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Food of the Cattle Egret (*Bubulcus ibis*) in South African grassland

By Grzegorz Kopij

Abstract: KOPIJ, G. (1999): Food of the Cattle Egret (*Bubulcus ibis*) in South African grassland. Vogelwarte 40: 98–109.

The study is based on stomach content and boli analyses originated from chicks and adult birds living in South African grassland. Bulk of the Cattle Egrets' diet consisted there of insects (69% of total dry mass), other arthropods constitute 2% and vertebrates 28%. Insect prey consisted mainly of Orthoptera (47%, mainly Acrididae) and Isoptera (12%, exclusively *Hodotermes mossambicus*). Coleoptera, Lepidoptera and Diptera constituted only a supplementary insect ingredient. In the diet of the chicks, a two-fold higher proportion of vertebrates and a lower proportion of insects was shown in comparison with the adult diet. In the same colony, during the 1976/1977 breeding season (with higher rainfall) the proportion of invertebrates and vertebrates was similar, while during the 1993/1994 breeding season (lower rainfall), the proportion of invertebrates was much higher than that of vertebrates. In summer (September – March) most of the adult diet consisted of insects, whereas in winter (June – August) it consisted mainly of vertebrates. The proportion of invertebrates increased and that of vertebrates decreased in the diet of chicks, as they grow.

Key words: Cattle Egret (*Bubulcus ibis*), diet, South Africa.

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1. Introduction

In the present century the Cattle Egret (*Bubulcus ibis*) has expanded its range from Africa and the Oriental Region into all other zoogeographical regions of the world (DEL HOYO et al. 1992, RUIZ 1984). This expansion is partly attributed to the rapid development of cultivated pastures for cattle and the construction of small dams, creating environments which resemble the species' original habitat in eastern Africa, where it is associated mainly with the African Buffalo *Syncerus caffer* (BLAKER 1971).

This expansion has been facilitated by the dietary adaptability of the species in response to environmental changes. Studies on Cattle Egret diet have been carried out in various parts of the world: Egypt (KIRKPATRICK 1925, KADRY 1942), Spain (RUIZ & JOVER 1981, RUIZ 1985), Australia (MCKILLIGAN 1984, BAXTER & FAIRWEATHER 1989), Japan (IKEDA 1956), Mexico (VAZQUEZ & MARQUEZ 1972), Cuba (MARTIN et al., 1967), south-eastern USA (JENNI 1969, 1973, FOGARTY & HETRICK 1973, SNODDY 1969).

In the Afrotropics, the diet of the Cattle Egret was studied in an area with intensive dairy farming in the fynbos biome of the Western Cape province, South Africa (SIEGFRIED 1966, 1971), and in the former Transvaal (mainly in the industry area of the Gauteng), South Africa (O'CONNOR 1993). In this paper the diet of the Cattle Egret is investigated in South African grassland with extensive farming. For the first time, the diet of Cattle Egret chicks in relation to their age is investigated.

2. Material and methods

For food analysis both stomach contents (n = 204) and boli (regurgitated pellets, n = 245) were used. Stomachs were collected from adults (n = 119) and from chicks (n = 85). Stomachs of adult birds were collected throughout the year during a period 1980–1996. Most of the birds were shot at Bloemfontein (29°06' S, 26°19' E), Kimberley (28°48' S, 24°46' E) and Johannesburg (26°00' S, 28°20' E) airports as part of bird control programme. In laboratory they were sexed by gonadal examination.

Chick stomachs and boli were collected from two colonies situated c. 20 km apart in the Dewetsdorp district, Free State, in the Dry Sandy Highveld Grassland (BREDENKAMP & VAN ROOYEN 1996) utilised as pasture for cattle and sheep, with small, numerous farm dam scattered over the area. Rainfall for this area is presented in Fig. 1. The two sites surrounded by the same natural vegetation with very similar farming practice could be considered one site in this study. As feeding places of the Cattle Egret extend up to c. 20 km around their nesting sites (pers. obs.), birds from the two colonies might even share some feeding areas.

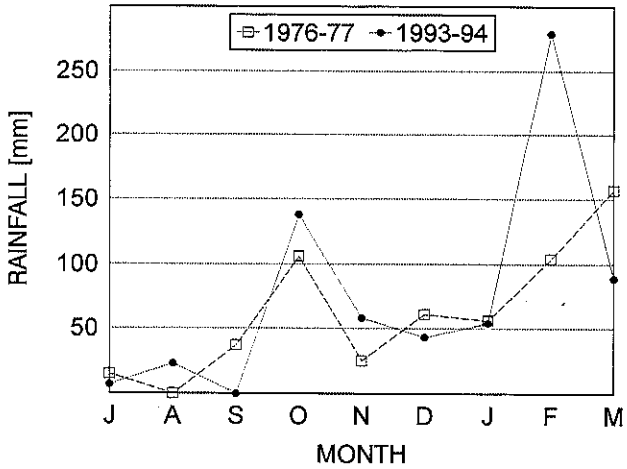

Fig. 1: Rainfall at Dewetsdorp during the breeding seasons of 1976/1977 and 1993/1994.

Abb. 1: Niederschläge im Dewetsdorp-Distrikt während der beiden Brutsaisons 1976/77 und 1993/94.

Collections of the samples from the two colonies were made in two breeding seasons. During 1976/1977 103 boli were collected at Geluk (29°26' S, 26°32' E) and during 1993/1994, both stomachs (n = 85) and boli (n = 142) were collected at Wolwekop (29°40' S, 26°45' E). Only fresh boli, formed by not digested material, were collected. The material obtained from stomachs was, however, in various stages of digestion, with vertebrates usually more digested than the invertebrate prey. Most boli were found on the ground, while stomachs were dissected from chicks fallen from nests. Culmen-length was taken to determine the approximate age of a chick after SIEGFRIED'S (1972b) criteria and confirmed during this study. Chicks with culmen-length 15–24 mm fall into the first age class (1–7 days), 25–32 mm into the second class (8–14 days), 33–36 into the third class (15–21 days) and longer than 35 mm, into the fourth class (22 and more days).

On collection, the stomachs and boli were placed into 50% alcohol and labelled. In the laboratory each stomach and bolus was analysed separately. The entire contents were sorted into particular classes or orders and dried at 60° C for 48 hours. Dry prey items from stomachs and boli were weighed to the nearest mg, and identified to the order, family or, for some vertebrates, to the species.

Frequency of occurrence of each food category is given as the percentage of food samples in which the category was recorded. Statistical test was only applied to test differences in frequency of occurrence of main food categories. Prey were identified using the following keys: BRANCH (1988), PASSMORE & CURRUTHERS (1979) and SCHOLTZ & HOLM (1986).

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3. Results

3.1. General stomach and boli contents

The number of prey species and prey items was much higher in chick boli than in chick stomachs (Table 1). The dry mass of these boli ranged from 0.1 to 9.6 g. Mean dry mass of stomach content of chicks was 1.3 g (n = 65) and that of adults, 5.4 g (n = 119). Diet was more varied in mid-summer than during the rest of the year.

Table 1: Mean dry mass and number of prey species and items per boli and stomachs in Cattle Egret chicks.
Tab. 1: Durchschnittliche Trockenmasse sowie Anzahl der Beutetiere und Nahrungsbestandteile pro Speiballen bzw. Mageninhalt von Kuhreiher-Jungvögeln.

Characteristics	Mean	Range	Sample size
Mean number of prey species per stomach	3.7	1–12	65
Mean number of prey species per bolus	8.4	1–23	106
Mean number of prey items per stomach	23.9	1–114	65
Mean number of prey items per bolus	43.5	1–189	96
Mean dry mass (g) of stomach content	1.3	0.1–10.8	65
Mean dry mass (g) of bolus content	4.0	1.2–9.6	106

3.2. Chick and adult diet ($\chi^2 = 118$; df = 35; $p < 0.01$)

For this analysis all stomach contents and boli of both chicks and adults were used. The Cattle Egret preyed upon animals which can be classified into two ecological groups, namely grass-living and aquatic. The aquatic group was composed mainly of frogs (Amphibia: Anura), with few *Potamon warreni* crabs (Crustacea: Decapoda) and dragonfly larvae (Insecta: Odonata), while the grass-living group comprised mainly Orthoptera, Coleoptera, Arachnida, Reptilia and Mammalia. In the diet of chicks, the proportion of aquatic to grass-living prey was as 26% to 74%, while in the diet of adult birds it was as 1% to 99%. In comparison with the diet of adult birds, a lower proportion of insects was found in chicks' diet. Isoptera were virtually absent in the diet of chicks, while they contributed 6% of the total dry mass in the diet of adults. They were exclusively represented by *Hodotermes mossambicus*. The workers/alates ratio was 1.00:2.16 (n = 5 793). In 32 stomachs, the mean number of workers was 218 and that of alates 198. Other Arthropoda constituted supplementary food both in the diet of adults and chicks.

Within the Coleoptera, prey items of the following families were identified: Carabidae, Scarabaeidae, Tenebrionidae and Curculionidae. Most (95%) of the lepidopteran prey consisted of larvae; imagos of Noctuidae (4%) were also recorded. Diptera were represented by larvae, and imagos of Calliphoridae, Asilidae, Tabanidae and other families, while hymenopteran prey were represented exclusively by Formicidae. Other insect orders constituted together less than 1% of the total dry mass. Among other arthropod prey items, Ixodidae, Araneae, Solifugae, Scorpionidea and Chilopoda were identified (Table 2).

Although one of the local names for the Cattle Egret is 'bosluisvoël' which in Afrikaans means 'tick bird', both in diet of adults and chicks, Ixodidae were only occasional items (Table 2). The following groups were found: *Rhipicephalus* spp. (n = 38 individuals), *Hyaloma* spp. (n = 12), *Boophilus* spp. (n = 4) and unidentified specimens (n = 14). Both in stomachs and in boli, only single ticks were usually present (n = 21 cases), but sometimes more were encountered (n = 8 cases). One bolus contained as many as 23 unengorged *Rhipicephalus* ticks. No fish (Pisces), earthworms (Oligochaeta), and very few aquatic invertebrates were found in the diet of both adults and in chicks.

Frequency of occurrence of the grass-living vertebrates was low, in terms of dry mass, however, they constitute a quite significant component of the diet. They were represented by reptiles (4.2% and 6.3% of the total dry mass in the diet of chicks and adults respectively), ploceid chicks (only in the diet of chicks) and small mammals (2.4% and 8.4% in the diet of chicks and adults respectively). Reptiles were represented by Lacertidae (39% of reptile dry mass), Scincidae (53%), Agamidae (6%) and Gekkonidae (2%), while mammals, mainly (85% of mammalian dry mass) by *Rhabdomys pumilio* (Rodentia).

Table 2: Food composition of 330 chicks and 119 adult Cattle Egrets in the Free State and Northern Cape. Frequency of occurrence is given as percentage of food samples in which the category was recorded.
Tab. 2: Nahrungszusammensetzung junger (n = 330) und alter (n = 119) Kuhreiher. Als Häufigkeitsmaß ist der Prozentsatz von Proben angegeben, in welchem die betreffende Nahrungskomponente gefunden wurde.

Taxa	Chicks		Adults	
	Frequency of occurrence	Dry mass %	Frequency of occurrence	Dry mass %
Crustacea	1.8	0.4	–	–
Arachnida	29.1	3.1	28.6	0.6
Acarina	9.1	1.6	4.2	0.2
Araneae	20.3	1.2	15.1	0.2
Scorpionida	–	–	0.8	0.1
Solifugae	4.8	0.3	11.8	0.1
Chilopoda	0.9	0.1	5.9	0.2
Diplopoda	0.3	<0.1	–	–
Insecta	92.1	55.4	99.2	82.8
Blattaria	6.1	0.1	–	–
Coleoptera	39.7	1.3	53.8	3.3
Carabidae	29.4	1.0	3.0	0.2
Curculionidae	11.5	0.2	–	–
Scarabeidae	0.9	<0.1	4.0	0.3
Tenebrionidae	0.3	<0.1	8.0	0.3
Other families	6.1	0.2	–	–
Unidentified	–	–	–	2.5
Dermaptera	1.8	<0.1	2.5	0.1
Diptera	45.5	1.5	24.4	0.5
Asilidae	14.5	0.2	9.0	0.1
Calliphoridae	27.3	0.7	1.0	<0.1
Muscidae	20.6	<0.1	–	–
Tabanidae	17.3	0.3	–	–
Tachidae	0.9	<0.1	–	–
Larvae	1.2	0.4	–	–
Unidentified	–	–	–	0.4
Hemiptera	7.6	0.2	1.7	0.2
Hymenoptera	11.5	0.1	10.9	0.2
Isoptera	10.6	0.1	26.9	12.0
Lepidoptera	13.6	0.8	33.6	0.8
Mantodea	40.6	0.3	6.7	0.3
Neuroptera	2.4	<0.1	0.8	<0.1
Odonata	7.3	0.9	0.8	<0.1
Aeschnidae	3.0	0.3	–	–
Coenogrionidae	4.2	0.1	–	–
Libellulidae	6.7	0.4	–	–
Unidentified	–	–	–	<0.1
Orthoptera	87.0	41.1	89.9	52.8
Acrididae	72.7	35.0	88.0	2.6
Truxalinae	17.6	0.6	–	–
Gryllidae	47.6	4.7	5.0	0.6
Gryllacrididae	0.3	<0.1	–	–

Continuation of Table 2 on page 102.
Fortsetzung von Tab. 2 auf Seite 102.

Continuation of Table 2. – Fortsetzung von Tab. 2

Taxa	Chicks		Adults	
	Frequency of occurrence	Dry mass %	Frequency of occurrence	Dry mass %
Pamphagidae	2.7	0.3	1.0	0.2
Tettigonidae	25.2	0.6	6.0	2.4
Unidentified	–	–	–	47.0
Phasmatodea	0.6	0.2	1.7	<0.1
Plecoptera	0.3	<0.1	–	–
Trichoptera	–	–	0.8	<0.1
Unidentified	–	9.0	–	12.4
Amphibia	32.4	24.7	7.6	1.0
Cacosternum boettgeri	22.7	4.4	–	–
Rana angolensis	23.0	14.8	–	–
Rana fuscigula	0.3	0.3	–	–
Rana sp.	0.3	0.1	–	–
Phrynobatrachus sp.	6.4	3.4	–	–
Unidentified	–	1.7	–	1.0
Reptilia	5.8	4.2	17.6	6.3
Agamidae	–	–	3.0	0.5
Gekkonidae	–	–	1.0	0.1
Lacerta sp.	2.1	0.2	14.0	4.1
Mabuya sp.	3.3	1.7	–	–
Scincidae, unident.	3.3	2.3	3.0	1.5
Aves	8.8	6.2	–	–
Ploceidae	6.1	5.5	–	–
Quelea sp.	0.6	0.7	–	–
Mammalia	2.4	4.1	8.4	9.0
Rhabdomys pumilio	2.1	3.8	3.0	7.2
Suncus sp.	0.9	0.3	–	–
Unidentified	–	–	–	1.8
Plants	31.2	0.6	20.2	<0.1
Inorganic matter	7.0	1.2	1.7	<0.1
Sample size	n = 330	676 g	n = 119	637 g

Plant matter and inorganic materials (small stones, sand, pieces of glass and plastic) constituted only 1.2% of the total dry mass in the diet of chicks and less than 0.1% in the diet of adults.

3.3. Variation in chicks' diet between two breeding seasons ($\chi^2 = 76$; df = 17; $p < 0.01$)

Based on boli analysis collected at the Wolwekop colony, much higher proportion of aquatic prey was shown in 1976/1977 (42% of total dry mass) than in 1993/1994 (3%) in the diet of Cattle Egret chicks. During the breeding season of 1976/1977, invertebrates and vertebrates contributed equally (48.9% against 48.5%) to the main dry mass of the chicks' diet, while during 1993/1994, the amount of invertebrates was much higher than that of vertebrates (Table 3). Concerning insects, Orth-

Table 3: Composition of boli of Cattle Egret chicks collected at Wolwekop, Dewetsdorp district, Free State, during 1976/77 and 1993/94. Frequency of occurrence as in Table 2.
Tab. 3: Nahrungszusammensetzung in Speiballen von Kuhreiher-Jungvögeln. Häufigkeitsmaß s. Tab. 2.

Taxa	1976/77		1993/94	
	Freqency of occurrence	Dry mass %	Frequency of occurrence	Dry mass %
Crustacea	7	0.7	–	–
Arachnida (total)	67	2.2	42	3.6
Acarina	14	0.1	8	2.1
Araneae	66	1.7	15	0.8
Solifugae	–	–	4	0.7
Unidentified	1	0.5	1	0.1
Chilopoda	1	<0.1	1	0.2
Diplopoda	–	–	1	0.1
Insecta (total)	88	46.0	94	86.4
Blattaria	10	0.1	4	0.1
Coleoptera	42	1.6	29	1.2
Dermaptera	3	0.1	2	0.1
Diptera	63	2.1	41	3.1
Hemiptera	2	<0.1	10	0.1
Hymenoptera	28	0.2	6	0.1
Isoptera	6	0.1	8	0.2
Lepidoptera	26	0.4	13	1.8
Mantodea	49	2.1	44	3.8
Neuroptera	–	–	4	0.1
Odonata	31	1.4	1	0.1
Orthoptera	83	20.5	90	72.1
Phasmatodea	3	0.1	2	0.1
Plecoptera	–	–	1	0.1
Unidentified	57	17.4		3.5
Amphibia	87	39.7	19	2.5
Reptilia	5	0.6		6.4
Aves	3	1.2	–	–
Mammalia	5	7.0	–	–
Plant matter	27	0.5		1.0
Inorganic matter	6	2.0	–	–
Sample size	n = 103	397 g	n = 190	112 g

optera dominated both in 1976/1977 and 1993/1994 (44.6% and 83.5% of total dry mass of the insect component of the diet, respectively). In both seasons, Diptera and Mantodea constituted 2–4% of the total dry mass. Arachnids comprised similar proportions in both years, but Ixodidae (Acari) were more often recorded in 1993/1994 (2.1% of total dry mass) than in 1976/1977 (0.1%). Amphibia were the main component of the vertebrate diet in 1976/1977, while Reptilia were important in 1993/1994 (Table 3).

3.4. Month-to-month variation in the diet of adult birds

This comparison is based on stomach contents of adult birds collected during the years 1980–1995. Throughout the year aquatic prey contributed only 0–2% of total dry mass in each month to the diet

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Solifugae	–	–	4	0.7
Unidentified	1	0.5	1	0.1
Chilopoda	1	<0.1	1	0.2
Diplopoda	–	–	1	0.1
Insecta (total)	88	46.0	94	86.4
Blattaria	10	0.1	4	0.1
Coleoptera	42	1.6	29	1.2
Dermaptera	3	0.1	2	0.1
Diptera	63	2.1	41	3.1
Hemiptera	2	<0.1	10	0.1
Hymenoptera	28	0.2	6	0.1
Isoptera	6	0.1	8	0.2
Lepidoptera	26	0.4	13	1.8
Mantodea	49	2.1	44	3.8
Neuroptera	–	–	4	0.1
Odonata	31	1.4	1	0.1
Orthoptera	83	20.5	90	72.1
Phasmatodea	3	0.1	2	0.1
Plecoptera	–	–	1	0.1
Unidentified	57	17.4		3.5
Amphibia	87	39.7	19	2.5
Reptilia	5	0.6		6.4
Aves	3	1.2	–	–
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This comparison is based on stomach contents of adult birds collected during the years 1980–1995. Throughout the year aquatic prey contributed only 0–2% of total dry mass in each month to the diet

of adult birds. In summer (September–March), most of their diet consisted of invertebrates, while in winter (June–August), it comprised largely vertebrates (Fig. 2). Orthopteran prey constituted a significant component of the diet for most of the year, however in early summer (October–December) this component of the diet was replaced by large quantity of termites. Small quantities of Coleoptera (usually less than 1–4% of total dry mass in a particular month) were also recorded throughout the year. Lepidoptera were encountered mainly in summer, especially in January (33% of total dry mass) and in September (16%), these comprised the bulk of the diet. In March, Formicidae were taken in large numbers, but due to their small size, these contributed only 5% of total dry mass during that month.

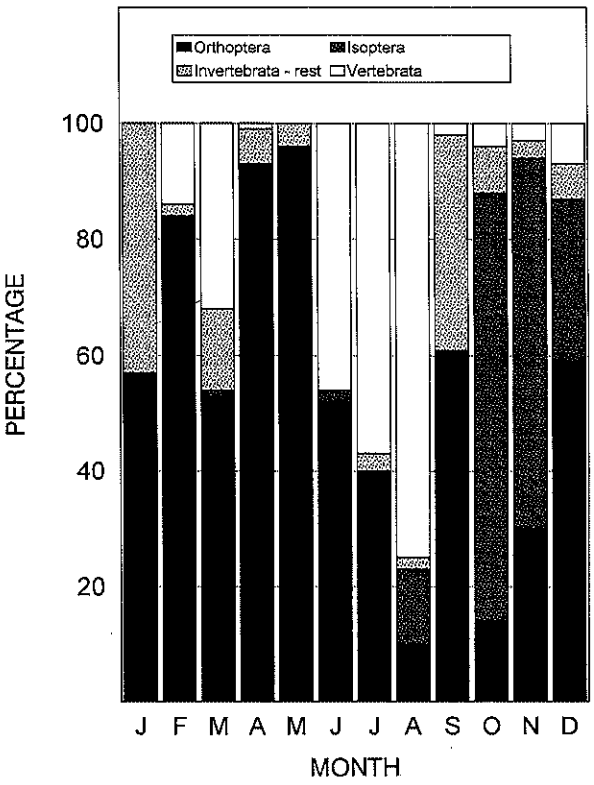

Fig. 2: Seasonal variation in the Cattle Egret diet (dry mass) in South African grassland (n = 119).
Abb. 2: Jahreszeitlicher Wechsel in der Nahrungszusammensetzung (Trockenmasse) von Kuhreihern nach Analyse des Mageninhalts von 119 im südafrikanischen Grasland geschossener Altvögel.

3.5. Male and female diet ($\chi^2 = 7$; df = 9; $p > 0.5$)

The same material as in the previous analysis was used. No obvious differences in the main components of the diet were found between males (n = 60) and females (n = 48) (Table 4).

3.6. Diet variation in relation to chicks' age

This analysis is based on stomach contents collected during one breeding season (1993/1994) at the Wolwekop colony. It was shown, that as the Cattle Egret chick grows, the diet changes markedly. In their first seven days, grass-living vertebrates constituted the bulk of the diet (mainly ploceid chicks with a few reptiles and frogs). In their second week of life, the proportion of vertebrates (predominately grass-living) and invertebrates (exclusively grass-living insects) was equal, and in the third week of life, grass-living invertebrates predominated. Older chicks were fed almost exclusively (94%) on grass-living insects (mainly Orthoptera, 71%) with only a few frogs (6%; Fig. 3).

3.7. Variation in the diet of chicks in relation to sample kind ($\chi^2 = 77$; df = 19; $p < 0.01$)

Only stomach contents and boli from one season (1993/1994) and from one site (Wolwekop) were analysed. Similar proportions of invertebrates (58%, mainly Orthoptera, 52%) and vertebrates

Table 4: Differences in diet composition (percentage of dry mass) between male and female Cattle Egret.
Tab. 4: Unterschiede in der Nahrungszusammensetzung (Prozentsatz Trockenmasse) zwischen männlichen und weiblichen Kuhreihern.

Prey taxa	Male	Female
Arachida	0.5	0.9
Crustacea	<0.1	0.5
Insecta	(82.9)	(81.4)
Diptera	0.4	0.6
Hymenoptera	0.7	0.3
Isopoda	30.0	16.0
Lepidoptera	1.2	2.2
Orthoptera	47.5	58.0
Other	0.2	0.2
Unidentified	1.1	3.5
Amphibia	1.4	0.4
Reptilia	4.9	8.1
Mammalia	9.9	8.7
Other	0.4	0.0
Number of stomachs	60	48

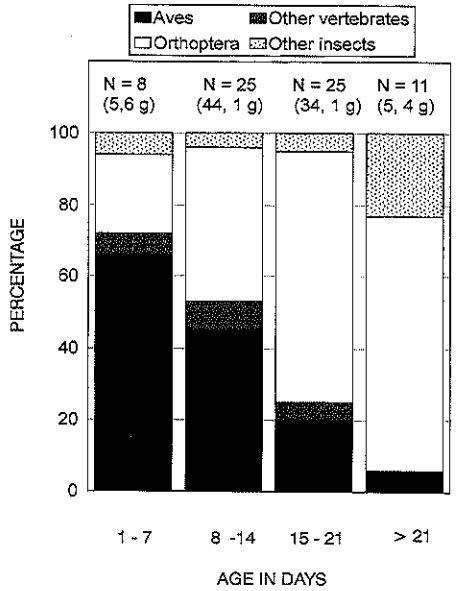

Fig. 3: Variation in the diet (dry mass) compositon of Cattle Egret chicks in relation to their age (above the colums the number of stomachs and total dry mass analysed is given).
Abb. 3: Nahrungszusammensetzung bei unterschiedlich alten Kuhreiher-Jungvögeln (über den Säulen ist jeweils die Zahl untersuchter Mägen und die Menge der analysierten Trockenmasse angegeben).

(40%; mainly ploceid chicks, 33%) were recorded in the chicks' stomachs, while in their boli, the total mass of invertebrates (80%; including 66% Orthoptera) exceeded 5-fold the dry mass of vertebrates (15%) (Table 5).

3.8. Variation in the diet of chicks in relation to the study site

Only stomach contents of chicks collected during the same breeding season (1976/1977) were analysed. The chicks were originated from two colonies situated in a distance of c. 20 km (*see* Material and Methods). Similar proportion of main groups of prey (grass-living versus aquatic) has been shown, but the birds preyed more often upon mammals at Geluk than at Wolwekop.

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Insecta	(82.9)	(81.4)
Diptera	0.4	0.6
Hymenoptera	0.7	0.3
Isopoda	30.0	16.0
Lepidoptera	1.2	2.2
Orthoptera	47.5	58.0
Other	0.2	0.2
Unidentified	1.1	3.5
Amphibia	1.4	0.4
Reptilia	4.9	8.1
Mammalia	9.9	8.7
Other	0.4	0.0
Number of stomachs	60	48

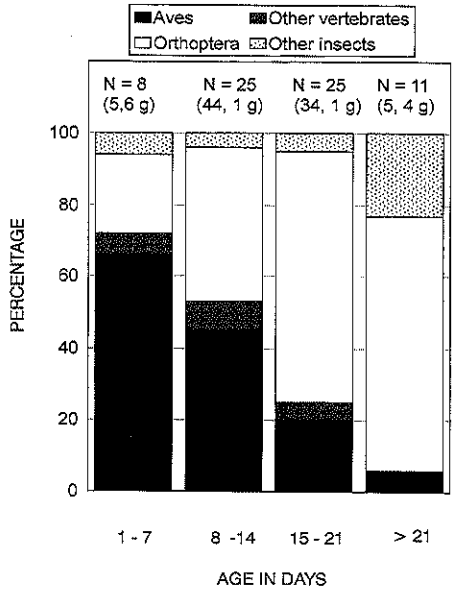

Fig. 3: Variation in the diet (dry mass) compositon of Cattle Egret chicks in relation to their age (above the colums the number of stomachs and total dry mass analysed is given).
Abb. 3: Nahrungszusammensetzung bei unterschiedlich alten Kuhreiher-Jungvögeln (über den Säulen ist jeweils die Zahl untersuchter Mägen und die Menge der analysierten Trockenmasse angegeben).

(40%; mainly ploceid chicks, 33%) were recorded in the chicks' stomachs, while in their boli, the total mass of invertebrates (80%; including 66% Orthoptera) exceeded 5-fold the dry mass of vertebrates (15%) (Table 5).

3.8. Variation in the diet of chicks in relation to the study site

Only stomach contents of chicks collected during the same breeding season (1976/1977) were analysed. The chicks were originated from two colonies situated in a distance of c. 20 km (*see* Material and Methods). Similar proportion of main groups of prey (grass-living versus aquatic) has been shown, but the birds preyed more often upon mammals at Geluk than at Wolwekop.

Table 5: Comparison between the bolus and stomach contents of Cattle Egret chicks during 1993/1994 breeding season at Wolwekop. Frequency of occurrence as in Table 2.

Tab. 5: Vergleich zwischen den Nahrungsbestandteilen in Speiballen und Mageninhalten von Kuhreiher-Jungvögeln während der Brutsaison 1993/94. Häufigkeitsmaß s. Tab. 2.

Prey taxa	Boli		Stomachs	
	Frequency of occurrence	Percentage of total dry mass	Frequency of occurrence	Percentage of total dry mass
Arachnida	64	3.9	22	0,7
Insecta	(97)	(75.7)	91	(57.5)
Coleoptera	35	1.5	68	2,6
Diptera	41	2.4	39	1,4
Lepidoptera	15	0.2	3	0,2
Mantodea	37	2.6	10	0.6
Orthoptera	92	66.0	83	52.1
Other	24	3.0	60	0.6
Amphibia	27	3.1	10	2.1
Reptilia	7	6.9	7	4.2
Aves	6	4.9	17	33.4
Other	.	5.5	.	2.1
Sample size	n = 147	16 642 mg	n = 69	8 978 mg

4. Discussion

In the Cattle Egret boli, most prey items were whole and not digested. However in stomachs, some prey were partly, and possible even entirely digested. Vertebrates, especially frogs were found to be more digested than invertebrate prey. Results based on stomach content analysis may therefore be biased. As far as dry mass of prey is concerned, it can be assumed that proportion of vertebrate prey was actually higher than the analysis shown. The difference between the recorded and the expected proportion of vertebrate dry mass might be especially marked for chicks, as their rate of digestion is higher than that of adult birds.

Seasonal variation in the Cattle Egrets' diet (Fig. 2) reflects prey availability in the environment. In summer, Orthoptera are the most abundant invertebrates in South African grassland. In winter, Orthoptera are scarce, while rodents become more numerous and easier to find and catch, as the grass cover is sparse. The high proportion of Isoptera in October, November and December is coincident with alates in mass flight. Isoptera in that time and other non-orthopteroid insects a month before and after this period, play a similar role in the Cattle Egrets' diet, as vertebrates in the winter, being supplementary to the diet. This study also suggests the existence of a balance between orthopteran and non-orthopteran biomass in the diet. JENNI's (1973) data from Florida suggest a similar balance between orthopteran and amphibian ingredients, and RUIZ's (1985) between amphibian and coleopteran/orthopteran biomass. The much higher proportion of frogs in the Cattle Egret's diet in 1976/1977 compared with the 1993/1994 breeding season in the Free Sate (Table 3) could be linked to rainfall, which was relatively high in 1976/1977 and low in 1994/1995 (Fig. 1). Frogs are, generally, less numerous in dry years.

There is no obvious difference between the males' and females' diet in my material (Table 4). This was expected, as there is no statistical difference in body mass between sexes in central South Africa. KOK & VAN ZYL (1996) give the mean body mass of 47 males as 379 g and 38 females as 368 g, thus females are only 3% lighter than males. Even in Australia, where the gender difference in mass was found to be much higher (15%), no obvious differences in diet between the male and female existed (MCKILLIGAN 1984).

SIEGFRIED (1972b) suggested that parents can display preferences in the size or kind of prey relative to the age of their young. He showed a progressive increase with the age of the chicks, in proportion of birds eating vertebrates, and a decline in the number of food items per meal with the increasing age of the chicks. In other words, mean mass of the prey brought to the nestlings increases with the age of the young. My results appear to negate that finding, as average prey mass steadily decreases with chick age (Fig. 3).

Cattle Egret chick mass increases relatively rapidly during the first two weeks of life, during which it gains c. 70% of its total growth (SIEGFRIED 1972b). As the vertebrate prey is more rich in energy and more easy digested than chitinous invertebrates (SIEGFRIED 1969), it would appear axiomatic that vertebrates are more nutritious. The parents may also need less energy to collect vertebrate prey. Given that the chicks of Cattle Egret show their greatest need for nutrition when they are c. 10-days old (SIEGFRIED 1972b), preying on warm-blooded animals at that time could be an adaptive strategy. It is doubtful that the large proportion of the ploceid chicks found in the diet of Cattle Egret chicks coincided with their abundance during the short period when most of Cattle Egret chicks are 1–2 weeks old as the Red Bishop *Euplectes orix* and other ploceid species breed in the Free State throughout the summer (pers. obs.). Chicks of passerine seed-eating birds as prey of the Cattle Egret were also recorded in the Free State by VAN EE (1973).

The diet of breeding Cattle Egrets in South African grassland with extensive stock-farming differs markedly from intensively irrigated dairy-cattle paddocks in the South African fynbos (Table 6). While in the grassland, Orthoptera, Isoptera and Vertebrata constitute the main components of the diet, in the fynbos, Oligochaeta, larvae of Lepidoptera, Coleoptera and Orthoptera formed the bulk of diet. Especially striking is the presence of the Oligochaeta in the intensively irrigated paddocks. These would be abundant and commonly available in the paddocks, especially after watering. Similarly in Bloemfontein city, some irrigated grassy areas are often frequented by Hadada Ibises (*Bostrychia hagedash*), Cattle Egret and other birds which forage mainly on Oligochaeta

Table 6: Diet of the Cattle Egret chicks (based on bolus analysis) in different parts of the world (computed as a percentage of the total mass of prey).

Tab. 6: Zusammensetzung der Nahrung junger Kuhreiher nach Speiballen-Analysen in verschiedenen Regionen seines Verbreitungsgebietes (jeweils angegeben als Prozentsatz der gesamten Nahrungsmasse).

Place	Free State RSA	Western Cape RSA	'Transvaal' RSA	Ebro Delta Spain	Queensland Australia	New South Wales Australia	Florida USA
Habitat	extensive farming in grassland	intensive farming in fynbos	intensive farming in grassland	alluvial rice cultivation	alluvial intensive farming	freshwater wetland	extensive farming in wet grassland
Arthropoda							
Orthoptera	66	36	59	4	73	66	76
Coleoptera	2	3	1	5	+	+	2
Lepidoptera	+	32	5	4	+	1	2
Diptera	2	5	6	+	+	1	2
Arachnida	4	1	10	3	6	3	5
Vertebrata	20	20	18	84	19	23	13
Number of boli	147	98	192	151	677	61	510
Sources	this study	SIEGFRIED 1966a, 1971	O'CONNOR 1993	RUIZ&JOVER 1981; RUIZ 1985	MCKILLIGAN 1984	BAXTER & FAIRWEATHER 1989	JENNI 1969, 1973; FOGARTY & HETRICK 1973

(pers. obs.). In predominately dry, not irrigated grassland in the Dewetsdorp district Oligochaeta are possible less available. Lepidoptera and Coleoptera are two main groups associated with intensive farmlands, while Isoptera and Coleoptera are the dominant component of the insect fauna in more natural grasslands and this is reflected in the Cattle Egret diet in South Africa.

In the former Transvaal (South Africa), the Ebro delta (Spain), Florida (USA), Queensland and South New Wales (Australia) the main prey during the breeding season was such as found in South Africa (Table 6). Throughout the world, arachnids, including ticks, constituted supplementary diet of Cattle Egret chicks, while freshwater invertebrates and fish were virtually absent (Table 6).

A few authors (e. g. SKEAD 1966; BLAKER 1965) have stressed the importance of Diptera in the Cattle Egrets' diet. This study appears to support BLAKER's (1965) statement that in some circumstances, Cattle Egrets may play significant role to control flies, especially Tabanidae, which annoy cattle.

The Cattle Egret is therefore a highly opportunistic feeder which depends rather not on the presence of any particular prey species but on feeding habitats. Wherever these resemble its original habitat in East Africa (RUIZ 1984), the bird is able to adapt by feeding on a wide range of available prey.

5. Zusammenfassung

Zur Nahrung des Kuhreihers (*Bubulcus ibis*) im südafrikanischen Grasland.

Der vorliegenden Studie liegen Untersuchungen von Mageninhalten und Speiballen junger und alter Kuhreiher südafrikanischer Grasländereien zugrunde. Den Hauptteil der Nahrung machen Insekten aus (69% der Trockenmasse), auf andere Gliederfüßler entfallen 2% und auf Wirbeltiere 28%. Die Insektennahrung besteht hauptsächlich aus Geradflüglern (47%, vor allem Feldheuschrecken) und Termiten (12%, ausschließlich *Hodotermes mossambicus*). Käfer, Schmetterlinge und Zweiflügler sind dagegen als Nahrung unbedeutend. Bei Jungvögeln war der Anteil an Wirbeltieren in der Nahrung höher und der Anteil an Insekten niedriger als bei Altvögeln. In der relativ regenreichen Brutsaison 1976/77 hatten Wirbellose und Wirbeltiere einen etwa gleich hohen Anteil an der Kuhreiher-Nahrung, während in der relativ regenarmen Brutsaison 1993/94 Invertebraten stark dominierten. Im Sommer (September bis März) bestand die Nahrung von Kuhreiher-Altvögeln vor allem aus Insekten, im Winter (Juni bis August) dagegen hauptsächlich aus Wirbeltieren. Der Wirbellosen-Anteil in der Nahrung nahm bei Jungvögeln im Verlauf ihres Wachstums zu und der Anteil an Wirbeltieren ab.

6. References

Baxter, G. S., & P. G. Fairweather (1989): Comparison of the diets on nestling Cattle Egrets and Intermediate Egrets in the Hunter Valley, New South Wales. Aust. Wildl. Res 16: 395–404. * Branch, W. R. (1988): Field Guide to the Snakes and other Reptiles of Southern Africa. Struik Publisher. Cape Town. * Bredenkamp, G., & N. van Rooyen (1996): Moist Cool Highveld Grassland. In: Low, A. B., & A. G. Rebelo (eds). Vegetation of South Africa, Lesotho and Swaziland. Department of Environmental Affairs & Tourism. Pretoria. * Blaker D. (1969): Behaviour of the Cattle Egret *Ardeola ibis*. Ostrich 40: 75–129. * Ditto (1971): Range expansion of the Cattle Egret. Ostrich Suppl. 9: 27–30. * del Hoyo J., A. Elliot & J. Sargatal (eds, 1992): Handbook of the Birds of the World. Vol. I. Lynx Edicions. Barcelona. * Fogarty, M. J., & W. M. Hetrick (1973): Summer food of Cattle Egrets in north central Florida. Auk 90: 268–280. * Ikeda, S. (1956): On the food habits of the Indian Cattle Egret *Bubulcus ibis cormandus* (Boddaert). Japan J. app. Zool 21: 83–86. * Jenni, D. A. (1969): A study of the ecology of four species of herons during the breeding season at Lake Alice, Alachua County, Florida. Ecol. Monograph 39:245–270. * Ditto (1973): Regional variation in the food of nestling cattle egrets. Auk 90: 821–826. * Kadry, I. (1942): The economic importance of the Buff-backed Egret (*Ardeola ibis* L.) to Egyptian agriculture. Bull. zool. Soc. Egypt 4: 20–26. * Kirkpatrick, T. W. (1925): The Buff-backed Egret (*Ardeola ibis* L. Arabic abu qedran) as a factor in Egyptian agriculture. Bull. tech. sci. Serv. Egypt 56: 1–6. * Kok, O. B., & J. M. van Zyl (1996). Body mass of birds from central South Africa. Ostrich 67: 160–162. * Martin, N., L. Cabrera, L. Ordunas, M. Vila & B. Iglesias (1967): The Cattle Egret, the bird of major importance for the agricultural economy of the country. Cuban Acad. Sci. Bull. 42. [in Spanish]. * McKilligan, N. G. (1984): The food and feeding ecology of the Cattle Egret *Ardeola ibis*, when nesting in south-east Queensland. Aus. Wildl. Res. 11: 133–144. * Middlemiss E. H. J. (1955): Food

of juvenile egrets. Ostrich 26: 159. * O'Connor, T. G. (1993): The diet of nestling Cattle Egrets in the Transvaal. Ostrich 64: 44–45. * Passmore, N. I., Carruthers V. C. (1979): South African Frogs. A Complete Guide. Witwatersrand University Press. Johannesburg * Ruiz X. (1984): Reflexiones acerca de la expansion gracilla bueyera – *Bubulcus ibis* (L., 1758) (Aves, Ardeidae). P. Dept. Zool. Barcelona 10: 73–91. * Ditto (1985): An analysis of the diet of Cattle Egrets in the Ebro Delta, Spain. Ardea 73: 49–60. * Ruiz, X., & L. Jover (1981): Sobre la alimentacion otonal de la gracilla bueyera – *Bubulcus ibis* (L.) – en el delta del Ebro, Sarragona (Espana). P. Dept. Zool. Barcelona 6: 65–72. * Scholtz, C., & E. Holm (eds, 1986): Insects of Southern Africa. Butterworths. Durban * Siegfried, W. R. (1966): On the food of nestling Cattle Egrets. Ostrich 37: 129–220. * Ditto (1969): Energy metabolism of the Cattle Egret. Zool. afr. 4: 265–273. * Ditto (1971): The food of the cattle egrets. J. appl. Ecol. 8: 447–468. * Ditto (1972a): Aspects of the feeding ecology of Cattle Egrets (*Ardeola ibis*) in South Africa. J. anim. Ecol. 41: 55–62. * Ditto (1972b): Food requirements and growth of Cattle Egret in South Africa. Living Bird 11: 193–206. * Skead, D. M. (1963): Cattle Egret *Bubulcus ibis* feeding on flies off the Cape Eland *Taurotragus oryxs*. Ostrich 34: 166. * Snoddy, E. L. (1969): On the behavior and food habits of the Cattle Egret, *Bubulcus ibis* (L.). Georgian entomol. Soc. 4: 156–158. * van Ee, C. A. (1973): Cattle Egrets Prey on Breeding Queleas. Ostrich 44: 136. * Vazquez, M., & C. Marquez (1972): Algunos aspectos biologicos y la alimentacion de la garza garrapatera *Bubulcus ibis ibis* (Linneo) en la region de la Mancha, Actopan, Veracuz. Ana. Inst.Biol. Univer. Nac. aut. Mexico 43.