Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online) DOI: 10.7176/JBAH
Vol.9, No.13, 2019

Ecology of Caracals and Their Distribution in Africa: A Review Paper

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Abstract
Caracals (Felis caracal, Schreber 1776) are medium-sized wild cats. They are placed in the family felidae and subfamily felinae. These species were first described by German naturalist Johann Christian Daniel von Schreber as Felis caracal. Caracals occur in northern Africa, Asia and at least 36 sub-Saharan African countries, yet little has been published regarding their spatial ecology. Caracal occupies a wide variety of habitats, from semi-desert to relatively open savannah and scrubland to moist woodland and thicket, evergreen forest, montane grassland, and arid mountains. Its habitat is mostly arid areas and it has a key role in the control of rodent populations. They typically ranges up to 2,500 m and 3,000 m above sea level. The conservation status of caracal populations is not clear across most of the range, but the Asiatic population is threatened and listed in CITES Appendix I and all others as Appendix II. The main threats for the caracal are habitat loss and human conflict due to frequent livestock attacks. Lack of knowledge about the caracal and the unknown impacts of the conflict on its population may drive the species to an endangered situation. Possessing tremendous speed and agility, the caracal is a formidable predator capable of tackling prey two to three times larger than its size. Their long, powerful hind legs enable them to make incredible leaps up to three metres high and catch birds in flight by batting them from the air with its large paws. Similar to all other species in the family felidae, caracals are strict carnivores. Caracals are usually nocturnal, being active from dusk to dawn and early morning and resting during the day in dense vegetation or rock crevices. Caracals prey mainly on small- to medium-sized mammals, from small murids to antelope up to ~50 kg, but they will also feed upon birds, reptiles, invertebrates, fish, small-sized carnivores and some plant matter. Camouflage is a primary defence against predators. They are polygynandrous (promiscuous). Both sexes become sexually mature by the time they are a year old; production of gametes begins even earlier at seven to ten months, the earliest successful copulation occur around 14 to 15 months of age. These species are classified as problem animals in Africa and are commonly regarded as vermin because of occasional predation upon small stock. This negative perception has resulted in extensive persecution of caracals.
Keywords: Caracals, IUCN, CITES, Conservation, Distribution
DOI: 10.7176/JBAH/9-13-05
Publication date:July 31st 2019

1. Introduction

Caracals (Felis caracal, Schreber 1776) are medium-sized wild cats occur in northern Africa, Asia and at least 36 sub-Saharan African countries, yet little has been published regarding their spatial ecology (Nowell and Jackson, 1996). Although rarer in Asia, the caracal is relatively common in sub-Saharan Africa and occupies a wide variety of habitats (Sunquist and Sunquist, 2002).

Despite weighing only 8–20 kg, caracals regularly kill prey more than twice their own mass, and take a wide range of prey species (Grobler, 1981; Sunquist and Sunquist, 2014). Possession of tremendous speed and agility make caracals to be formidable predators. It's long, powerful hind legs enable it to make incredible leaps up three metres high and catch birds in flight by batting them from the air with its large paws (CITES, 2011). The caracal is also the fastest cat of its size, and uses its speed to run down prey such as hyraxes, hares and small antelopes (Nowak, 1999). This species is superbly adapted for life in arid environments and requires very little water, apparently getting adequate supplies from its food (IUCN Red List, 2011). Caracals are usually solitary, and maintain territories which may vary from less than 10 km^2 for females in prey-rich habitats to greater than 300 km^2 for males in prey-poor habitats in South Africa, and up to 221 square kilometres in the Middle East (Avenant and Nel, 1998; Marker and Dickman, 2005). Male caracals possess the largest territories, which usually encompass the home ranges of several females; caracals appear to breed throughout the year, although breeding is known to peak between October and February in South Africa (Nowak, 1999). After nine or ten months the young become independent, and may travel large distances to find their own territory. Caracals become sexually mature in their first year, and while wild individuals' life spans are not recorded, caracals in captivity have been known to live for sixteen up to nineteen years (Richard Weigl 2005; CITES, 2011).

The Caracal occupies a wide variety of habitats, from semi-desert to relatively open savannah and scrubland to moist woodland and thicket, evergreen forest, Montana grassland, and arid mountains. It typically ranges up to 2,500 m and above 3,000 m asl in the Lesotho and Ethiopian Highlands, respectively (Avenant and du Plessis, 2012; du Plessis, 2014; Ray et al. 2005; Avenant, 2004).

The caracals are classified as problem animals in Namibia and South Africa and are commonly regarded as

vermin because of occasional predation upon small stock (Nowell and Jackson, 1996; Avenant and Nel, 1998). This negative perception has resulted in extensive persecution: from 1931 to 1952, over 2000 caracals have destroyed annually in South Africa's Karoo, while Namibian farmers reported killing 2800 caracals during 1981 alone (Nowell and Jackson, 1996). Although in some areas livestock can form a significant part of their diet, and they may engage in surplus killing, most studies have shown that caracals predominantly prey upon hyraxes, rodents, birds and small antelope, indicating that the threat posed to domestic stock may be less than is commonly perceived (Avenant, 1993; Stuart and Hickman, 1991).

Caracals are widespread and prevalent in sub-Saharan Africa, except for the equatorial forest belt and true deserts, and cover is needed wherever it occurs (Skinner and Chimimba, 2005; Ray et al. 2005; Breitenmoser-Wursten, 2008; Henschel and Sogbohossou, 2008). In South Africa caracals can be destroyed with or without permits (legislation varies per province) as they are classified as a Damage Causing Animal (Cape Nature, 2013). Caracals may utilize niches on farmland previously occupied by black-backed jackals (Canis mesomelas, Schreber 1778), which are also intensively removed by farmers (Mendelssohn, 1989; Nowell and Jackson, 1996). Increased knowledge regarding the range use of caracals is fundamental in terms of furthering the understanding of this cat's ecology, and is important for developing more effective and ecologically sound methods for its management. Thus, this seminar paper is to review the ecology and distribution of caracals in Africa.

2. General features of Caracals

2.1. Biology

2.1.1 Size

The caracal in Asia is smaller and in arid areas has a paler fur than those in sub-Saharan Africa, and females are markedly smaller than males (Nowell and Jackson, 1996). Body weight range in South Africa is 7.2-20 kg (mean 12.9 Kg) for males and 7-15.9 kg (mean 10 Kg) for females, while in Israel the average weight of male caracal is 9.8 kg and the average female weight is 6.2 kg, although an individual with 25kg has been reported from western Iran (Stuart, 1982).

2.1.2 Morphology

The caracal is a slender, graceful cat with a short, dense brown to red coat and distinctive, long, black-tufted ears (Nowak, 1999; CITES, 2009). They have longer hind legs than forelegs so that a standing caracal seems taller at the rump than at the shoulders. The structure of its hindquarters enables the caracal to make spectacular leaps (CITES, 2011). They have tufts of stiff hairs on the paws between the pads as an adaptation to live in arid habitats for moving through soft sandy ground. The body color varies from reddish-brown to tawny-grey, but occasionally entirely black, “melanistic” individuals may occur (Sunquist and Sunquist, 2014; Burnie, 2001). Similar to African golden cats their undersides are white and, are adorned with many small spots; the chin, throat and under parts are white, with pale red spots or blotches on the belly and the insides of the legs that vary from very faint to distinct in different individuals (CITES, 2009). The caracal produces a range of vocalization, including miaows, growls, hisses and coughing calls (Nowak, 1999). The trademark features of caracals are their elongated triangular and black-tufted ears, and they have a broad face, eye color varies from golden or copper to green or grey; Juveniles differ with their shorter ear tufts and blue tinted eyes (CITES, 2009; Burnie, 2001).

Although the tail is short, it still makes up a significant portion of the total body length; its length ranges from 18 cm (7 in) to 34 cm (13 in). Head and body length is measured from the nose to the base of the tail and ranges from 62 to 91 cm (about 24 in to 36 in). Even the smallest adult caracal is larger than most domestic cats (Kingdon, 2004). The ears tufts hang down like tassels in older animals. On the face, a dark line from the center of the forehead turns down to near the nose and another line starts from the inner edge of the eyes to the nostrils (Sunquist and Sunquist, 2002) (Figure 1).

Figure. 1 An individual caracal (source, The Africa Cat Foundation)

2.1.3. Reproduction

Existing data on the reproduction of the caracal, which are based on a limited number of field observations and observations of captive animals, indicate that reproduction can occur throughout the year but most births occur during an extended summer reproductive season, (Stuart, 1981; Smithers, 1983). Before mating begins, chemical signals in the female's urine attract and notify the male of her readiness to mate and a distinctive "cough-like" mating call has also been reported as a method of attraction (Bernard and Stuart, 1987; Kingdon, 2004). When a female is being courted by multiple males, the group may fight to mate with her or she may choose her mates, preferring older and larger males to younger and smaller males; mating may occur with multiple individuals over the course of about a week (Kingdon, 2004; Sunquist and Sunquist, 2002). Estrus lasts 1-3 days, its cycle is 14 days and the estrus condition is absence of fertile copulations persists for 3-6 days; infanticide by males has been observed and this may be to induce ovulation in a female undergoing lactational amenorrhea (Bernard and Stuart, 1987; Kingdon, 2004). In captivity, gestation lasts 78-81 days and the litter size varies from one to six young, though three are most commonly produced (Farhadinia et al. 2007; Karami, et al. 2008; CITES, 2011; Stuart and Durk Stuart, 1985; Bernard and Stuart, 1987; Nowell and Jackson, 1996; Sunquist and Sunquist, 2014). Age of independence is 9-10 months and females can have their first pregnancy when 14-16 months old, while males are sexually mature when 12.5-15 months old (Bernard and Stuart, 1987).

2.1.3.1 Mating System

Caracals are polygynandrous (promiscuous). A female may go into estrus at any time during the year. One hypothesis to explain the breeding habits of C. caracal is the "use" of an opportunistic strategy. This strategy is controlled by the female's nutritional status (Avenant et al. 2016). When a female is experiencing pinnacle nutrition (which will vary by range), she will go into estrus. This explains peak birth timing between October and February in some regions (Sunquist and Sunquist, 2014; Werdelin, et al. 2010). A female cannot have more than one litter per year because of the parental investment involved and the lack of post partum estrus (Karami, et al. 2008; Bernard and Stuart, 1987; Sunquist and Sunquist, 2002).

2.1.3.2 Parental investment

Parental investment in caracals plays a large role in greater reproductive behavior. The time a mother spends with her kits (and the combined lack of post partum estrus) restricts females to one litter per year (Farhadinia et al. 2007; Karami et al. 2008). Once the young are conceived, males play no role in their direct or indirect care; females invest a great deal of time and energy into their young and a tree cavity, cave, or abandoned burrow is often chosen for parturition and the first four weeks of postnatal development (O'Brien and Johnson, 2007). After the first month, a mother may move her young continuously; around this time, kittens begin to play and eat meat but nursing continues until the kittens are around 15 weeks of age, because true independence does not take place for another 5 to 6 months (Bernard and Stuart, 1987; Sunquist and Sunquist, 2002).

2.2 Taxonomy and Etymology

The caracal is placed in the family Felidae and subfamily Felinae and the species was first described by German naturalist Johann Christian Daniel von Schreber as Felis caracal in the journal Die Säugetiere in Abbildungen nach der Natur mit Beschreibungen in 1776 (Wozencraft, 2005; Breitenmoser-Wursten et al. 2008). In 1843, British zoologist John Edward Gray placed the animal in the genus Caracal; the name "caracal" is composed of two Turkish words: kara, meaning black, and kulak, meaning ear. The first recorded use of this name dates back to 1760 (Wozencraft, 2005).

Alternative names for the caracal include gazelle cat, Redcat, rooikat, and red or Persian lynx

(http://dx.doi.org /10.1080/ 02541858. 1979.11447639; http: // getway .isi knowledge.com / getway / getway. cg). The "lynx" of the Greeks and Romans was most probably the caracal and the name "lynx" is sometimes still applied to it, but the present-day lynx proper is a separate species (Encyclopædia Britannica, 1889; Johnson et al. 2006).

The Caracal has been classified variously with Lynx and Felis in the past, but a 2006 phylogenetic study (molecular evidence) supports a monophyletic genus (Johnson et al. 2006). It is closely allied with the African Golden Cat (Caracal aurata) and the Serval (Leptailurus serval), having diverged around 8.5 mya (Janczewski et al. 1995; Johnson and O'Brien, 1997; Johnson et al. 2006). The Caracal lineage came into existence 8.5 mya, and the ancestor of this lineage arrived in Africa 8.5–5.6 mya (Werdelin et al. 2010). It diverged from the serval probably within the last five million years, around the boundary between the Pliocene and the Pleistocene (Johnson et al. 2006; Werdelin et al. 2010; Johnson and O'Brien, 1997).

Although the taxonomy and geographical distribution of putative caracal subspecies are not well known, the IUCN/SSC Cat Specialist Group recognizes eight subspecies (Wilson and Reeder, 2005; Breitenmoser-Wursten, et al. 2008; Wozencraft, 2005).

1. North African caracal (C. c. algira) (Wagner, 1841) – Occurs in northern Africa (Algeria, Libya, Morocco, Tunisia)
2. Common caracal (C. c. caracal) (Schreber, 1776) – Occurs in central and southern Africa (South Africa)
3. Namibian caracal (C. c. damarensis) (Roberts, 1926) – Occurs in Namibia
4. Transvaal caracal (C. c. limpopoensis) (Roberts, 1926) – Occurs in Botswana and northern South Africa.
5. Gabon caracal (C. c. lucani) (Rochebrune, 1885) – Occurs in northern Angola, Democratic Republic of the Congo, the Gabon and the Republic of the Congo
6. Nubian caracal (C. c. nubica) (J. B. Fischer, 1829)–Occurs in central Africa (Cameroon, Ethiopia, South Sudan and Sudan)
7. West African caracal (C. c. poecilotis) (Thomas and Hinton, 1921) – Occurs in western and central Africa (Senegal, Nigeria, Niger and western Sudan)
8. Asiatic caracal (C. c. Schmitz) (Matschie, 1912) –Occurs in Asia (Afghanistan, western India, Iran, Iraq, Israel,Southwestern Kazakhstan, Kuwait, Lebanon, Oman, Pakistan, Qatar, Russia, Syria, southern Turkey, Turkmenistan, United Arab Emirates, south-western Uzbekistan).

Seven subspecies have been recognized in Africa, of which two occur in southern Africa: C. c. damarensis from Namibia, the Northern Cape, southern Botswana and southern and central Angola; and the nominate C. c. caracal from the remainder of the species' range in southern Africa (Smithers, 1975; Meester et al. 1986). According to Stuart and Stuart (2013), however, these subspecies should best be considered as geographical variants.

2.3 Population

Early scientifically-gathered information on density estimates is virtually non-existent and makes comparison with newly gathered information, using relatively modern techniques, difficult. For the first time, benchmark information useful for future comparison has only recently been gathered, in South Africa's the Northern provinces (Thorn et al. 2011; Power, 2014). Caracal densities (as inferred from home range size) can vary markedly between habitats, depending on environmental variables such as the size, type, density and composition of prey available, habitat characteristics, and the degree of persecution by humans (Avenant, 1993). Similar differences were observed in female home ranges, with home ranges in a farming area, southwest Western Cape, significantly larger than at both Moutain Zebra National Park (MZNP) and Postberg Nature Reserve (PNR) (Moolman, 1986; Stuart 1982; Avenant and Nel, 1998). The smaller home range size of females in the Postberg Nature Reserve (PNR) could reflect the high density of rodent prey, the most common item in Caracal scats and the only prey group whose density and biomass significantly correlated with its percentage volume in Caracal scats at Postberg Nature Reserve (PNR) (Avenant and Nel, 1998). Fitting into the normal felid pattern, male home ranges are larger than those of females, and typically overlap with a number of female home ranges (Moolman, 1986; Avenant, 1993; Stuart and Stuart, 2013). While sexual dimorphism, and the fact that the larger males may prefer larger prey species which are less densely spaced than the smaller prey species, are still debated as a possible reason for this observation, Avenant (1993) found, strong positive correlations between home range size and Standardised Metabolic Needs (SMN) Where (SMN) equals to body weight (Stuart, 1982; Norton and Lawson, 1985; Moolman, 1986; Avenant, 1993).

2.3.1 Abundance and density estimation

The Royle–Nichols model provides estimates of the parameters k and r, representing the average abundance per site and innate species detectability, respectively (Royle and Nichols, 2003). The parameter k can be interpreted as an index of abundance. However, if the detection of individuals is independent and the site-specific abundance of individuals follows a Poisson distribution (which is the mixture distribution used in presence models), k may also be interpreted as the expected number of individuals per sample unit (MacKenzie et al. 2006). Avenant and Nel (1998) estimated a density of 0.23–0.47 Caracal / km² in Postberg Nature Reserve (PNR), while Moolman

(1986) estimated a density of 0.38 Caracal / km² for Mountain Zebra National Park (MZNP). A density of 0.3 Caracal / km² is thus a reasonable estimate for a high-density population, should blanket extrapolations be required. Large differences may, however, occur on farmland where Caracals are actively hunted, and territoriality and social structure may differ from that in protected populations (du Plessis et al. 2015). Furthermore, in areas where Caracals and Black-backed Jackals (Canis mesomelas) co-exist, Caracal densities may be markedly lower in some habitats where they are excluded by Black-backed Jackals and vice versa (Ferreira, 1988). Current information shows that, in such areas, Caracal seems to be the dominant species in more rocky and mountainous terrain and Black-backed jackal more dominant on open plains areas; this situation may, however, be impacted by the type and combination of prey items, as well as the persecution history of the area (du Plessis, 2013). Compensatory breeding is a factor that may explain the Caracal's resilience to persecution, but this has not been confirmed for this species (Avenant and du Plessis, 2008; du Plessis, 2013). Considering the possibility of such varying density estimates, a robust population estimate would be difficult to attain based on the current lack of data. However, given their wide distribution in South Africa, that Caracals seems to prefer rocky or mountainous terrain (such as at Postberg Nature Reserve and Mountain Zebra National Park), but are very adaptable and can occur in many different vegetation types (e.g. they also occur in the Kalahari), the total Caracal population in the assessment region could be anywhere between 45,000 and 150,000 individuals, depending on local densities (0.15–0.5 individual / km^2) and occupancy (Avenant et al. 2016).

2.4 Distribution

The caracal is widely distributed in most of Africa except in the true deserts of Sahara and Namib, and in the Congo and equatorial forest belt of western and central Africa. Caracals are widely distributed across Africa, Central Asia, and southwest Asia into India (Avgan et al. 2016). Beyond Africa, the caracal is found in Asia from Turkey in the west and Arabic peninsula in the south-west to India in central Asia and to Turkmenistan in the northern edge of the species range (Nowell and Jackson, 1996; Sunquist and Sunquist, 2002). The caracal is native in these countries: Afghanistan; Algeria; Angola; Benin; Botswana; Burkina Faso; Cameroon; Chad; Democratic Republic of the Congo; Côte d'Ivoire; Djibouti; Egypt; Eritrea; Ethiopia; Gambia; Ghana; Guinea; Guinea-Bissau; India; Iran; Iraq; Israel; Jordan; Kazakhstan; Kenya; Kuwait; Lebanon; Lesotho; Libya; Malawi; Mali; Mauritania; Morocco; Mozambique; Namibia; Niger; Nigeria; Oman; Pakistan; Saudi Arabia; Senegal; Somalia; South Africa; South Sudan; Sudan; Swaziland; Syrian Arab Republic; Tajikistan; Tanzania, United Republic of; Togo; Tunisia; Turkey; Turkmenistan; Uganda; United Arab Emirates; Uzbekistan; Western Sahara; Yemen; Zambia; Zimbabwe (IUCN Red List of Threatened Species, 2015).

The historical range of the Caracal mirrors that of the Cheetah (Acinonyx jubatus), and both coincide with the distribution of several small desert gazelles (Sunquist and Sunquist, 2002). Felis caracal is widely distributed in Africa around the margins of the Sahara desert in North Africa, from Morocco east to Egypt, Sudan, Ethiopia, Central and Sothern Somalia, and in the west to Mauritania and Northern Niger (Skinner and Chimimba, 2005; Bothma, 2012). It occurs throughout the rest of Africa, to the south of Sahara, excluding the tropical forests of West African and Zaire, and most of Natal and Zululand in the south-eastern sector of South Africa (Bothma, 2012). The total range of F.caracal also includes from eastern Turkey, Israel, Arabian Peninsula, Syria, Iraq, Iran the desert of Turkmania (USSR) and in the vicinity of the sea of Aral, Afghanistan, Baluchistan(Pakistan) to the Northern and central areas of India (Smithers, 1975).

2.4.1 Caracal distribution in Africa

2.4.1.1 North Africa

Felis caracals are considered to be unusual in Morocco, Algeria and other North Africa countries (Roservaer, 1974). The Paris Museum of Natural History has specimens from Essaouira (Mogador), in Morocco and one specimen from Ouarsenis in Algeria (Avgan et al. 2016). The Museum of zoology (Firenze, Italy) has one specimen from Morocco and the Moroccon specimens were taken in 1915 and 1977 and the Algerian specimen in 1954 (Stuart, 1984; Avgan et al. 2016). Harrison (1968) recorded caracal in Egypt, Libya, Algeria and Morocco.

2.4.1.2 West Africa

Roservear (1974) mentioned that F.caracal manages to retain a foothold in West Africa but in many areas it is very rare. There are specimens in the British Museum (London) from the Gambia, Lake Chad, Ghana and Nigeria. In this region the caracal is primarily restricted to the Sudan, Sahel and sub-desert regions. Two records are from the vicinity of high forest, the Gambia (Doka zone) and, Nigeria, (Ado Ekiti), (Anon, 1970). Deforestation has burned the Ado Ekiti area primarily in to open wood-land (Rosevear, 1974).

2.4.1.3 Central Africa

Although absent from much of west and central Africa, specimens of caracal are known from the Katanga area of Zaire and one specimen from Kigali, Ruanda (as Stuart, 1984 cited, D.Meirte, pers.comm). Ansell (1978) notes F.caracal as being uncommon but distributed throughout most of Zambia. Hill and Carter (1941) mentioned caracal as occurring in Angola. Huntley (1973) records the presence of this field in the south-western Angolan provinces of Iona and Mocamedes. J.crawford-Cabral (as Stuart, 1984 cited, per. Comm.) has confirmed the occurrence of

caracal in the same area caracal distribution in adjacent areas of Zambia and Namibia would seem to indicate the possibility of caracal occurring in Angolan border areas.

2.4.1.4 South Africa

Present records indicate that caracals are widespread in Namibia. F.caracal is classified as problem species in this territory and particularly in the south (Joubert and Mostert, 1975; Lensing and Joubert, 1977). Roberts, (1935) and Smithers, (1971) have given records for Botswana, where F.caracal distribution is widespread but discontinuous. Smithers and Wilson (1979) suggest that the caracal is widely distributed in Zimbabwe. Rautenbach (1978) found the caracal to be widespread in the Tranvaal, South Africa. Lynch, (1975) recorded F.caracal as widespread in the Orange Free state. In Natal caracals are apparently restricted to the foothills of the Drakensberg (south-west) and the Itala Game Reserve (Rowe-Rowe, 1978).

Felis caracal is widespread and common in the Cape Province, although records are sparse in the interior; it is known to occur throughout this area (Stuart, 1981, 1983). The highest densities are reached in the southern and western Cape, particularly along the costal belt, the coastal mountain zone and the adjacent interior. In 82% of the Cape divisional council districts, caracals are considered by farmers to be the principal wild predator of domestic small-stock (Stuart, 1984).

2.4.1.5 East Africa

Felis caracal is probably widely distributed in the Sudan and Ethiopia (Harrison, 1968). Azzaroli and Simonetta, (1966) have documented caracal distribution in former Italian Somaliland from 16 localities primarily concentrated in the south records for northern Somaliland are given by Harrison (1968). The most detailed distributional picture has given for caracal occurring in Kenya, Uganda and Tanzania (Kingdon, 1977). In Uganda it is restricted to the drier areas north of the Victoria Nile; there appear to be no locality records for southern and western Tanzania (Kingdon, 1977).

In Mozambique, F.caracal occur widely, although it may be absent from the north-central area and in the vicinity of the lower Zambezi River (Smithers and Tello, 1976). Although caracals are rare in Mozambique as stated by Travasson (1968), Smither and Tello (1976) believed that this cat is probably not as uncommon as the few records might indicate. Records from Malawi suggest that caracal could occur widely in that country (Ansell, 1978; Smither and Tello, 1976).

2.5 Ecology and Behaviour

2.5.1 Activity pattern

Caracals are usually nocturnal, being active from dusk to dawn and early morning and resting during the day in dense vegetation or rock crevices in areas where arid habitats are predominant, but are often observed in daytime, particularly in protected areas (Singh et al. 2014). The activity pattern can be influenced by the environmental temperature and activity pattern of their prey (Singh et al. 2014).

2.5.2 Habitat and Home range

The Caracal occupies a wide variety of habitats, from semi-desert to relatively open savannah and scrubland to moist woodland and thicket, evergreen forest, montane grassland, and arid mountains(Avenant and du Plessis, 2012; du Plessis et al. 2015; Ray et al. 2005; Avenant, 2004). In the Kalahari, Caracals showed a definite selection for dune slope aspect in relation to specific types of behavior (Melville, 2004). They did not select dune crests and dune slopes for specific activities more than expected, and the dune streets were selected less than expected except when killing prey. On rangelands where Caracals co-occur with Black-backed Jackals, the former is more common in the rocky areas than on open plains (du Plessis, 2013). In the North West Province, Caracals occur in all vegetation types, but they generally prefer wooded vegetation types, especially mountain bushveld, and were found to have a local preference for the Gold Reef Mountain Bushveld, Caracals also occur in mountain and coastal fynbos, Strandveld, and in the various Nama and Succulent Karoo vegetation types (Power, 2014).

In protected areas with large carnivores, they may be susceptible to interference competition (Braczkowski et al. 2012). One particular competitor is the Leopard (Panthera pardus), with which they share a similar ecological role (Norton and Lawson, 1985; Braczkowski et al. 2012; Power, 2014). Although spatial overlap between these species has been recorded, interspecific killing of Caracals by Leopards has also been documented and Caracals are thus likely to avoid areas where Leopards are prevalent (Jansen, 2016: Martins, 2010). In the areas where large predators have been extirpated, the Caracal often assumes the role of apex predator (du Plessis, 2013; Pohl, 2015). On Free State farmland, Ferreira (1988) reported that Black-backed Jackal and Caracal numbers inversely fluctuated in some habitats where they co-occur, suggesting that these species may actively limit each other's numbers in certain areas; their diets do not only overlap to a large extent, but they have been reported predating on each other's young, and adult, Caracal even kill and eat adult Black-backed Jackal (Melville, 2004; Ferreira, 1988; Pohl, 2015).

2.5.2.1 Ecosystem and cultural services:

2.5.2.1.1. Ecosystem Services

Caracals have a wide and almost uninterrupted distribution in South Africa, where they feed opportunistically on

a wide variety of prey, ranging from invertebrates, reptiles and birds to sympatric carnivores and mammals of up to greater than 50 kg (Avenant et al. 2016). They, therefore, serve as key regulators in the ecosystem, suppressing both competing predators and prey populations, and are therefore important for the conservation of biodiversity (Avenant, 1993; du Plessis, 2013; Pohl, 2015). The importance of this role increases in the different regions of South Africa, such as the central Karoo, and large areas of the Western Cape, Gauteng and the Free State, where Caracals fill (mostly together with Black-backed Jackal) the role of apex predator (Avenant et al. 2016). The exclusion of Caracals from, or their severe suppression in, ecosystems will almost certainly have direct negative impacts, such as smaller-predator release, an eruption of prey numbers, an overexploitation of associated species, and a decrease in vertebrate and invertebrate species (du Plessis, 2013). Indirectly, this may potentially also start a cascade effect leading to an overall decrease in biodiversity and healthy ecosystem functioning (Avenant et al. 2016). In addition, many of these competing predator and prey species can themselves be damage-causing: e.g. rodents destroying crops, Rock Hyrax (Procavia capensis) competing for forage with sheep, mole-rat tunnels causing damage to tractors and ploughs, carnivores (Yellow Mongoose and Black-backed Jackal) and rodents carrying disease, and carnivores that are problem predators to livestock or poultry farming (Black-backed Jackal, many of the mongooses, genets and otters) (du Plessis, 2013; Avenant et al. 2016).

2.5.2.1.2 Cultural use of caracals

The caracal appears to have been religiously significant in the ancient Egyptian culture. It occurs in paintings and as bronze figurines; sculptures were believed to guard the tombs of pharaohs. Embalmed caracals have also been discovered. Caracal ear tufts have been elaborately depicted in some tombs, and referred to as ummrisha't ("mother of feathers") (Heptner, 1992).

Chinese emperors used caracals as gifts. In the 13th and the 14th centuries, Yuan dynasty rulers bought numerous caracals, cheetahs and tigers from Muslim merchants in the western parts of the empire in return for gold, silver, cash and silk. According to the Ming Shilu, the subsequent Ming dynasty continued this practice (Mair, 2006; Heptner, 1992).

Until as recently as the 20th century, the caracal was used in hunts by Indian rulers to hunt small game, while the cheetah was used for larger game. In those times, caracals would be exposed to a flock of pigeons and people would bet on which caracal would kill the largest number of pigeons (Mair, 2006). This probably gave rise to the expression "to put the cat among the pigeons". The coat of the caracal is used in making fur coats, while its skin does not have much economic significance (Sunquist and Sunquist, 2014; Heptner, 1992).

2.5.3 Behaviour

The caracal is typically nocturnal (active at night), though some activity may be observed during the day as well (Skinner and Chimimba, 2006). However, the cat is so secretive and difficult to observe that its activity at daytime might easily go unnoticed and study in South Africa showed that caracals are most active when air temperature drops below 20 °C (68 °F); activity typically ceases at higher temperatures (Skinner and Chimimba, 2006). The solitary cat, the caracal mainly occurs alone or in pairs; the only group seen is of mothers with their offspring (Farhadinia et al. 2007). Females in oestrus will temporarily pair with males (Avenant and Nel, 1998). A territorial animal, the caracal marks rocks and vegetation in its territory with urine and probably with dung, which is not covered with soil. Claw scratching is prominent, and dung middens are typically not formed (karami et al. 2008; Farhadinia et al. 2007). The conspicuous ear tufts and the facial markings often serve as a method of visual communication; caracals have been observed interacting with each other by moving the head from side to side so that the tufts flicker rapidly; like other cats, they produce sounds for communication meows, growls, hisses, spits and purrs (Estes, 2004).

2.5.4 Anti-predator strategies

Camouflage is a primary defence against predators; when threatened in their preferred, open habitats, caracals lie flat and their plain, brown coats act as instant camouflages (Estes 2012). Caracals have cryptic (having well camouflage) anti-predator adaptation and its Agile climbing abilities also aid caracals in escaping larger predators such as leopards, lions, and hyenas (Avenant et al. 2016; Sunquist and Sunquist, 2002).

2.5.5. Food and Foraging behavior

Similar to all other species in the family Felidae, caracals are strict carnivores and they prey mainly on small- to medium-sized mammals, from small murids to antelope up to ~50 kg, but they will also take birds, reptiles, invertebrates, fish, and some plant matter (Stuart and Stuart, 2013). Like cheetahs, caracals were captured and trained to hunt for Indian royalty, but although it is capable of taking the larger ungulates it was mainly used for small game and birds. Caracals often scavenge (Nowell and Jackson, 1996).The bulk of their diet is made up of hyraxes, hares, rodents, antelopes, small monkeys and birds; such as, doves and partridge in particular, are seasonally important as well as Mountain reedbucks, dorcas gazelles, kori bustards, mountain gazelles, gerenuks and Sharpes, grysbok's are specific examples of what caracals might hunt and Caracals consume some reptiles, although this is not a common component of the diet (Grzimek et al. 2003; Kingdon, 2004). The staple components of the diet vary with geography. For example, an individual in Africa might consume larger animals such as ungulates, while an Asian cat might consume only small vertebrates, such as rodents (Kingdon, 2004). Live stocks

are sometimes hunted as well; small preys such as hyraxes are killed with a bite to the nape, while large preys, such as gazelles are killed with a suffocating throat bite and preys are usually stalked within a few long bounds, and then captured when the caracal leaps using its disproportionately long and muscular back legs (Grzimek et al. 2003). Perhaps a result of its opportunistic appetite, caracals may engage in surplus killing, unlike leopards, caracals rarely hoist their kill into trees and in undisturbed environments, caracals will instead scrape earth over an unfinished carcass and continually return to feed until it is gone (Grzimek et al. 2003; Kingdon, 2004; Sunquist and Sunquist, 2002).

Very little plant material is ingested, and then considered mostly accidental; larger quantities have been found in scats, but then together with scorpion remains (Avenant, 1993). They are known to kill and eat other carnivores, including Black-backed Jackal, Aardwolf (Proteles cristata), Bat-eared Fox (Otocyon megalotis), Cape Fox (Vulpes chama), Water Mongoose (Atilax paludinosus), Cape Grey Mongoose (Herpestes pulverulentus), Yellow Mongoose (Cynictis penicillata), Polecat (Ictonyx striatus), African Wildcat (Felis silvestris), Small-spotted Genet (Genetta genetta) and even conspecifics have been listed (Stuart, 1982; Bekker, 1994; Avenant, 1993; Kok, 1996; Melville, 2004; Braczkowski et al. 2012; Pohl, 2015).

3. Conservation and Threats of caracals

3.1 Conservation

The caracal is categorized as Least Concern by the International Union for Conservation of Nature and Natural Resources (IUCN); African populations are listed under CITES Appendix II while Asian populations come under CITES Appendix I. The Convention on International Trade of Endangered Species (CITES) lists Asian populations as Appendix I and all others as Appendix II. This means Asian populations may not be traded for any commercial reason, but trade involving scientific research is allowed. Appendix II indicates that trade of these animals will be controlled by authorization of permits in cases that will not detrimentally harm the species (CITES, 2009; Breitenmoser et al. 2008). In sub-Saharan Africa, the species is protected from hunting in about half of its range states (Nowell and Jackson, 1996).

3.1.1 Conservation conflicts with human

Conservation conflicts between human and wildlife populations are apparent across much of sub Saharan Africa (Happold, 1995; Balmford et al. 2001; Rondinini et al. 2006). These are compounded by shortfalls in conservation capacity, including funding, governance, and technical training for wildlife research and monitoring (Barrett et al. 2001; Bruner et al. 2004; du Toit et al. 2004; Struhsaker et al. 2005). Within Africa, attention to wildlife conservation has been focused most intensively on well-known parks and biodiversity hotspots in eastern or southern Africa (e.g., Serengeti-Mara, Kruger, and Eastern Arc Mountains). While such areas are deserving of attention, disproportionately little effort has been directed toward regions like West Africa, despite the latter's exceptional biodiversity and pressing conservation challenges (Bakarr et al. 2002; Ray et al. 2005; Norris et al. 2010). In fact, some conservation biologists have suggested abandoning West Africa, describing it as a "conservation disaster" and arguing that conservation dollars are best spent elsewhere (Terborgh, 1999). Indeed, many previous studies present a bleak outlook for wildlife in the region, depicting population declines and extinctions in the face of widespread habitat loss and bushmeat hunting driven by rapidly growing human populations (Barnes, 2002; Oates et al. 2000; Brashares et al. 2001, 2004; Fischer and Linsenmair, 2001; Beier et al. 2002; Oates, 2002; Thiollay, 2007; Craigie et al. 2010; Norris et al. 2010).

3.2. Threats of caracals

Habitat destruction (for expansion of agriculture and desertification) is a significant threat to the survival of the caracal in central, west, north and northeast Africa where caracals are naturally sparsely distributed (Ray **et al.** 2005). It is also likely to be the main threat in the Asian part of its range (Sunquist and Sunquist, 2002).

Brand (1989) found that Caracals are often killed in retaliation for preying on small livestock and they were responsible for the loss of up to 5.3 domestic stock / 100 km² per year and recorded 0.02–1.6 Caracal(s) killed or captured / 100 km² per year in the former Cape Province of South Africa. In more recent surveys, livestock farmers have indicated that Caracal is responsible for between 9% (in Mpumalanga) and 36% (in the Western Cape Province) of small stock predations and 11% of cattle calf predation in the North West Province (van Niekerk, 2010; Badenhorst, 2014). Some tribes kill it for its meat. In sub-Saharan Africa, the species is protected from hunting in about half of its range states (Nowell and Jackson, 1996). As of 1996, hunting of caracals is prohibited in Algeria, Egypt, Morocco and Tunisia. However, Namibia and South Africa recognize it as a "problem animal" (vermin) and allow it's hunting to protect livestock and aracals occur in a number of protected areas across their range (CITES, 2009; Breitenmoser et al. 2008). As Caracals are causing significant damage to the small livestock, cattle and game farming industries, they are subject to persecution through hunting, trapping and, in some areas, even poisoning (van Niekerk, 2010; Thorn et al. 2012; du Plessis, 2013; Badenhorst, 2014; Power 2014; Schepers, 2016). Stuart (1982) recorded that over the years 1931–1952, an average of 2,219 Caracals / year were killed in control operations in South Africa's Karoo ecosystem. In a similar environment, Namibian farmers responding to

a government questionnaire reported killing up to 2,800 Caracals in 1981 (Nowell and Jackson, 1996).

Cattle farmers in the North West Province have indicated Caracal as a serious damage causing animal (DCA) and game farmers in the Limpopo Province currently consider Caracal as one of the three major predators of game (Badenhorst, 2014; Schepers, 2016). In the North West Province, around 50% (N = 198) of surveyed game farms complained about the Caracal as a problem animal (Power, 2014). The annual persecution rate reported by farmers in the North West Province was 1.1 Caracals / 100 km^2, which compares favourably to the scale estimated for the Cape Province of 1.6 Caracals / 100 km^2 (Brand, 1989; Thorn et al. 2012). This rate may be higher in areas like the southern Free State where stock losses due to predation are reported to be amongst the highest in South Africa (van Niekerk, 2010).

4. Conclusion

Similar to all other species in the family Felidae, caracals are strict carnivores. Caracals have very speedy and agility body, and are successful predators capable of tackling prey two to three times their body size. The bulk of caracals diet is made up of hyraxes, hares, rodents, antelopes, small monkeys and birds; such as, doves and partridge in particular, are seasonally important as well as mountain reedbucks, dorcas gazelles, kori bustards, mountain gazelles, gerenuks and Sharpes, grysbok's are specific examples of what caracals might hunt and caracals consume some reptiles, although this is not a common component of the diet. It occupies a wide variety of habitats, from semi-desert to relatively open savannah and scrubland to moist woodland and thicket, evergreen forest, montane grassland, and arid mountains. It typically ranges up to 2,500 m and above 3,000 m asl in the Lesotho and Ethiopian Highlands respectively. This species is superbly adapted for life in arid environments and requires very little water, apparently getting adequate supplies of water from its food. Caracals are widely distributed across Africa (North, West, Central, South and East Africa), Central Asia, and southwest Asia into India.

The primary concern to be made comfortable for conservation of caracals is loss of habitat in northern, central, and western Africa. The habitat destruction (agriculture and desertification) is a significant threat in central, west, north and northeast Africa where caracals are naturally sparsely distributed. As Caracals are causing significant damage in the small livestock, cattle and game farming industries, they are subject to persecution through hunting, trapping and, in some areas, even poisoning.

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