming and scratching: Grooming and scratching is considered contiguous, as the goral is host to insects and other ecto-parasites (Owen, 1982). Moreover, there is also certain comprehensive material tracking on all parts of the goral's body. The grooming and scratching behavior of the goral depends on several factors, which are considered the driving environmental forces (Immelmann, 1980).

Regarding the collar scratching behavior, the frequency of this behavior before and after the collar was put on, was not significantly different. This observation was consistent with the frequency of collar scratching that occurred before and after (3 months) the collar was put on each goral because this behavioral pattern was considered very rare when compared with the other behavioral patterns. This means that further study is needed to test whether this behavioral pattern is unnecessary, which can save both time and the investment needed for future research projects. Moreover, our study indicated that the radio collar was very helpful in tracking the location of gorals under soft release conditions with high efficiency. This technique could be very useful in analyzing the dispersal patterns, land usage, and habitat selection of wildlife (Riecken and rarhs, 1996). However, this approach is limited by certain conditions, such as (1) the radio collar cannot be used to forecast movement, (2) transmission distance of the radio collar is about 10 km (ground level), if the

distance is more than 10 km, there may be an error in the estimated position of the goral, and (3) the radio collar approach has a high cost. In comparison with the other methods, there are some important advantages in using radio transmitters. Unlike the harmonic – radar approach, radio tracking makes it possible to use several different frequencies. Thus, it is possible to identify several specimens individually in the same area. Due to the relatively large transmitting range, it is also possible to study dispersal over greater distances. However, in contrast to the harmonic – radar approach, specimens and transmitters can go astray owing to technical problems like short circuits that can be caused by humidity or when batteries run down prematurely (Shackleton, 1997).

When considering that the frequency of feeding (foraging) was founded to be higher than the frequency of feeding (concentrate) because the forage materials are the common natural dietary foods of gorals that help them to produce energy. This result suggested that the planning of the reintroduction initiative in further studies should be to give the concentrated feed in some areas for supplemental nutrients under natural conditions.

Presently, the goral *(N griseus)* can be a great natural food source, a potential source of income, a simple part of the wildlife population, and an envaluable subject of research. It is classified as an endangered species with a decreasing population distribution (Sheikh and Molur, 2005); it also is listed as being threatened by the IUCN (IUCN, 2008), and has been assigned a status of vulnerability based on the information gathered from different sources (Sheikh and Molur, 2005). Due to the lack of suitable education, most hunters and the public community along both valleys do not know about the biological and behavioral importance of *N. griseus* in the wild. The management and conservation of large herbivores is particularly difficult to evaluate due to their large requirements for space. Intensive human land use is responsible for habitat fragmentation, which has resulted in direct and indirect conflicts with those herbivores that compete with humans for the remaining semi-natural spaces and resources (Noss *et al*. 1996; Woodroffe and Ginsberg, 1997). Hence, the management and conservation of the goral in Thailand and other countries is important to ensure the long – term survival of the relevant ecosystems. Hence, this study on the behavior of the goral has provided updated information

on creating an understanding of goral behavior that can be used by conservation management officers to plan and monitor the increase of the goral populations in the future. Additionally, it could be adjusted and applied to the process of reintroduction of other protected species back into the wild in the future.

ACKNOWLEDGEMENTS

I would like to thank Mr. Adisorn Kongprempoon, Mr. Romyen Thongsibsong, Mr. Dissakul Thumasanukul and every member of the staff at the Om Koi Wildlife Breeding Station, Om Koi Wildlife Sanctuary and Maeloa-Maesae Wildlife Sanctuary, Department of National parks, wildlife and plant conservation for their hard work and kind support. I am very grateful to Dr. Sumate Kamolnoranath, Dr. Boripat Siriaroonrat, Dr. Wanlaya Tipkantha, Dr. Khwanruean Doungsa-ard, Miss Runglawan Sangsuri, Miss Keeta Korkusol and everybody at the bureau of conservation, research and education; Chaing Mai zoo of the zoological park organization, Thailand. We would like to thank Dr. J. F. Maxwell for editing our manuscript. Finally, we acknowledge the national research council of Thailand for partly supporting the funding of this research.

REFERENCES

Archer, J. (1979). Animals Under Stress. London: Edward Arnold.

Bromlei, G. F. (1956). Goral (*Nemorhaedus caudatus raddeanus* Heude, 1894) Zool. Zhurnal, 35, 1395-1405.

Bruver, W. (1973). Fauna of north Thailand. Nat. His. Bull. Siam, 24, 463–466.

Chaiyarat, R. (1997). Ecology of goral (*Nemorhaedus goral* (Hardwicke, 1825)) in Om Koi wildlife sanctuary, changwat Chiang Mai and Tak. Unpublished M. S. Thesis. Kasetsart University.

Chaiyarat, R., Laohajinda, W., Kutintara, U. and Nabhitabhata, J. (1999) The goral *(Naemorhedus goral)* in Om Koi sanctuary, Thailand. Nat. Hist. Bull. Siam, 4, 191-205.

Dearden, P. (1996). Development, the environment and social differentiation in northern Thailand. In: Rigg, J. (Ed.), Counting the Costs: Environmental Growth and Economic Change. Singapore: ISEAS.

Department of National Park, wildlife and plant conservation. (2005). Master plan of wildlife resource conservation. Bangkok: Ministry of National Resources and Environment.

Dobroruka, L. J. (1968). Breeding group of gorals. Internat. Zoo Yearb, 8, 143-145.

Geist, V. (1971). Mountain Sheep: A Study in Behavior and Evolution. Chicago: The University of Chicago Press.

Gilby, I. C., Pokempner, A. A. and Wrangham R. W. (2010). A direct comparison of scan sampling methods for measuring wild chimpanzee feeding behavior. Fol. Proma. (Basel), 81, 254-264.

Groves, C. P. and Grubbv P. (1985) Reclassification of the Serows and Gorals (Nemorhaedus: Bovidae), 2nd ed. London: Croom Helm.

Hofmann, R. R. (1988). Anatomy of the Gastro-Intestinal Tract. *In*: Church, D.C. (ed). The Ruminant Animal: Digestive Physiology and Nutrition. New Jersey: Prentice Hall.

Immelmann, K. (1980). Introduction to Ethology. New York: Plenum Press.

IUCN (2008). IUCN red list of threatened species. Retrieved April 5, 2009, from: www.iucnredlist.org.

IUCN. (2013). The IUCN red list of threatened species version 2013. Retrieved August 16, 2013. from: www.iucnredlist.org.

Kongprempoon, A (2003). Goral behavior in semi-captive/wild, Om Koi wildlife breeding centre. Thailand: Department of National Park, Wildlife and plant conservation.

Lovari, S. and Apollonio, M. (1994). On the rutting behavior of the himalayan goral *Nemorhaedus goral* (Hardwicke, 1825). Ethol, 12, 25–34.

Mead, J. I. (1989) *Nemorhaedus goral* : Mammalian species. Amesociety Mammal, 335, 1-5.

Myslenkov, A. I. and Voloshina, I. V. (1997) Sexual Behavior of Amur Goral., 2nd ed. Granada: Proc World Conf Mt Ungulates.

Noss, R. F., Quigleym, H. B., Hornocker, M. G., Merril, I. T. and Paquet P. C. (1996). Conservation biology and carnivore conservation in the rocky mountains. Conserv. Biol, 10, 949–963.

Owen, D.G. (1982). Animal Models in Parasitology. London: The MacMillian Press Ltd.

Riecken, U. and Rarhs, U. (1996). Use of radio telemetry for studying dispersal and habitat use of *Carabus coriaceus* L. Ann. Zool. Fennici, 33, 109-116.

Roberts, T. J. (1997). The Mammals of Pakistan. London: rnest Benn Limited.

Schaulskaya, N. A. (1980). Seasonal changes in plant consumption by the goral *(Naemorhedus goral)* in the Sikhote-Alin reservation, Russian SFSR, USSR, Rastitelnye Resursy, 16, 177-186.

Seddon, P. J., Armstrong, D. P. and Maloney, R. F. (2007). Developing the science of reintroduction biology. Conserv Biol, 21, 303-312.

Shackleton, D. M. (1997). Wild sheep and goats and their relatives: status survey and conservation action plan for Caprinae. Nat. Pak: Intl. Uni. Conserv.

Sheikh, M. K. and Molur, S. (2005). Status and red list of Pakistan mammals based on Pakistan's conservation assessment and management plan for mammals. Nat. Pak: Intl. Uni. Conserv.

Shrock, J. L. I., Crowe, M., Fromme, D. E., Gosier, V. S., Mckenzie, R., Myers, W. and Stegeman, P. L. (1970) Minority groups in Thailand. Washington D.C.: Department of the Army.

Tinbergen, N. (1972). Social Behavior in Animals. London: Chapman and Hall Limited.

Willson, M. F. (1984) Vertebrate Natural History. Philadelphia: CBS College Publishing.

Wongsprasert, S. (1975) Lahu trade and commerce. J. Siam, 63, 199–219.

Woodroffe, R. and Ginsberg, J. R. (1997). Measures for the conservation and management of free-ranging wild dog populations. Woodroffe, R., Ginsberg, J.R., Macdonald, D.W. (eds), In the african wild dog: status, survey and conservation action plan. Switzerland: IUCN/Species Survival Commission Canid Specialist Group, Gland.

Xie, Y. (2006) Primary observations on rutting behavior of the captive red goral. Zoo Biology, 25, 17–123.

Young, G. (1967). Tracks of an Intruder. London: Souvenir Press.

Zhang, C. (1987). *Naemorhedus cranbrooki* and planted tree growth on Japanese Serow populations. Eco. Res, 8, 19-25.