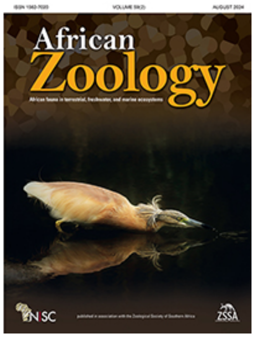

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Short Communication

Cape genet *Genetta tigrina* diet in the Albany Thicket Biome, South Africa

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The diet of the Cape genet *Genetta tigrina* is only well known in the coastal forests of South Africa, where either arthropods or small mammals are their dominant prey. Here, we aimed to demonstrate this species' opportunistic behaviour by investigating its feeding habits in the Albany Thicket Biome (Great Fish River Nature Reserve, Eastern Cape). We analysed 61 scats collected across the four seasons of the year deposited at 15 latrines by Cape genets, as confirmed through video-recordings. Small mammals were primary and arthropods secondary prey, respectively. We recorded seasonal variations in both percentage occurrence and volume of food remains, with peaks in consumption of small mammals in winter, and arthropods in spring–summer. The consumption of supplementary food items such as plant material was higher in spring and autumn, and particularly seeds/fruit in autumn. Reptiles and other food items occurred as trace foods throughout the year, although birds reached a peak in winter. Intermediate to high diet diversity and low to intermediate diet breadth indices were obtained for all seasons. Inter-seasonal diet overlap was intermediate to high depending on the diet descriptor and pairs of seasons considered. Cape genet is therefore a generalist opportunist forager that likely adjusts its diet according to seasonal variations in main prey availability, potentially leading to apparent seasonal or local "specialisms".

Keywords: Carnivora, diet, generalist opportunist forager, *Genetta tigrina*, scat analysis, seasonal variations

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The Cape genet *Genetta tigrina* (Order Carnivora, Family Viverridae) is endemic to South Africa and Lesotho (Gaubert and Do Linh San 2015). It is distributed along the coast from about Lambert's Bay southward to Cape Agulhas and eastward to west of Durban/Pietermaritzburg. It occupies a wide variety of habitats, namely coastal forests, fynbos, thickets as well as agricultural lands and peri-urban areas with dense vegetation cover, but generally avoids more open habitats (Gaubert 2013; Widdows et al. 2016). In comparison to the common or small-spotted genet *G. genetta* (see review in Gaubert et al. 2024), there are few studies on the ecology and biology of the Cape genet. An in-depth revision of the genus *Genetta* by Gaubert et al. (2005) revealed that previous research conducted on *G. tigrina* in Botswana (Smithers 1971), Zimbabwe (Smithers and Wilson 1979) or in captivity (Wemmer 1977) in fact involved the rusty-spotted genet *G. 'maculata'* (a taxonomically inappropriate specific name; ICZN 2007). Similarly, recent studies carried out in a peri-urban area in KwaZulu-Natal (e.g. Widdows and Downs 2015, 2016; Widdows et al. 2015) most likely also involved *G. 'maculata'* based on currently available evidence (https://inaturalist.org).

Like other genet species, the Cape genet is partly arboreal but otherwise generally forages on the ground (Gaubert 2013). Faeces are deposited at latrine sites, usually located inside burrows or ground holes, on top of termite mounds, inside hollow branches and tree trunks, or on rocks (Roberts et al. 2007; Carvalho et al. 2024). In the coastal dune forest of Dwesa Nature Reserve (Eastern Cape), Cape genets prey mainly on arthropods based on the frequency of occurrence and the volume of remains found in scats (Roberts et al. 2007). However, an unpublished study carried out in the coastal belt forest of Vernon Crookes Nature Reserve (KwaZulu-Natal) revealed that, although remains of arthropods are found in almost every scat sample, their contribution to the diet in terms of biomass is insignificant compared to that of small mammals (Maddock 1988). This difference between these study sites is not surprising, as Roberts et al. (2007) reported that Cape genet diet varies not only seasonally but also based on habitat type (e.g. forest, riparian, beach) within the same Indian Ocean Coastal Belt biome.

In the present study, we investigated the diet of the Cape genet in a different biome (Albany Thicket), with the aim to demonstrate its opportunistic foraging habits. Previous studies in the study area indicated that ground arthropod biomass culminates in summer and is very low in winter (Mdodana 2014; Sikade 2017). Rodent availability and biomass is overall higher in winter or autumn (Arnolds 2009; Bizani 2014). We therefore predicted that the Cape genet, like the intensively studied common genet, would display seasonal changes in its diet due to variations in abundance/availability of these main prey/food items.

The study was conducted in the Great Fish River Nature Reserve (GFRNR; Eastern Cape, South Africa), which spans between *ca* 32°55' S, 26°27' E and 33°08' S, 26°58' E. The reserve falls within the Albany Thicket Biome and its dominant vegetation type is the Great Fish Thicket (Hoare et al. 2006). It is characterised by a mixture of dense evergreen sclerophyllous shrubs and scattered bushclumps surrounded by a matrix of karroid shrublets. The area is semi-arid, with summer temperatures often exceeding 35°C. Rainfall generally peaks in October and March (Birch et al. 1999).

Genet latrines were located between May and August 2017 by means of pedestrian transects (see Carvalho et al. 2024 for more details). Because *G. tigrina* and *G. genetta* occur in syntopy in the riverine areas of the study area (Xhobani 2024), identification of Cape genet scats could only be achieved through video-recordings of genet visits. Video-monitoring of latrines was achieved by placing one to two camera-traps (Bushnell NatureView HD Essential, 12 MP Infrared Glow, USA) against tree trunks or fixed to wooden poles (w × b × h: 5 × 5 × 90 cm) knocked into the ground. Cameras were set to take 1 min video-clips with an effective 5–10 s time interval between successive clips. Scats were initially collected from a pool of > 40 latrine sites that were visited monthly between September 2017 and August 2018. Due to biological and logistic challenges that were beyond our control (see Discussion), sample size was later increased through additional scat collection during 2-week field sessions (Nov. 2019, Feb. 2020, Oct. 2020, Jan.–Feb. 2021, Apr. 2021 and Aug. 2021). Collected scats were placed in Ziploc bags and information such as date, scat number and latrine code were recorded. A picture of the exact micro-site where the scat was deposited was taken with a DSLR camera (Canon EOS 1300D) to later cross-check the information with the video-recordings. Only isolated scats (i.e. not part of a pile) that could be linked to a Cape genet visit revealing defaecation at the corresponding micro-site were included in our analyses. Scats were stored in a freezer until needed for analysis.

Scats removed from the freezer were first transferred to a Petri dish for thawing at room temperature. They were then dried in an oven (Labcon Growth Chamber, Model "L.T.G.C.") for a period of 36 hours at 50°C and weighed (i.e. dry weight) using a digital balance (Sartorius, Model "Excellence"). Scats were then soaked overnight in beakers filled with water to soften them. They were broken down and placed in a 1 mm mesh sieve above a 0.5 mm sieve and washed through running water. The remaining content was then dried again in an oven at 50°C for 36 hours. Each dried scat was teased apart using tweezers and spread over 10 × 10 cm or 20 × 20 cm grids (depending on volume) to allow for the proportion of each prey category to be estimated. A dissecting microscope (Lasec, Model "Bestscope BS-3040") was used to identify food remains. The different food items were separated into broad prey categories such as (1) mammals, (2) arthropods, (3) birds, (4) reptiles, (5) plant material (fibrous material, grass and leaves), (6) seeds/fruit, and (7) unidentified material. When present, hair samples (*ca* 10 hairs randomly selected from fur remains) were taken from scats to identify the corresponding mammalian prey. Impressions of hair were made on slides using a 5% solution of gelatine (Do Linh San et al. 2009), and hair imprint (i.e. cuticular) patterns were identified under a compound microscope (Lasec, Model "UB202I") using published information and a private collection of digital pictures of scale patterns of hairs of small mammals collected during previous studies (Perrin and Campbell 1980; Arnolds 2009; Bizani 2014; Filonzi 2022).

The challenges of assessing carnivore diets from hard prey remains in faecal samples have been extensively discussed in the literature. Following the best-practice recommendations of Klare et al. (2011), we determined the diet of Cape genet using the following complementary frequency and volumetric descriptors: (1) percentage occurrence (PO, Number of scats in which a food item or category occurred / total number of scats examined × 100); (2) percentage volume (PV) of each food item or category in the scats. In addition, we calculated a combined metric, namely the percentage overall importance (POI) of each food category, and plotted PV against PO on paired axes (Maddock et al. 2016). Primary food categories were considered those above the 25% isopleth and secondary categories between the 6% and 25% isopleths. Supplementary categories were considered to be between the 1% and 5% isopleths, while categories below the 1% isopleth were regarded as "trace" foods.

Four seasons were considered in our analyses: spring (September–November), summer (December–February), autumn (March–May) and winter (June–August). Seasonal variations in the number of food categories and items found in scats, percentage volume of food categories, and percentage volume of dominant food items were tested with a Kruskal–Wallis test since the data were not normally distributed (Kolmogorov–Smirnov tests, $p < 0.05$). These analyses were carried out with the software SPSS 28.0 (SPSS Inc.).

We used formulas given in Krebs (1999) to calculate: (1) Shannon–Wiener diet diversity index (H'; range 0–2.807 for seven food categories); (2) the diet diversity ratio or evenness of representation (J'; range 0–1); (3) Levin's standardised niche breadth: (B_A; range 0–1) and (4) Pianka's dietary niche overlap (α; range 0–1) between seasons. For all these indices, the relative frequency of occurrence (RFO, number of scats in which a food category occurred divided by the sum of occurrences for all food categories) and the relative volume (RV = PV/100) were used as proportions to represent each food category. Following Do Linh San et al. (2020), to facilitate interpretation, J', B_A and α values were regarded as low/narrow when < 0.35, intermediate when between 0.35 and 0.65, and high/broad when > 0.65.

We used Brillouin (1956) index equation to estimate the sampling effort adequacy of food diversity consumed in different seasons,

$$H_b = \frac{\ln N - \sum \ln n_i}{N}$$

where H_b is the diversity of food categories, N is the total number of food categories in all samples (scats) and n_i is the number of food categories in the ith sample. A diversity curve was calculated by resampling with replacement over the range of scats obtained in each season, in increments of 2. For each sample, a value for H_b was calculated and then resampled 10 000 times to obtain a mean and 95% CI following recent adaptations of the method (Hass 2009; Müller et al. 2022). Adequacy of scats sampling effort was determined by whether an asymptote was reached in the diversity curve and another curve calculated from the incremental change in each H_b with the addition of two more samples (< 1%). Sampling effort adequacy analyses were performed using the R statistical platform, version 3.6.1 (R Core Team 2019).

We collected and analysed 61 scats deposited at 15 latrines by Cape genets, as confirmed through video recordings. The mean number (± SD) of food categories and items per scat was 2.49 ± 0.89 (range 1–4) and 3.51 ± 1.43 (range 1–7), respectively. Dominant items accounted for a mean of 81.21 ± 16.43% of the percentage volume across all scat samples (Table 1). There was no significant seasonal difference in the number of food categories ($H = 2.198$, df = 3, $p = 0.53$), food items ($H = 7.10$, df = 3, $p = 0.07$) and percentage volume of dominant items ($H = 5.69$, df = 3, $p = 0.13$) per scat. Our sampling effort was adequate in most seasons considered, with diversity curves reaching an asymptote and the incremental change decreasing to < 1% at ≥ 15 scats for spring ($n = 16$ scats), ≥ 14 scats for autumn ($n = 19$) and ≥ 15 scats for winter ($n = 16$) (Figure 1). For summer, however, our 10 scats only allowed reaching an incremental decrease of < 2.3% (Figure 1).

Mammals (72%) and arthropods (70%) were the dominant categories in terms of percentage occurrence (PO), followed by plant material (54%), seeds/fruit (34%), birds (7%), unidentified material (7%) and reptiles (7%). Among mammals, some species such as *Elephantulus rupestris* (found in 50% of 44 scats containing hair remains) and *Grammomys cometes* (23%) were mostly predated in autumn and winter. *Rhabdomys pumilio* (20%) was frequently consumed in autumn, while *Mus minutoides* (9%), *Otomys unisulcatus* (5%) and *Crocidura cyanea* (2%) remains were only found in winter scat samples. *Micaelamys namaquensis* (9%) and *Otomys irroratus* (7%) were mainly or exclusively eaten in spring. Coleoptera (67%) was the arthropod order consumed most often, followed by Orthoptera (44%) and Scorpiones (26%), while Ixodida (3%), Blattodea (2%) and Diplopoda (2%) contributed the least towards the diet of *G. tigrina*. Nine of the 21 seeds ingested by genets could not be identified. Five seeds of *Euclea* sp. and seven seeds of *Vachellia* sp. showed no damage from passage through the alimentary tract.

Mammals (50%) had the highest overall percentage volume (PV), followed by arthropods (32%), plant material (8%), birds and seeds (4% each) and reptiles and unidentified material (1% each) (Figure 2). There was a significant seasonal difference in the percentage volume of mammal ($H = 13.23$, df = 3, $p < 0.05$), arthropod ($H = 24.69$, df = 3, $p < 0.001$), plant ($H = 10.80$, df = 3, $p < 0.05$) and seeds/fruit ($H = 11.68$, df = 3, $p < 0.05$) remains in scats (Figure 2). The consumption of mammals culminated in winter, and that of arthropods in spring and summer. The ingestion of plant material was higher in spring and autumn, and particularly seeds/fruit in autumn. Birds were essentially consumed in winter.

Mammals were the primary food category in the diet of Cape genet when considering the percentage overall importance (POI) (Figure 3). Owing to their lower volumetric contribution, arthropods were only secondary prey. Plant material and seeds/fruit acted as supplementary foods, while the other categories were only present as trace foods.

When comparing diet diversity over the year using Shannon–Wiener's formula, the diversity indices (1.17–2.27; $H'_{max} = 2.8074$), and therefore the evenness measures of representation (0.42–0.81), were intermediate to high, with only slight variations between seasons (Table 1). The seasonal and yearly values calculated with RFO and RV did not differ substantially. The standardised niche breadth was intermediate (0.42–0.53) when calculated with RFO, but values obtained with RV were low to very low (0.11–0.33). The diet overlap indices between the six possible seasonal dyads were generally high with both RFO (0.81–0.94) and RV (0.79–0.98), although intermediate overlaps were recorded between spring and winter (0.51) and between summer and winter (0.63), using RV as proportions.

Little research has been conducted on the diet of the Cape genet. A previous study conducted in the former Cape Province (Stuart 1981) was based on the frequency

Table 1: The number of Cape genet *Genetta tigrina* scats collected in the Great Fish River Nature Reserve (Eastern Cape province, South Africa) between September 2017 and August 2021 with corresponding seasonal dietary parameters

Parameters	Spring	Summer	Autumn	Winter	Year
Number of scats	16	10	19	16	61
Mean number of food categories per scat (n)	2.44 ± 0.89	2.40 ± 0.97	2.74 ± 0.73	2.31 ± 1.01	2.49 ± 0.89
Mean number of food items per scat (n)	3.56 ± 1.36	4.40 ± 1.65	3.53 ± 1.12	2.88 ± 1.50	3.51 ± 1.43
Mean percentage volume of dominant items in scats (%)	80 ± 18%	81 ± 17%	76 ± 16%	89 ± 13%	81 ± 16%
Shannon–Wiener diversity index (H')					
With RFO	2.17	2.10	2.09	2.27	2.29
With RV	1.49	1.18	1.82	1.17	1.80
Evenness of representation (J')					
With RFO	0.77	0.75	0.74	0.81	0.82
With RV	0.53	0.42	0.65	0.42	0.64
Standardised dietary niche breadth (B_A)					
With RFO	0.48	0.42	0.52	0.53	0.55
With RV	0.23	0.18	0.33	0.11	0.29

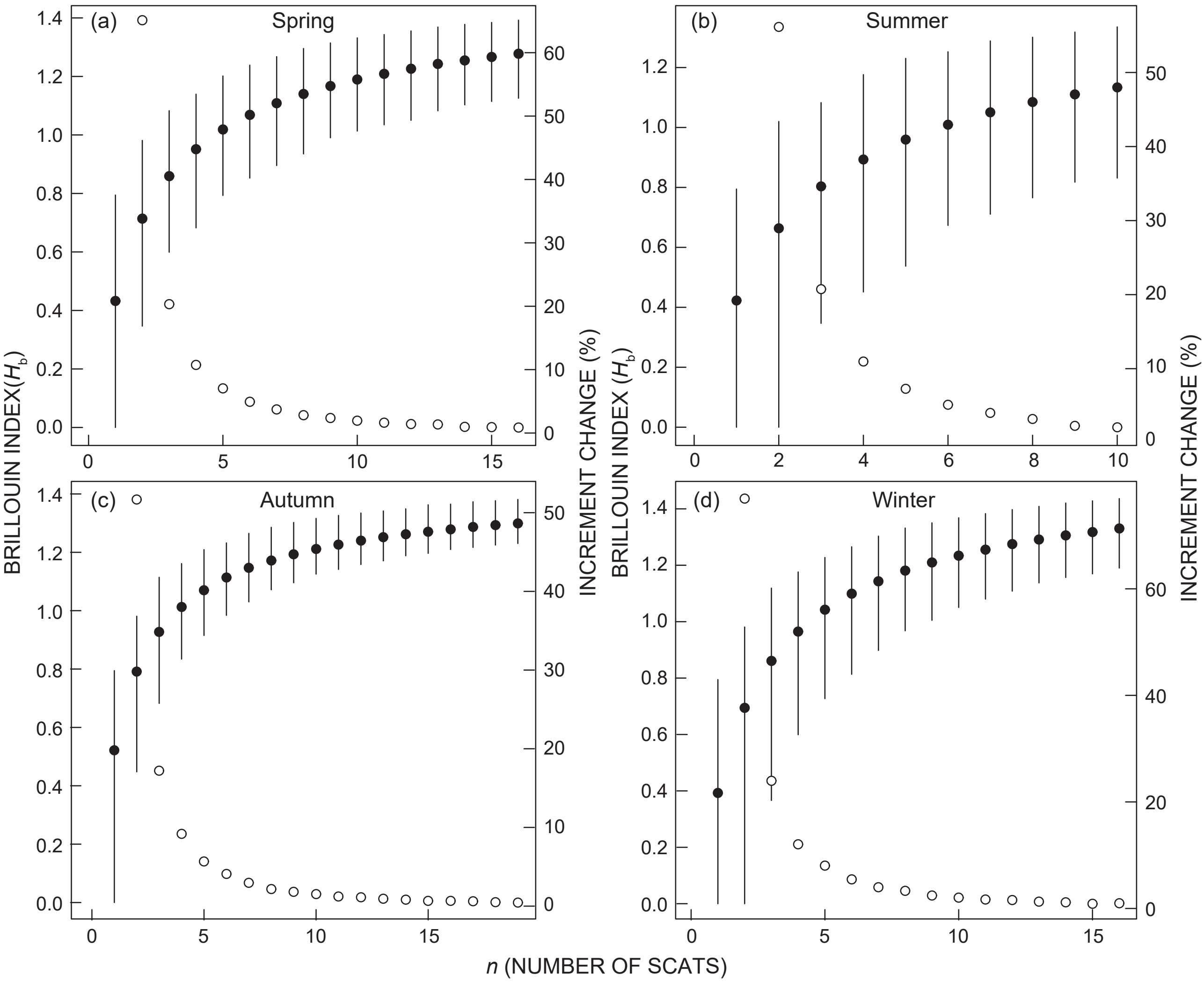

Figure 1: The seasonal Brillouin diversity curves (black dots) and percentage (incremental) change curves (white dots) for the diet of Cape genet *Genetta tigrina* in the Great Fish River Nature Reserve. Mean values and 95% CI intervals were obtained by resampling with replacement 10 000 times

of occurrence of different vertebrates, invertebrates and plant material in only 17 stomachs. This contrasts with the studies of Maddock (1988) and Roberts et al. (2007) in which 113 and 372 scat samples were collected across the year and analysed, respectively. According to modelling simulations from Trites and Joy (2005), a minimum of 59 scats are necessary to identify principal prey remains of a target carnivore, but 94 scats are needed to detect dietary changes over time (e.g. across years) or between areas. Of course, these thresholds will vary depending on the study species and their level of dietary specialisation – the more specialised the diet, the lower the number of scats needed. We managed to obtain 61 scats that revealed the presence of two dominant prey categories, which therefore should allow for a fair evaluation of Cape genet diet in the GFRNR. In addition, except for summer, our analyses focusing on the Brillouin diversity index indicated that the number of scats collected seasonally was appropriate to highlight broad seasonal differences. Despite extensive field efforts, obtaining a larger sample size of *G. tigrina* scats was hindered by the species' lower abundance and its confinement to riverine areas compared to *G. genetta* (E Do Linh San and F Carvalho, unpublished data) and the difficulty distinguishing numerous scats due to overmarking. Additionally, dung beetles, birds and ungulates contributed to the rapid degradation or disturbance of scat samples (Xhobani 2024; R Marikhele pers. obs.), impacting their collection during latrine visits.

In our study, percentage occurrence (PO) and percentage volume (PV) were calculated, and the combined percentage overall importance (POI) index revealed that *G. tigrina* feeds mainly on small mammals (primary prey), followed by arthropods (secondary prey). The third most consumed category was plant material. Grass was the main type of plant material that was consumed and "remains" were usually located at the distal end of scats. Grass helps in digestion, removes hairs from the intestines and also speeds up vomiting (Roberts et al. 2007). According to

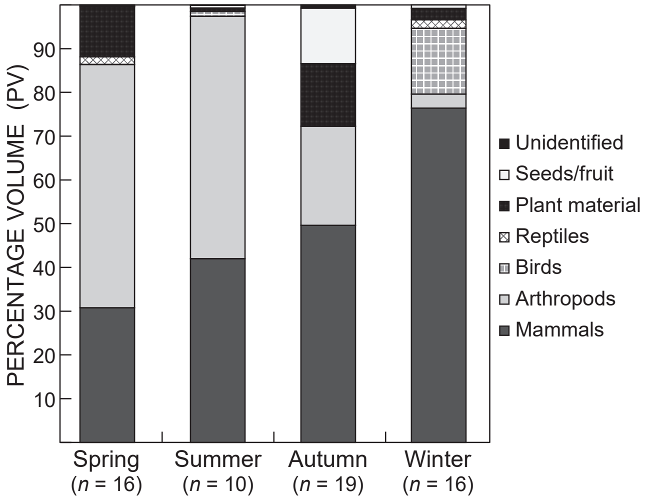

Figure 2: The seasonal percentage volume of prey items found in the scats (*n* = 61) of *Genetta tigrina* in the Great Fish River Nature Reserve, Eastern Cape province, South Africa

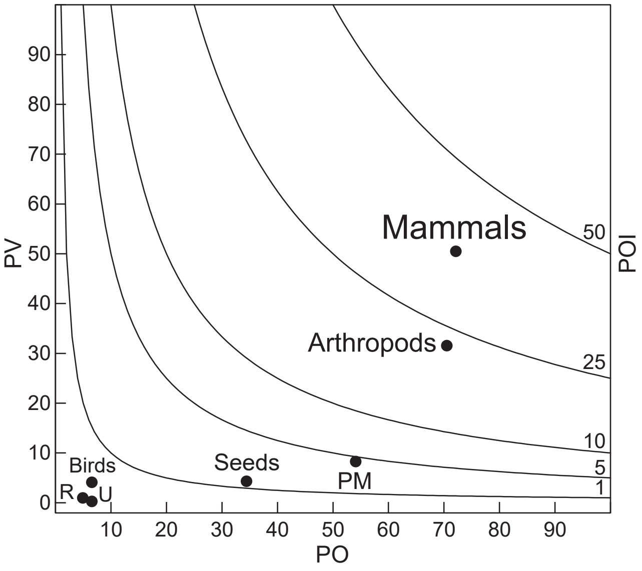

Figure 3: Graphical representation of the percentage overall importance (POI) of the broad food categories in the diet of *Genetta tigrina* based on the analysis of 61 scats collected between October 2017 and August 2021 in the Great Fish River Nature Reserve. Percentage volume (PV) is plotted against percentage occurrence (PO) of the corresponding food category. Isopleths connect points of equal overall importance. Font size used to represent food categories is proportional to their overall importance. PM, Plant material; R, Reptiles; Seeds, Seeds/fruit; U, Unidentified material

Widdows and Downs (2015), grass was commonly found in *Genetta* sp. scats that contained a large proportion of fur (as initially noted by Morris 1996 for felids) and this was also observed in scats of *Canis mesomelas* by Loveridge and Macdonald (2003). Birds only acted as trace foods and were reported to be more or less important in other studies of *Genetta* spp. (Roberts et al. 2007; Amroun et al. 2014; Widdows and Downs 2015). Similarly, reptiles were only found in small proportions in the diet of Cape genet, as also found for *G. 'maculata'* in Zimbabwe (PO = 8%; Smithers and Wilson 1979) and Botswana (PO = 1%; Smithers 1971). Seeds and remains of fruit pulp were found in Cape genet scats, and fruit consumption has also been reported for this and other genet species (Roberts et al. 2007; Rosalino et al. 2010). Amphibians were absent from the diet, which is in line with what has been observed in the Dwesa Nature Reserve (Roberts et al. 2007). This could be linked to their lack of palatability or low abundance in the GFRNR. Overall, the wide range of food items consumed across the year corresponds to that of a generalist rather than a specialist forager.

In addition, as expected for an opportunist forager, the diet of the Cape genet varied seasonally. Small mammal consumption culminated in winter, which coincides with peaks in rodent numbers and biomass recorded in several habitats of the GFRNR (Arnolds 2009; Bizani 2014). This also aligns with other genet diet studies where small mammals were mostly consumed in autumn and winter (Rosalino and Santos-Reis 2002; Amroun et al. 2014; Zemouche 2018). In contrast, arthropods contributed the most in spring and summer and the least in autumn and winter, when arthropod abundance and biomass decrease in the GFRNR (Mdodana 2014; Sikade 2017). Comparable findings were reported in other genet studies where insect occurrence was higher in warmer seasons (Rosalino and Santos-Reis 2002; Roberts et al. 2007; Sánchez et al. 2008). The intake of birds was highest in winter, as noted by others, and has been associated with birds' mating season (Virgós et al. 1996; Roberts et al. 2007; Sánchez et al. 2008). Reptiles contributed the most in the diet of *G. tigrina* in spring – likely due to increased activity of reptiles at higher temperatures (Blair 2009) – and winter – possibly with reptiles being easier to catch when they are lethargic.

To summarise, this study showed that small mammals and arthropods are respectively the primary and secondary prey of *G. tigrina* in the Great Fish River Nature Reserve. Plant material supplemented its diet in spring and autumn, and particularly seeds/fruit in autumn, as well as birds in winter. The wide spectrum of food items consumed, associated to the low to intermediate diet breadth, indicate that the Cape genet is a generalist opportunist forager that seasonally consumes – as driven by variations in climatic conditions, vegetation and prey life cycle – the most abundant and likely most profitable prey, such as small mammals and arthropods in the GFRNR. The same reasoning could explain the existence of apparent local dietary "specialisms" in genet populations living in less variable environments. Further studies with larger sample sizes are recommended to confirm the seasonal patterns observed in our study. In addition, estimating the biomass ingested, as well as the energetic content and nutritional value of the different food items, would help gain a better understanding of the Cape genet's dietary ecology.

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