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Authors: Kok, Ordino B., Kok, Aletta C., and Van Ee, Cor A.

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Diet of the migrant Lesser Kestrels *Falco naumanni* in their winter quarters in South Africa

Ordino B. Kok, Aletta C. Kok & Cor A. Van Ee

Department of Zoology and Entomology, University of the Orange Free State, P. O. Box 339, Bloemfontein 9300, SOUTH AFRICA

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Abstract. Analysis of stomach contents from 386 Lesser Kestrels *Falco naumanni* obtained at Bloemfontein, South Africa, during the austral summer over a 12 year period (1984–1996) showed this species to be predominantly insectivorous. Isoptera (Harvester Termite *Hodotermes mossambicus),* followed by Solifugae and Chilopoda, formed the staple food. Lesser Kestrels consumed large quantities of small-sized prey, mainly Isoptera, early in the austral summer, while larger-sized food items, mostly *Acrididae*, dominated at the end of the non-breeding season. Results from pit trap sampling suggest that Lesser Kestrels are opportunistic foragers utilising the most abundant prey species.

Key words: Lesser Kestrel, *Falco naumanni*, diet, winter quarters, South Africa

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INTRODUCTION

The Lesser Kestrel *Falco naumanni* is a Palearctic migrant to South Africa during the austral summer from October to March (Maclean 1993). During this period it is the most abundant falconiform over much of the country (Cade 1969). As shown by Siegfried & Skead (1971), the kestrels tend to concentrate in the open, sweet-grass areas of the Highveld region, with the Free State province representing the stronghold of the species' southern African range. Little information is available on the non-breeding ecology of diurnal raptors in their winter quarters (Newton 1979), even though it is now appreciated that the non-breeding period constitutes the major part of the annual cycle in migrant birds (Tréca 1994). Particularly, the ecology of Lesser Kestrels in Africa is badly neglected (McCann 1994, Pepler et al. 1994), leading to an incomplete understanding of their habitat utilisation (Biber 1990). In an attempt to fulfil this gap, the diet of Lesser Kestrels was studied in their winter quarters in South Africa.

STUDY AREA AND METHODS

Birds which pose a threat to passenger and/or military aircraft at inland airports in South Africa are often shot as part of a control programme to promote safety standards. Through the kind cooperation of the management, all carcasses of Lesser Kestrels collected at the Bloemfontein airport over a period of 12 years were made available for research purposes. The airport is situated centrally in the Free State (29°06'S; 26°19'E), South Africa, and surrounded by vast grass plains and isolated hills at altitudes ranging from 1 382–1 533 m a.s.l. The vegetation in the area can be classified as a central variation of Dry grassveld *Cymbopogon–Themeda* (Acocks 1988). The climate is, in general, semi-arid. Warm, sunny summers (October–April) and cold, dry winters (May–September) are experienced in the area. Mean daily maximum and minimum temperatures vary from 29.8°C in January to -2.4°C in July, while absolute temperatures range from 37.6 to -8.8°C during the corresponding months. Approxi-

mately half of the mean annual rainfall of 560.3 mm occurs from January to March.

Table 1. Sampling distribution of 386 Lesser Kestrel males and females (219 and 167, respectively) investigated during 12 austral summers (1984–1996).

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar
1984/85		1+0				0+1
1985/86	2+0	28+24	2+3	5+1	5+1	1+1
1986/87	1+1	34+34	21+20	15+11	2+1	
1987/88			3+3	5+3	2+0	1+0
1988/89		0+1	3+4	1+0		
1989/90		3+2				
1990/91		3+0	15+9	5+2		
1991/92		0+2	2+1	2+0		
1992/93		17+15	1+0		1+1	
1993/94		7+6	18+8	2+3		
1994/95		4+0	5+2			
1995/96		0+1	1+5		1+1	
Total	3+1	97+85	71+55	35+20	11+4	2+2

A total of 386 Lesser Kestrels were obtained from the Bloemfontein airport during the period November 1984–February 1996 (Table 1). All birds were shot with a 12-bore shotgun by airport personnel. Carcasses were usually frozen within half-hour of being shot and collected for examination on a monthly basis. In all cases external sex determination by plumage was confirmed by internal dissection.

Stomach contents were sorted macroscopically and dried at 75°C for 48 hours before being searched with a dissecting microscope. As far as possible food items were identified to either species or family level and each taxon weighed separately on an electric balance (Mettler P160N). The number and caste of the relatively indigestible head capsules of the Harvester Termite *Hodotermes mossambicus* were also recorded. For all taxa the frequency of occurrence was calculated as the proportion of stomachs containing a particular food taxon expressed as a percentage of the total number of stomachs analysed.

To establish the relative availability of major prey taxa of Lesser Kestrels at their non-breeding range, 270 pit traps were set in 27 transects of ten each at 10 m intervals in pure grassveld at the Bloemfontein airport, from October 1994 to March 1995. Each pit trap, consisting of an opened cooldrink tin (350 ml) filled one quarter with glycerol, fitted tightly into a 15 cm piece of plastic pipe which was implanted level to the ground surface. In this way the traps could easily be emptied at bi-monthly intervals and the potential prey items identified and counted.

Statistical analyses were performed using SPSS release 4 for Unix.

RESULTS

Stomach contents

No significant differences in the diet at class and/or ordinal level were found between the sexes (Hotelling's T^2-test, $p > 0.05$). The data of 219 males and 167 females were therefore combined. Overall, 94.5% of the dry mass composition of the stomach contents consisted of animal matter whilst inorganic matter, mostly grit and sand, contributed 5.3%. Fragments of mono- and dicotyledons formed an insignificant portion (0.1%) of the diet. Both inorganic and plant matter are probably ingested inadvertently when feeding on invertebrate prey items on the ground.

Invertebrate prey items constituted the bulk of the Lesser Kestrel's diet in their Bloemfontein winter quarters (Table 2). More than half of this consisted of insects, the rest being mainly represented by arthropods such as sun spiders Solifugae and centipedes Chilopoda. The only non-arthropod invertebrates in the sample consisted of small gastropod shells. Isoptera, as represented by the family Hodotermitidae, was the most important insect

Table 2. Stomach contents (weight and % of dry mass) of 386 Lesser Kestrels collected during the years 1984–1996. F — percent frequency of occurrence.

Taxa	g	%	F
Animal matter			
Insecta (Total)	**279.4**	**56.3**	**84.2**
Isoptera	158.9	32.0	40.4
Orthoptera	79.3	16.0	48.2
Coleoptera	18.8	3.8	19.9
Hymenoptera	5.5	1.1	3.9
Lepidoptera	3.1	0.6	3.6
Odonata	0.1	<0.1	0.8
Blattodea	0.1	<0.1	0.5
Dermaptera	0.1	<0.1	0.3
Hemiptera	0.1	<0.1	0.3
Phasmida	0.1	<0.1	0.3
Unidentified	13.3	2.7	1.8
Arachnida (Total)	**99.7**	**20.1**	**40.4**
Solifugae	97.7	19.7	34.5
Araneae	2.0	0.4	7.3
Chilopoda	83.9	16.9	23.6
Mammalia	3.4	0.7	1.0
Reptilia	1.7	0.3	0.8
Diplopoda	0.6	0.1	0.3
Gastropoda	0.1	<0.1	0.3
Aves	<0.1	<0.1	0.3
Plant matter			
Monocotyledons	0.5	0.1	8.5
Dicotyledons	0.2	<0.1	0.5
Inorganic matter			
Grit	25.1	5.1	7.3
Sand	1.3	0.3	0.5

order, followed by the Orthoptera and Coleoptera. Based on the frequency of occurrence, however, the Orthoptera, almost exclusively represented by Acrididae with traces of the families Tettigoniidae and Gryllidae, were taken more often than the Isoptera (48.2% of frequency as against 40.4%). Other taxa frequently recorded included the Solifugae (34.5%) and Chilopoda (23.6%). Within the Coleoptera, prey items of three families, the Carabidae, Scarabaeidae and Curculionidae in ranked order of dominance, could be positively identified. All vertebrate prey combined (passerines, rodents, lizards and snakes) scarcely contributed 1% to the total dry mass.

The Lesser Kestrel's diet varied throughout the wintering period (Fig. 1). Isoptera, exclusively represented by *Hodotermes mossambicus*, were taken in fairly large numbers at the beginning of the season. Maxima of 628 and 403 workers were found in the stomachs of a female and male Lesser Kestrel respectively, whilst maxima of 238 and 201 alates were recorded for a male and female collected in December and November respectively. A total of 156 stomachs contained a mean number of 128 Harvester Termites. Overall, the worker : alate ratio was 1.0 : 0.3, with the most even monthly ratio (1.0 : 0.9) occurring in December when the termites were actively swarming. As the initial termite prey became less available, the Orthoptera, mainly members of the family Acrididae, became the dominant prey consumed during the latter part of the season. During the transitional period solifugids, scolopendrans and other prey components (predominantly coleopterans) formed an important part of the diet.

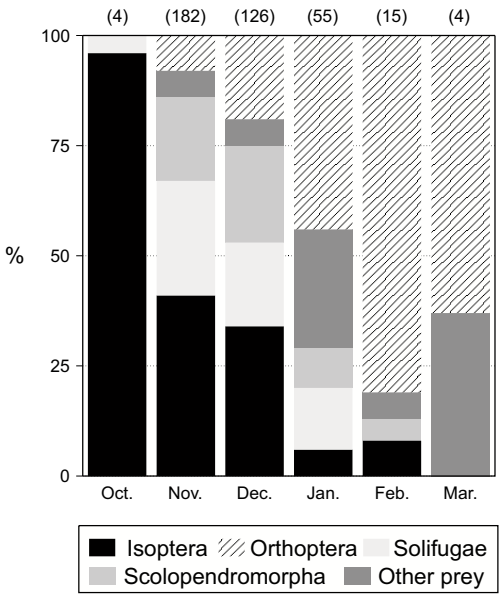

Fig. 1. Monthly variation (%) in the dry mass composition of major food taxa in the stomach contents of 386 Lesser Kestrels collected during the years 1984–1996. "Other prey" — the remainder of the animal matter. Brackets refer to monthly combined samples.

Food availability

Monthly variation in linear regression analyses (Fowler & Cohen 1993) of the number of arthropods collected in pit traps at the study area (Fig. 2) indicate significant relationships between pit-trapped Isoptera ($p < 0.01$) and Orthoptera ($p < 0.05$) potentially available and prey items of the same taxa actually ingested. As the season progressed, the number of isopterans gradually decreased concomitant with an increase in orthopteran numbers. Throughout the season solifugids formed an important proportion of the total numbers, whilst scolopendrans only made a small but constant contribution.

DISCUSSION

Most studies on feeding ecology of the Lesser Kestrel have been conducted at its Palearctic breeding range using regurgitated pellet analysis (Glutz von Blotzheim et al. 1971, Franco & Andrada 1976, Bijlsma et al. 1988). Results from these studies have all indicated that the kestrels are highly insectivorous, showing a strong preference for prey items from the orders Orthoptera and Coleoptera. Our

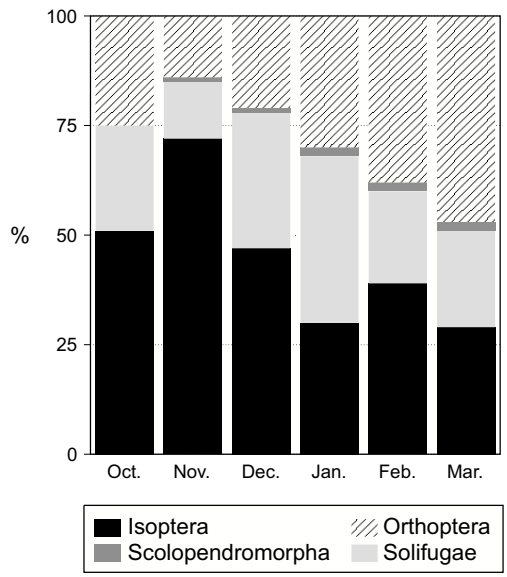

Fig. 2. Monthly variation (%) in the number of individuals of the four most important prey taxa of Lesser Kestrels collected in 270 pit traps during the 1994/95 austral summer.

data, based on stomach contents from birds in their winter quarters, suggest that this is only partly true as approximately two fifths of the animal component by dry mass (39.3%) consisted of arthropods other than insects, notably solifugids and centipedes. Compared to the diet of breeding birds (Franco & Andrada 1976), the general lack of vertebrate prey during the wintering season is also striking, an aspect also mentioned by McCann (1994) and Anderson et al. (1999). This discrepancy can probably be attributed to the higher energy demand during breeding, necessitating the predation on prey-groups with relatively high biomass (Glutz von Blotzheim et al. 1971, Cramp & Simmons 1980, Rudolph 1982, Village 1990), as well as the occurrence of courtship feeding involving vertebrate prey (Franco & Andrada 1976, Cade 1982).

Lesser Kestrels are opportunistic (non-specialist) foragers with great potential to feed on locally and temporally abundant invertebrate food sources (Anderson et al. 1999). This is well illustrated by the marked monthly variation in their dietary composition which hints at a possible relationship between the abundance of different prey species and the frequency of their capture. The birds' arrival during the early austral summer coincides with the period when Harvester Termite alates emerge after the first substantial rains of the season (Nel & Hewitt 1978). It is notable that seven of the ten specimens with the highest stomach content dry mass values, ranging from 5.4 to 12.0 g compared to the average value of 1.2 ± 2.8 g ($n = 386$), consisted entirely of *Hodotermes mossambicus* alates. This indicates that the birds concerned chose food items available in large quantities on which they could gorge themselves. Indications are also that large discrepancies in the annual occurrence frequencies of prey items within the same invertebrate orders can be related to local variation in the relative abundance and availability of prey (Anderson et al. 1999). The fact that orthopterans were predominantly consumed during late summer implies that larger-sized prey are involved in fat deposition and the consequent increase in body mass (Kok & Van Zyl 1996, Anderson et al. 1999) prior to the birds' northward migration to their breeding grounds. By maintaining a high and rapid turnover in biomass, southern African grassland habitats seem ideally suited to support migratory birds of prey, especially insect-eaters, during the austral summer, a phenomenon also reported on by Moreau (1972) and McCann (1994).

Studies on the diet of the Lesser Kestrel are mostly limited to pellet analyses (Glutz von Blotzheim et al. 1971, Franco & Andrada 1976, Bijlsma et al. 1988, McCann 1994). This can partly be attributed to the inavailability of stomach contents as the Lesser Kestrel is a globally endangered species (Bibby 1992, Nuttall 1992, Collar et al. 1994). The present study is, therefore, important as a finer-grained assessment of prey composition can be achieved by analysing stomach contents. Families of Coleoptera and Orthoptera as well as isopteran species were, for example, identifiable which is often not the case when analysing pellets (McCann 1994).

Substantial numbers of prey belonging to the Isoptera and Orthoptera, which often assume plague proportions and cause much damage to forage in particular areas during some years (Nel 1968, Duncan 1988, Meinzingen 1993), are consumed by the Lesser Kestrel. As such the birds act not only as important natural predators of the insects but are also of commercial value. In view of the latter, as well as the world-wide population decline of these kestrels (Roos & Roos 1986, Biber 1990, Colahan 1993, Donazar et al. 1993), every effort should be made to actively conserve this small-sized raptor, amongst others by educating decision-makers to implement alternative measures of bird control at inland South African airports.

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STRESZCZENIE

[Skład pokarmu pustułeczki na zimowisku w Południowej Afryce]

Ekologia pustułeczki na jej afrykańskich zimowiskach jest mało poznana (McCann 1994, Pepler et al. 1994).

Materiał przedstawiony w pracy pochodził z analiz żołądków pustułeczek zastrzelonych przez służby odpowiedzialne za ochronę samolotów przed kolizjami z ptakami na lotnisku w Bloemfontein w Republice Południowej Afryki. W ciągu 12 lat (listopad 1984–luty 1996) przekazano do badań 386 pustułeczek (Tab. 1). Zawartość żołądków była sortowana makroskopowo, szczątki zdobyczy identyfikowano z dokładnością co najmniej do rzędu. Obliczano również suchą masę i częstość występowania danej zdobyczy - w stosunku do wszystkich badanych żołądków. Nie stwierdzono różnic w składzie pokarmu samców i samic, wobec czego w analizach obie płcie potraktowano łącznie. Zbadano też dostępność potencjalnej zdobyczy poprzez odłów bezkręgowców przy pomocy 270 pułapek cylindrowych, rozmieszczonych na lotnisku w ciągu jednego sezonu (październik 1994–marzec 1995).

Główną część pokarmu badanych ptaków stanowiły bezkręgowce, w większości owady (Tab. 2). Wśród owadów pod względem suchej masy dominowały Isoptera (32%), oraz Orthoptera (16%) i Coleoptera (4%). Natomiast najczęściej występowały Coleoptera (48%) przed Isoptera (40%). Różnicą w stosunku do diety pustułek na terenach lęgowych, badanej przez Franco & Andrada (1976), był tu brak kręgowców.

Na początku pory letniej (listopad, grudzień) w diecie stwierdzono licznie termity z gatunku *Hodotermes mossambicus* (Fig. 1). Natomiast później dominowała zdobycz większa, głównie chrząszcze Acrididae. Pod tym względem stwierdzono znaczną zgodność z dostępnością zdobyczy, określoną na podstawie zawartości pułapek (Fig. 2). Można więc wnioskować o oportunizmie (małym stopniu specjalizacji) pokarmowym pustułeczki, wykorzystującej na zimowisku pokarm lokalnie najbardziej dostępny.

Autorzy postulują stosowanie w ochronie lotnisk przed ptakami metod nie wymagających zabijania pustułeczki, szczególnie, że gatunek ten zmniejsza swoją liczebność (Biber 1990, Bibby 1992).