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Diet of the helmeted guineafowl (*Numida meleagris galeata* Pallas) in the Waza region of North Cameroon

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Summary

Through laboratory and field experiments, we investigated the effect of food availability and food nutritive value on food selection by helmeted guineafowl (*Numida meleagris galeata* Pallas) during the dry season in the Waza region of North Cameroon. Field study and crop analysis shows that a wide variety of food types are eaten by guineafowl during the dry season. Analysis of 101 crops from wild birds reveals a statistically significant positive correlation between the sodium and water content of food items and the quantity found in the crops. Rhizomes of *Stylochiton lancifolius* and termites form the bulk of the diet of this species during the dry season. It is concluded that the selection of water-rich food may be an adaptation to dry environment.

Key words: correction-factor, diet, guineafowl, Waza

Résumé

Par des expériences en laboratoire et sur le terrain, nous avons étudié l'effet de la disponibilité en nourriture et de la valeur nutritive des aliments sur le choix de la nourriture par la pintade casquée (*Numida meleagris galeata* Pallas) pendant la saison sèche, dans la région de Waza, au nord du Cameroun. Une étude sur le terrain et une analyse des gésiers montrent que la pintade mange une grande variété de types de nourriture. L'analyse de 101 gésiers d'animaux sauvages révèle une corrélation positive, statistiquement significative, entre le contenu en sodium et en eau de la nourriture et la quantité trouvée dans les gésiers. Les rhizomes de *Stylochiton lancifolius* et des termites forment la plus grande part du régime alimentaire de cette espèce pendant la saison sèche. On conclut que le choix d'une nourriture riche en eau est une adaptation à un environnement aride.

Introduction

The helmeted guineafowl (*Numida meleagris galeata* Pallas 1767) is a species characteristic of the Waza region of North Cameroon in general and the Waza National Park in particular. However, their populations decreased drastically

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from 1990 to 1995 (pers. obs.). Factors responsible for this decline include natural causes (mostly climatic changes) and human interference (mainly habitat destruction and poaching).

Poaching occurs mostly during the dry season, when both food and water for wildlife are scarce, and the situation is even worse in drought years. In the present context, it is important to know how guineafowl survive this critical period. A possibility is that during the dry season, guineafowl are less selective in their feeding with respect to nutrient content, but more selective with respect to water content. This study was aimed at finding out which food is eaten by this bird during the critical dry period.

Guineafowl can vary their diet with season and location (Skead 1962; Ayeni 1980, 1983). Studies of the food of *N. m. meleagris* and *N. m. coronata* in both natural and agricultural land include those of Chapin (1932) in Congo, Skead (1962), Grafton (1970), Mentis *et al.* (1975) in South Africa, Benson (1963) in former Rhodesia and Swank (1977) in Kenya. To our knowledge, the only study on the diet of the subspecies *N. m. galeata* is that of Ayeni (1980) in the Kainji Lake area of Nigeria.

The following questions were asked:

1 What types of food do guineafowl select during the dry season?;

2 Will crop contents analysis alone suffice to determine what birds eat or are field observations and a correction factor necessary to complement this?;

3 What are the mineral, nutrient and water content of the guineafowls' diet during the dry season? Will this influence the choice of food by the bird?

The study area

The study area covers about 10,000 ha, mainly the south-western part of the Waza National Park (Fig. 1). Average altitude is about 300 m, and the topography is generally flat, sloping gently towards the East. Yearly maximum temperature is around 40°C and the minimum is around 18°C. The hottest month is April (average temperature 32·8°C) and the coldest is January (average temperature 26·1°C). There are two main seasons, a rainy season from May to October and a dry season from November to April. Rainfall varies from 500 to 800 mm per year. The vegetation of whole Waza region was described by Wit (1975) and Gaston (1991) as a Sudan-Sahelian grassland with two distinct vegetation types: a wooded savannah to the West and a grassland savannah to the East. There are no rivers in this study area, but some natural and artificial water holes provide water for animals for most of the year.

The most common grasses and herbs in the whole region are of the family Cyeraceae, Araceae and Malvaceae, but the vegetation of the whole region can be divided into eight main vegetation formations by Gaston (1991); (Fig. 1). The six vegetation formations covering a major portion of the main study area are shown in the rectangle on Fig. 1.

Methods

Crop contents

To find out what guineafowl eat during the dry season 73 guineafowl were collected from licensed hunters in the south of Waza National Park for crop

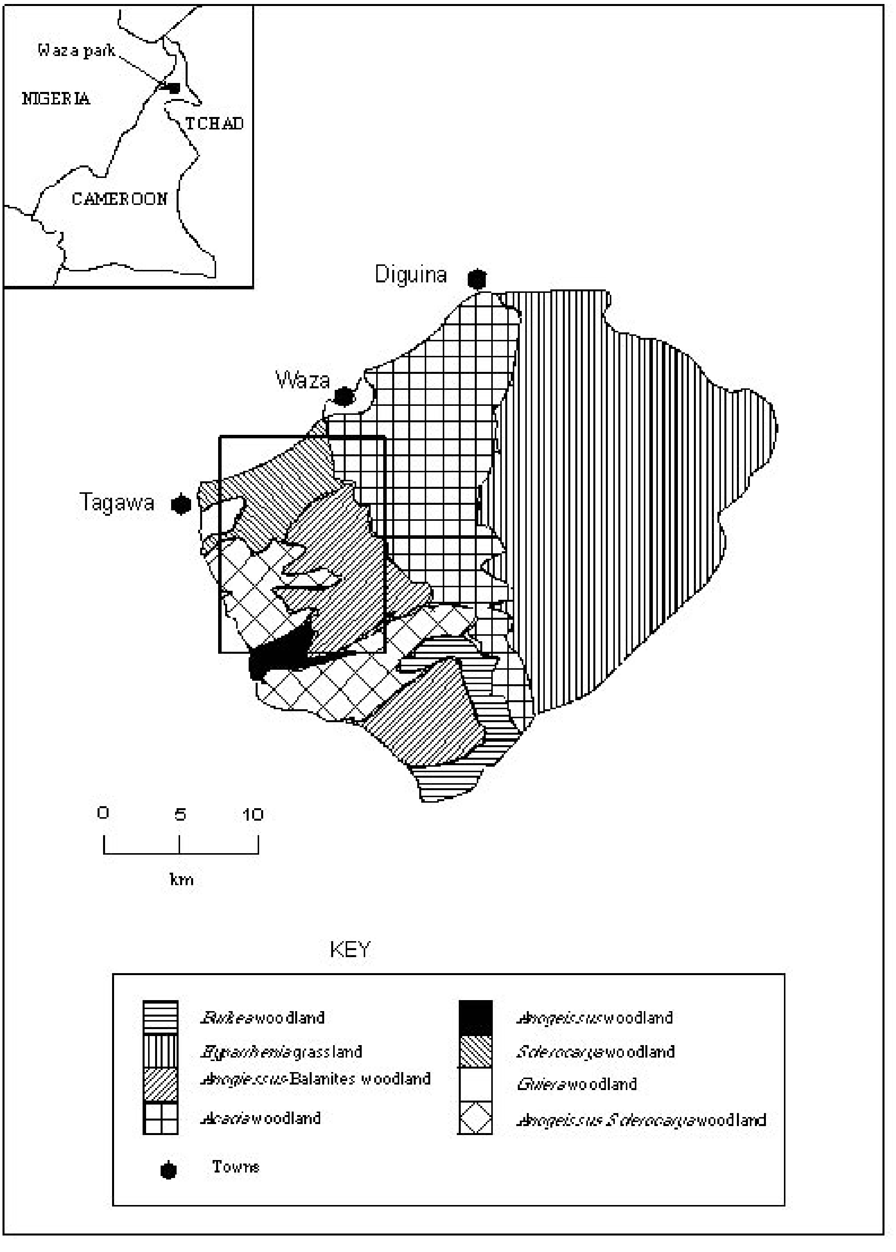

Fig. 1. A vegetation map of the Waza National Park. The rectangle represents the main study area (adapted from Gaston 1991).

content analysis. All the shooting took place between the months of February and March 1994. Shooting was usually carried out in the evening (from 2 to 3 h before sunset and dusk). Dead birds were sexed by examining the cloaca, given a number tag, put in a plastic bag and stored in a large cooler to inhibit decomposition. After each shooting session, the birds were weighed on an electronic balance of precision 0·2 g, dissected, and the crops were removed, weighed, and stored in 65% alcohol for later analysis.

Additional data were collected from 28 crops of guineafowl taken from poachers in 1993. The crop contents were sorted into different orders of insects, species of plants (leaves grains and roots), pebbles and unidentified items under a microscope at 10 × magnification. Unidentified seeds were germinated in trays containing sterile soil. A Spearman rank correlation test was used to describe the relationship between the number of pebbles in the crop and the full crop weight.

Food correction-factor

The feeding habit of birds can be investigated by crop contents analysis. However, because of differences in digestibility, the crop contents may not give a true picture of what was consumed. It might thus be necessary to use a correction-factor to make up for the differences. If a bird that consumed a certain quantity (A) of a food item is killed after a fixed time period, an unknown quantity of food (α) would have been digested. The quantity of food that will be found in the crop may be say a. The quantity of food consumed (A) can then be calculated from the following formula:

$$A = a + \propto, \tag{1}$$

or,

$$\frac{A}{a} = 1 + \frac{\propto}{a}, \tag{2}$$

where $\propto$ is the correction-factor for food item. If the birds are of different age groups resulting in different correction-factors, the average correction can be calculated by taking the harmonic means for the different age groups, since correction-factors are proportions (eqn 2).

To find out whether this food correction-factor is necessary for guineafowl, fifteen semi-wild guineafowl (eight adults and seven subadults) were kept in two cages (one for adults and one for subadults), and fed with meals composed of seeds, rhizomes, leaves and insects found in the diet analysis. Each food item was weighed separately on an electronic balance accurate to 0·2 g; all of them were mixed up and given to the birds three times a day (morning, afternoon and evening) for a seven day habituation period. At the end of the seventh day, the cage was thoroughly cleaned. On the eighth day, the same feed composition was given at 0600 h and the birds allowed to feed till 1000 h after which all food was removed from the cage, sorted into identical food type, counted and weighed. At 1800 h the birds were killed, dissected, and the crops were removed and weighed. The crop contents were separated into the different food items which were counted and weighed. The amount of each food item eaten was calculated by subtracting the weight given from what remained. The correction-factor for each food item was calculated using eqn (2).

Food selection from field observation

To verify whether analysis of crop contents provide a good estimate of the guineafowls' diet, birds were observed while feeding in all six vegetation types.

Observations were carried out for 2 h a day (from 1500 h to 1600 h), four times a week for 12 dry season weeks. When a group was encountered, feeding birds were identified by scanning through the group. Food types taken were either identified in the field or collected for identification.

Influence of mineral and water content on food selection

The crop contents were weighed, oven dried at 50–60°C until constant weight and the dry weight recorded. Percentage of water content was calculated from the difference of dry and fresh weight of the crop contents. The water content of some food items that were only found in small amounts in the crops and those seen to be fed on in the field but not found in the crops were estimated from samples collected in the field. Samples of identified plant food were also collected from the field and sent with those from the crops to the Biochemical Laboratory of the University of Wageningen for mineral and nutrient content analysis. A Spearman rank correlation test was used to evaluate the relationship between the water content of food items and the quantity found in the crops. The relationship between the mineral and nutrient contents of each food item and the quantity consumed by birds was also tested using correlation statistics.

Results

Crop contents

The average weight of crop contents plus or minus 95% confidence limit was $25{\cdot}6 \pm 2{\cdot}0$ g, while that of empty crops was $6{\cdot}8 \pm 0{\cdot}06$ g. Water occupied an average of $56{\cdot}5 \pm 3{\cdot}5\%$ of the fresh weight of crop contents. Plant seeds and roots formed $64{\cdot}8 \pm 6{\cdot}3\%$ of the dry weight of the crop contents, insects $26{\cdot}0 \pm 3{\cdot}3\%$, pebbles $0{\cdot}1 \pm 0{\cdot}6\%$ and unidentified crumbs $9{\cdot}1 \pm 2{\cdot}4\%$. Seeds were found in all the 101 crops (100%), while insects were found in 60 (58·9%) of the crops. Pebbles were found only in six crops (5·9%).

Rhizomes of *Stylochiton lancifolius* occurred in 99·0% of the crops with a relative dry weight (weight expressed as a percentage of the weight of all food in the crops) of 23·0% for all the 101 crops (Table 1). It was followed closely by seeds of *Hibiscus asper* with 63·4% frequency and 21·8% relative dry weight, *Vegna* sp. and *Monecma ciliata* with frequencies of 53·5 and 44·6% and relative dry weights of 2·2 and 4·1%. Frequencies of the other plant items ranged from 1% for *Cassia obtucifolia* and *Cuccumulus* sp. to 39·6% for *Cyperus* sp. Some of the plant food with high percentage frequency of occurrence in crops had low relative dry weight. For example, seeds of *Vigna* sp. with a relative frequency of 53·5% had a relative dry weight of only 2·2%. Leaves were only found in a few crops, and, when found, were usually difficult to identify because they were fragmented.

Numerically, the order Isoptera was the most important with 5725 insects in 40 crops. It was closely followed by Hymenoptera (23 crops) and Heteroptera (28 crops) with totals of 483 and 397 insects, respectively. The orders Coleoptera (15 crops) and Orthoptera (2 crops) only had 68 and 3 insects, respectively.

Table 1. Food items and their relative dry weights from the analysis of 101 wild helmeted guineafowl crops (harmonic mean) ± 95% confidence limits

Food	Number observed in 101 crops	Frequency (%)	Dry weight for all crops (g)	% (Corrected) of total dry weight
Plants				
Gramineae				
Brachiaria sp.	16	15·8	403·0	3·7
Loudetia togoensis (Pig.) C.E. Hubb.	6	5·9	45·6	0·4
Sorghum arundinaceum (Desv.) Stapf.	38	37·6	1664·4	15·2
Oryza barthii A. Chev.	29	28·7	698·9	6·4
Combretaceae				
Anogeissus leiocarpus Guill. & Perr.	4	4·0	10·8	0·1
Anonaceae				
Anona senegalensis Pers.	6	5·9	39·6	0·4
Cesalpiniaceae				
Cassia obtucifolia L.	1	1·0	0·3	<0·1
Fabaceae				
Commelina forskalaei Vahl.	38	37·6	604·2	5·5
Vigna sp.	54	53·5	237·6	2·2
Cucurbitaceae				
Cucumulus sp.	1	1·0	0·3	<0·1
Malvaceae				
Hibiscus asper Hook	64	63·4	2380·8	21·8
Acanthaceae				
Hygrophila africana T. Anders	2	2·0	6·2	0·1
Monecma ciliata (Jacq.) Milne-Redhead	45	44·6	445·5	4·1
Onagraceae				
Ludwigia leptocarpa (Nutt.) Hara	18	17·8	174·6	1·6
Anacardiaceae				
Sclerocaria birrea *A. Rich.) Hochst.	4	4·0	6·4	0·1
Bignonaceae				
Stereospermum kunthianum Cham.	8	7·9	8·8	0·1
Nyctaginaceae				
Boehaavia erecta L.	4	4·0	36·4	0·3
Rhamnaceae				
Ziziphus sp.	3	3·0	1·5	<0·1
Bulbs and roots				
Cyperaceae				
Cyperus esculentus Linn.	30	29·7	936·0	8·6
Cyperus sp	40	39·6	664·0	6·1
Araceae				
Stylochiton lancifolius Lepr.	100	99·0	2520·0	23·0
Insects				
Coleoptera	16	15·8	1·0	1·8*
Heteroptera	31	30·7	7·1	13·0*
Hymenoptera	27	26·7	13·2	24·5*
Isoptera	40	39·6	31·6	57·8*
Orthoptera	2	2·0	1·6	2·9*
Pebbles	6	5·9	1·8	8·2

*Percentage relative to total dry weight of insects only.

Table 2. Correction-factors for the guineafowls' diet estimated from feeding experiment

Food item	% dry weight eaten		% (dry weight) found in crops		Correction factor		Overall correction factor (hamonic mean) ± 95% confidence limits
	sub-adults	adults	sub-adults	adults	sub-adults	adults	
Seeds	86·83	78·1	98·27	99·07	1·13	1·27	1·2 ± 0·14
Leaves	11·00	18·11	0·32	0·40	34·38	45·28	39·08 ± 10·68
Rhyzomes	1·28	0·13	0·22	0·20	5·82	0·65	1·17 ± 5·07
Insects	0·89	3·65	1·19	0·33	0·75	11·6	1·41 ± 10·63

Pebbles were found only in six crops and there was a very significant positive correlation between the number of pebbles in the crop and the weight of the full crop ($P<0{\cdot}05$).

Food correction-factor

Apart from seeds, the correction-factors for subadult birds were different from those of adults for most of the food items (Table 2). Adult birds digested insects faster than subadults. The overall correction-factors were 1·2 ± 0·14 for seeds, 39·08 ± 10·68 for leaves, 1·17 ± 5·07 for rhizomes and 1·41 ± 10·63 for insects.

Food selection from field observation

All insect orders found in the crop analysis were also observed to be fed on in the field. Ten plant seeds found in the crop analysis were not seen to be eaten in the field while one rhizome and one leaf eaten in the field were not found in the crop analysis. Table 3 shows the differences in guineafowl diet from field observations and crop content analysis.

Birds were observed to feed on the rhizomes of *Stylochiton lancifolius* and *Cyperus* spp. as often as they found them. Birds were digging actively for these rhizomes as deep as 50 cm, especially in the southern sandy part of the park. Rhizomes of Cyperaceae and wild onions (*Albuca nigritana*) were frequently eaten in areas where there was no surface water. Leaves and flowers of *Leptadenia hastata* were also consumed in all areas. Analysis showed that leaves of *L. hastata* contained 78·7 ± 3·2% water, *A. nigritana* 92·2 ± 4·1%, and *S. lancifolius* 86·1 ± 6·3% water, while different species of *Cyperus* had water contents ranging from 68·2 to 89·6%.

Influence of mineral and water content on food selection

A very high water content (up to 92·2% for *A. nigritana*) was found in some selected food items. There was a significant correlation between the water content of selected food items and their percentage occurrence in the crops ($r=0{\cdot}82$, d.f. = 25, $P<0{\cdot}05$). Sodium was found to be the only mineral with a significant influence on food choice ($r=0{\cdot}78$, d.f. = 7, $P<0{\cdot}05$). Other minerals like nitrogen, phosphorus calcium, magnesium, and nutrients like starch and fat had no significant influence on choice. Table 4 shows the mineral content of the most common plants eaten by guineafowl.

Table 3. Comparison of the diet of guineafowl from crop content analysis and field observations

Food	Found in crop*	Consumed in the field*
Plants		
Gramineae		
Brachiaria sp.	Y	Y
Loudetia togoensis (Pig.) C.E. Hubb.	Y	Y
Sorghum arundinaceum (Desv.) Stapf.	Y	Y
Oryza barthii A. Chev.	Y	Y
Combretaceae		
Anogeissus leiocarpus Guill. & Perr.	Y	N
Anonaceae		
Anona senegalensis Pers.	Y	N
Cesalpinicaceae		
Cassia obtucifolia L.	Y	N
Fabaceae		
Commelina forskalaei Vahl.	Y	Y
Vigna sp.	Y	Y
Cucurbitaceae		
Cucumulus sp.	Y	N
Malvaceae		
Hibiscus asper Hook	Y	Y
Ancanthaceae		
Hygrophila africana T. Anders	Y	Y
Monecma ciliata (Jacq.) Milne-Redhead	Y	N
Onagraceae		
Ludwigia leptocarpa (Nutt.) Hara	Y	N
Anacardiaceae		
Sclerocaria birrea (A. Rich.) Hochst.	Y	N
Bignonacea		
Stereospermum kunthianum Cham.	Y	N
Nyctaginaceae		
Boehaavia erecta L.	Y	N
Rhamnacea		
Ziziphus sp.	Y	N
Bulbs and roots		
Cyperaceae		
Cyperus esculentus Linn.	Y	Y
Cyperus sp	Y	Y
Araceae		
Stylochiton lancifolius Lepr.	Y	Y
Albuca nigritana	N	Y
Asclepiadaceae		
Leptadenia hastata	N	Y
Insects		
Coleoptera	Y	Y
Heteroptera	Y	Y
Hymenoptera	Y	Y
Isoptera	Y	Y
Orthoptera	Y	Y

*Y = yes, N = no.

Table 4. Percentages of some mineral and weights per kilogram of food item for some nutrients found in the principal food of wild helmeted guineafowl

Guineafowl food	Mineral content								
	Nitrogen (%)	Phosphorus (%)	Sodium (%)	Potassium (%)	Calcium (%)	Magnesium (%)	Starch (g/kg)	Fat (g/kg)	Water (%)
Poacea	1·93	0·22	0·05	0·31	0·00	0·11	—	—	52·20
Oryza longistaminata	1·67	0·33	0·09	0·39	0·07	0·14	551·60	19·50	53·25
Cyperus sp.	1·09	0·19	0·14	0·50	0·10	0·12	112·90	218·90	68·20
Sclerocaria birrea	0·44	0·14	0·21	1·02	0·02	0·08	—	—	49·30
Brachiaria sp.	1·58	0·31	0·13	0·5	0·03	0·14	—	—	57·40
Hibiscus asper	4·16	0·82	0·07	1·28	0·27	0·40	10·30	152·50	64·22
Cyperus esculentus	0·84	0·22	0·07	0·64	0·02	0·11	269·60	230·40	89·60
Commelina forskalaei	2·26	0·22	0·30	0·81	0·72	0·20	528·00	7·30	49·20
Albuca nigritana	2·49	0·08	0·56	1·36	1·02	0·22	—	—	92·20
Liliacea	1·62	0·16	0·27	1·74	0·85	0·19	364·15	5·70	58·31
Graminae	1·67	0·41	0·09	0·47	0·02	0·02	419·90	41·10	—
Echinochloa stagnina	3·12	0·46	0·45	1·97	0·57	0·38	93·60	22·10	66·20
Datyloctenium aegyptium	1·42	0·36	0·07	0·31	0·64	0·18	482·00	19·30	61·20
Cassia obtusifolia	3·90	0·76	0·00	1·37	0·74	0·35	1·50	69·50	52·11
Stylochiton lancifolius	1·53	0·18	0·50	1·50	0·47	0·18	287·80	16·20	86·10

Discussion

Food supply of the guineafowl in the Waza National Park is lowest during the dry season. This is due to a number of factors which include the annual burning that takes place between the months of December and February, the drying out of most plants and the decrease in insect number. Late burning may be the most important cause of this decrease in food supply not only to guineafowl but also to most of the animals in the park. Early burning may however, be useful to this bird, since its moderately hot flames will only burn part of the vegetation, and expose seeds lying on the ground. Bodenkamp & Edelaar (1993) found no significant difference in seed abundance between early burned and unburned areas in the Waza Park. Early burning will thus increase food availability to the birds. Ayeni (1983) had recommended patchy burning as a management tool for the guineafowl habitat.

During the dry season, the helmeted guineafowl feeds mostly in the early mornings and late afternoons because of the high temperatures leading to a decrease in food intake by some birds. Skead (1962) reported that nine out of 44 birds shot at sunset for crop contents analysis had empty crops. This might have been due rather to the birds feeding early in the morning on highly digestible food and being shot before they fed in the afternoon, than to birds not having fed at all. No empty crops were found in the present study. However, the smallest crop contents weighed only 2 g. Ayeni (1983) had noted a correlation between the ingestion of hard and bulky plant material by guineafowl and the intake of pebbles, which was confirmed by this study.

Out of the 25 plant species cited by Ayeni (1983) as food of the helmeted guineafowl (*N. m. galeata*) from crop contents analysis, 20 were present in our study area in varying abundance, but only four were found in the diet (either from crop analysis or direct observation). Ayeni (1983) found a slightly lower percentage dry weight for insects eaten by this bird, $21{\cdot}6 \pm 5{\cdot}1\%$ as compared to $26{\cdot}0 \pm 3{\cdot}3\%$ (corrected) for this study. However, he found more insect orders than this study. The fact that most of the plant species he found to be consumed by the helmeted guineafowl in his study area were also present in ours but not found in the crops, might be due to differences in habitat composition between our study area and his. We could not however, verify these differences from his paper. It may also be possible that factors other than the presence of a food item in an area determine whether guineafowl will feed on it or not.

The differences in digestibility between food items may mean that crop contents analysis data should be corrected before interpretation. The high 95% confidence limits for the overall correction factors for insects and rhizomes suggest that it might be necessary to correct these food items separately for adults and subadults. The correction-factor for leaves was higher than those for both insects, rhizomes and seeds, suggesting that leaves are easier to digest. This may explain why very few leaves could be found in the analysed crops. Fresh leaves may also provide birds in very dry habitat with water, which may be one of the reasons why guineafowl can live in very dry habitat.

Some species that were observed to be eaten voraciously (for example *L. hastata*) were only found in traces in the crop analysis. This could be either due to a high digestibility, or their being in crumbs by the time they reach the crop, making identification difficult. This means that one should not interpret data on the feeding habit of this bird from crop contents analysis alone or do so with a lot of caution.

Studies of *N. m. coronata* and *N. m. meleagris* showed that agricultural waste and farmland weed as well as insects make up the bulk of their food (Skead 1962; Grafton 1970; Mentis *et al.* 1975 and Swank 1977). Rhizomes of Cyperaceae seems to be a favourite food of most guineafowl species, especially in the dry season. Rhizomes of Cyperaceae were found to be important food in all the studies of *N. m. coronata* and *N. m. meleagris* by the above mentioned authors, and in *N. m. galeata* by Ayeni (1980, 1983) and this study. Rhizomes of *Stylochiton lancifolius* are, however, the most important dry season food of *N. m. galeata* in the Waza region.

There are no biological reasons known to the present authors to explain the choice of sodium-rich food by this bird. However, the high water content of most selected food items and the highly significant correlation of the water content of food and the number of birds eating it confirms our hypothesis that the birds feed on water-rich food during the dry season. This may explain why the guineafowl can exist in regions devoid of any surface water (Njiforti unpublished data), and its wide distribution in Sub-Sahara Africa (Crowe 1978).

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