

Reproductive ecology of Persian leopard, *Panthera pardus saxicolor*, in Sarigol National Park, northeastern Iran

Mohammad S. Farhadinia, Alireza Mahdavi, Fatemeh Hosseini-Zavarei

Abstract. According to our surveys carried out between April 2005 and March 2008 in the Sarigol National Park; northeastern Iran, the mating season of the Persian Leopard *Panthera pardus saxicolor* extends from mid-January to a peak in mid-February. Males and females associate briefly and just after the short mating period, they separate. We never found the leopards to raise more than two cubs. Most observations of leopard families were made in areas of high prey density. Our data verified by camera trapping indicate that track size alone is not reliable for the accurate identification of leopard age/sex categories.

Key words. Persian Leopard; *Panthera pardus saxicolor*, reproduction, Sarigol, Iran, Middle East.

Introduction

The Persian Leopard *Panthera pardus saxicolor* Pocock, 1927 is one of the least studied subspecies of the Leopard. It was once abundant across most mountainous and forest habitats of Iran (JOSLIN 1990), but it is now regarded as *endangered* by IUCN 2008. While Iran is home to more than 65% of the taxon's population (KHOROZYAN et al. 2005), little is known about the Persian leopard's biology, which makes development of effective conservation strategies difficult. For this purpose, we studied reproduction biology at Sarigol National Park in northeastern Iran.

Study area and methods

With an area of more than 7037 ha, Sarigol National Park is located some 20 km east of the city of Esfaryen, North Khorasan Province. It has been part of Sarigol Protected Area, which has been protected since 1973, and separated and promoted to a national park in 2002. An altitude range of 1400 to 2940 m, a mean annual temperature of 14°C and a mean annual precipitation of 273 mm give the region a temperate semi-arid climate (DARVISHSEFAT 2006). The area is mainly composed of hilly terrain merging to high rolling mountains aligned in a south-north direction. Highest elevations can be found in north central parts of the National Park.

Leopard surveys were carried out intermittently from April 2005 until March 2008 along trails and routes known to be used by leopards. We measured all leopard tracks encountered, recording maximum track length, width and pad or "heel" width, following LUKARESIVSKY et al. (2004). All measurements were taken by one of us (MSF) during the entire survey period in order to avoid bias caused due to variation between different tracers' abilities, as noted by SHARMA et al. (2005) for tigers. Camera trapping was applied during the survey period in order to estimate leopard density as well as to verify real owners of the tracks measured at the camera trap stations. Since leopards occupy ranges that probably exclude other adults of the same sex (HAMILTON 1976, BERTRAM 1982, SUNQUIST & SUNQUIST 2002), adult tracks accompanied by a constant number of

cubs within a given area were considered as belonging to a single family. We also interviewed local game guards to obtain information on leopard sightings.

Results and discussion

We found and analysed a total of 47 leopard tracks and 32 camera-trap photos in the national park. A male leopard was photographed on 21 January 2008 spraying urine on a *Berberis* tree; he was photographed several times until mid-February in the same area and an adult female was photographed sniffing the tree he had sprayed. Leopard roaring was heard for one hour in early February 2008, which is typically associated with females in estrus (SUNQUIST & SUNQUIST 2002). A single adult female was photo-trapped on 9 and 20 February 2007, but she was also photographed on 14 February in the company of an adult male.

Our limited data indicate that the mating season of the Persian leopard in the Sarigol National Park is from mid-January to a peak in mid-February, which is similar to general belief that the Persian leopards' mating season peaks in mid-winter (SUNQUIST 1991, ZIAIE 1996, KHOROZYAN & MALKHASYAN 2005). However, we are not sure if the mating season extends beyond this period. The leopards more move along their territory and scent-mark more frequently during this period which is an indicator for days preceding mating and when mating occurs (BOTHMA & COERTZE 2004, GHODDUSI et al. 2008). Males and females associate briefly during mating periods which may last for two to seven days (GUGGISBERG 1975, HAMILTON 1976, BAILEY 2005) and just after the short mating period, they separate.

After a gestation period of 96 days (ranging from 90 to 106 days), the animal gives birth (SUNQUIST & SUNQUIST 2002), which is supposed to be in late April/May in the Sarigol National Park. In Central Alborz Protected Area (northern Iran), a local guide reported seeing a female with 2 newborn cubs in late April.

During the survey period, we identified a total of four families across the national park (Table 1). Moreover, we verified 3 more reports of leopard families prior to our research. No females with more than two cubs have ever been recorded in Sarigol. As a result of similar surveys in Central Alborz Protected Area, a total of four sightings of different leopard families were verified each time with 2 cubs, based on camera trap results as well as interviews with local people. Persian Leopards in the Sarigol National Park normally have 1-2 cubs. While larger litter sizes have been reported for leopards elsewhere (e.g. three: SUNQUIST & SUNQUIST 2002, four: EATON 1977), it seems that the Persian Leopard is not likely to raise more than 2 cubs in our study area.

Tracks of leopard families were usually found within the home range of particular males, based on track measurements. Meanwhile, direct observation of leopards accompanied by cub(s) was a small proportion of total number of observations made by game guards/local people (less than 7%), but it made up a higher percentage of the total individual tracks (17%) we found during the survey period. It seems that mothers with small cubs are extremely vigilant and avoid humans, and are maybe more active during nighttime.

Most female leopards with cub(s) were regularly found in areas of high prey density; we never found any sign/report of leopard cub presence in marginal habitats as well as the Protected Area where prey base has depleted significantly. Meanwhile, leopard cubs have never been encountered during spring and early summer, which coincides with the likely early maternal period when the cubs are inside dens in more safe areas. Several studies conducted

Table 1. Number of Persian leopard (*Panthera pardus saxicolor*) cubs in Sarigol National Park, Iran.

No. of cubs in family	Abundance		
	Juvenile (<1 year)	Adolescent (1 year till independence)	Total
1	1	2	3
2	3	1	4

in Africa have found that female leopards tend to configure their home ranges around important resources, such as patches of prey-rich habitat, den sites and possibly water-points (BAILEY 2005, MIZUTANI & JEWELL 1998) and male ranges typically encompass those of several females (STANDER et al. 1997, BAILEY 2005, MARKER & DICKMAN 2005).

In November 2004, an adult leopard accompanied by 2 full grown cubs was seen a few times by game guards in central national park. On 29 October 2005, two sub-adult leopards were sighted at the same area from a close distance by game guards, who reported that one was larger, probably a sub-adult male. It is supposed that the pair was recently independent offspring, which still roam inside the maternal home range together; however, after at least 10 months of independence, they were never again sighted together. Our small sample is in agreement with SKINNER & SMITHERS (1990) that siblings may remain together for several months before separating. BAILEY (2005) found that sub-adult females stayed in their natal ranges but made exploratory movements elsewhere, whereas sub-adult males had unstable home ranges and explored over vast areas. In Namibia, two male cubs remained close to their mothers' home range for approximately 8 and 6 months before dispersing from maternal range (STANDER et al. 1997). In 2005, direct observations as well as fresh tracks of a family were regularly seen along the central zone of the national park. Accordingly, it was likely that the previous year mother has a cub in 2005.

Meanwhile, tracks of a mother was accompanied by a yearling cub on 27 October 2006, which was supposed to be the same family we tracked since 2005, indicating that the young leopard has not yet become independent. They commonly reach independence after 12 to 18 months and then leave their mother (SUNQUIST & SUNQUIST 2002).

On 20 October 2005, an adult horse was killed by a large male (according to camera trap picture). Fresh tracks of an adult female accompanied by a young cub were regularly seen near the kill, but we are not sure if they have fed on the kill. GUGGISBERG (1975) reported that in eastern Africa, male and female leopards have been seen to feed on a kill with cubs. Also, on 4 February 2008, a ewe was found to be killed by a female with a juvenile cub. They fed on the kill for nearly 5 days.

We found the maximum pad "heel" width to have the least variation between rear and front paws. Our data verified by camera trapping indicate that track size alone is not reliable for the accurate identification of leopard age/sex categories. However, it can be safely assumed that a heel width less than 60 mm indicates a cub (<2 years) and one wider than 80 mm a large male. However, we recommend that in order to avoid confusion between adult females and young adult males whose track sizes overlap, presence of cub should be sought to support identification. Young males usually return regularly to their natal range after dispersal (BAILEY 2005) which increases the probability of overlap in track sizes.

Acknowledgements. Our research was a collaborative effort by the Iranian Cheetah Society (ICS) and the North Khorasan Provincial Office of the Department of the Environment (DOE). It was funded by the Iranian Department of the Environment who provided both financial and logistical support for field surveys. We are also indebted to the Conservation Leadership Programme, particularly for providing field equipments for the

Project Persian Leopard in the Sarigol National Park. We would like to thank , Kambiz Baradarani, Ali Aghar Hosseinzadeh and Taher Ghadirin for their occasional companionship during field surveys. Special thanks go to Luke HUNTER and Sriyanie MITHTHAPALA for their precise revision of this paper and useful advice.

References

- BAILEY, T. N. (2005): The African leopard: a study of the ecology and behavior of a solitary felid. 2nd Edition. – New York.
- BERTRAM, B. C. R. (1982): Leopard ecology as studied by radio tracking. – Symposium at the Zoological Society of London 49: 341-352.
- BOTHMA, J. D. & R. J. COERTZE (2004): Scent-marking frequency in southern Kalahari Leopards. – South African Journal of Wildlife Research 34: 163-169.
- DARVISHSEFAT, A. A. (2006): Atlas of Protected Areas of Iran – Iranian Department of the Environment.
- EATON, R. L. (1977): Reproductive biology of the leopard. – Zoologischer Garden 47: 329-351.
- GHODDOUSI A., A. H. KHALEGHI HAMIDI, T. GHADIRIAN D. ASHAYERI, M. HAMZEHPUR, H. MOSHIRI, H. ZOHRABI & L. JULAYI (2008): Territorial marking by Persian Leopard (*Panthera pardus saxicolor* Pocock, 1927) in Bamu National Park, Iran. – Zoology in the Middle East 44: 101-103.
- GUGGISBERG, C. A. W. (1975): Wild cats of the world. – New York, p. 216-246.
- HAMILTON, P. H. (1976): The movements of leopards in Tsavo National Park, Kenya, as determined by radio-tracking. – M.S. thesis, Nairobi University.
- IUCN (2008): IUCN Red List of Threatened Species. www.redlist.org. – Gland [downloaded 23.x.2008].
- JOSLIN, P. (1990): Leopards in Iran. – Unpublished report.
- KOROZYAN, I. & A. MALKHASYAN (2005): Persian Leopard photographed in Armenia. – Cat News 43: 13.
- LUKAREVSKY, V., E. ASKEROV & G. HAZARYAN (2004): Condition of the leopard population in the Caucasus. – Beiträge zur Jagd- und Wildforschung 29: 303-319.
- MARKER, L. L. & A. J. DICKMAN (2005): Factors affecting leopard (*Panthera pardus*) spatial ecology, with particular reference to Namibian farmlands. – South African Journal of Wildlife Research 35: 105-115.
- MIZUTANI, F. & P. A. JEWELL (1998): Home-range and movements of leopards (*Panthera pardus*) on a livestock ranch in Kenya. – Journal of Zoology 244: 269-286.
- SKINNER, J. D. & R. H. N. SMITHERS (1990): The mammals of the southern African subregion. 2nd edition. – Pretoria.
- SMALLWOOD, K. S. & E. L. FITZHUGH (1993): A rigorous technique for identifying individual mountain lions (*Felis concolor*) by their tracks. – Biological Conservation 65: 51-59.
- STANDER, P. E, P. J. HADEN & G. KAQECE (1997): The ecology of asociality in Namibian leopards. – Journal of Zoology 242: 343-364.
- SUNQUIST, M. E. (1983): Dispersal of three radiotagged leopard. – Journal of Mammalogy 64: 337-341.
- SUNQUIST, M. & F. SUNQUIST (2002): Wild Cats of the World. – Chicago, 452 pp.
- ZIAE, H. (1996): A field guide to the mammals of Iran. – Iranian Department of the Environment, Tehran.

Authors' addresses: Mohammad S. Farhadinia, Conservation of the Asiatic Cheetah Project (CACP) and Iranian Cheetah Society (ICS), P.O. Box 14155-8549, Tehran, Iran. – Alireza Mahdavi and Fatemeh Hosseini-Zavarei Iranian Cheetah Society (ICS), Tehran, Iran. – Email contact: msfarhadinia@wildlife.ir.