Food Habits of Snow Leopard in Ladakh, India

The snow leopard (*Uncia uncia*) remains a little studied animal and most information available is either in the form of natural history or anecdotal notes. The inaccessibility of its terrain and its secretive habits make this one of the more difficult animals to study in the wild. In the past decade, several ecological surveys have been conducted in India, Nepal, China and Mongolia, which gave us information on the status and distribution of snow leopard (Jackson 1979a, 1979b, Mallon 1984a, 1984b, Fox et al. 1988, Schaller et al. 1988, Chundawat et al. 1988). Although a detailed study conducted in Nepal threw light on its secretive behavioral habits (Jackson and Ahlborn, 1989), very little is known about its feeding habits. The present paper discusses this aspect from an investigation which was part of a detailed study conducted on the ecology of snow leopard in India from October 1987 to February 1990.

STUDY AREA

The intensive study area was located just south of the Indus river in the north-western part of Hemis National Park in Ladakh, Jammu and Kashmir. The study area encompassed the entire catchment of Rumbak river, a small north-flowing tributary of the Indus. Elevation ranged from 3200 m to over 6000 m. The catchment boundary of the study area was high and acted as a barrier to the movement of blue sheep (*Pseudois nayaur*), and this provided a relatively discrete prey population for study.

Vegetation of the region has a typical high altitude desert characteristic and can be defined as "dry alpine steppe" (Chundawat et al. 1991). Climate of the region is characterized by extreme cold and arid conditions. Winter is severe and minimum temperatures go well below -25^{o}C.

The study area included three villages and approximately 600 resident domestic sheep and goats, 80 head of cattle and 30 donkeys and horses. It also had a great diversity of mammalian fauna; besides blue sheep, the major ungulate, there were ibex (*Capra ibex sibirica*), nayan (*Ovis ammon hodgsoni*) and Ladakh urial (*Ovis vignei vignei*). Smaller animals included Himalayan marmot (*Marmota bobak*), Tibetan woolly hare (*Lepus oiostolus*) and mouse hare (*Ochotona* sp.).

METHODS

It is extremely difficult to collect data on the food habits of a predator from direct observation. In the case of snow leopard, it is also difficult to locate kills in the mountainous terrain. Therefore, the snow leopard diet was quantified from analysis of scats because these were relatively easy to collect in large number from the study area. Scat analysis is commonly used to determine a carnivore's diet (Joslin 1973, Floyd et al. 1978, Johnsingh 1983, Ackerman et al. 1984, Leopold and Krausman 1986, Reynolds and Aebischer 1991).

All the major travel routes and marking sites of snow leopard in the study area were monitored regularly to collect only fresh snow leopard scats. These were washed and oven dried. Food items were identified mainly from the macro- and microscopic structure of hairs. For this purpose, cuticular scale patterns of hairs and medullary structure was used to identify the prey (Joslin 1973, Koppikar and Sabnis 1976). This evidence was further substantiated from the remains of bones, claws and hooves found in the scats.

We have attempted to estimate the biomass consumed by snow leopard because quantification of the diet of snow leopard merely on the basis of percent occurrence is not a reliable method. It has been observed that smaller animals are usually over represented in the scat analysis (Mech 1970). An inverse relationship has been observed between the number of collectible scats and prey size (Floyd et al. 1978). Since snow leopard and cougar (*Felis concolor*) are comparable, an equation developed for cougar by Ackerman et al. 1984 was used for the purpose.

The equation is as follows : $\mathbf{Y = 1.98 + 0.035\ X}$

where: **Y** = is weight of prey consumed per scat, and
X = is average body weight of the prey.

It has been estimated that an adult snow leopard (45 kg) requires 1.5 to 2.5 kg meat per day (Wemmer and Sunquist 1988). Assuming an average diet of 2 kg per day for a snow leopard (i.e. <5% of

body weight), the biomass consumed by snow leopard was calculated and the number of prey species required was determined.

RESULTS AND DISCUSSION

Out of 173 scats collected from the study area, 256 food items were identified. Most of the scats consisted of single prey items and only six scats had remains of more than one species. Our analysis indicated that snow leopards had a varied diet and that domestic animals formed a significant part of it. Among all the prey, blue sheep remains were encountered most frequently (23%), followed by domestic sheep and goats (Table 1). Scat analysis showed that snow leopards ate considerable amounts of plant matter. Although several explanations have been put forward on the consumption of plant matter by carnivores, its occurrence in such a high quantity (41% frequency) in the diet of a large cat is not known. The scat analysis also showed the predominance of one plant species, *Myricaria germanica*, which accounted for 65% of all the plant matter, and 25 scats were composed of only this species. It is interesting to note that a snow leopard was once seen feeding on the *Myricaria* plant soon after it had fed on a kill. On several occasions while following snow leopard tracks, we came across evidence of snow leopard feeding on this plant in large quantities. This was observed more frequently during the mating season in the months of February and March. It is extremely difficult to come to any conclusion and explain this feeding habit of the snow leopard unless a detailed chemical analysis of the plant parts and the remains of the plant matter in the scat is conducted.

TABLE 1. Food habits of snow leopard in Ladakh, India (n=173).

Prey item	Frequency	% Occurrence
Large mammals		
Blue sheep	60	23.4
Ladakh Urial	1	0.4
Domestic Goat	26	10.2
Domestic Sheep	6	2.3
Small mammals		
Marmot	25	9.8
Hare*	8	3.1
Rodents**	11	4.3
Birds	8	3.1
Probable scavenging		
Yak	3	1.2
Donkey	1	0.4
Horse	2	0.8
Plant matter	105	41.0

*= Tibetan woolly hare
**= Includes mouse hares

The snow leopard is an opportunistic feeder as was indicated by the presence of yak, donkey and horse remains in the scats (Table 1). Snow leopards are generally not known to prey on donkeys, mules and horses in Ladakh, although on several occasions during the study evidence of its feeding on the carcasses of these animals was seen.

The annual prey consumption by snow leopard (based on 2 kg/day) was estimated to be five blue sheep, twenty five marmots, five domestic goats, one domestic sheep, nine Tibetan woolly hare and fifteen birds. In terms of biomass consumed by snow leopard, blue sheep (50%) was the major prey species (Table 2).

TABLE 2. Calculation of biomass consumed (kg) by snow leopards in the Rumbak Valley, Ladakh, India (n=173).

PREY SPECIES	Assumed weight A	Biomass per scat B	No. scats C	Biomass consumed D	Biomass eaten E
Large mammals					
Blue sheep	60	4.0	48	195.8	343
Ladakh Urial	35	3.2	1	3.2	6
Domestic goat	25	2.9	26	74.1	130
Domestic sheep	30	3.0	5	36.6	27
Small mammals					
Marmots	4.5	2.1	22	47.1	82
Hare*	3.5	2.1	7	14.6	25
Rodents**	0.2	2.0	6	11.9	21
Birds	1.5	2.0	6	13.1	21
Probable scavenging					
Yak	300	12.5	2	25.0	44
Donkey	60	4.1	1	4.1	7
Horse	140	6.9	2	13.8	24

A= assumed weight of the prey species.
B= Y (*i.e.* Y=1.98+0.035xA).
C= number of scats.
D= biomass consumed (*i.e.* B x C).
E= biomass eaten by a snow leopard assuming a rate of 2 kg./day.
*= Tibetan woolly hare; **= Includes mouse hares.

Smaller animals which have been reported as important food of snow leopard (Zirjakov 1990) also formed a substantial portion of the diet. During the study, evidence of snow leopard making kills on mouse hares was encountered on several occasions. In January, evidence of a chukar partridge killed at its roosting site by snow leopard was also observed. Smaller animals, as alternate prey in the diet of snow leopard, become critical when its major prey is not readily available. This is more obvious in summer, when marmots are abundant and blue sheep move to open pastures at higher slopes. Marmots become the major prey of snow leopard during this season and this shift in the diet reduces excessive predation pressure on the blue sheep population. In winter, during extended fasting periods between major kills, smaller animals such as Tibetan woolly hare, mouse hare and birds were important in the diet of snow leopards.

Very little is known about the role of alternate prey in a predator's diet (Shaw 1977). If we remove all the domestic prey from the study area, the role of smaller animals as alternate prey will be of greater importance and their availability will certainly have a direct impact on the blue sheep population.

Predation by snow leopard can be compensatory if it stimulates an increase in reproduction (Mech 1970) and helps to maintain the optimum population level of the major prey (Connolly 1980), the blue sheep. In this study area it is estimated that if the ratio goes below forty five blue sheep to one snow leopard, the blue sheep population will face a decline. At an annual increment of 29 individuals the blue sheep population of 220 to 240 in Rumbak Valley can sustain the predation pressure of four snow leopards. Thus, during our study duration predation by snow leopard alone was not a substantial threat to the blue sheep population in Rumbak valley. This equation would change drastically, however, if all the domestic animals were to be removed from the study area. The presence of competing predators can also produce a negative impact on the blue sheep population. In such a situation alternate prey will play a crucial role in the dynamics of predation by snow leopard.

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