Seasonal variation in the diet of common quail *Coturnix coturnix* in the Eastern Cape

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Crops were analysed and dietary components identified from a total of 175 quails (*Coturnix coturnix*) sampled on several farms in the Alexandria district (Eastern Cape) during Sept 1994–Sept 1995. Quail were found to feed primarily on forb seeds and insects. Diet did not vary between male and female quail, but varied seasonally, with a decrease in seed consumption during the period of peak quail abundance and breeding (October–November), when insect consumption increased. Overall, seed was the dominant food type (both in frequency and quantity). Quail have a seasonally varied diet, relying on seeds of forbs characteristic of cultivated and fallow fields.

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The quail *Coturnix coturnix* is a popular gamebird species, with many thousands hunted in South Africa annually. Despite its status as a gamebird, our understanding of the ecology of this species is limited, with Bourquin's (1980) study of quail in Kwazulu/Natal being the most comprehensive. There is a heavily hunted population of quail in the Alexandria District, Eastern Cape, which exhibits strong seasonal changes in abundance. The quail are present in very high densities during spring and early summer while breeding, and then most migrate out of the area for the remainder of the year. Ecological information needed for sustainable utilization of this population is virtually non-existent (Little 1993).

Literature on the diet of *C. coturnix* is scarce. Dietary descriptions tend to be generalised e.g. seeds of grasses, weed and fallen grain, arthropods, buds, tubers, flowers, worms and molluscs (Winterbottom 1967; Clancey 1976; Wynne-Jones 1993; Maclean 1993). According to Bourquin (1980), winter diet comprises mainly seeds of weeds, grasses and agricultural crops, whilst in the summer months, quail diet is dominated by invertebrates. No such data are available for the Eastern Cape population, and this study reports on the diet of quail in the Alexandria District. We were specifically interested in determining whether quail consumed crops, and also whether quail diet could be related to the seasonal changes in quail density.

A total of 175 quail (85 females, 90 males) were collected on farms in the Alexandria district (Eastern Cape) from September 1994 to September 1995. Samples were obtained from an opportunistic hunting effort and it was therefore not possible to obtain samples on a rigorous seasonal basis, and most specimens were collected in the season of peak abundance during the austral spring.

The crops were removed and preserved in 70% ethyl alcohol. Dietary analysis was performed on a percentage/area basis (Martin, Gensch & Brown 1946), using a petri dish with 0,5 x 0,5 cm gridlines to estimate the area of each food item under a dissecting microscope, in relation to the total area of the total crop contents, expressed as a percentage.

Food items were categorized as seeds, insects, herbage, fruits or other (grit, etc.), and reported as percentage contribution to crop contents and as frequency of occurrence.

Grass and forbs occurring in the study area were collected and identified. This collection was used, in collaboration with seed identification manuals (Martin & Barkley 1961; Van Oudtshoorn 1992), to identify seeds recovered from quail crops. Herbaceous items in the crops were identified following McAllister & Bornman (1972). Slides were made from plant material in the crops and the reference collection and using the epidermal structures as a guide, these were matched to reference slides.

All invertebrates were identified following Annecke & Moran (1982); Scholtz & Holm (1986) and Migdoll (1988) to family level. As a result of discoloration in the preservation medium, it was not possible to identify the lepidopteran larvae.

Dietary components were compared between sexes and between seasons using Student's t on arcsine transformed data (Zar 1984). We identified October and November as the season of peak quail abundance, and March to August as the season of low quail abundance from surveys during the sampling (unpubl).

The overall diet of quails was dominated by seed (69.5%), followed by insects (21.5%), fruit (5.1%) and herbage (3.3%). More specifically, the grass seed *Panicum* sp. was the dominant seed, both in frequency and quantities, followed by *Sorghum* sp. (millet), *Rumex* (dock) and *Solanum* (nightshade) (Table 1).

Dominant invertebrate species from the beetle order included members of super families Caraboidea (family Carabidae), Curculionoidea (Curculionidae) or weevils and Pentatomidae (stink bugs) from the order Hemiptera. Although weevils were found frequently, quantities were not high, whereas Lepidopteran larvae were found both in great numbers and large quantities (Table 1).

The only herbage present was lucerne (*Medicago sativa*). Small amounts of other objects such as grit and eggshell were also found (Table 1).

Males and females consumed similar amounts of seed and herbage, but females consumed more insects and less fruit than males (Figure 1). These differences were not significant ($t < 0.78$; $df = 173$; $p > 0.05$).

Quail exhibited strong seasonal shifts in their diet. During the peak in abundance (October–November), the diet was more varied, including herbage, which was not consumed at other times of the year (Figure 2). In addition, the intake of seed was significantly lower ($t = 3.17$; $df = 123$; $p = 0.0019$), and that of insects was significantly higher ($t = 2.17$; $df = 123$; $p = 0.03$) than during the period from March to August (Figure 2). The increased intake of fruit during spring (Figure 2) was not significant ($t = 1.30$; $df = 123$; $p = 0.19$).

Females showed greater seasonal shifts in diet than males, consuming significantly ($t = 2.62$; $df = 59$; $p = 0.011$) less seed (60.2%) during the spring peak in abundance than during winter (85.7%), and consuming significantly more insects during spring (29.7%, $t = 2.25$; $df = 59$; $p = 0.028$) than winter (10.2%). In contrast, although lower, male intake of seeds in spring (69.7%) and winter (90.2%) was not significantly dif-

Table 1 Food items found in Eastern Cape quail crops (n = 175) between September 1994 and September 1995, expressed as frequency of occurrence (no. of crops and %), and the mean percentage contribution of each item to the crop contents

Food item	Frequency of occurrence: No. of crops	Frequency of occurrence: %	% food item/crop ± *SE*
Seeds			
Forbs: *Eleocharis* sp. (spikerush)	1	0.6	0.2
Physalis sp. (groundcherry)	1	0.6	0.1
Polygonum sp. (knotweed)	7	4.0	1.0 ± 2.0
Oxalis sp. (suring)	3	1.7	0.1 ± 0.6
Solanum sp. (nightshade)	12	6.9	3.9 ± 2.0
Amaranthus sp. (pigweed)	9	5.1	1.3 ± 0.6
Rumex sp. (dock)	18	10.3	4.5 ± 0.8
Grass: *Panicum* sp	43	24.6	18.9 ± 0.5
Carex sp. (sedge)	2	1.1	0.3
Digitaria sp. (crabgrass)	8	4.6	1.1 ± 0.3
Lolium sp. (ryegrass)	10	5.7	3.7 ± 4.1
Crops: *Triticum* sp. (wheat)	1	0.6	0.5
Sorghum vulgare (millet)	41	23.4	16.9 ± 0.2
Invertebrates			
Insecta			
Coleoptera (beetles)			
Caraboidea: Carabidae (ground beetles)	16	9.1	1.1 ± 0.4
Gyrinidae (whirligig beetles)	1	0.6	0
Dysticidae	1	0.6	0
Cucujoidea: Coccinellidae (lady birds)	4	2.2	0.3 ± 0.1
Erotylidae	2	1.1	0.02
Anthicidae	2	1.1	0.1
Melanoidae (blister, oil & CMR beetles)	1	0.6	0
Corylophidae	5	29.0	0.2 ± 0.1
Curculionoidea: Curculionidae (weevils, snout beetles)	43	24.5	3.6 ± 0.1
Elateroidea (click beetles)	1	0.6	0.3
Hydrophiloidea	8	4.5	0.4 ± 0.1
Lymexyloidea: Lymexilidae	2	1.1	0.1
Staphilinoidea: Leiodidae	3	1.7	0.1 ± 0.7
Silphidae	1	0.6	0.01
Scarabaeoidea (chafers, white grubs)	1	0.6	0
Hymenoptera (wasps, ants)	2	1.1	0.1
Hemiptera (bugs)			
Pentatomoidea: Pentatomidae (stinkbugs)	8	4.5	0.8 ± 0.6
Aphidoidea: Aphididae (aphids)	9	5.1	0.6 ± 0.2
Isoptera: Rhinotermidae (termites)	2	1.1	3.0
Lepidoptera (butterflies & moths): Larvae	43	24.5	10.2 ± 0.6
Pupae	2	1.1	0.03
Orthoptera: Acridoidea (grasshoppers)	7	4	1.1 ± 0.9
Diptera (flies)	1	0.6	0
Blattodea: Blattoidea (cockroaches)	9	5.1	0.6 ± 1.2
Arachnida	3	1.7	0.02 ± 0.1
Mollusca	5	2.9	0.4 ± 0.6
Other invertebrates	6	3.4	0.4 ± 0.4
Herbage: *Medicago sativa* (lucerne)	10	5.7	2.7 ± 2.5
Fruit: Solanacea	6	3.4	1.2 ± 1.5
Other fruit	15	8.6	3.9 ± 3.2
Grit:	3	1.7	0.1 ± 0.2
Eggshell:	1	0.6	0.1
Unidentified:	7	0.04	0.2 ± 0.1

ferent (t = 1.79; df = 61; p = 0.08). Similarly, the male consumption of insects did not differ between spring (16.6%) and winter (8.5%, t = 0.66; df = 61; p = 0.51).

Although this study indicates that quail in the Eastern Cape have a seasonally varied diet, only seed and insects were eaten throughout the study period, whereas herbage and fruit consumption was limited to the warmer seasons. These results agree with the findings of Mentis (1978) and Bourquin (1980) for the diet of Kwazulu/Natal quail populations.

The seasonal variation in quail diet depicted in Figure 2, with increased insect consumption and decreased seed consumption during the period of peak abundance in spring may reflect increased availability of insects in the warmer months (Wolda 1978; Little, Gous & Crowe 1993). Alternatively, these dietary shifts may reflect changes in the nutritional requirements of the quail during the breeding season. This is supported by the greater variation in the diet of female quail, which may be a reflection of the greater energy demand of females during egglaying and incubation, as found by Moss & Watson (1976) for grouse. Bourquin (1980) also found differences in male and female diets, i.e. females showed an increased volume and frequency in the consumption of different food types over that of males during the breeding period. Information on the availability and nutritional value of insects and seeds and the costs of reproduction are needed in order to test the insect availability hypothesis and the breeding nutritional requirements hypothesis. In addition it would be of value to determine whether the quail are congregating in the Alexandria District during the spring breeding period because of increased insect availability.

There was no evidence that quail were reliant on crop species, despite a large proportion of the quail being shot in cultivated fields. It is unlikely that quail will damage crops, as they can only eat fallen seeds from grain crops, and in addition their main diet consists of smaller grass and forb seed. In fact their presence in agricultural lands could be of benefit to the farmer, as they consume a large amount of insects which have been identified as pest species in agricultural crops i.e.

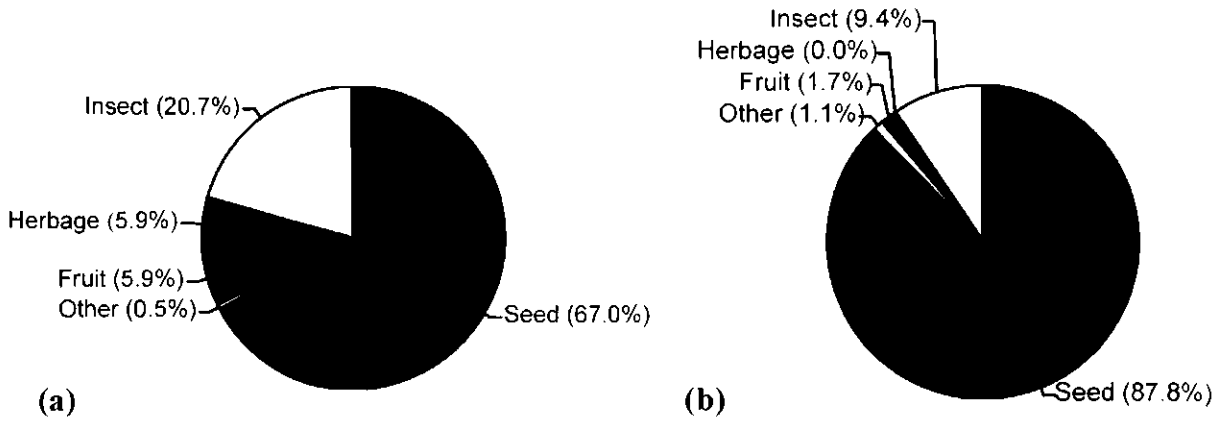

Figure 1 Diet composition for male (a, $n = 90$) and female (b, $n = 85$) quail over the sampling period (Sept 1994–Sept 1995).

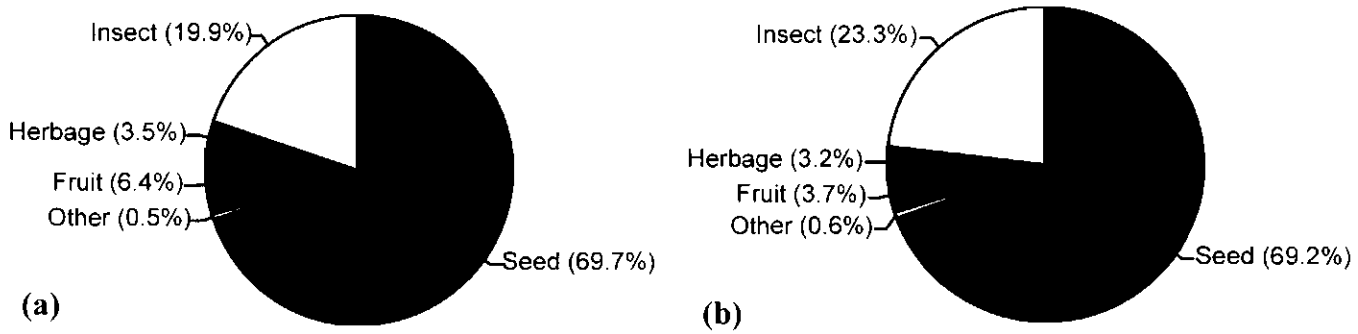

Figure 2 Quail diet composition for (a) spring peak in abundance (Oct–Nov 1994, $n = 84$) and (b) cooler months (Mar–Aug 1995, $n = 41$).

weevils, aphids, click beetles and CMR beetles. Thus they may play an essential role in keeping these potentially hazardous pests under control. Conversely, chemical control of these insect species may impact on the quails' nutritional resources, and thereby affect the availability of the quail population for hunting.

These results suggest that quail are dietary generalists, particularly utilizing the seeds of a variety of forb species. These forbs are characteristic of cultivated and fallow fields, suggesting that the availability of these habitats is an important management option, if farmers aim to encourage quail populations. Ploughing, mowing, burning or heavy grazing prior to or during the breeding season (austral spring) will remove these food sources and destroy juveniles and eggs

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