

Research Article

Primary Observations on Rutting Behavior of the Captive Red Goral

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The rutting behavior of the red goral (*Naemorhedus cranbrooki*) was studied at the Breeding Center of Shanghai Zoo from September 16–November 21, 2004. Twenty-three qualitatively distinct behavior patterns was observed. Males showed a more extensive repertoire (18 patterns, 15 carried out only by males) than did females (10 patterns, 6 carried out only by females). Smelling and licking behavior was used most by males, whereas escape was used most by females. Zoo Biol 25:117–123, 2006. © 2006 Wiley-Liss, Inc.

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INTRODUCTION

The red goral (*Naemorhedus cranbrooki*) is a member of the subfamily Caprinae in the Bovidae. On the basis of its small body size, simple horn shape, habitat frequented, and small group size, the goral has been assumed to be a solitary, territorial, resource defender [Schaller, 1977; Geist, 1987]. It was ranked as a Vulnerable Species by International Union for Conservation of Nature and Natural Resources (IUCN) in 1996 [International Union for Conservation of Nature and Natural Resources, 2005], and in Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) Appendix I [Convention on International Trade in Endangered Species of Wild Flora and Fauna, 2005]. It is also one of the highest-rank protected species in China [Wang, 1998].

The red goral is distributed over a narrow region of southeast Tibet and Yunnan province in China, northern Myanmar and an area along the Myanmar–

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India boundary [Wang et al., 1997]. According to the last surveys in 1989 in China, the wild population was <1,500 animals [Wang, 1998].

The wild populations have been declining for decades owing to excessive hunting and habitat loss or degradation across their range areas [Wang et al., 1997]. The species is threatened with extinction. To help toward conserving the wild red goral population, in 1982 the Breeding Center of Shanghai Zoo began a breeding program with seven wild red goral. Over the last 22 years, the Breeding Center has successfully raised 27 red gorals, not including those used for exchange.

The reproductive behavior of red goral has received little study either in captivity or in the wild. Behavior around estrus is key to successful reproduction of red goral in captivity, but estrus of wild red gorals has rarely been studied due to their secretive behavior and the nature and location of their habitat (at high elevation), hence at present most information is likely to be available only from captive animals. In captivity, female goral enters estrus at the age of 1.5 years and gives birth at 2 years of age, whereas males first show rutting behavior and mating at 3 years of age [Zhang et al., 1993a; Guo et al., 2004]. Females that fail to conceive in one estrus will recycle and copulate in next estrus, 17–23 days later [Zhang et al., 1993b]. The mean duration of true estrus is reported to range from 6–72 hr, and the number of copulations in one estrus ranges from 10–20 [Zhang et al., 1993b].

Representatives of the family Bovidae demonstrate different types of mating systems. In ungulates, there are some common in behavioral patterns. Female may temporarily abandon their young when rutting activities peak [Lovari and Apollonio, 1994]. Much research work on sexual behavior has been done on the Amur goral (*N. caudatus raddeanus*) [Myslenkov and Voloshina, 1998], the Himalayan goral (*N. goral*) [Lovari and Apollonio, 1994], aoudad (*Ammotragus lervia*) [Habibi, 1987], red deer (*Cervus elaphus*) [Clutton-Brock et al., 1982], and sika deer (*Cervus nippon*) [Endo et al., 1997]. The sequence of phase in sexual interactions are similar: preliminary, touching, mounting, copulation. For sika deer, Endo et al. [1997] reported the post-copulative guarding after the phase of copulation. The most common mating system is polygyny [Owen-Smith, 1977; Gosling, 1986]. Some behaviors are unique among Caprinae, such as “stroking of female’s head” in Amur goral [Myslenkov and Voloshina, 1998].

The limited information on the rutting behavior of red goral, was attained primarily through descriptive observations or assumptions based on other species of goral. I collected data of rutting behavior of the red goral at the Breeding Center of Shanghai Zoo from September 16–November 26, 2004. The aim of the *Naemorhedus cranbrooki* study was to describe the behavioral repertoire with emphasis on the mating/rutting behavior.

MATERIAL AND METHODS

Animals and Management

The study was conducted at the Breeding Center of Shanghai Zoo (31.2°N, 121.4°E), situated 5 m above sea level with an annual rainfall of 1,100 mm and average temperature of 15°C. The center holds the only captive population of this species in China.

Twenty-seven red gorals were kept in two types of enclosures in the center. One enclosure consisted of $3.30 \times 3.00 \text{ m}^2$ indoor area and adjoining $5.00 \times 5.00 \text{ m}^2$ outdoor yard. One or two individuals were kept in this type. The second enclosure was for group housing, and had a large outdoor area over 700 m^2 . The large area has vegetation such as privet, paulownia, and willow, etc. There were eight enclosures in a row with iron-mesh fences in between to prevent gorals from interacting with animals in neighboring enclosures. Animals were fed twice a day (about 09:00 and 15:00), primarily with fresh leaves (in summer and autumn) or dried leaves (in winter and spring). Supplementary feed and ad lib water were also provided.

Males were separated from females from December–August by the zoo staff, but in early September, one sexually experienced male was introduced into one enclosure to mate with a group of females (six this year) and removed after the last females had completed estrus. The young of the previous year were not separated during this time.

During observations Enclosures 2 and 4 were used for breeding. One male and two females in were kept in Enclosure 2 and one male with six females and three offspring born in 2004 were in Enclosure 4.

Data Collection and Statistical Analysis

Ad lib sampling [Martin and Bateson, 1993] was used to conduct pre-observations from September 16–21, 2004 to become familiar with the behaviors and to identify individuals based on their gender and body features (e.g., spots, scars, color patterns). Formal data collection was carried out from September 29–November 21 using scan sampling [Martin and Bateson, 1993]. Focal animals were selected before observations and each focal individual was observed for 10 min. The first focal animal of a day's observations, was the last focal animal observed on the previous day. This was to ensure equal observation times among the different individuals. During sampling, all occurrences of social behavior patterns carried out were recorded. Lovari and Locati [1991] and Myslenkov and Voloshina [1998] were followed for the classification of behavior patterns. Observations were made from 08:00–12:00 one day and from 12:00–16:30 on the following day to present one "observation day." If a female showed "tail raising," then that day was recorded as estrus day. The estrus status lasts about 27 hr [Zhang et al., 1993b]. Data were recorded for a total of 132 hr and 792 focal animal scans.

RESULTS

Qualitative Description of Behavior Patterns

Twenty-three qualitatively distinct behavior patterns (visual, auditory, olfactory) were observed (Table 1). Males showed a more extensive behavioral repertoire (18 patterns, 15 carried out only by males) than females (10 patterns, 6 carried out only by females). Five patterns were common to both sexes. There is no behavior pattern between males studied because no two males are kept in one enclosure. Descriptions of each of the 24 social behavior patterns observed are given in Table 1. If the definition does not mention the gender of the actor or receiver, it means the pattern could be used by both genders.

TABLE 1. Behavior patterns of red goral

Behavior patterns	Description	Behavior classes
Tongue flick	Male flicks his tongue between his lips toward a female. Accompanied by “ze-ze-ze” sound.	Courtship
Chin rest	Male rests his chin on the top of a female’s rump.	Courtship
Following	Male walks after a female and continues to stay close to her.	Courtship
Front kick	Male kicks a female with a stiff foreleg. Kicks are directed to the rear of the female.	Courtship
Tail bite	When male sniffs female ano-genital; occasionally bites the female tail upward. Observed only two times.	Courtship
Flehmen	After sniffing a female, or the place where she urinated, a male sometimes show flehmen, raising its head and curling his upper lip.	Courtship
Low stretch	When approached, the actor stands slightly crouched with flexed carpal joints and a lowered but outstretched neck. The chin is slightly raised and the horns are held parallel to neck.	Submissive or courtship
Mounting	A male rises on his hind legs and rests his forelegs and chest on the rump of a female.	Courtship
Naso-genital contact	A male touches (or almost touches) female ano-genital region with his nose or tongue.	Courtship
Head butt	Two individuals face each other, clashing horns and foreheads slightly. An intentional head butt occurs without horn or forehead contact, but kept about 10–20 cm apart. This can be accompanied by an abrupt upward nodding of the head, and may be carried out as if to gore the opponent.	Threat
Forehead pushing	A female pushes with its forehead against an opponent’s body to drive it away.	Threat
Hook	The actor may attempt to gore and more often sweep its horns upward.	Threat
Approach	The actor moves directly straight toward another.	
Chase	Male pursues a female.	
Tail raising	A female raises her tail to reveal its ano-genital region. Usually observed before copulation.	
Smelling and licking	A male approaches a lying female and lick her. This may be followed by an attempt naso-genital contact. Bouts of smelling and licking, may last several minutes, and are usually terminated by the female getting to her feet and moving away.	
Reactive urinating	A female squats and urinates after being chased by male or when male approaches her.	
Escape	A female runs away when a male approaches.	
Smell urine	Male smells the urine when a female is urinating or the urine on the ground.	
Gamboling	Females jumping and raising both the forequarters and hindquarters.	
Horning	An individual rubs its horns on an inanimate object (e.g., tree trunk, fence, door, or wall).	
Whistling	Female utters whistle when a male approaches or chases her. The sound is audible to humans up to 500 m away.	

Quantitative Description of Behavior Patterns

Smelling and licking were behaviors used most frequently by males, whereas escape was used primarily by females (Table 2). Low stretch was the second most frequent behavior in the female repertoire, whereas males showed three other patterns with occurrences >6% (naso-genital contact, mounting, following) (Table 2). Adult males seemed to ignore kids and the males showed no chasing during courtship. Not surprisingly, females interacted with kids and yearling more often than males did.

DISCUSSION

Wild red gorals live in a seasonal environment and are seasonal breeders [Zhang et al., 1993b]. In my study, the climate in the region where the breeding center is located also undergoes seasonal climatic patterns. The captive red goral at the Center have been regular seasonal breeders since 1982 [Zhang et al., 1993b], even though they are provided with supplemental food and are housed in an enclosure that reduces fluctuations in temperature and food availability. It might be expected that the environmental seasonality of captive red goral should not be as strong as that of wild red gorals, and the rutting patterns of captive females are less synchronous than those of wild females [Orihuela, 2000].

TABLE 2. Frequency of behavior patterns in the repertoire of adult females and males

Behavior patterns	Female		Male	
	<i>n</i>	%	<i>n</i>	%
Chase	0		8	1
Mounting	0		74	7
Following	0		63	6
Tongue flick	0		40	4
Flehmen	0		22	2
Front kick	0		24	2
Chin rest	0		15	1
Bite tail	0		0	0
Naso-genital contact	0		162	16
Hook	10	2	23	2
Approach	0		53	5
Head butt	31	5	20	2
Smell urine	0		15	1
Intentional head butt	25	4	5	0
Horn threat	94	14	21	2
Horning	0		32	3
Low stretch	181	28	5	0
Smelling and licking	0		203	20
Tail raising	5	1	0	
Reactive urine	2	0	0	
Forehead pushing	61	9	0	
Escape	147	23	0	
Whistling	95	15	0	

It was observed that when a female was in estrus, a male directed most of his attentions toward her, interacting more frequently with her than with other females. The male typically mounted females in estrus several times before ejaculating and remained close to them afterward, but subsequently showing progressively more interest in other females. The copulations with the same female usually took place over 1–2 days. There are two stages for rutting: courtship and copulations.

In the first stage, the key patterns displayed by the male are “smelling and licking,” “naso–genital contact,” and “following.” Male probably detects the estrus condition of a female through intensive olfaction such as “smell (social),” “smell urine,” and “flehmen.” If the female is not in estrus, she reacts to the male’s approach by “low stretch” or “escape.”

The copulation stage begins with the onset of estrus in a female. When a male displayed “low stretch” or “approach” and the female did not threaten him, he would then sniff and lick her ano-genital region, followed almost always by flehmen. At this time, the female began to raise her tail that seemed to signal the female’s readiness for copulation. Before mounting, the male flicked his tongue toward the female and smelled her ano-genital region. During this phase, the male licked the female’s hair and spread its spittle all over the surface of the female, especially the hind. Maybe one of the functions of “smell” and “lick hair” of the female is to prepare them for copulation. Most often copulation attempts were initially unsuccessful attempts to mount. The duration of successful copulations was from 2–4 sec. Usually one pair has 10–20 copulations per day (daylight hours).

Female and male red gorals have different courtship strategies. Males are more active during courtship than are females and show a greater variety of courtship patterns. This may give males more chance to monitor the estrus status of females. The only visual signal given by females during estrus is tail raising. Hormone analysis is in progress in our laboratory to more closely investigate the relationship between breeding behavior and physiological estrus.

Because red gorals in the center were kept in captivity, their rutting behavior might differ somewhat from those of wild conspecifics. Compared to the Himalayan goral (*N. goral*), the captive red gorals were not observed to show “body/head shakes” [Lovari and Apollonio, 1994]; which is a male behavior pattern and is thought to be a mild dominance display when used in social interactions. Captive red goral males are raised in isolation from each other, however, so this behavior might have not developed. The Amur goral (*N. caudatus raddeanus*) has a unique pattern “strokes a female’s head” [Myslenkov and Voloshina, 1998], which was not observed in this study.

In ungulates, female may temporarily abandon their young when rutting activities peak [Lovari and Apollonio, 1994]. During our observation, none of the females showed this behavior. Moreover, the males did not chase kids during courtship. This may be because the kids are young and do not pose any potential threat or competition for the male, nor do they have much effect on their mother’s estrus behavior.

This research results were based on data collected in one single breeding season, during which two males and eight females were available and the observation time lasted 132 hr (including 792 scans). The data presented in this study was limited. Further research is in progress to explore the rutting behavior of captive red goral.

CONCLUSIONS

Twenty-three qualitatively different behavior patterns (visual, auditory, olfactory) were observed in red gorals in captivity. Males showed a more extensive behavioral repertoire than females. Five patterns were common to both genders. When a female red goral was in estrus, the male in the same enclosure displayed “naso-genital contact,” “smelling and licking,” and “chin rest” more often around this time.

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REFERENCES

- Clutton-Brock TH, Guinness FE, Albon SD. 1982. Red deer. Chicago: University of Chicago Press.
- Convention on International Trade in Endangered Species of Wild Flora and Fauna. 2005. CITES Appendix I. <http://www.cites.org/>.
- Endo A, Dooi T, Shiraki A. 1997. Post-copulative guarding: Mating behavior of non-territorial male sika deer (*Cervus nippon*) in an enclosure. *Appl Anim Behav Sci* 54:257–63.
- Gosling M. 1986. The evolution of mating strategies in male antelopes. In: Rubenstein DI, Wrangham RW, editors. *Ecological aspects of social evolution*. Princeton: Princeton University Press. p 244–81.
- Geist V. 1987. On the evolution of the Caprinae. In: Soma H, editor. *The biology and management of Capricornis and related mountain antelopes*. London: Croom-Helm. p 3–41.
- Guo WL, Pei EL, Li ZK, Wang AS, Tu RX. 2004. Preliminary observation on eco-biology of captive red goral (*Naemorhedus cranbrookii*). *Acta Theriol Sinica* 24:82–3.
- Habibi K. 1987. Behavior of aoudad *Ammotragus* during the rutting season. *Mammalia* 51: 497–514.
- International Union for Conservation of Nature and Natural Resources. 2005. 2004 IUCN red list of threatened species. <http://www.redlist.org/>.
- Lovari S, Locati M. 1991. Temporal relationship and structure of the behavioral repertoire in male Apennine chamois during the rut. *Behaviour* 119:77–103.
- Lovari S, Apollonio M. 1994. On the rutting behavior of the Himalayan goral *Nemorhaedus goral* (Hardwicke, 1825). *Ethology* 12:25–34.
- Martin P, Bateson P. 1993. *Measuring behavior*. Cambridge: Cambridge University Press.
- Myslenkov AI, Voloshina IV. 1998. Sexual behavior of Amur goral. *Proc 2nd World Conf Mt Ungulates* p 75–80.
- Owen-Smith N. 1977. On territoriality in ungulates and an evolutionary model. *Q Rev Biol* 52: 1–38.
- Orihuela A. 2000. Some factors affecting the behavioral manifestation of oestrus in cattle: a review. *Appl Anim Behav Sci* 70:1–16.
- Schaller GB. 1977. *Mountain monarchs*. Chicago: University of Chicago Press.
- Wang S, Gu J, Hu DL, Ning L, Zhang Y, Wang Z, Yang R, Cai G. 1997. China. In: Shackleton D, IUCN/SSC Caprinae Specialist Group. *Wild sheep and goats and their relatives. Status survey and conservation plan for Caprinae*. Cambridge, UK: IUCN. p 148–72.
- Wang S. 1998. Red data book of endangered animal in China. Beijing: Science Press.
- Zhang CZ, Zhou JH. 1988. The reproductive ecology of captive red goral (*Naemorhedus cranbrookii*). *Wildlife* 4:36–7.
- Zhang CZ, Wu F, Wei SD, Zhou JH, Ding MS. 1993a. The breeding of red goral population. Management of red goral population. In: *Thesis collections of zoos in East China*. 13: 47–52.
- Zhang CZ, Wu F, Wei SD, Zhou JH, Ding MS. 1993b. The breeding of red goral population. Reproductive ecology of captive red goral. In: *Thesis collections of zoos in East China*. 13: 53–7.