THE DIET OF ADULT AND NESTLING BLACKSHOULDERED KITES, AND BREEDING SUCCESS

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Summary

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Blackshouldered Kite diet was examined at Settlers, Transvaal, by pellet analysis. Rodents made up 98 % by number of the adult diet, comprising 51 % *Otomys angoniensis*, 31 % *Praomys natalensis*, and 16 % *Rhabdomys pumilio*. There was no apparent selection for either prey species or age groups. As the breeding cycle progressed the chances of success increased. We found no evidence that nestling survival was related to the quality of their diet.

Introduction

The food intake of raptors has been shown to have important effects on clutch size (e.g. Korpimaki 1981; Newton & Marquiss 1981; Village 1981); laying date (e.g. Cave 1968; Dijkstra *et al.* 1982; Hirons 1985; Korpimaki 1981; Lundberg 1981; Village 1981), and nest desertion (e.g. Cave 1968; Korpimaki 1987; Mendelsohn 1981). Breeding in Blackshouldered Kites *Elanus caeruleus*, which feed almost exclusively on small rodents (Mendelsohn 1982), is probably intricately linked to their food supply (Mendelsohn 1984; Slotow 1987).

This paper examines the diet of Blackshouldered Kites at Settlers, focusing on the species composition and age of prey consumed. Adult and nestling diets were examined separately, and were related to breeding productivity.

Methods

From February 1986 to May 1987, kites were studied in a 5 000-ha area near Settlers (24 57 S; 28 33 E) in the Springbok Flats, Transvaal. This study area fell inside that delineated by Mendelsohn (1981, 1982) and a detailed description is available from those sources. The topography is flat, with a 60 m drop over 12 km from north to south. Several drainage lines produce a gentle rolling landscape from east to west. The study area consisted of black turf soil (64 %) and red clay soil (35 %). The area was used for mixed farming, with cultivated fields (72 %) interspersed with patches of grazed bushveld (27 %). The major crops farmed were cotton, sunflowers, maize, millet, sorghum, and manna. The entire area was on Springbok Flats Turf Thornveld (Acocks 1975).

Kite pellets were collected regularly from selected roosts, air-dried, weighed on an electronic balance, soaked, and dissected to identify prey remains. Rodent skull remains were identified (Coetzee 1972), and separated into two age classes, adult and juvenile. Juveniles fell into classes I and II of Henschel *et al.* (1982) and Perrin (1982), and classes I to IV of Perrin (1979). Individuals of other prey species were not aged.

To quantify rodent prey availability, two livetrap lines were established. The first ran through grazed bushveld on black turf and crossed a dry river bed which was later flooded. The second ran along a fence between a tarred road (5 m away) and a cultivated field (5 m away). This line incorporated both black turf soil and red clay soil. Trapping was initiated in February 1986, and in June 1986 the number of traps was increased from 20 to 35 traps in line A and from 20 to 40 traps in line B. Both lines were set weekly where possible, on two trapping nights per week. The traps were placed about 6 m apart, adjacent to runways or other signs of rodents (in order to increase the capture rate of *O. angoniensis*). The traps were baited with a mixture of peanut butter and oats. No prebaiting was carried out, although the traps were left in place throughout the study period. From February to May 1986 all animals caught were removed, but from mid-June 1986 capture–mark–recapture (Flowerdew 1976) was instituted, using the toe-clipping method (Twigg 1975).

An index of population numbers was obtained by determining the minimum number of mice alive (MNA) (David & Jarvis 1985) (MNA = the number of mice actually caught + the number of mice marked before to the i^{th} trapping occasion, which were not caught at the i^{th} occasion but were captured subsequently (i.e. mice assumed to have been present at time i).

Shrews were not identified to species level. Where no skull remains were present, prey species were identified from hair characteristics (Mendelsohn 1982). Reptilian prey were identified by the presence of characteristic scales. Feathers were found in only one pellet. Three pellets contained remains of insects (grasshoppers: Orthoptera). The number of prey items in each pellet was a conservative estimate of the number consumed because only one prey item was recorded for hair remains of any prey species.

All breeding activity was recorded, and active nests were visited regularly. The dates of nestbuilding, egglaying, hatching and nest departure of chicks, in addition to signs of desertion, were noted. Pellets found below nests were assumed to reflect the diet of nestlings.

RESULTS

Adult diet

The abundance of rodent prey in the field as revealed by trapping (Fig. 1), is summarized from Slotow (1987). Three species predominated in the captures, and comprised 98 % of the diet of the kites, by frequency. An analysis of the diet through the year (Fig. 2) showed *Otomys angoniensis* (mean mass ±SE 72,7 ± 3,0 g (Slotow 1987)) to be the major prey item by number (51 %) followed by *Praomys natalensis* (25,5 ± 0,7 g (Slotow 1987)) (31 %), *Rhabdomys pumilio* (25,2 ± 1,0 g (Slotow 1987)) (16 %), and others (2 %). The proportion of *P. natalensis* in the diet decreased from May to October, and then dramatically increased (Fig. 2a). [The reason for this was the decrease in the number of *O. angoniensis* and *R. pumilio* in the field (Fig. 1). The subsequent decrease in the proportion of *P. natalensis* in the diet from February to May, may be ascribed to an increase in the availability of *R. pumilio* and *O. angoniensis*.] The mean pellet mass per month (Fig. 2b) fluctuated little through 1986, and then decreased to February 1987. This reflected a decrease in the total mass of prey consumed (Tarboton 1977). Pellet mass then increased to average levels in May 1987.

Changing proportions of juvenile rodents eaten (Fig. 3d) corresponded to changes in the proportion of juvenile rodents present in the field (Slotow 1987), the proportion being highest in May at the end of the rodent breeding season. This trend held for both *P. natalensis* (Fig. 3a) and *R. pumilio* (Fig. 3b). *O. angoniensis* juveniles (Fig. 3c) were present in Blackshouldered Kite diet whenever this prey species was eaten. [Lower proportions (all species combined) were present during October, November and December (Fig. 3d) but this was because of the absence of young rodents in the field at that time.] About twice as many adults as juveniles of all three species were present in the pellets. The number of adult *O. angoniensis* was under-represented as kites frequently tore the head off larger *O. angoniensis*, and the number of juveniles of the other two species were under-represented as their skulls were often digested.

Nestling diet

Analysis of nestling diet showed *O. angoniensis* to be the most important prey (56 %), followed by *R. pumilio* (19 %) and *P. natalensis* (16 %). These proportions varied greatly between nests (Fig. 4), with no indication that the composition of the adult or juvenile diets was related to the success of the nesting attempt.

Breeding success

Of the nine nests in which eggs were laid, 34 eggs were laid (mean clutch size = 3,8; range: 3–4) (Table 1). Fifteen of these eggs hatched, from which 11 chicks were reared. Seven clutches were successfully incubated, and chicks flew from six nests. The major loss in breeding productivity occurred during incubation, and once the chicks had

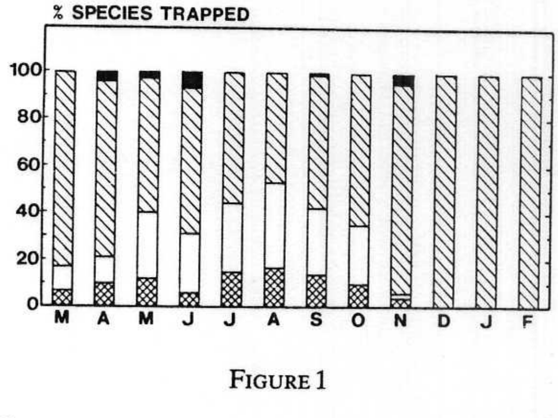

FIGURE 1

The proportion of rodent species "available" in the field from March 1986 to February 1987. Cross-hatched = *Otomys angoniensis*, clear = *Rhabdomys pumilio*, hatched = *Praomys natalensis*, and black = others.

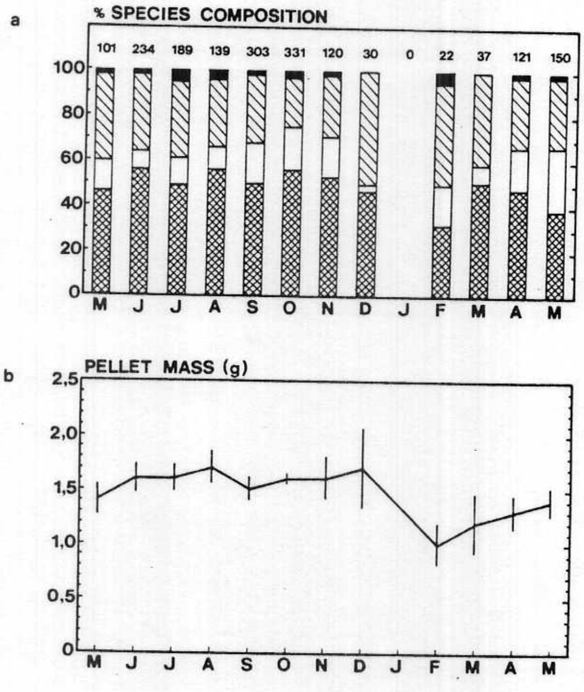

FIGURE 2

The diet of Blackshouldered Kites at Settlers from pellets analysed from May 1986 to May 1987. a: The proportions of rodent prey species in the diet. Figures are number of prey items. Cross-hatched = *Otomys angoniensis*, clear = *Rhabdomys pumilio*, hatched = *Praomys natalensis*, and black = "others", which included mainly shrews (*Crocidura* spp.) and reptiles. b: The dry mass of pellets collected through the year. Vertical lines indicate 95 % confidence intervals.

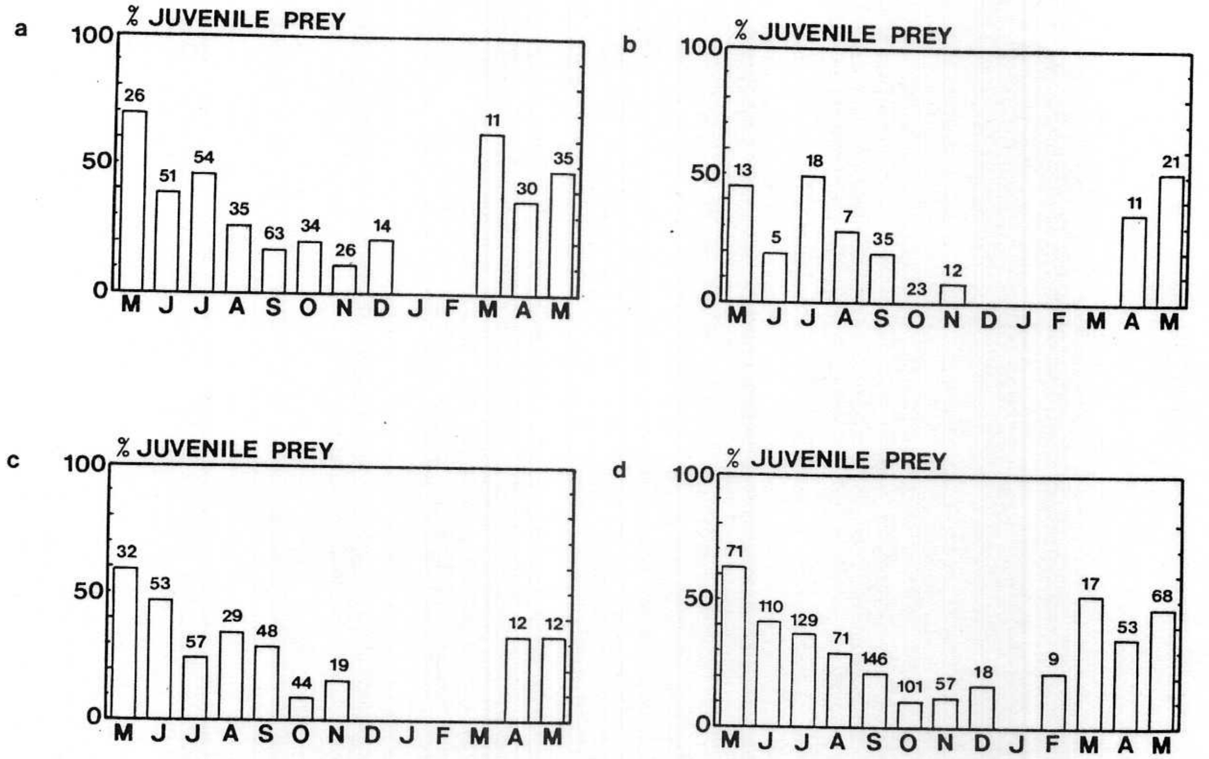

FIGURE 3

The age structure of rodent prey of Blackshouldered Kites, derived from pellet analysis, during the study period. Percentage juvenile prey is the proportion of juvenile to adult prey found in pellets, per month. a: *Praomys natalensis*; b: *Rhabdomys pumilio*; C: *Otomys angoniensis*; d: All species combined. Figures indicate sample sizes (number of prey items).

hatched they had a higher chance of leaving the nest successfully.

DISCUSSION

Adult diet

Blackshouldered Kites normally produce one pellet per day, the mass of which is related to the biomass of food consumed the previous day (Tarboton 1977). The lightest pellets were produced in February, when body mass of *P. natalensis* and *R. pumilio* was greatest (Slotow 1987). The mean pellet mass ±SE obtained for adult kites in our study ($\bar{x}$ = 1,50 ± 0,95 g; n = 1 363) is higher than that obtained by Mendelsohn (1982) for kites at the same study site ($\bar{x}$ = 1,28 ± 0,63 g; n = 1 990), but similar to Tarboton's (1977) figure ($\bar{x}$ = 1,56 ± 0,05 g; n = 260). There was large variation in the mean monthly pellet mass, both in our study (range = 1,0 g to 1,7 g) and in Mendelsohn's (1982) study (range = 1,1 g to 1,5 g). The discrepancy in

TABLE 1

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Nest code	Start of egglaying	Clutch size	Start of hatching	Effective brood size	Eggs hatched	Date of nest departure	Number reared	Rearing rate	Success rate
A	10/2/86	4	15/3/86	1	0,25	20/4/86	1	1,00	0,25
B	12/1/86	4	15/2/86	4	1,00	6/4/86	4	1,00	1,00
C	February 1986	(postulated)	— no data						
D	February 1986	(postulated)	— no data						
E	March 1986	(postulated)	— no data						
F	April 1986	(postulated)	— no data						
G	16/8/86	4	17/9/86	1	0,25	—	0	0,00	0,00
H	30/9/86	3	20/10/86	1	0,33	23/11/86	1	1,00	0,33
I	25/2/87	4	28/3/87	4	1,00	30/4/87	1	0,25	0,25
J	23/2/87	4	26/3/87	3	0,75	26/4/87	3	1,00	0,75
K	15/2/86	3	—	0	0,00	—	0	0,00	0,00
L	3/11/86	0	—	0	0,00	—	0	0,00	0,00
M	5/3/87	4	4/4/87	1	0,25	5/5/87	1	1,00	0,25
N	1/4/87	4	—	0	0,00	—	0	0,00	0,00
Total	—	34	—	15	44	—	11	73	31

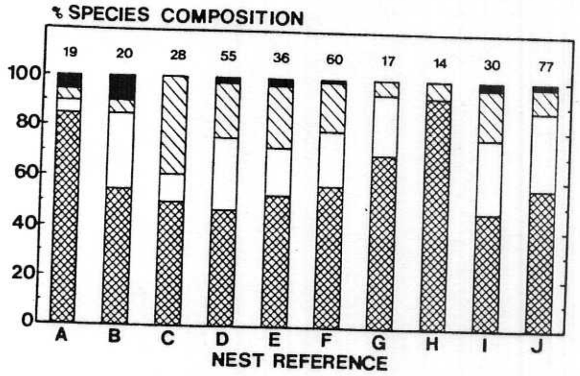

FIGURE 4

The diet of nestling Blackshouldered Kites at Settlers. The histories of the nests (A to J) are given in Table 1. Cross hatched = *Otomys angoniensis*, clear = *Rhabdomys pumilio*, hatched = *Praomys natalensis*, and black = others, which included mainly shrews (*Crocidura* spp.) and reptiles. Figures indicate sample sizes (number of prey items).

the overall mean mass is therefore not important. Mendelsohn (1982) found a decrease in pellet mass from May to August, whereas this study showed an increase. The lightest pellets were produced in midsummer, and pellet mass increased from February to May, in both studies.

The mean number of prey items per pellet for our study (1,30) compares well with that found by Mendelsohn (1982) of 1,32. The following is a comparison (our study: Mendelsohn (1982)) of the percentage of each prey species which was identified from hair remains (as opposed to skulls): *P. natalensis* (29 % : 28 %); *R. pumilio* (45 % : 27 %); *O. angoniensis* (64 % : 41 %); and overall (52 % : 32 %). Although our results included more hair identifications, especially for *O. angoniensis*, the fact that the overall number of prey items per pellet is so similar to Mendelsohn's (1982), suggests the results are comparable. Stendell (1972), working on Whitetailed Kites *Elanus leucurus*, found 1,18 prey items per pellet.

The overall proportion of kite prey species found in this and other studies is shown in Table 2. Although differences in overall diet are apparent, the monthly variations in prey composition proportions were great in our study as well as Mendelsohn's (1982 — Fig. 7). For example in this study, *O. angoniensis* proportions ranged from 32 % to 56 %, and in Mendelsohn's (1982) study from 12 % to 62 %, in different months. The proportion of each prey species in the diet varied less with time in our study than in Mendelsohn's (1982). There seemed to be little prey selection since changes in the species composition in the diet (Fig. 2) reflected prey trapped in the field for most of the study period (Fig. 1). Mendelsohn (1982) found a significant correlation between the proportion of *P. natalensis* in the diet and the trapping success of *P. natalensis*. Similarly there was probably no selection for different age classes of prey, as proportions of adult and juvenile prey in the diet reflected proportions available in the field.

Nestling diet

Nestling diet varied from nest to nest, suggesting that nestlings were fed whatever prey individuals the parent happened to catch. However, they may have been preferentially fed larger prey since the proportion of *O. angoniensis* in the nestling diet was higher than in the adult diet. This could be because the nestlings were fed at a greater frequency during the day, or since adults ate more at dusk when higher numbers of *P. natalensis* are caught. Northern Harriers *Circus cyaneus* preferentially bring heavier items to the nest (Barnard 1984), but when there is an increase in the activity of smaller mammals after rain, there is an increase in the delivery rate of small mammals (Barnard 1984). This suggests that there is little prey selection, and that the parent delivers prey to the nest as it becomes available, regardless of size.

Breeding success

As the breeding cycle progressed, the reproductive success increased, a trend also found by Mendelsohn (in press) in his study at Settlers. His finding that most failures were a result of complete loss of clutches or broods, disagrees with our study (one out of four eggs or nestlings survived in some nests).

In Whitetailed Kites, predation, inclement weather, and desertion by adults generally accounted for the loss of entire broods (Stendell 1972). Infertile eggs and embryonic mortality resulted in the loss of individual eggs within a brood (Stendell 1972). Our data suggest that there was no link between the quality (in terms of species composition) of nestling diet and their survival. We were unable to test whether the quantity of food nestlings received affected their survival.

The important criterion for breeding success was not related to the quality of diet the nestlings received, but was perhaps limited to the ability of

TABLE 2
COMPOSITION OF PREY SPECIES IN THE DIET OF BLACKSHOULDERED KITES

Site	*O. angoniensis*	*R. pumilio*	*P. natalensis*	Others	n
Settlers[1]	51 %	16 %	31 %	2 %	1 777
Settlers[2]	28 %	30 %	30 %	13 %	2 573
Nylsvlei[3]	30 %	43 %	14 %	13 %	250

[1]This study, [2]Mendelsohn (1982), [3]Tarboton (1977, 1978).

the male to supply prey to the female. There appeared to be a threshold level of prey supply, below which the female became innattentive, and deserted the nest.

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REVIEW

HASTINGS BELSHAW, R. H. 1985. **Guinea Fowl of the world**. Nimrod Book Services, P.O. Box 1, Liss, Hants, GU33 7PR, England. 192 pp., 3 maps, 15 colour plates, a large number of black and white illustrations, 71 tables, 5 appendices including an extensive bibliography.

This marvellous compilation of information about guineafowl (Family Phasianidae, Subfamily Numidinae) covers the gamut from folklore to the farmyard. It comprises eight chapters entitled: guinea fowl in history; the species; the common guinea fowl; guinea fowl culture; selective breeding; nutrition; diseases, parasites, pests and predators; and preparation for market and table. Although it has very weak sections on the evolutionary biology of guineafowl and has far too many spelling errors (including my surname!), it is an absolutely essential acquisition for anyone attempting to manage the species, especially on a commercial basis. The many tables are, in effect, a "cookbook" as to how to make a success of a commercial venture.

Timothy M. Crowe