

# The diet of caracal, *Caracal caracal*, in two areas of the southern Cape, South Africa as determined by scat analysis

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**Caracal (*Caracal caracal*) diet in southern Africa has primarily been quantified in protected areas dominated by natural vegetation. Here we present data on the diet of caracal ranging in two coastal landscapes (George and Vleesbaai, South Africa) with considerable anthropogenic modification (pine plantation and agricultural land). In terms of the corrected frequency of occurrence (CFO), rodents dominated the diet (>70%) and the vlei rat (*Otomys irroratus*) formed the bulk in terms of volume of the rodents recorded in the diet at both sites. Bushbuck (*Tragelaphus scriptus*) formed an important component of the diet in George (11.4% CFO) while small carnivores comprised 11.6% CFO in Vleesbaai. Although our results are relevant in light of the extensively modified vegetation of this part of South Africa's coastal region, they are unlikely to represent the full extent of the diet in Vleesbaai, as farmers in this region regularly report livestock losses attributed to caracal.**

**Key words:** carnivore diet, scat analysis, vlei rat, pine plantations, urban-development.

## INTRODUCTION

The caracal (*Caracal caracal*) is widespread across much of sub-Saharan Africa (Nowell & Jackson 1996; Macdonald & Loveridge 2010) and in southern Africa occurs in a wide variety of habitats including savanna, karoo, fynbos and Afrotropical forest. Despite its wide distribution, data from this mesocarnivore are limited compared to larger sympatric species such as leopards (*Panthera pardus*) and lions (*Panthera leo*). Previous studies in southern Africa indicate that mammals constitute most of caracal diet but that the importance of prey, such as rodents and ungulates, varies widely between studies (Grobler 1981; Moolman 1984; Palmer & Fairall 1988; Stuart & Hickman 1991; Avenant & Nel 2002; Melville *et al.* 2004). As caracal can be significant contributors to livestock losses on farmland (Avenant & du Plessis 2008), some work has focused on this aspect (Moolman 1984; Stuart & Hickman 1991; Melville *et al.* 2004). However, most caracal research has been done in protected areas. Here we report on the diet of caracal ranging in two coastal regions of the southern Cape. The natural vegetation of the region is dominated

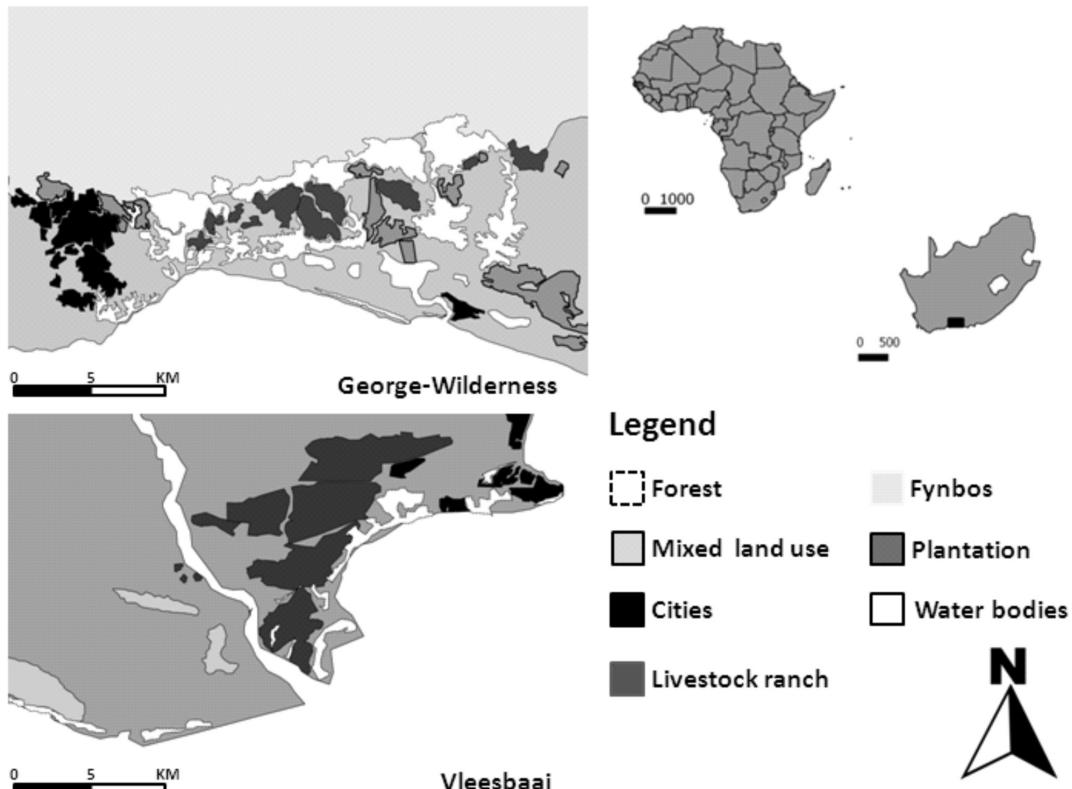
by forest and fynbos. However extensive areas have been developed as plantations and agricultural land. Against this background, our study aimed to investigate the dietary composition of caracal in two regions with strong anthropogenic modification.

## METHODS

### Study area

Our study was conducted in two regions of the southern Cape; the first in the George region (approximately 320 km<sup>2</sup> in size; midpoint = 33°58'S; 22°27'E) and the second approximately 53 km south of George, in the Fransmanshoek Conservancy centred around Vleesbaai (approximately 100 km<sup>2</sup>; midpoint = 33°57'S; 22°31'E). The George site is located on a narrow coastal strip at the base of the Outeniqua mountains, while Vleesbaai is part of an extensive coastal plateau in the southern Cape (Fig. 1). The region has a Mediterranean climate characterized by warm, dry summers and cool, wet winters. Due to the Outeniqua mountains, the mean annual rainfall (783 mm, mean annual; Van Zyl 2003) of the George region is higher than for the Vleesbaai region (436 mm, mean annual; Fransmanshoek

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**Fig. 1.** Maps of the two study localities. Vegetation is classed into broad units for comparative purposes and a detailed vegetation map is available in Mucina & Rutherford (2006).

Conservancy). In the George region, the dominant natural vegetation on the mountain slopes of the coastal strip is Southern Afrotemperate Forest and South Outeniqua Sandstone Fynbos (Mucina & Rutherford 2006). The natural vegetation is however interspersed with extensive pine plantations and rangeland, mainly for cattle (*Bos taurus*). The Vleesbaai site is dominated by Canca Limestone Fynbos, Groot Brak Dune Strandveld and patches of Southern Coastal Forest (Mucina & Rutherford 2006). The former is used as rangeland but has also been extensively transformed for cropland and pastureland, mainly for sheep (*Ovis aries*) and ostriches (*Struthio camelus*).

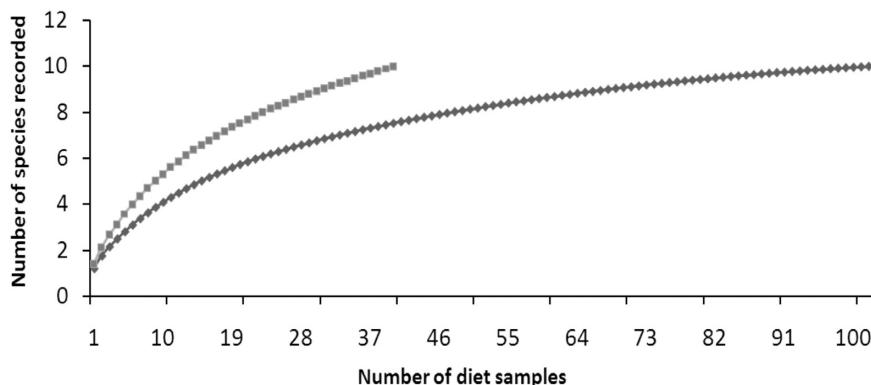
#### Scat collection and analysis

Caracal scats were collected opportunistically by the first and third author while hiking along roads and tracks in forest, plantation and pastures in George (May 2008 to September 2009). In the Vleesbaai region scats were collected by the third author along hiking trails in coastal forest, pastures and dune strandveld (June 2009 to Septem-

ber 2010). We mainly used the criteria of Norton *et al.* (1986) and Ott *et al.* (2007) to identify scats (*i.e.* <20 mm scat diameter) but also used tracks (Melville *et al.* 2004) and camera-trap photographs to confirm the origin of scats. We used the laboratory procedure of Martins *et al.* (2011) to analyse scats. Macroscopic remains were removed from each scat and compared with an osteological collection while hairs were microscopically examined and compared to reference material sourced from the Amathole Museum, King William's Town, and to published keys (Perrin & Campbell 1979; Keogh 1983) and the unpublished key of the African Centre of Ecology, Nelson Mandela Metropolitan University. We could not identify birds to species level and simply grouped them as 'Aves'. Mammal Nomenclature follows Skinner & Chimimba (2005).

#### Data analysis

For each site, we used EstimateS software (Colwell, 2009) to determine if prey species richness reached an asymptote for the collected scats.



**Fig. 2.** Sampling efficiency curves derived from EstimateS for caracal scats from the George (diamonds;  $n = 102$ ) and Vleesbaai study sites (squares;  $n = 40$ ).

Here we present the frequency of occurrence (FO) and the relative occurrence (RO) for comparison with previous studies. As the quantity of meat eaten per species decreases with the number of species per scat, we also present the corrected frequency of occurrence (CFO; Karanth & Sunquist 1995). The CFO is obtained by counting each prey item per scat as a proportion of the number of items in that scat (*i.e.* 0.5 if two prey items occurred in one scat).

## RESULTS

We collected 102 caracal scats in the George site and 40 in the Vleesbaai site. Analysis of sampling effectiveness suggested an asymptote was reached for George but not for Vleesbaai (Fig. 2). We recorded 15 mammal species in the diet across both sites (George = 10; Vleesbaai = 10) and a number of unidentified birds in George (Table 1). Rodents comprised most of the diet at both sites (George, CFO = 72.1%; Vleesbaai, CFO = 79.3%). In George, ungulates formed the next most common prey group (CFO = 15.4%), but ungulates comprised a low proportion of the diet in Vleesbaai (CFO = 2.5%). In Vleesbaai, small carnivores formed the next highest proportion of the diet after rodents (CFO = 11.6%) and this category was also important in George (CFO = 5.4%).

At the species level, the vlei rat (*Otomys irroratus*) formed the bulk of the diet at both sites (George, CFO = 69.6%; Vleesbaai, CFO = 66.7%; Table 1). In George, this was followed by bushbuck (*Tragelaphus scriptus*; CFO = 11.4%) and domestic cat (*Felis catus*; CFO = 4.1%), while at Vleesbaai the multi-mammate mouse (*Mastomys natalensis*; CFO = 8.8%) was the next most abundant prey, followed by the Cape grey mongoose

(*Galerella pulverulenta*; CFO = 8.3%). Scrub hares (*Lepus saxatilis*) were also recorded at Vleesbaai (CFO = 4.6%) but were not recorded in the diet of caracal in George.

## DISCUSSION

Similar to previous studies (*e.g.* Melville *et al.* 2004); mammals dominated the diet of caracal at both our sites. As we found too, rodents have been shown to be the dominant prey in several studies (Palmer & Fairall 1988; Stuart & Hickman 1991; Avenant & Nel 2002; Melville *et al.*, 2004) but of low importance in others (Grobler 1981; Moolman 1984). In our study, rodents dominated the diet of caracal at both sites, and our results are in the order of some of the highest reported frequencies of rodents in the diet of caracal (see also Avenant & Nel 2002; Mukherjee *et al.* 2004). Of the rodents, the vlei rat was the most important prey, forming the bulk of the diet at both sites (CFO > 65%). Caracal are considered generalist and opportunist feeders (Avenant & du Plessis 2008) and the importance of this species in caracal diet is probably related to its high abundance in both sites, although this was not quantified.

In George, bushbuck constituted an important prey item, but was not recorded in the diet at Vleesbaai. This probably reflects the relatively high abundance of bushbuck in the forests of the George region, compared to their relatively low abundance in the more open fynbos and transformed vegetation of the Vleesbaai region (Braczkowski *et al.* 2012). Although the caracal's use of bushbuck was considerably lower than that recorded for leopard in George (11.4% vs 58.3% CFO; Braczkowski *et al.* 2012) the occurrence of this species in their scats reaffirms the

**Table 1.** Prey of caracal in George and Vleesbaai. *n* = number of samples.

Species name	George ( <i>n</i> = 102)			Vleesbaai ( <i>n</i> = 40)		
	% Frequency of occurrence	% Corrected frequency	% Relative occurrence	% Frequency of occurrence	% Corrected frequency	% Relative occurrence
<b>Rodents</b>						
Vlei rat, <i>Otomys irroratus</i>	79.4	69.6	65.3	80.0	66.7	57.1
Striped mouse, <i>Rhabdomys pumilio</i>	3.9	2.0	3.2	7.5	3.8	5.4
Woodland dormouse, <i>Graphiurus murinus</i>	1.0	0.5	0.8	10.0	8.8	7.1
Multi-mammate mouse, <i>Mastomys natalensis</i>						
<b>Ungulates</b>						
Bushbuck, <i>Tragelaphus scriptus</i>	12.8	11.4	10.5			
Blue duiker, <i>Philantomba monticola</i>	2.0	2.0	1.6			
Bushpig, <i>Potamochoerus larvatus</i>	2.0	2.0	1.6			
Cape grysbuck, <i>Raphicerus melanotis</i>						
<b>Carnivores</b>						
Domestic cat, <i>Felis catus</i>	7.8	4.1	6.5	5.0	2.5	3.6
Cape grey mongoose, <i>Galerella pulverulenta</i>	2.0	1.3	1.5	17.5	8.3	12.5
Large spotted genet, <i>Genetta tigrina</i>				2.5	0.8	1.8
<b>Other mammals</b>						
Baboon, <i>Papio hamadryas</i>	1.0	1.0	0.8	10.0	4.6	7.1
Scrub hare, <i>Lepus saxatilis</i>				2.5	0.8	1.8
Rock hyrax, <i>Procavia capensis</i>				2.5	1.2	1.8
Round-eared elephant shrew, <i>Macroscelides proboscideus</i>						
<b>Aves</b>	9.8	6.1	8.1			

findings of others that recorded medium-sized ungulates in their diet (e.g. Grobler 1981; Avenant & Nel 2002). The two bushpig (*Potamochoerus larvatus*) remains found in the scats collected in George probably represent scavenging episodes as observed in other studies (e.g. Van Heezik & Seddon 1998; Avenant & Nel 2002).

Similar to the study of Melville *et al.* (2004), small carnivores also formed an important component of caracal diet in both our sites, and Cape grey mongoose and domestic cats were recorded as eaten at both sites. These findings strengthen the notion of the caracal's proclivity for small carnivores (Bothma & Walker 1999; Melville *et al.* 2004). In George, a camera trap set in the residential periphery recorded a number of caracal photographs (Braczkowski, unpubl. data) and the scats containing domestic cat were collected <1 km from this site.

Although our results suggest that rodents are an important prey for caracal in both our study sites, frequency of occurrence methods may overemphasize the importance of smaller prey items in the diet of carnivores (Klare *et al.* 2011). Relative biomass is considered a superior diet index (Klare *et al.* 2011) but due to the absence of a suitable live mass correction factor we did not calculate this index (e.g. Ackerman *et al.* 1984). We also did not use a direct mass estimate (e.g. Grobler 1981) as this is likely to overestimate the importance of larger prey items that are not completely consumed by caracal. We recommend that future studies of caracal diet incorporate a volumetric approach (e.g. Avenant & Nel 2002) in combination with a correction factor for ecologically analogous species (e.g. *Lynx rufus*, Baker *et al.* 1993; *Lynx lynx*, Rühe *et al.* 2007).

Our study did not detect the presence of livestock in caracal scats at both sites. In the George region, cattle are the main form of livestock and conflict is limited (CapeNature, unpubl. data). By contrast, sheep and ostrich dominate the livestock in the Vleesbaai region and conflict is relatively high, and at least 60 caracal hunting permits have been allocated to farmers in the region (Cape Nature, unpubl. data). Although our scats do not reflect the conflict in Fransmanshoek, this finding should be treated with caution due to the small sample size from the region.

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