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CHARACTERISTICS OF SNOW LEOPARD (Uncia uncia) MOVEMENTS IN THE TIEN SHAN

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Evidence about spatial movements of animals provides definite information both about their use of places and environmental conditions. While these questions have been fully covered for predators (Carnivora) of forest regions (Hornocker 1970, Matyushkin 1977, Rukov skiy 1977, Schaller & Crawshaw 1980), the study of high-mountain species is incomplete on this aspect. Very little attention is given at the present time to the study of the snow leopard. Much of the material on the irbis in the literature frequently reflects merely a general set of encounters (Fi1, Afanas'yev, 1973), or their number and distribution in the wild (Pokrovskiy 1976, Geits & Shopin 1977, Grachev & Fedosenko 1977, Sopin 1977). The reports by various authors, for example, about the distribution of snow leopards (Pokrovskiy 1976, Geits & et a!. 1983), or about their morphology (Aizin 1972) are somewhat doubtful because they are based on little field research. A serious problem is presented when studying territorial "searching" by predators, although interpreting this link is a necessary basis for work on conservation and management measures of this species.

Although not claiming to have a complete answer to this question, we made the attempt to show the general picture of the snow leo pard's territorial use through analysis of con crete field evidence and reports of hunters and trappers, and to link this picture with behavior which we were able to "read" through tracks or draw from questionnaire data.

Material was collected for the most part in the winters of 1981-83 and partly in 1984 in the regions of the north, central, and interior Tien Shan in Issyk-Kul' Oblast. Basic systematic investigation was conducted in the basins of the Chon-Kyzyl-Su River (northern major slopes of the Terskei Alatau) and SarychatIrtash-Uchkul' Rivers (southern major slopes of Terskei Alatau and the joints of the AkShiyraka, Koilyu, and Eshek-Art mountain massives).

As was emphasized by E.N. Matyushkin (1977) and G.A. Novikoviy (1981), the most complete picture of movements of animals can be obtained by following tracks. However, the ability to conduct this type of work in the Tien Shan is strongly limited. The peculiarities of the spatial distribution of snow cover and the ecology of the snow leopard does not permit long observations along the route of the animals. Because of this, we had to conduct tracking along short segments. The length of tracks we followed, consisting of those for 26 animals, totalled almost 52 kilometers (the maximum length of a route was 11.5 km.; the minimum, 0.15 km.). We tracked both solitary animals and ones in groups of 2-3. Other routes were examined with impressions of tracks, scat, and snow leopard scrapes, totalling close to 23 km. of regular movements.

An analysis of the available material allowed us to delineate the basic forms of relief used by the snow leopard when moving through the mountains:

I. crests of watersheds (also crests of lateral spurs and more finely dissected relief Picture I)
2. rivulets, hollows, mountain slopes
3. talus slopes
4. moraines, snowfields, glaciers
5. paths (connecting various relief forms).

The snow leopard used most rarely, and for short times, the bottoms of valleys, although for cats as large as the tiger (Panthera tigris)

this path is common (Matyushkin 1977). The

straightforward motion of the snow leopard line of movement in the mountains is distinctive. For example, even on slopes with steepness ranging from 30 to 45 degrees, it

preferred a zigzag route of ascent "in front" with rare exceptions. Deviation from a straightline path was observed more in the absence of well-defined crest lines, river cuts, or rockpiles. **In** these caSes the predator moved along the slopes in a near-diagonal direction.

The movement of snow leopards along the crests of watersheds and hollows in the slopes is probably conditioned by the relative ease and convenience of such paths. **It** is not by accident that this is exactly the relief used most often by alpinists or tourists in the mountains. Descending down and going along cuts, crests of moraines, buttresses, and ridges are basic paths of mountain climbing when moving across crests and passes. Crests of moraines served as trails for caravans moving through mountains. Furthermore, the snow leopard uses predominan t heights even during hunting. Most probably, the ability to hunt "from above" is the most effective method for solitary predators in the high mountains. Six cases are known to us from following tracks, in which the capture of prey by this "upper"-type raid was confirmed. Descriptions of such hunts are presented in accounts by G.B. Schaller (1977, cited by A.K. Fedosenko 1982) and M.D. Zverev (1980).

Movement along rockpiles is observed for I he snow leopard in regions where the upper parts of crests impede the field of vision of adjoining and opposite slopes. Principally there occurs a haphazard piling up of rocks, strongly broken up. **In** such a situation, the snow leopard chooses a path along the upper limit of the talus and main rocky outcroppings. **In** any case, the main part of the route along the bare rock should allow a good field of vision. The extent of this type of route known to us was 3--5 kilometers.

During the summer period. more often than at other times, tracks and visual encounters with snow cats repeatedly occurred on moraines, snowfields, and glaciers (25 oc currences). We connect this fact with seasonal migration of ibex (Capra i. sibirica) which, along with other wild ungulates (Artiodactyla) is the main prey of the irbis (Koshkarev 1983). Interestingly, in all the known cases in the Terskeiy Alatau, no migration of a snow leo

pard through the pass of a main watershed was ever documen ted: for example, from Priissykkul'ya in the central and interior Tien Shan or back again. Movement along glaciers in a diagonal direction was noted, as well as the crossing of the lateral spurs of main ridges from one basin to another.

The movement of animals along paths is very unequally noted, and depends on actual conditions. Their movement is noted chiefly when it coincides with the direction of predator movemen t. Th us, the snow leopard regularly uses the "Kochevnik" horse trail in the basin of the Chon-Kyzyl-Su River for a length of 0.4 to 2.0 km. and a 0.6 km. trail leading to the upper reaches of the forests along the Savator River.

Within the network of cat movements, paths of mountain goats and other animals are also in cluded. For example, on February 28, 1982 a snow leopard moving along the valley of the Chon-Kyzyl-Su River under conditions of a deep snow cover of 36 cm. used the tracks of a wild boar (Sus scrofa) for I 16 meters (Picture 2), the trail of rabbits (Lepus tolai) for 200 meters, and my ski tracks for 19 meters (Picture 3). The snow leopard rarely moves along roads, unlike the lynx (Felis lynx; Rukovskiy 1977) and only uses it for short segments during which the details of its crossing may be taken for that of the tiger (Panthera tigris; Matyushkin 1977). The maximum length that a snow leopard travelled along a road that is known to us did not exceed 700 meters.

The tracking data and verification of questionnaire evidence showed that the irbis avoided large open spaces when crossing river valleys (Picture 4). All of the crossings from one slope of the ridge to another by the animal were recorded to be on the most narrow areas. The choice of these areas underlines how small the distance is between opposite slopes, and thus the distribution of trees (in the forest zone) probably provides cover for the animals. Therefore, the following detail we noted at three points of the Chon-Kyzyl-Su and Sarychata-Irtasha river basins is interesting. Here, in order to cross from one valley to another, the predator preferred to move along a route where it had to ascend and descend from overhanging heights of 300-400 meters, along slopes with up to 45 degrees steepness, rather than choosing the easier route along the foot of the ridge. Following the tracks of the

snow leopard, we spent three and one-half to five hours on these paths, with the initial climb up to the beginning point along the foothill taking 40-120 minutes.

Unlike the tiger (Matyushkin l 977) and lynx (Rukovskiy 1977, Parker 1980), the snow leopard rarely rests during the crossings. Although we did not obtain sufficient material about the lenght of its daily movements, we can, however, cite the facts which show the ability of the animal to move through the high mountains.

Thus, in the whole lenght of travel of the animal in the basin of the Chon-Kyzyl-Su River, when following its tracks through the watershed from drops of *500-600* meters at a steepness of 20-45 degrees, we did not register one rest or stop. The depth of loose snow on the JOute equalled 25-30 centimeters, and the snow leopard penetrated the snow down to 24 centimeters. In another case, just one rest was encoun tered on the ridge crest along an 1 l .5 kilometer tracking session (Picture 5). Subsequent to this, the animal did not rest once along ten kilometers of an ascent through the forest zone, despite snow depths of 30- 85 centimeters. The depth of paw penetration into the snow varied from lO to 43 centimeters. Another snow leopard passed along this very same route, descending practically nine days. Along a seven kilometer segment of the route, just one rest occurred. With a snow depth of 58 centi meters, the predator's paws penetrated to 2025 cm.; with a depth of 85 cm. of snow, the penet ration was 5l cm. Thus, the irbis here did not only penetrate the snow with its paws, but also the belly created a wall in the snow t hrough the movemen t of its left and right sides (Picture 6). A resting spot was found in deep snow along the forest zone portion of the route (the "Kochevnik" trail) 3.8 kilometers from the previous resting point. On March 28, l 983 during an actual pursuit of the animal at the two-kilometer area of a snowy slope, the snow leopard switched to the "front" position, and, despite its exhaustion and moving by far much quicker than the person, the cat made a 657 meter ascent at a 30 degree slope and left the crest.

A definite choice of route was observed when the snow leopard moved along snowy areas. One could see this most distinctly in the forest zone of Terskiy Alatau ridge, as a large accumulation of snow is uncharacteristic for these areas. All the animals, without exception, which passed through the forested areas, made a trail under the crowns of the spruce t rees (Picea schrenkiana) and in places where the snow was most densely packed. Thus, in January of 1983 on the basin of the Arasham River and in a depth of snow in the forest zone of 32 37 cm., the depth of snow leopard tracks under the wood did not exceed 7 l 0 cm. Descending into the valley along a grassyshrubby slope (with snow depth of 30 58 cm.), the snow leopard chose a narrow, brokenup spot where there had been an avalanche. Passing through thick snow up to the top of the avalanche path, the snow leopard then turned to the spruce grove. On the Chon-Kyzyl-Su River in February of 1984, with a snow depth of 23-40 cm., three snow leopards moved stepby-step along a line also lying near the trees.

The height of snow cover under the spruce grove did not exceed 48 cm. However, one fact remained that was not completely understood: when going out onto the "Kochevnik" trail (snow depth 32 62 cm.), the animals moved in a straight line along it for almost two kilometers, not choosing a parth. It should be pointed out that movement along the "Kochevnik" trail, under any thickness of snow accumulation, was characterist ic for all the animals noted here (number = 17).

Snow conditions on the Terskei Alatau influence even the peculiarities of snow leopard travel. For example, in the Priissykul'skiy region of the mountain ridge, winter snow remains down to the base of those slopes which face north and east, while the opposite slopes usually have lit tIe or no snow. Because the goats also choose to inhabit the open areas during the winter, the snow leopard when crossing does not use the watershed line of the ridge, but moves somewhat below it, avoiding the snowy slope. A similar manner of movement was noted for three spurs with snow ledges and a good view from above (Picture l).

The crossing of snow cats is linked with a curious phenomenon, described earlier by S.I. Ognev (1935, cited by M.D. Zverev 1980): the coincidence of crossings with times of snow or rainfall. However, there is no absolute measurement of this phenomenon. Out of a verified 3l cases of crossings, 15 (19 animals) were noted after a snowfall; 2, before a snowfall; ll, during a heavy snowfall; and 4, after a rainfall. Movement of animals within two

days after a heavy snowfall was noted once; within three days, once; and in seven cases, animal crossings were not linked with precipitation at all. Thus, the tendency to cross directly after a snowfall or rainfall accounted for 61.2 % of cases. **In** our opinion, an explanation of this can be found by looking at the hunting behavior of the snow leopard. Freshly fallen snow and moist soil may provide a silent approach to prey. Snow cover also masks the noise of small rocks which *be*come loosened under a careless motion (which is rare for the snow leopard, but does occur); and apparently, because of these factors, the snow leopard can make use of weather conditions for its hunt.

On March 28, 1983 in the forest zone of the Chon-Kyzyl-Su River, a snow leopard which had been moving along a rabbit path right after a snowfall attacked a rabbit from a distance of 2.9 meters. The rabbit, judging by the tracks, had been sitting with its back toward the predator and had been gnawing needles from the top shoots of the shrenka spruce which had been thrown down by a squirrel (Sciurus vulgaris exalbidus). He undoubtably had not even noticed the approach of the snow leopard and was instantly killed. Along the upper reaches of the western Koilo River on February 24,1983, also after a snowfall, a snow leopard which had been moving along the base of a rock pile approached (not less than by 14 meters) a herd of pasturing ibex and attacked them. The snow leopard brought down a ten-year-old male ibex. Even the professional snow leopard trapper, V.N. Smolin, has remarked upon the snOw leopard making a disguised approach to ibex in a fresh snowfall (personal correspondance). Moving along the ridge crest among the Juniper bushes, the animal approached pasturing animals from above and attacked a female.

CONCLUSIONS

Three primary factors determine the choice of path by the snow leopard:

- distribution of game in the territory
- local relief
- ability of the animal to use the relief

Observations of tracks show that the irbis is well-acquainted with the distribution of prey animals in the territory. The hunt for them is the leading factor which determines all the basic movements of the predator. As a rule, the network of the snow leopard's route coincides with its consecutive visits and investigations to places where game is concentrated. It follows that movement along predominant relief points is one of the most important adaptations of the animal to life in the high mountains. Realizing the advantage of such paths, one concludes that just as they are convenient for crossing moves, they also allow a high viewpoint. Moving along the watershed line, the irbis is able to control the territory of two valleys, and when prey is detected, it can use the more advantageous situation. However, one should bear in mind that the "knife-edge" crests are not the norm for snow leopard movements, and the field of vision from predominant points will always depend on the nature of the relief. When other routes are chosen, such as the lower lines of watersheds or along the foot of rock piles, the view narrows, and the effectiveness of raids on prey is diminished.

The snow leopard's choice of route in snowy areas, relating to its paws in the deep snow, underlines the impracticality of movement in snow cover. But in comparison with the lynx and the tiger, the snow leopard is truly more hardy, as noted by the fewer poin ts of rest along its route.

Weather factors such as snow and rain are used by the snow leopard in its hunting. Un. fortunately, we have very little firsthand evidence of the predator's activi ty during times of precipitation due to the difficulty of conducting field observations. Never. theless, examining the connection of times of movements and times of precipitation gives a basis to assume that the hunt in the rain and snow is more successful. A deterioration of visibility in foul weather allows the predator to approach prey closely.

The direct motion of the irbis noted under ascents of narrow cliffs can be interpreted via the research of Aitchson and Reichman (1981), Movement along the more narrow but shorter paths provides advantageous energy use for the animals, as long as their weight is not a limiting factor. We can conclude, then, judging by the data obtained by tracking the snow leopard, that weight does not limit its movement along narrow areas.

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