Biology and Ecology of the Leopard in the Caucasus

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The Caucasus leopard is large, weighing up to 60 kg, and light in colour. The taxonomy has been confused, with at least three named forms reportedly occurring in the area. It is now considered that all leopards occurring in the Caucasus, northern Iran and Turkmenistan, are a single form, referred to here as *Panthera pardus saxicolor*. Very little field research has been conducted on the biology and ecology of leopards in the Caucasus. Estimates of abundance range from 0.4 individuals/100km^2 based on scat analyses to 1 per 100 km^2. Anecdotal reports indicate that one male overlaps the ranges of 2–3 females. Leopards in the Caucasus often move along mountain ridges that offer a wide view of the surrounding area and frequently make use of established paths. A dietary study based on scat analysis showed that wild boar formed the main prey in south Armenia. Wild ungulates are generally considered to constitute the main prey, along with smaller mammals such as hares and porcupines and game birds. Habitat consists of subalpine meadows, broad-leaved forests and rugged ravines from 600–3,800m in the Greater Caucasus and rocky slopes, mountain steppes, and sparse juniper forests in the Lesser Caucasus and Iran.

Description of the "Caucasus leopard"

Leopards living in the Caucasus are rather large animals, somewhat larger than in the Russian Far East. The weight may reach 60 kg and the body length varies from 126 – 171 cm; higher values found in the literature are very likely erroneous. They leave footprints of about 9 – 11 by 8 – 9 cm (Fig. 1). Condylobasal length[1] is 185 – 223 mm for males and 186 – 188 mm for females, zygomatic width 133 – 172 for males and 122 – 135 for females (Heptner & Sludskii 1972).

The colour of leopards in the Caucasus is usually light and pale (Fig. 2). The main background colour is grey-ochre, sometimes light grey with sandy or various intensities of reddish, but always relatively faint. The colour is more vivid on the back. The spots are relatively few, usually not pure black, and often with a brownish tinge. Most of the spots are compact and relatively small. Rosettes consist of three to five spots. There are also dark-coloured individuals. Their spots are larger and sparser. A significant number of spots form complete rings.

[1] Condylobasal length and zygomatic width are standard measures to describe skull size, which directly correlated with body size.

Short review of the taxonomic classification of the leopard in the Caucasus

Various authors have identified the leopards in south-central Asia and the Near East as belonging to the subspecies *P. p. tulliana* Valenciennes, 1856 (a.o. Flerov & Gromov 1934, Flerov 1935, Baryshnikov 1987). Other Russian researchers called this leopard *P. p. ciscaucasica* Satunin, 1914 (Heptner & Sludskij 1972, Sludskij 1976, Sokolov 1986), while western scientist tended to use the name *P. p. saxicolor* Pocock, 1927 (Misonne 1959, Tylinek *et al*. 1987, Shoemaker 1977, 1978).

P. p. tulliana has commonly been used in the Soviet literature. According to Heptner & Sludskij (1972) *tulliana* has formerly been widely distributed in Asia Minor. Its occurrence was confined to the extreme south-western corner of the Turkish Peninsula between the lower course of the Chediz and Antalya Bay already during the 1940s and 1950s. It is possible that these leopards originated from a glacial refuge after the last ice age and never have been in contact with the leopards in the Caucasus eco-region. Thus the subspecies status in southern Turkey and Syria/northern Israel remains unclear and still needs to be clarified. Although zoologists have described five subspecies for the area of the former Soviet Union, Heptner and Sludskij (1972) recognise only two: *P. p. orientalis* in the Russian Far East and *P. p.ciscaucasicus* or *saxicolor* in the Trans-Caucasus, the Great Caucasus, Iran (at least northern Iran) and Turkmenistan. Based on morphology, Khorozyan *et al*. (2006) suggested to retain the name *P. p. ciscaucasica* (= *saxicolor*, *transcaucasica*) for the Caucasus, northern Iran and Turkmenistan.

Fig. 1. Leopard tracks (Photo D. Mallon).

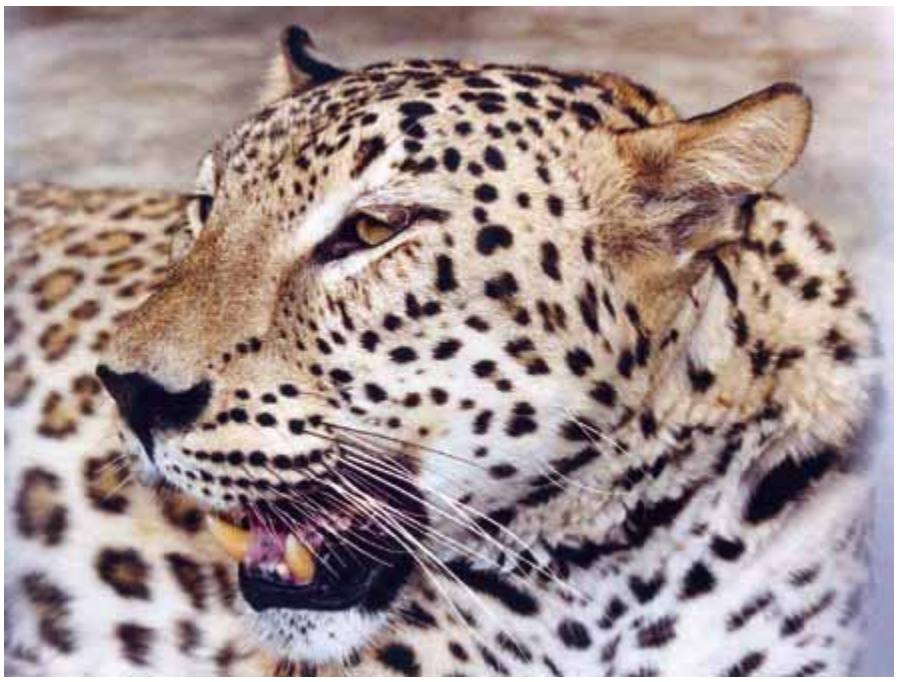

Fig. 2. Leopards from the Caucasus are typically light and pale (Photo WWF Caucasus Programme Office).

Newer revisions of the taxonomy of the leopard based on genetics identified the leopards living in the Caucasus eco-region as belonging to *P. p. saxicolor* (Miththapala *et al*. 1996, Uphyrkina *et al*. 2001; Fig. 3). Miththapala *et al*. 1996 have united seven putative subspecies from Central Asia and the Arabian Penninsula into *P. p. saxicolor*. Uphyrkina *et al*. 2001 confirmed this with the exception of the Arabian Penninsula. They think that these leopards belong to an own subspecies, *P. p. nimr*. We suggest following this proposal and consider the leopard in the Caucasus and adjacent areas to belong all to the same subspecies, *P. p. saxicolor*[2].

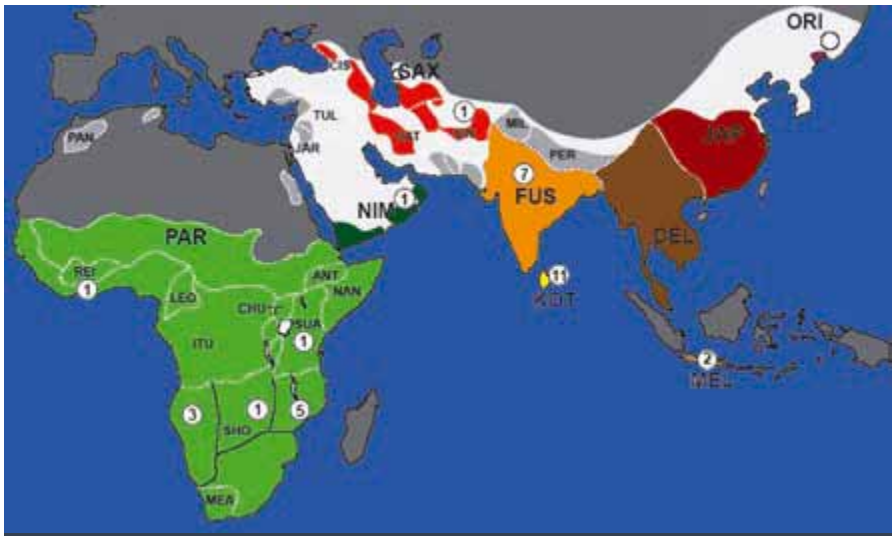

Fig. 3. Historic (dark grey) and present (various colours) geographical distribution of leopards; distribution of named classical leopard subspecies (big and small three-letter codes together) and distribution of revised subspecies classifications according to Uphyrkina *et al*. 2001 (big three-letter codes in coloured polygons); sample collection sites and number of samples from each site are given in circles. Classical subspecies that were not examined are given in light grey. PAR = *Panthera pardus pardus* African leopard; NIM = *P. p. nimr* Arabian leopard; SAX = *P. p. saxicolor* Persian leopard, FUS = *P. p. fusca* Indian leopard, KOT = *P. p. kotiya* Sri Lankan leopard, MEL = *P. p. melas* Javan leopard, DEL = *P. p. delacouri* North China leopard, JAP = *P. p. japonensis* North China leopard, ORI = *P. p. orientalis* Far Eastern leopard. Map redrawn from Uphyrkina *et al*. 2001.

Life history data

No data on the duration of mating and birth time are available from the Caucasus eco-region. Observations of leopards in captivity have shown that oestrus in female leopards lasts for 12–18 days, with an oestrus cycle of 6–210 days, with an average of 52.6 days (Shereshevsky 1940a,b, Eaton 1977). This variability of cycle allows leopard females to mate relatively soon again after the loss of a litter, which has great significance for the survival of the species. It indicates that the reproduction is not strictly seasonal. However, the Caucasus is, within the species' huge distribution range, one of the regions with distinct seasons. We saw pairs of adult leopards in January, February, May and July in southern Nakhchyvan at the border with Armenia, and in Armenia itself (Lukarevsky *et al*. 2004). The peak of fertility seems to be in spring and the first half of summer (from March until July). Vereshagin (1942) describes that leopards in the Caucasus become sexually aroused in January indicating a seasonal reproduction. Small cubs are most often seen in April and May, but it is possible to find them during other months (Heptner & Sludskij 1972). Seasonality in reproduction seems to be more prominent in the Greater Caucasus – where young leopards need their mothers to survive through the winter. In captivity, litters comprise one to four kittens, but no litters with more than two kittens have been reported from the wild. Of the 28 reliable accounts of sightings of female leopards with kittens in Turkmenistan and Iran, 14 had one and 14 two kittens.

The gestation period in captivity is 96 (90–105) days and should be similar in the wild. Interbirth intervals recorded in Africa were on average over two years (Schaller 1972, Bailey 1993). Animals reach sexual maturity at 2–3 years and can live up to 20 years (Nowell & Jackson 1996). Young leopards become independent at the age of 13–18 months. Siblings may remain together for sev-

[2] *P. p. saxicolor* is a synonym to *P. p. ciscaucasica*, which has been described earlier. Against the general taxonomic rules, we here use saxicolor, as this name is used in the IUCN Red List.

eral months before separating (Skinner & Smithers 1990). Therefore, seeing tracks of two animals does not necessarily mean observing a mating pair.

Social and spatial organisation

A number of factors determine the size of a leopard's home range: abundance and distribution of prey animals, habitat, topography, and anthropogenic transformation of the landscape. There are no reliable information on home range size in the Caucasus. Nasimovich (1952) estimates 100 km^2, and Heptner & Sludskij (1972) interpret this as very large.

Studies across the leopard's range show that home range size varies greatly with prey density and habitat (Lukarevsky 2001, 2005). In their review, Marker & Dickman (2005) list individual home ranges from 9–388 km^2 for adult males and 8–487 km^2 for adult females. Large ranges were found in very arid areas and small ranges in tropical rain forest. Khorozyan (2003a) tried to estimate leopard density based on the number of scats found per km of inspected trail. He made a comparison of nine studies from Africa to India and found a significant relationship between a faecal relative abundant index and the actual leopard density. Based on this relationship, he estimated a leopard density in Armenia of 0.4 leopards/100 km^2, which is at the low end of known leopard densities (Khorozyan 2003a, Marker & Dickman 2004).

Anecdotal observations indicate that adult males usually live entirely or partially on the territories of two or three adult females (Pikunov & Korkishko 1992, Lukarevsky 1993, 2001). In contrast to females, adult males are more mobile and often change their hunting grounds. They remain in an area only if young males show signs of territoriality, or if a female is in oestrus. In such cases the resident male traverses nearly all of the trails and walks along all of the ridges and puts special effort into marking the territory with scrapes. When the females are in heat, their behaviour changes significantly, including their use of territory. Observations indicate that leopard females actively search for males, intensely marking their territory. In this period, both males and females patrol almost their entire territory, and cover the heart of their ranges completely. Leopards use most frequently trails with a good view to move from one hunting ground to another. Such trails are located in places where a ridge offers a panoramic view of one or two, sometimes three or four ravines, and the visibility reaches up to several kilometres. Besides acting as observation points, mountain ridges also allow an animal to travel quickly through a territory. Leopards prefer well-travelled paths also used by other animals or men, and even roads (Lukarevsky 2001, 2005).

Fig. 4. Kavkasky Zapovednik in the Russian part of the Greater Caucasus (Photo WWF, F. Mörschel).

Diet

According to Heptner & Sludskij (1972), wild ungulates – bezoar goat, tur, mountain sheep, chamois, roe deer, red deer and wild boar – constitute the main prey of leopards in the Greater and Lesser Caucasus. Sometimes they also catch European hare, pheasant, rock partridge, black grouse, snow cock and porcupines. Where wild ungulates are abundant, almost no attacks on domestic animals occur, but from areas with low wild prey density, predation on cattle, sheep, horses, donkeys, dogs and poultry are reported.

Lukarevsky *et al*. (2004) identified for the Lesser Caucasus and the eastern part of the Greater Caucasus bezoar goat, wild boar and roe deer as most important prey species, and for the western part it used to be wild boar, red deer and roe deer. Leopard prey on many different species in the Caucasus eco-region, but the predator significantly depends on the populations of a few small to mid-sized ungulates. The leopard's primary prey in the Caucasus eco-region also include mountain sheep, tur, red deer, chamois, and livestock. The analyses of 74 scats collected in the vicinity of Nyuvadi village on Meghri ridge in Armenia 2004-2006 showed that wild boar was the staple food in southern Armenia (Table 1).

Table 1. Diet of the leopard in the vicinity of Nyuvadi village on the Meghri ridge, Armenia, based on scat analyses.

Prey item	n	%
Wild boar	32	43.2
Porcupine	8	10.8
Bezoar goat	7	9.5
Roe deer	2	2,7
Badger	2	2,7
Fox	1	1,4
Horse (foal)	7	9,5
Unidentified	10	13,5
Vegetation	5	6,8
Total	**74**	

Habitat

In the Greater Caucasus Mountains, the leopard resides in subalpine steppe-covered meadows, deciduous and mixed forests and dense shrub vegetation. As a rule, leopards live near slopes and rock outcrops (Heptner & Sludskij 1972). More important than the vegetation cover is the presence of a sufficient number of ibex, tur, chamois, deer,

Fig. 5. Araz/Araks river valley at the border between Azerbaijan and Iran (Photo E. Askerov).

and wild boar, as well as areas with limited snow cover in winter, as snow negatively affects not only the distribution of prey, but also the leopard itself. Nasimovich (1955) wrote the most detailed description of the distribution of the tur - one of the leopard's primary food sources - with respect to snow accumulation. However, the relationship between snow cover, leopard presence and the behaviour of large ungulates is not fully understood; there have been only anecdotal reports and observations for the past 50 years.

In winter, the western part of the Greater Caucasus is covered with a deep layer of snow, which can reach several meters in Kavkazsky Zapovednik (Fig. 4). Such severe conditions hinder movements of animals and, to a significant extent, hinder the leopards to hunt wild ungulates.

In Dagestan, the leopard remains in the Andiskoye and Avarskoye Koisu regions (see chapter 3), where the jagged slopes of ravines are covered with forest and snow rarely lasts more than three to five days and disappears within a day on slopes with southern exposition. These slopes are covered with mixed, broadleaf, and coniferous forests. In broadleaf forests birch, beech, and oak dominate, depending on elevation, exposition, and steepness. Wild boars congregate at one or another place, depending on the season and productivity of the vegetation, for instance in oak-dominated forests. Roe deer – and occasionally bezoar goat – live in most of the habitats described. Animals that have secondary importance in the leopard's diet, such as hare, fox, and badger, are rather common. The most favourable habitats for the leopard in Dagestan are located in the Andiskoye Koisu basin, where – different from Avarskoye Koisu basin – the cats still find large areas not divided by towns and other anthropogenic features. In the Avarskoye Koisu basin, leopard habitat is significantly more fragmented and restricted to the lower part of slopes, two to three kilometres wide. The best habitat is found in Ingushetia and is, but only to the lesser part, located in Erzi Zapovednik. Here, we still find an area of 600–800 km², without a single town or village. The slopes of the Skalisty Ridge, covered with pine, beech, hornbeam, and oak forest, form a habitat favourable to many mammals, including leopard. These are the best leopard habitats in the Greater Caucasus.

Fig. 6. Old-growth forest in the Istisuchai River Valleyin the Talysh Mountains in Azerbaijan (Photo V. Lukarevsky).

In the Lesser Caucasus, habitats used by leopards are rather diverse. They use rocky ravines almost completely devoid of trees or shrubs (Zangezur Range, especially the southwestern slopes; Fig. 5), highland steppes, areas with sparse juniper or deciduous growth on steep ravines with wild ungulates such as bezoar goats and wild boar (Reserve, Bargushatsky and Meghri Ranges). Signs of leopards have been found from the foothills (600–800 m) up to 3800 meters above sea level (Mt. Gazangeldag; Lukarevsky *et al*. 2007).

In the Istisuchai River valley in the Talysh Mountains (Fig. 6), leopards live in steep ravines with old-growth forests (maple, beech, hornbeam, linden, oak, walnut, etc.) with rock outcrops and cliffs. Evidence of leopards was found in areas with good visibility and with high numbers of wild boar and roe deer. According to reports from local

hunters, roe deer density is 1–1.5 individuals/km², and according to Kuliev (2000), wild boar density reaches 10 individuals/km², a figure which appears too high to us. In the Talysh Mountains, where the forest understory is well developed, roe deer do not migrate during the snowy season, but eat from directly under the snow, forming a system of trenches. Rakhmanov Babakhan reported that he once found eight animals following such trenches. In the early 1900s the leopard was quite common in the Zuvand Basin of the Talysh, where its habitat was significantly different than in the Hyrcan forests. Here the leopard's habitats are nearly identical to those still preserved on the Meghri Ridge (Fig. 7) in Armenia and in the Qara-Dagh Mountains in Iran.

The critical habitat for the Leopard in the Khosrov Reserve in Armenia (Fig. 8) is sparse juniper forest (Khorozyan 2003b). Human activities are very limited in the Khosrov Reserve area, where all villages were abandoned, although the area is still used as summer pastures for livestock. On the other hand, the Gndasar Mountain and Noravank Canyon area contains high road density and 13 inhabited villages with high human and livestock numbers. This area is a vital movement corridor for leopards and other wildlife between Khosrov Reserve and southern Armenia, and also to northern Iran where significant numbers of leopards live (see chapter 3).

In Iran the leopard's habitats are rather diverse and range from almost treeless rocky ravines (Kopet-Dagh, Parapamiz, Qara-Dagh, Kiyamaki Dagh and Marakan Mountains, as well as nearly all of the Iranian highlands) to steppe highlands and hills in Marakan Reserve (Fig. 9). Other areas are covered with sparse juniper and deciduous forests on steep slopes where wild ungulates – bezoar goats and wild boars – live (Arasbaran Reserve, Talysh Mountains). Evidence of leopards has been found from the lowlands (600–800 m) up to 2,400 meters above sea level (Daradiz and Kyiamaki Mountains).

Fig. 7. Meghri range in southern Armenia (Photo WWF, F. Mörschel).

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Fig. 8. Khosrov Reserve in Armenia (Photo K. Manvelyan).

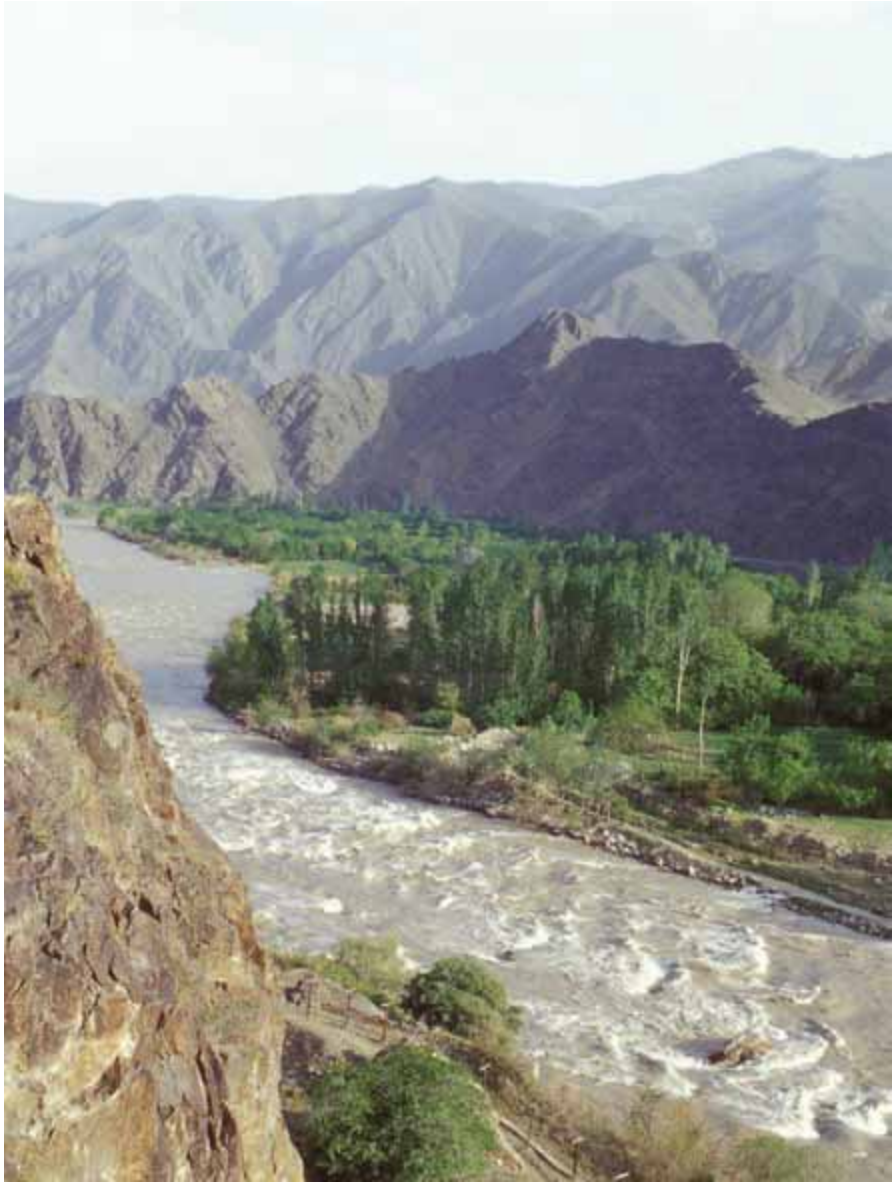

Fig. 9. View from southern Armenia across the Araz/Araks river towards Iran (Photo WWF, F. Mörschel).

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