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The caracal in Iran - current state of knowledge and priorities for conservation

Little information is present regarding biology and ecology of the caracal *Caracal caracal* in Iran. The majority of the available information comes from cheetah reserves in the central provinces, where about a decade of monitoring initiatives and extensive camera trapping surveys have been conducted. The caracal occurs in a wide variety of habitats across Iran, and presence records are currently lacking only from the Caspian Sea region, hyper-arid central deserts, and the Iranian Caucasus. The Iranian caracal's diet purportedly includes a great variety of prey of different sizes from small rodents and birds to medium-sized ungulates. Occasional predation on domestic small stock is likely to bring the caracal into conflict with local pastoralists. In spite of being highly adaptable and widely distributed, the caracal is in need for conservation attention. The main conservation priorities for the caracal in Iran are scientific research and mitigating negative interactions between caracals and traditional pastoralists. The caracal has been the subject of little empirical research in Iran, and elsewhere outside southern Africa. Here, we provide a thorough summary of what is known to date about the caracal in Iran, enriched with reliable field observations, unpublished reports, and anecdotal accounts. By summarizing the current state of knowledge about the biology and ecology of Iranian caracals, we provide suggestions for future research, as well as priority conservation actions.

We performed a comprehensive review of existing literature referencing aspects of caracal ecology and natural history, including peer-reviewed papers and grey literature, as well as an extensive attempt to collect unpublished reports and field observations by interrogating with Iranian biologists, and trained rangers, taxidermists, and hunters. Finally, we briefly reviewed a large dataset of camera-trap surveys aimed at the Asiatic cheetah *Acinonyx jubatus venaticus* between 2002 and 2013. Following Moqanaki et al. (2010), we assessed reliability of each record individually by considering whether any hard evidences (e.g. photo, video, carcass, museum specimen of known origin, genetic sample) are present, or only soft evidences are available. We considered all such records before 2000 as 'historical', and classified hard evidences as 'C1', and soft evidences as 'C2'. The remaining ambiguous records were not considered in this study.

Description

The caracal is a medium-sized cat of Africa and Asia, almost twice the size of a domestic cat. However, with a slender body build and long legs, caracals appear much larger superficially resembling a small puma *Puma*

concolor. The tail is proportionally short and reaches up to one-third of the body length. Males are larger and heavier than females. Adults in Iran weigh between 7.3 to 25 kg (Table 1). Though seasonal variation may exist, the Middle Eastern caracals are paler and relatively smaller than African caracals (Harrison & Bates 1991). The coat ground colour is uniform, varies from light sandy to reddish-brown, and whitish on the underparts. Apart from scattered lighter-coloured spots on the belly and undersides of the animal's chest and legs, no distinct marking pattern is present. Facial marking of dark lines and white patches occur inside the nose and eyes' edges. The most unambiguous characteristics are the well-developed, silvery black-backed ears, accompanied by long black tufted hairs (Fig. 1).

Taxonomy

The caracal was first classified by Schreber (1776) as a species of the genus *Lynx*, however, later assigned to the *Felis* group. More recent incorporation of morphological and molecular studies has proposed a new lineage, *Caracal*, with two genera, *Caracal* and *Leptailurus*. Hence, three species of *Caracal*, caracal *C. caracal*, African golden cat

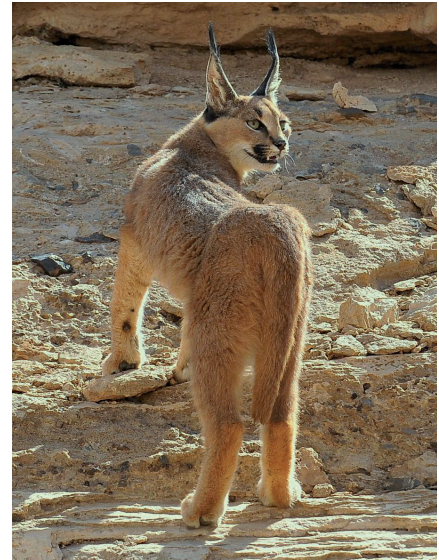


Fig. 1. A caracal in the vicinity of Nadushan, Yazd Province, in May 2009. Accused of killing domestic fowl, this caracal was chased by local villagers into a water canal to get drowned, but was eventually rescued by the local wildlife authority (Photo H. Moghimi).

C. aurata, and serval *Leptailurus serval* are grouped together (Johnson et al. 2006, Werdelin et al. 2010).

There is a necessity to accurately define the subspecies classification so that the caracal's conservation status can be determined. Although their geographical distribution is not well defined, the IUCN/SSC Cat Specialist Group recognizes eight subspecies (Nowell & Jackson 1996): (1) *C. c. caracal* in South Africa; (2) *C. c. limpopoensis* in the Northern province of Limpopo in South Africa to Zimbabwe; (3) *C. c. damarensis* in Namibia; (4) *C. c. nubicus* in the Nubian Desert westward to Cameroon; (5) *C. c. poecilictis* from Nigeria and the grasslands of southeastern Gabon (where previously it was suggested for later dismissed *lucani*); (6) *C. c. algirus* in North Africa; (7) *C. c. schmitzi* from the Sinai Peninsula through West Asia to India; (8) *C. c. michaelis* in the Caspian region of Turkmenistan eastward to the Amu Darya (River). The Iranian subspecies is considered to be *schmitzi*, although *michaelis* might occur in the north-east of the country as well (Karami et al. 2008, Hassan-Beigi et al. 2014).

Habitat

Despite being highly adaptable, caracals apparently prefer drier open terrains with sufficient shelter and vegetation cover and avoid true deserts and dense tropical rain forests (Heptner & Sludskii 1972, Weisbein

Table 1. Measurement and weights of caracals from Iran (n= 21). Sex: F = female, M = male, ? = sex unknown. W = weight, HB = head-body length; T = tail length; SH = shoulder height.

Location, Province	Sex	W (kg)	HB (cm)	T (cm)	SH (cm)
Chahar-Khaneh, Esfahan	F	N/A	73	27	45
Shiraz-Kouh, Esfahan	M	13.0	78	27	46
Kouh-e Parviz, Esfahan	F	N/A	70	24	44
Anarak, Esfahan	F	8.4	69	21	43
Abbas Abad, Esfahan	M	N/A	81	28	47
Zavar, Esfahan	M	4.0	39	16	27
Hormod PA, Fars	?	N/A	82	24	N/A
Moshajjareh, Esfahan	M	11.0	76	26	45
Chupanan, Esfahan	F	9.2	77	23	43
Kouh-e Zard, Esfahan	M	8.8	69	N/A	43
Shahrud, Semnan	?	12.0	105	27	37
Southeast Semnan, Semnan	?	10.3	109	N/A	N/A
Vicinity of Naein city, Esfahan	?	13.0	N/A	N/A	N/A
Abbas Abad WR, Esfahan	M	13.6	80	26	44
Parvand PA, Razavi Khorasan	M	10.5	91.5	32.5	N/A
Jen-e Naein, Esfahan	F	N/A	66	21	39
Ashtian, Esfahan	M	12.0	82	28	47
Abbas Abad WR, Esfahan	F	7.3	75	23	42
Tang-e Haft, Lorestan	M	25.0 *	N/A	N/A	N/A
Abbas Abad WR, Esfahan	M	9.8	67	26	42
Abbas Abad WR, Esfahan	F	5.9	56	22	37

* We could neither verify nor reject this measurement. As long as no additional evidence is available, we suggest to cite this specimen with caution.

& Mendelssohn 1990, Avenant & Nel 1998, Adibi et al. 2014, Singh et al. 2014). Caracals in Iran live in a wide variety of habitats: from the temperate Kopet Dag plains in the north-eastern-most corner to the semi-arid mountainous woodlands of Central Zagros in the west, and from southern Alborz forest steppes through the central extreme dry lands to the semi-desert coasts of the Persian Gulf (see Distribution; Fig. 2). Camera-trapping surveys in Iran have captured the animal at stations mostly characterized by dry riverbeds and well-vegetated foothill trails (Fig. 3).

Distribution

Geographical distribution of the caracal expands over 20 million km² across, at least, 40 African and 19 Asian countries (Nowell & Jackson 1996, Avgan et al. 2016). But the knowledge on its current status is outdated, in particular for the North African and Asian populations. A present-day assessment of the caracal population trend is lacking. The caracal is rare in North Africa and throughout a large proportion of its entire Asian range it is believed to be threatened to some extent

(Sunquist & Sunquist 2002). Despite a lack of empirical data, the species is thought to be in decline in Iran (Ziaie 2008).

In Iran, the distribution of the caracal has been poorly documented. It seems that the species has a broad distribution (Fig. 2). Lay (1967) reviewed previous accounts from Persia and together with his findings provided only four records from Khuzestan, Kerman, and Tehran Provinces. Etemad (1985) noted 10 new reports, together with the first evidence from the Zagros region. No additional sites beyond these records were presented by later authors (Harrison & Bates 1991, Ziaie 1996). In the IUCN Action Plan for Wild Cats, Nowell & Jackson (1996) shaded almost the whole country as the potential species range. The authors reported occurrence of the caracal within five Iranian protected areas, including Kiamaky Wildlife Refuge WR, East Azarbayjan Province. Although their source is not presented, to date, this is the only indication of the species' occurrence in the Iranian Caucasus (north-western Iran). Accordingly, recent global efforts have also included this region within the caracal geographical distri-

bution (Sunquist & Sunquist 2002, Breitenmoser-Würsten et al. 2008).

Literature on the current distribution of the caracal in Iran is still limited in Etemad's (1985) work (Firouz 2005, Karami et al. 2008, Ziaie 2008). However, due to recent cheetah surveys using remotely triggered camera traps, a wealth of up-to-date and reliable records are available (see Supporting Online Material SOM T1). Previously, the most representative information on current distribution of caracals in the country had been proposed by Ghoddousi et al. (2009), which is a modified version of the Etemad's map updated by more recent observations. No further information on the origin of the data is presented. Mousavi (2010) also endeavoured to map the range of the caracal in Iran. However, the author ignored the previous literature and exclusively shaded the eastern and central part of Iran.

The majority of the C1 records are restricted to the central provinces of Iran (Fig. 2) where, more than a decade of field surveys for cheetahs has been undertaken (Jourabchian & Farhadinia 2008). The caracal marginally occurs in western Iran as well. In the south in Sistan-va-Baluchestan, Hormozagan and Bushehr Provinces, the caracal has rarely been recorded. To our knowledge, no reliable records exist from the Iranian Caspian region either. Overall, the Global Mammal Assessment distribution (data in Breitenmoser-Würsten et al. 2008) provides a good representation of the caracal distribution in Iran. However, the caracal's occurrence in the Iranian Caucasus must be evaluated, and it is likely that the caracal's distribution is more extended in southern Iran.

North-eastern Iran (North, Razavi, and South Khorasan Provinces)

Prior to 2000, the only official evidence of caracal occurrence on the Khorasan region was a single dubious report by Etemad (1985) from the Kopet Dag along the Turkmenistan border (Fig. 2). The cat has been recently photo-captured in Miandasht WR (Farhadinia et al. 2007, H. Absalan, unpubl. data) and Behkadeh Razavi No-Hunting Area (Farhadinia et al. 2009), North Khorasan Province. In Razavi Khorasan Province, C1 records are from Bardaskan, Parvand Protected Area (PA), and Shir-Ahmad WR where the animal has regularly been reported. Recent human-induced mortality records from Ark & Korang PA (Hasan-Beigi et al. 2013) confirm the presence of caracal in South Khorasan Province as well, excluding the newly annexed Tabas County.

Central and South-Central Iran (Qom, Markazi, Tehran, Semnan, Esfahan, Yazd, Fars, and Kerman Provinces)

A majority of both historical and recent C1 and C2 records are from the drier provinces of Iran in the central plains (Fig. 2), including by-catch camera-trap photos during cheetah surveys (SOM T1). This species has been recorded from various sites in Fars and Kerman Provinces, and more frequently in Semnan, Esfahan, and Yazd Provinces. Only scattered records are available from Tehran, Qom and Markazi Provinces (Fig. 2). During camera-trapping surveys (SOM T1) some authors reported a higher capture success for the caracal compared to other sympatric felids, thus hypothesized a higher relative abundance for this lesser cat in central Iran (e.g. Farhadinia et al. 2007, Farhadinia et al. 2008, Ghoddousi et al. 2009). On the other hand, some failed to or rarely photo-captured the species in its potential habitat (SOM T1). Taking into account the opportunistic methodology that most of the previous surveys have followed, these encounter rates are unlikely to represent true indices of abundance.

Western Iran (Zagros region toward Khuzestan Province)

Records in this region are rare and sporadic. Hamedan Museum of Natural History possesses an adult specimen allegedly collected from vicinity of Hamedan city in 1974-5. In mid-1980s, a sub-adult individual was found in Sefid-Kouh, Lorestan Province (Etemad 1985). In 2010, the species was photo-trapped at c. 2300 within a highland oak forest in Ilam Province. Besides more consequent records from Ilam, new hard evidence is documented from Lorestan, Kohgiluyeh-va-Buyer Ahmad, and Khuzestan Provinces (Fig. 2). This species' occurrence in Chahar Mahal-va-Bakhtiari and Kermanshah Provinces is still uncertain.

Southern Iran (Bushehr, Hormozgan, and Sistan-va-Baluchestan Provinces)

Alongside the Persian Gulf coast, caracal occurrence has seldom been reported (Fig. 2). To our knowledge, previously the only verifiable caracal record from this region was a carcass of an individual discovered in Mond PA, Bushehr Province in 1999. This specimen is purportedly in possession of Natural History and Technology Museum of Shiraz University. In September 2013, a carcass of a female caracal killed by local herders was

Caracal caracal

Names:

کاراکال [kârâkâl],
یوزو(ک) [yuzu(k)],
یوز خفو [yuz xafu],
منگوله گوش [manguleh gush]
Caracal

Head and body length:

61-108 cm

Tail length:

18-34 cm

Weight:

6.2-20 kg

Global Population:

Unknown

Iranian Population:

Unknown

Distribution in Iran:

Everywhere but north (Caspian Sea region), northwest (Iranian Caucasus), and extreme central deserts of Iran

IUCN Red List:

Least Concern (2014)

CITES:

Appendix I (Asian population) and II

Country Red List:

N/A

Iran environmental conservation laws & regulations:

Category II (Near Threatened and Protected)



Photo M. Eslami Dehkordi

discovered in Jam County, Bushehr Province. One sub-adult individual accompanying the female was subsequently captured and released in the area later on.

Ecology and behaviour

Caracals are considered to be solitary predators, although reports of adults roaming together exist (e.g. Grobler 1981), also from Iran (Farhadinia et al. 2007, Mousavi 2010, Hamidi et al. 2011; Fig. 4). However, there is insufficient information whether female caracals with their sub-adult offspring(s) have been distinguished in the reported observations. The activity period is nocturnal-crepuscular, albeit in less disturbed habitats caracals appear to be active during the daytime (Avenant & Nel 1998, İlemin & Gürkan 2010, Singh et al. 2014). New camera-trap data from central Iran also did not detect significant differences in diurnal and nocturnal activity periods of caracals (Farhadinia et al. 2012, Akbari et al. 2016). Nonetheless, the daily activity of caracals is correlated with ambient temperature rather than the photoperiod; the warmer the temperature in

summer, the more active the caracals will be during the night (Avenant & Nel 1998).

Males occupy notably larger home ranges that often overlap with one to several females. Home range size varies significantly across their geographic range, averaging from 26.9 km² in sub-humid habitats (Avenant & Nel 1998) to 316.4 km² in arid landscapes (Marker & Dickman 2005), and is probably correlated with food availability and habitat type. Seasonal variation in size of home range may exist in an order of magnitude (Bothma & Le Riche 1994, van Heezik & Seddon 1998). Little information is available regarding reproduction and development of free-living caracals. Earlier captive studies noted that reproduction is weakly seasonal and mating takes place year-round (review in Sunquist & Sunquist 2002). In South Africa, births peak in October-February, with average litter size of 2.2 (Bernard & Stuart 1987). Farhadinia et al. (2007) speculated that births occurred in April on a semi-arid site in Naein, Esfahan Province. All confirmed field observations from Iran (n = 10) have recorded two kittens except one litter with 3 kittens that has been

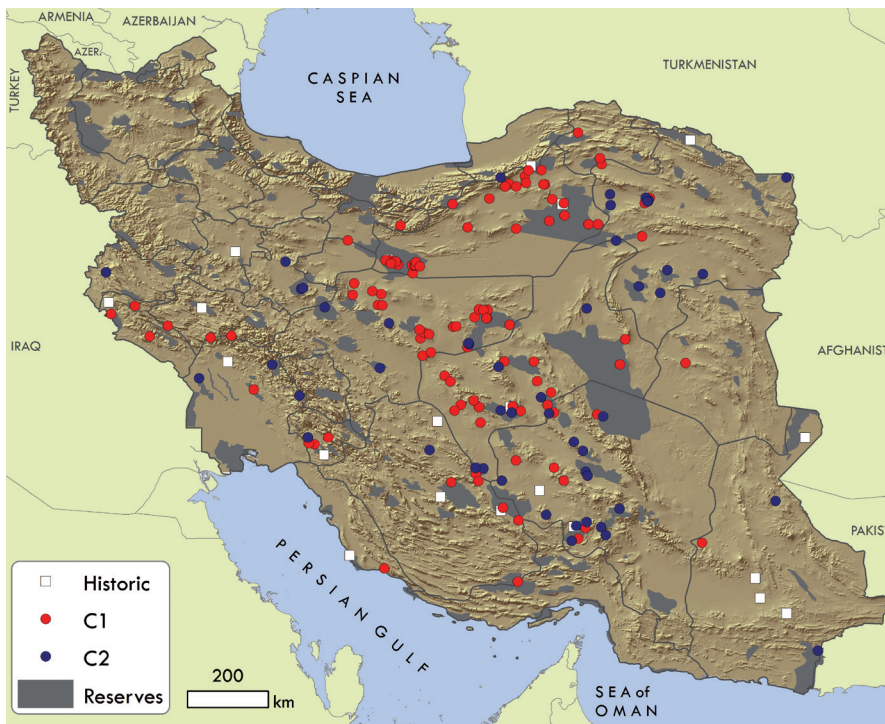


Fig. 2. Former and current distribution information for the caracal in Iran (1975-2016). Historical records (white squares): confirmed presence records before 2000, including data in existing literature; 'C1' (red dots): hard evidences, such as photos, videos, dead specimens, genetically-identified samples; 'C2' (blue dots): soft evidences, such as reliable field observations, either verified by the authors or via a trained person. 'Reserves' includes National Parks, Wildlife Refuges, and Protected Areas.

30

observed in Bahram'gur PA, Fars Province (Farhadinia et al. 2007).

Prey

The caracal's diet includes insects and small birds to medium-sized (<40 kg) ungulates (Avenant & Nel 2002). Caracals predate domestic animals and occasionally feed on carrion. Although the majority of a caracal's diet comprises <5 kg prey, the preferred prey are believed to be gazelle-sized ungulates (review in Sunquist & Sunquist 2002). The bulk of the diet across the poorly-studied Asian distribution is made up of lagomorphs and small rodents (Heptner & Sludskii 1972, Weisbein & Mendelssohn 1990, Mukherjee et al. 2004, Singh et al. 2014).

In Iran, caracals have anecdotally preyed upon a variety of species including gray francolin *Francolinus pondicerianus* in Khabr National Park (NP) (A. Sharafi, pers. comm.), an unidentified rodent in Darband-e Ravar WR, Kerman Province (ICS, unpubl. data), hedgehog *Paraechinus* spp. in Dareh Anjir WR and Rueppell's fox *Vulpes rueppellii* in Siah-Kouh NP, Yazd Province (A. Jafarpour pers. comm.). Additionally, Farhadinia et al. (2007) and Ghoddousi et al. (2009) found remains of cape hare *Lepus capensis*, Libyan jird *Meriones libycus*,

and various unidentified rodents in caracal scats collected in Abbas Abad WR, Esfahan Province, and Bahram'gur PA, Fars Province, respectively. In other instances, camera trap pictures of caracals on hare hunt have been taken in Touran NP, Semnan Province, and Abbas Abad WR, Esfahan Province (CACP, unpubl. data). In February 2013, a caracal was photographed in Khaeez PA, Kohgiluyeh-va-Buyer Ahmad Province, killing supposedly a mongoose *Herpestes* spp. (Fig. 5). Predation on gazelles *Gazella* spp. is also documented in Iran. The secretive cat has several times invaded the chinkara's *G. bennetti* enclosure at Shir-Ahmad WR, Razavi Khorasan Province, and held responsible for a few cases of killing them (A. Khani, pers. comm.). Additionally, in October 2011, three caracals were observed on a goitered gazelle *G. subgutturosa* carcass in Kalmand-Bahadoran PA, Yazd Province. The hind limbs had been consumed (A. Zare', pers. comm.). A caracal scavenging ungulate carcasses left by the cheetah and an unidentified predator have been photo-captured in Kavir NP, Semnan Province (CACP, unpubl. data). In Iran, and elsewhere, caracal predation on domestic livestock brings caracals into conflict with humans; the result is killing of caracals in retaliation (Farhadinia et

al. 2007, Tourani 2010, Hassan-Beigi et al. 2013; see Fig. 1).

In captivity

Single individuals of unknown origins were kept at private zoos in Mashhad (Vakil Abad Zoo) and Shiraz prior to 2010. In October 2010 the latter, a three-years-old male caracal presumably wild-caught in Fars Province, was released in Bahram'gur PA in order to study the rehabilitation consequences (Hamidi et al. 2011). This caracal stayed near the release site for around 2 months, but then 10 days later it was found in poor conditions approximately 95 km away in Shahr-e Babak, Kerman Province, accompanying another adult caracal (Hamidi et al. 2011). The animal was recaptured and because of health concerns, translocated to Tehran and is now kept at Tehran Eram Zoo (Memarian et al. 2011). Presently, an adult caracal of unknown sex and origin is in possession of Isar Zoo, Alborz Province.

Main threats

Habitat loss and fragmentation are the main threats to the Asian caracals (Nowell & Jackson 1996). In Iran, conflict with humans has negatively affected the caracal populations in human-dominated areas, as Ziaie (2008) believes that the retaliatory killing and loss of prey are the principle causes of the species' decline in Iran.

Caracals suffer from traditional pastoralist systems in Iran. Interviewing villagers in the centre of the country has revealed that its persecution is relatively common (Farhadinia et al. 2007, Ghoddousi et al. 2009, Tourani 2010, Hassan-Beigi et al. 2013). We were able to collect 52 mortality records from the mid-1980s to December 2015, in which for 31 of these a clear cause could be obtained (59.6%). Accordingly, 45.2% were killed in vehicle collisions ($n = 14$), and 35.5% due to poaching activities or retaliatory killing ($n = 11$), and 19.3% ($n = 6$) had been chased and killed by herding dogs.

Protection measures

The IUCN Red List of Threatened Species considered the caracal's status as 'Least Concern'. In Asia, the animal is included in CITES Appendix II. The Iran Hunting and Fishing Law of 1967 (last revision 2015) classified the caracal in Category II, defined as a fully protected, near-threatened species. In addition, poaching will result in a fine of 100,000,000 Iran Rials (USD 1 ≈ IRR 35,000).

The paucity of information on the lesser cats of Iran, including caracals, has been an obstacle for their conservation. Many knowledge gaps remain about the status of the caracal in Iran. No research has been specifically carried out on the species and our state of knowledge is restricted to by-catch data from larger felid surveys, particularly cheetahs. Likewise, even globally, few in-situ studies have been undertaken on caracals (Brodie 2009). Extensive camera-trapping fieldwork would provide valuable information on caracals (and other sympatric species) in sites where its occurrence is uncertain, particularly in western and southern-most Iran. In the meantime, relevant ecological information for its conservation, such as habitat use and activity patterns could be obtained from such studies. The question of the subspecies status and genetic diversity remains another important, unsolved issue in conservation planning for caracals in the country.

A considerable number of protected areas have been established in the caracal's range in Iran (Fig. 2), but the lack of interest and coordination among local authorities would block any future management practices. Thus, more involvement of the local reserve staff in sharing their information should be centrally implemented. Yet, caracals are not confined to the protected areas in Iran and better management of the nomadic pastoralists and anthropogenic activities within the species' habitats is needed. Although caracals are highly adaptable and widely distributed, more attention is urgently needed by both national authorities and conservationists in order to thoroughly assess its conservation needs in Iran.

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Fig. 3. A camera-trap photo of a caracal from Miandasht Wildlife Refuge, North Khorasan Province, in October 2014 (Photo ICS/DoE/CACP).



Fig. 4. A pair of caracals photographed in Darband-e Ravar Wildlife Refuge, Kerman Province, in February 2014 (Photo ICS/DoE/CACP/Panthera).

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Fig. 5. A caracal photographed in Khaeez Protected Area, Kohgiluyeh-va-Buyer Ahmad Province, in February 2013, preying on a mongoose (Photo H. Dideban/Kohgiluyeh-va-Buyer Ahmad Department of Environment).

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