The Leopard in the Arabian Peninsula – Distribution and Subspecies Status

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Historically it was considered that there were four subspecies of leopards in the Arabian region. Today *P. p. jarvisi* no longer occurs and the ranges of *P. p. tulliana* and *P. p. saxicolor* have severely contracted north. Only *P. p. nimr*, the Arabian leopard, remains. Morphological data suggests nimr to be the smallest of the leopards and a distinct subspecies but this has yet to be conclusively confirmed by genetic evidence. Recent records give a bleak picture of the status of *P. p. nimr*. A few individuals survive in the Judean Desert and Negev Highlands while in the Arabian Peninsula leopards are known from just one location in the Republic of Yemen and one in the Sultanate of Oman. In Yemen the leopards of the Al Wada'a area are under great pressure from killing and from capture for trade. In Oman the situation is much more hopeful and the leopards of the Dhofar Mountains have benefited from comprehensive conservation measures. While the possibility, however remote, of the existence of other relict populations cannot be ruled out the need for urgent conservation action across the region is obvious given the reality that the Arabian leopard may soon be reduced to two, or even just one population in the wild.

النمر في شبه الجزيرة العربية: الأنواع والتوزيع المكاني والوضع الحالي

ملخص

في الماضي عاشت أربعة أنواع من النمور في المنطقة العربية. أما اليوم فقد اختفى أحدها، وأدت الظروف إلى نزوح نوعين باتجاه الشمال في حين بقي النمر العربي المعروف لاتينيا باسم *پانثرا پاردوس*. وتشير المعلومات المتوفرة حول الشكل البنيوي إلى أن النمر هو أصغر النمور وأميزها، ويجري حاليا التثبت من هذا الأمر عبر الفحص الجيني.

قدمت السجلات المنشورة في الآونة الأخيرة صورة واضحة حول وضع النمر العربي في منطقة شبه الجزيرة العربية حيث اتضح وجود تعداد صغير من النمور في صحراء النجف الواقعة إلى الشمال، وفي الجنوب توجد النمور العربية في كل من الجمهورية اليمنية وسلطنة عمان. ففي اليمن تعيش النمور في منطقة الودعة وتتعرضها تهديدات حقيقية كالقتل والإمساك بها للمتاجرة. أما في سلطنة عمان فيبدو الوضع أكثر إشراقا حيث استفادت النمور التي تستوطن جبال ظفار من تدابير الصون الشاملة.

بالرغم من ضآلة إمكانية وجود تعدادات جيدة أخرى من النمور العربية في المنطقة إلا أن هذا الأمر لا يمكن استبعاده. ومن هنا تبرز الحاجة لاتخاذ إجراءات عاجلة للحفاظ على هذا النوع النادر وخصوصا إذا ما نظرنا إلى حقيقة أن تعدادات النمور العربية في البراري قد تتناقص قريبا إلى اثنين أو حتى واحد.

Introduction

The leopard *Panthera pardus* once occurred throughout much of Arabia (Harrison & Bates 1991). However, over the past 100 years it has become increasingly threatened as a result of the depletion of its prey base, killing by hunters and shepherds and vulnerability of ever decreasing population size. The leopard is globally red listed as Least Concern, but *P. p. nimr* is classified as Critically Endangered (IUCN 2004) and is listed on Appendix I of the Convention on International Trade in Endangered Species (CITES).

Hemprich & Ehrenberg (1833) first described *Felis nimr*, based on an Abyssinian skin and partly on an Arabian one. By the middle of the 20th century it was generally considered that there was evidence for four subspecies in Arabia; *P. p. jarvisi* in Sinai to the west, *P. p. saxicolor* in Iraq to the north, *P. p. tulliana* from Syria south to the Dead Sea in the Levant with *P. p. nimr* extending over most of the region from the Jordan valley south and east to Oman and Yemen (Harrison 1968). In this paper we use published work and some new data to shed light on the historical distribution and current occurrence of *Panthera pardus* in the region and attempt to clarify the "subspecies" issue.

Distribution

Panthera pardus jarvisi

Pocock (in Harrison 1968) in 1932 described *P. p. jarvisi* from Sinai although the exact locality and origin of the specimen is not known. Harrison (1968) considered that the range of *P. p. jarvisi* extended south through the Hejaz of Saudi Arabia but later Harrison & Bates

(1991) described *P. p. jarvisi* as occurring only in Sinai and 'is probably little more than the local variant of nimr'.

Osborn & Helmy (1980) report a single specimen examined from Sinai but of unknown locality and list numerous published records and reports for the peninsula from 1872 to the early 1950s. Substantiated reports from recent years are lacking. In 1995, Saleh *et al*. (1995) who surveyed Ras Mohammed, Nabaq and Abu Gallum protected areas, reported tracks in Wadi El Omiyed and also reported that in May 1995 an adult leopard was caught in a leg-hold trap near the western boundary of Abu Gallum. In 1997 Prof. Ibrahim Helmy sighted a leopard near Abu Durba. In December 1997 there was a report of a leopard being sighted in Wadi Eltala and later the same month in Wadi Elgars, being a branch of Wadi Eltala (Ibrahim 1998). A camera-trapping programme and survey started in 1999 (Spalton 1999) has found no evidence of leopards in St. Katherine Protectorate or elsewhere in Sinai (Hussam El Alqamy, personal communication February 2006).

Nowell & Jackson (1996) recorded *P. p. jarvisi* as being in Sinai and extending east to the Judean desert. However, Ilani (1990) who radio-tracked leopards in the late 1970s and early 1980s reported that the leopards of the Judean desert and Negev Highlands were neither *P. p. jarvisi* or *P. p. tulliana* but resembled closest *P. p. nimr*. Shoemaker (1997) states that surveys conducted in December 1992 produced a maximum estimate of 8-10 leopards. Recent estimates based on molecular scatology are of a minimum of a male and two females in the Judean Desert and four males and one female in the Negev Highlands (Perez *et al*. 2006).

Panthera pardus tulliana

There are numerous reports of this subspecies in Syria, Palestine and Jordan in the late 19th and early 20th centuries (Harrison 1968). In Jordan records come from north of Aqaba, south of Petra and Wadi Zarqa Ma'en (Hardy 1947) and the most recent report was in 1987 (Qumsiyeh *et al*. 1993). In Nowell & Jackson (1996) *P. p. tulliana* is considered as the Anatolian leopard and only occurring in western Turkey. Harrison (1968) reports this subspecies in the Galilee area close to Lebanon where it is believed that the last specimen, an old male, was killed in 1965 (Mendelssohn 1990). Harrison & Bates (1991) cite reports that this subspecies is clearly flourishing further south in the Judean Hills (Ilani 1988) and that it occurs in the West Bank (Ilani 1986) although Ilani (1990) believes the subspecies of the Judean Desert to be *P. p. nimr.*

Panthera pardus saxicolor

The type locality for this subspecies is Asterabad in southern Iran where it was described in 1927. Its range is considered to extend east to Afghanistan and Turkmenistan (Nowell & Jackson 1996) and west to Turkey (Borner 1977). There is little evidence of this subspecies in the Arabian Peninsula region, the most southern records coming from a low lying area at Rawa on the Euphrates and yet further south on the floodplain of the Tigris at Kut al Imara in Iraq (Harrison 1968).

Panthera pardus nimr

As Harrison (1968) accounts, Hemrich and Ehrenberg's (1833) *Felis nimr* was based principally on an Arabian skin from the 'mountains in the vicinity of Qunfida, Asir, Saudi Arabia' and Pocock (1932), nearly 100 years later, proposed that this form might occur on both sides of the Red Sea. However, Harrison, who had access to additional information, did not agree and considered the S. Arabian leopard, *Panthera pardus nimr*, as distinct and that any extension across the Red Sea was doubtful.

Kingdom of Saudi Arabia

Harrison (1968) reported specimens only from the Asir mountains (where the type specimen was obtained) that run southeast towards Yemen. He considered specimens from the Hajaz (to the north-west) to be *P. p. jarvisi*. However, later Harrison & Bates (1991) referred to just one subspecies, *P. p. nimr*, for the leopards of the Hajaz and the Asir.

In 1982 a live-leopard was seen in Wadi Hiswa in the Asir (Gasperetti *et al.* 1985), while Nader (1989) reported on killings of leopards and the collection of leopard remains in the 1970s and 1980s and concluded that if they remain in the Kingdom they would be in the Asir mountains. One year later Biquand (1990) reported on a survey of the Asir concluding that they were probably present although they made no sightings. In a subsequent paper Nader (1996) reported a small population still in the Hijaz and one also in the Asir, although no evidence was presented. Judas *et al.* (2006) report just four confirmed records since 1999 although three were based on evidence of tracks and livestock killing and only in the fourth case, near the Yemen border, were remains of two leopards photographed in 1999. A recent paper by Al-Johany (2007) based on a survey from 1998 to 2001 concluded that the number of leopards in Saudi Arabia was greater than widely believed and included 65 sightings by local informants. However, none of the records or sightings was substantiated by photographic or other evidence and since that time field surveys and camera trapping programs have failed to confirm the continuing presence of leopards.

A number of leopards were captured in the wild between 1997 and 2003 and subsequently acquired by the National Wildlife Research Centre (NWRC), Taif and other private collections. However, Judas *et al*. (2006) suggest that all, with the possible exception of a young male in 1997, were captured in Yemen.

In conclusion, irrefutable evidence that leopards still occur in the Kingdom is lacking. The last substantiated record appears to have been the two animals found dead in 1999 near the Yemen border.

Republic of Yemen

Sanborn & Hoogstraal (1953) reported that the species was scarce but widespread while Harrison (1968) reports on several specimens of leopard from the mountains around Aden and Beihan. Obadi (1993) reports the killing of leopard during the late 1970s and early 1980s in the area of Lodar northeast of Aden.

Al Jumaily *et al*. (2006) provide details of post-1990 records for five broad clusters from areas in the north close to the Saudi border to the south in the Mahra Governorate and close to the Oman border. However, most capture records are from the area of Al Wada'a about 120 km north of the capital where Lagrot & Lagrot (1999) also reported signs of leopard as well as captures. A

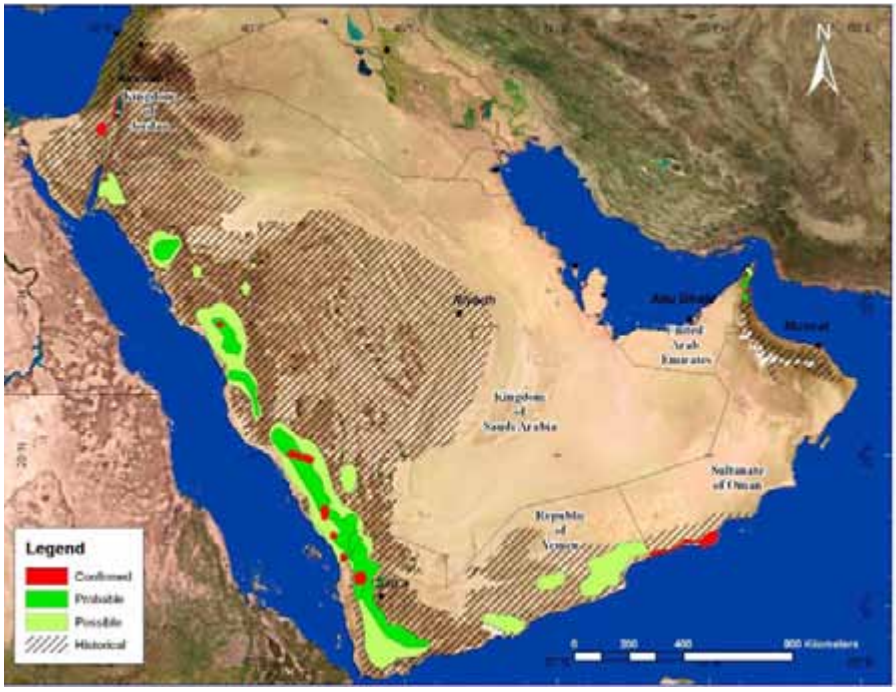

Fig. 1. Former and current (since 1990) distribution information for the leopard on the Arabian Peninsula. Confirmed records: Confident evidence or hard facts, such as dead specimens (with body, skin, etc. available), photo-trap pictures, and genetic analyses (e.g. from scats). Probable records: All records confirmed by any evidence or by a trained person. Possible or unconfirmed records: All not confirmed or not confirmable reports. This includes especially hearsay and direct observations.

spate of live-captures seems to have commenced in the early 1990s when a young female was killed in a leopard trap and her male offspring taken into captivity in Sana'a from where it was sold to the Breeding Centre for Endangered Arabian Wildlife, Sharjah in 1995 (Jongbloed 2001). In subsequent years at least 10 wild caught leopards entered zoos in Sana'a or Ta'iz (Budd 2003) and at least nine were reported to have come from the Al Wada'a area (EPAA 2000). Further animals were moved to the Breeding Centre for Endangered Arabian Wildlife, Sharjah and in 2002 an animal was wild caught and presumably sold to the Al Wathba Cheetah Breeding Centre, Abu Dhabi (Budd 2003).

Sultanate of Oman

In the Dhofar Mountains of southern Oman, leopards were known from the monsoon woodlands of Jabal Qara (Thomas 1932) and a specimen was collected from Jabal Samhan (Harrison 1968). It was from Jabal Samhan that leopards were captured in 1985 to establish the first captive breeding group (Usher Smith 1985). In northern Oman a single skin was obtained from the Al Hajar range (Harrison 1968) where in 1976 what is believed to be the last leopard was found killed. Specimens were recovered from the Musandam peninsula during a spate of killing in the early 1980s and the last confirmed report is of two animals killed in 1997 (Spalton *et al*. 2006b).

Camera-trap studies have confirmed the continuing presence of leopard in Jabal Samhan, Dhofar (Spalton & Willis 1999) where over 200 photographs of 17 leopards were obtained during the years 1997-2000 (Spalton *et al*. 2006a). Ongoing camera-trapping has also confirmed the presence of 9-11 leopards in Jabals Qara and Qamar that run west from Samhan to the Oman-Yemen border. A number of these leopards were fitted with GPS satellite collars and tracked in 2001-2005 (Spalton *et al*. 2006b).

United Arab Emirates

Harrison (1971) reports the presence of leopard from the mountains of the northern Emirates that border Musandam in Oman. In 1986 at least one leopard was killed in the same mountains and in 1991 a male was caught alive near Masafi while in 1992 one was shot in Wadi Bih (Jongbloed 2001). The male from Masafi joined the collection at the Breeding Centre for Endangered Arabian Wildlife, Sharjah but has not participated in the breeding programme. A survey in 1995 found tracks of leopards at one site and stated that there may be 20 'or far less' adults in the mountains (Stuart & Stuart 1995).

A survey in the Emirate of Ras al-Khaimah in 1999 and 2000 found some signs of leopard but were not confirmed by camera-traps deployed at the same time (Llewellyn-Smith 2002). There is a report of a leopard being killed on the UAE side of the Musandam Peninsula in February 2001 (EPAA 2003) but photographs or carcass remains seem to be unavailable.

Figure 1 shows the confirmed, probable, possible and historical range of *P. p. nimr*.

Morphological and Molecular Genetic Variation

Miththapala *et al* (1996), using molecular genetic analysis, grouped seven putative central Asian subspecies including *P. p. nimr, P. p. jarvisi, P. p. tulliana* and *P. p. saxicolor* together as the revised subspecies *P. p. saxicolor*. However, their analysis included material from only two of the seven subspecies: *P. p. sindica* (Baluchistan leopard) and *P. p. saxicolor* and the latter were represented entirely by a zoo-bred population.

This assessment was revisited by Uphyrkina *et al.* (2001) who used new genetic methods and additional samples. They had no material from *P. p. jarvisi* or *P. p. tulliana* and had one sample for *P. p. nimr* and three new samples for *P. p. saxicolor* that had not been used by Miththapala *et al* (1996). Their work confirmed the proposed subspecies of *P. p. saxicolor* but tentatively considered *P. p. nimr* as a subspecies writing that 'populations of *P. p. nimr* appear to have been isolated for quite a long time, accumulating multiple diagnostic sites that distinguish it from any other subspecies'. The single sample of *P. p. nimr* was obtained from Tel Aviv University but originated from somewhere in south Arabia.

A study conducted at the Breeding Centre for Endangered Wildlife, Sharjah (J. Williamson, pers. comm.) looked at possible differences between leopard from northern Arabia (UAE & northern

Table 1. Specimens of *Panthera pardus* from the region

Location	Year	Subspecies	Alive/ dead	Sex	Weight (kg)	Overall length (mm)	Length of tail (mm)	Reference
Jordan	1911	*tulliana*	Dead	F		2060	750	Harrison 1968
Judean desert	1979	*nimr*	Alive	M	29.5	1990	820	Ilani 1980
Judean desert	1979	*nimr*	Alive	F	23.5	1920	790	Ilani 1980
Judean desert	1979	*nimr*	Alive	F	22.0	1684	754	Ilani 1980
Iran		*saxicolor*	Dead		86.0	2130	-	Kiabi *et al.* 2002
Iran		*saxicolor*	Dead		66.0	2120	-	Kiabi *et al.* 2002
Iran		*saxicolor*	Dead			2040	-	Kiabi *et al.* 2002
Iran		*saxicolor*	Dead			1750	-	Kiabi *et al.* 2002
Iran		*saxicolor*	Dead			2000	-	Kiabi *et al.* 2002
Iraq	1951	*saxicolor*	Dead	M		2591	940	Harrison 1968
Iraq	-	*saxicolor*	Dead	-		2261	914	Harrison 1968
Oman	1947	*nimr*	Dead	-		1965	787	Harrison 1968
Oman	-	*nimr*	Dead	-		2007	813	Harrison 1968
Oman	2001	*nimr*	Alive	F	18.0	1600	670	OACE unpublished data
Oman	2001	*nimr*	Alive	M	26.0	1570#	540	OACE unpublished data
Oman	2001	*nimr*	Alive	M	34.0	2030	850	OACE unpublished data
Oman	2001	*nimr*	Alive	M	24.0	1820	770	OACE unpublished data
Oman	2003	*nimr*	Alive	M	18.0*	-	-	OACE unpublished data
Oman	2003	*nimr*	Alive	F	19.0	-	-	OACE unpublished data
Saudi Arabia	1955	*nimr*	Dead	F		1778	737	Harrison 1968
Saudi Arabia	1963	*nimr*	Dead	-		1676	660	Harrison 1968
Saudi Arabia	-	*nimr*	Dead	-		1600	660	Harrison 1968
Sinai	1900	jarvisi	Dead	-		2108	737	Harrison 1968

* sub-adult; # tail damaged; OACE: Office of the Adviser for Conservation of the Environment, Oman

Oman) and southern Arabia. These areas are both mountainous but are separated by open desert and gravel plains where the movement of animals between the populations may not have occurred or at best been very rare. The study used both mitochondrial DNA and nuclear DNA techniques but found no evidence to support species differentiation between northern and southern leopards. However, sample sizes of northern leopards were small (mitochondrial DNA n=3, nuclear DNA n=2). Other studies carried out by the King Khaled Wildlife Research Center, Saudi Arabia have been inconclusive (Judas *et al*. 2006) and a study in Oman has just commenced (Al Ansari *et al*. 2005).

Morphological data is generally lacking but based on measurements for overall length and some weight data and including specimens from Iran (Table 1), *P. p. saxicolor* seems to be larger and heavier than the other three subspecies. While sample sizes for *jarvisi* (n = 1) and *tulliana* (n = 1) are very small this difference was significant for *saxicolor* and *nimr* (P = 0.004, df = 17). Body length of *nimr* did not vary significantly between those of the Judean desert, Saudi Arabia and Oman.

Discussion

It seems that once three subspecies of leopard occurred in the region. *P. p nimr* is the principal leopard of the region and of the Arabian Peninsula in particular. *P. p. saxicolor* is a species of central Asia whose range extended south to southern Iraq and Jordan. *P. p. tulliana* occurred from Turkey through Syria to Lebanon. *P. p. jarvisi* probably never occurred but was actually *P. p. nimr*. Today *P. p. saxicolor* and *P. p. tulliana* seem no longer to occur in the region as their ranges have contracted north.

Genetic studies seem to have established that *P. p. saxicolor* is distinct from other subspecies. This is supported by morphological data that suggests this principally Asian subspecies is larger than other subspecies from the region. However, for the other subspecies genetic studies have not come close to resolving the subspecies debate. The proposal by Miththapala (1996) to lump the other species of the region has little scientific base since it did not include any material from populations of *P. p. nimr, P. p. jarvisi* or *P. p. tulliana.* Similarly Uphyrkina *et al*'s (2001) tentative suggestion of nimr as a subspecies has little credibility as it was based on a single sample.

Further genetic studies may help resolve subspecies issues. However, while we await such studies we should consider the likely reality that *P. p. nimr* is the only surviving subspecies in the region and that it does not occur elsewhere. In the Negev Highlands and Judean Desert numbers are very small and in the Arabian Peninsula it is restricted to Yemen and Oman. In Yemen leopards face severe persecution in the wild and in the last 10 years many have entered captive collections in the country and elsewhere in the region. However, there

still remains an opportunity for *in situ* conservation. In Oman the situation is more encouraging with ongoing conservation programmes but the total number in the wild is likely to be less than 200.

Whatever further evidence emerges as to the distribution and subspecies status of the leopard in the region the reality is that the Arabian leopard or 'nimr' in Arabic has largely gone from the region and if it is to survive in the wild it will most likely be in the mountains of southern Arabia, and in particular in the Dhofar Mountains of Oman.

References

Al Ansari A., Al-Khayat A., Spalton J.A., Al-Dafry K. and Al-Zadjali S. 2005. The molecular genetics of the Arabian leopard: A preliminary study. Poster presented at the joint annual meeting of the International Society for Molecular Biology and Evolution and the Genetics Society of Australasia, New Zealand, 19-23 June, 2005.

Al-Johany A. M. H. 2007. Distribution and conservation of the Arabian leopard Panthera pardus nimr in Saudi Arabia. Journal of Arid Environments 68, 20-30.

Al Jumaily M., Mallon, D. P., Naher A. K. and Thowabeh N. 2006. Status report on Arabian leopard in Yemen. Cat News Special Issue No. 1, 20-25.

Biquand S. 1990. Short review of the status of the Arabian leopard, *Panthera pardus nimr,* in the Arabian Peninsula. Unpublished Report of NWRC. Taif, Saudi Arabia.

Borner M. 1977. Leopards in Western Turkey. Oryx 14, 26-30.

Budd K. 2003. Arabian Leopard Regional Studbook. Breeding Centre for Endangered Arabian Wildlife, Sharjah.

EPAA 2000. CAMP for Arabian Carnivores & PHVA for the Arabian Leopard and Tahr. Final Report. Breeding Centre for Endangered Arabian Wildlife, Sharjah.

EPAA 2003. CAMP for the Fauna of Arabia, 23-26 February 2003 Mammal Briefing Book. Breeding Centre for Endangered Arabian Wildlife, Sharjah.

Gasperetti J., Harrison D.L. and Buttiker W. 1985. The Carnivora of Arabia. Fauna of Saudi Arabia 7, 397-461.

Hardy E. 1947. The Palestine leopard. Soc. Preserv. Fauna Empire 55, 16-20.

IUCN 2004. 2004 IUCN Red List of Threatened Species. Online www.redlist.org Downloaded on 25 October 2005.

Harrison D. L. 1968. The Mammals of Arabia. Vol. 2. Carnivora, Artiodactyla, Hyracoidea. Ernest Benn Ltd., London.

Harrison D. L. and Bates P. J. J. 1991. Mammals of Arabia. 2nd Edition. Harrison Zoological Museum Publication, Sevenoaks.

Hemprich F.W. and Ehrenberg, C.G. 1828-1833. Symbolae physicae seu icones et descriptiones mammalium, 1 and 2. Berlin.

Ibrahim R.W. 1998. The Sinai Leopard is alive out there. St. Katherine Protectorate Internal Document.

Ilani G. 1980. The leopards of the Judean desert. Israel Land and Nature 6, 59-71.

Ilani G. 1986. More Cats. Israel Land and Nature 12, 38.

Ilani G. 1988. Continuing the saga of the Judean Desert Leopards. Israel Land and Nature 13, 144-145.

Ilani G. 1990. Leopard *Panthera pardus* in Israel. Cat News 12, 4-5.

Jongbloed M. 2001. Working for Wildlife. Barkers Trident Communications, London.

Judas J., Paillat, P., Khoja, A. & Boug, A. 2006. Status of the Arabian Leopard in Saudi Arabia. Cat News Special Issue No. 1, 11-18.

Kiabi B. H., Dareshouri B. F., Ghaemi R. A. and Jahanshahi M. 2002. Population status of the Persian Leopard (*Panthera pardus saxicolor* Pocock, 1927) in Iran. Zoology in the Middle East 26, 41–47.

Lagrot I. and Lagrot J-F. 1999. Leopard in the Arabian Peninsula. Cat News 30, 21-22.

Llewellyn-Smith R. E. 2002. The Ru'us al-Jibal mountains of Ras al-Khaimah – considerations for and against establishing a protected area. Tribulus 12, 15-19.

Mendelssohn H. 1990. The Anatolian leopard (*Panthera pardus tulliana*). Felid 4, 6.

Miththapala S., Seidensticker J. and O'Brien S. J. 1996. Phylogeographic subspecies recognition in leopards (*Panthera pardus*): molecular genetic variation. Conserv. Biol. 10, 1115-1132.

Nader I. 1996. Distribution and status of five species of predators in Saudi Arabia. J. Wildl. Res. 1, 210-214.

Nader I. 1989. Rare and endangered mammals of Saudi Arabia. *In* Wildlife Conservation and Development in Saudi Arabia. Proceedings of the first Symposium, Riyadh February 1987. Eds. Abdulaziz H. Abu-Zinada, P. D. Goriup and I. A. Nader. NCWCD Publication No.3. pp. 220-233. Riyadh.

Nowell K. and Jackson P. (eds). 1996. Wild Cats: Status Survey and Conservation Action Plan. IUCN/SSC Cat Specialist Group, IUCN, Gland, Switzerland.

Obadi N. A. 1993. [Animals of Yemen: Mammals.] Vol. 1. Obadi Publication Centre. (In Arabic)

Osborn D. J. and Helmy I. 1980. The contemporary land mammals of Egypt (including Sinai). Fieldiana Zool. 5, 1-579.

Perez I., Geffen E. and Mokady O. 2006. Critically Endangered Arabian leopards *Panthera pardus nimr* in Israel: estimating population parameters using molecular scatology. Oryx 40, 295-301.

Pocock R. I. 1932. "The African Leopard", pp. 543-595, Plates I-IV, Proceedings of the scientific Meetings of the Zoological Society of London for 1932. London.

Qumsiyeh M. B., Amr Z. S. and Shafei D. M. 1993. Status and conservation of carnivores in Jordan. Mammalia 57, 55-62.

Saleh M. A., Salim M. I. B. and Bedare S. M. 1995. Ecological Survey of South Sinai Protected Areas – Land Vertebrates. Internal Publication Al Azhar University, Egypt.

Sanborn C. C. and Hoogstraal H. 1953. Some mammals of Yemen and their ectoparasites. Fieldiana Zool. 34, 229-252.

Shoemaker A. H. 1997. The status of the leopard, *Panthera pardus*, in nature: A country by country Analysis. Unpublished report. Riverbanks Zoological Park, P.O. Box 1060, Columbia, SC 29202, USA.

Spalton J. A. 1999. Camera-traps for carnivore surveys. Saint Katherine Protectorate Internal Report.

Spalton J. A. and Willis D. 1999. The status of the Arabian leopard in Oman: First results of the Arabian leopard survey. *In* The Natural History of Oman: A Festschrift for Michael Gallagher (eds M. Fisher, S.A. Ghazanfar and J. A. Spalton), Pp. 147-160. Backhuys Publishers, Leiden.

Spalton J. A., Al Hikmani H. M., Willis D. and Bait Said, A.S. 2006a. Critically Endangered Arabian leopards *Panthera pardus nimr* persist in the Jabal Samhan Nature Reserve, Oman. Oryx 40, 287-294.

Spalton J. A., Al Hikmani H. M., Jahdhami, M. H., Ibrahim, A. A. A., Bait Said A. S. and Willis D. 2006b. Status of the Arabian Leopard *Panthera pardus nimr* in the Sultanate of Oman. Cat News Special Issue No. 1, 26-32.

Stuart C. &. and Stuart T. 1995. Mammals of the UAE mountains. Tribulus 5, 20-21.

Thomas B. 1932. Arabia Felix. Jonathan Cape, London.

Uphyrkina O., Johnson W. E., Quigley H. Miquelle D., Marker L., Bush M. and O'Brien S. J. 2001. Phylogenetics, genome diversity and origin of modern leopard, *Panthera pardus*. Molecular Ecology 10, 2617-2633.

Usher-Smith J. H. 1985. Report on the Salalah leopard expeditions between January 16th and May 5th 1985. Report to the Government of Oman.