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Food and Feeding Ecology of Double-spurred Francolin (*Pternitis bicalcaratus* Linn.) in Ekiti State, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Authors OCO and AIA designed the study. Author OCO performed the statistical analysis and wrote the first draft of the manuscript. Author AIA corrected the methodology and the first draft of the manuscript. Author OCO designed the instrument of data collection, managed analyses of the study and the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

Double-spurred francolin *(Pternitis bicalcaratus)* is a bird with wide range of economic importance. In spite of this, there has been no previous studies on food and feeding ecology of the species in Ekiti State, Nigeria. 150 (male 69, female 81) bird specimens were collected through hunters, the crop and gizzard contents were sorted. Thirty food species having plants and animal origins were recovered. Plant and animal matters constituted 93.22% and 6.2% respectively. Mann Whitney U-test showed that there was no significant difference in the consumption of plant matters among sexes ($p > 0.05$) but a significant difference in the consumption of animal matters among sexes ($p < 0.05$).

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1. INTRODUCTION

Double-spurred francolin, *Pternitis bicalcaratus* comes under the order Galliformes. Male is brown, sparingly streaked, spotted darker and cream colour above, the chest and flank feathers are dark brown towards edges and centrally spotted cream. It has a chestnut neck collar and white cheek patches. The male usually has two spurs on each leg (Fig. 1), the upper one being blunt. The female is similar, but lacks spurs (Fig. 2). This species has an extremely large range, and hence does not approach the thresholds for vulnerable under the range size criterion. According to Bird Life International, the species is evaluated as least concern. The global population size has not been quantified, but the species is reported to be locally common and some areas it is declining due to over-hunting outside of protected areas. However, it remains abundant to common throughout most of its range [1]. *P. bicalcaratus* belongs to an ecologically diverse group that takes a wide variety of plant and insect food [2]. This species has an important role in maintenance of the regional ecosystems and biodiversity. Apart from allowing the normal food chain (web) to proceed smoothly through trophic cascade, they are commonly known as seed predators and help in their dispersal [3]. The bird has both positive and negative economic values. Some of them can be domesticated and farmed to produce meat and eggs for human consumption, while others are becoming important for the ecotourism industry [4]. At some places, these are harmful to agricultural crops, causing damage to young seedlings and shoot in the cultivated fields, and pick seeds to cause pre-harvest loss [5].

Double-spurred francolin is a famous game bird and is widely consumed as bush meat in Nigeria and other African countries [6]. Hunting pressure on different population of game bird is very common [7]. This resulted in a decline in different populations of these species, but those living within an easy human target were more seriously affected by such a declining trend [8,9,7]. Hunting pressure and other anthropogenic activities have posed threats on different species of francolins and other game birds. Double-spurred-francolin has wide range of economic importance and resultant impact on agriculture but there exists no previous study on its population, ecology, biology and feeding habits in the study area. Therefore, a knowledge gap exists between what is known and unknown about the food and feeding ecology of *P. bicalcaratus*. Food is the basic requirement of life and each species has adapted to broad types of food items, through long evolutionary process by developing structural adaptations and genetic armory [10]. The main objective of this study is to assess the food and feeding ecology and feeding preferences of *Pternitis bicalcaratus* in Ekiti State, Nigeria. It also determined the differences between food and feeding habits of sexes. Such studies are required for species management programme and evaluation of available habitat.

2. MATERIALS AND METHODS

2.1 Sample Collection

A total of four sampling sites were selected. Two sampling sites, Ijero (7.8120° N, 5.0677° E) and Ikole (7.7983° N, 5.5145° E) selected from the northern part and another two sites, Ikere (7.4991° N, 5.2319° E) and Ise-Orun (7.4563° N, 5.4332° E) were selected from the southern part of Ekiti State. One hundred and fifty bird specimens were bought from local hunters from these locations and used for laboratory analysis.

2.2 Laboratory Analysis

Bird specimens were dissected, the crop and gizzard contents were emptied, weighed and placed in petri-dishes containing physiological saline where they were examined and sorted with a binocular microscope. Prey items were identified to order level using taxonomic key and to an ecologically significant categories (e.g. egg cases, larvae etc.) using [11]. Insect and plant parts were identified by comparing them with identified reference collection from the field. Parts of plant and animal part of the food materials were sorted separately and also segregated for species (plant) and order (animal) levels. Food items, which could be counted such as seeds and insects were counted and weighed. Mandibles of ants, orthopterans and other insects, and fangs of spiders were matched and divided by two, beetle numbers were determined by counting the number of matching elytra and dividing by two, etc., so as to determine the actual number of prey items consumed.

2.3 Data Analysis

Three methods for the assessment of the crop and gizzard contents were utilized. That is, frequency of occurrence, numerical and gravimetric methods adapted from [12]. Mann-Whitney U-test was used to compare possible differences in the food and feeding habits of male and female birds.

3. RESULTS

3.1 Overall Food Items

The diets come from 30 identifiable food items (both plant and animal materials) with an overall weight of 858.6g/150 contents of which 93.8% (805.5g) came from plant source (Tables 1 and 2). Three species of cultivated tubers and 14 different seeds (6 cultivated and 8 wild) were recovered. The tubers were weighed, the seeds were counted and weighed, epicarp and mesocarp of *Elaeis guineensis* were weighed (Table 1). Among plants, *Manihot esculentum* was the most consumed tuber present in 51 contents with weight of 308.70g (Table 1). The most consumed cultivated seed was *Zea mays* with frequency of 52, weight of 210.32g (Table 1), percentage frequency and weight of 34.70% and 24.50% (Table 3). *Oryza sativa* was also frequently consumed with high frequency (44), number of seeds (2005), percentage frequency (29.33%) and percentage number of seeds (25.54%) (Tables 1 and 3). Some of the seeds of *Zea mays* recovered could not be numerically assessed because they were crushed pieces and this was responsible for reduced number of seeds (502) but increased frequency of occurrence (52) and weight (210.32g) (Table 1). Out of all the wild seeds consumed, *Margaritaria discoidea* was the most consumed with frequency of 45 and weight of 127.81 g (Table 1), percentage frequency and weight of 30% and 14.9%respectively (Table 3).

Twelve (12) species of prey items were recovered belonging to seven orders of arthropods with a total weight of 53.08 g (Table 2). Hymenoptera was the most consumed order of insects with frequency of 67 (Table 2) and percentage frequency of 44.7% (Table 4) followed by Isoptera with frequency and percentage frequency of 30 and 20%, Coleoptera with frequency and percentage frequency of 14 and 9.3% respectively (Tables 2 and 4).

Table 7 is a summary of the consumption of plant and animal materials by female and male Double-spurred francolins, which revealed that out of 17 plant materials recovered, 15 was consumed by females and 12 by males while female consumed 13 animal items whereas 7 animal items were consumed by males. The mean and standard deviation of plant and animal materials consumption among sexes in Table 7 was higher in female than male.

3.2 Sex Variability

Table 2 presents relative composition of different food items by two sexes. The females consumed more cultivated plant tubers than males. Out of the 6 seeds of cultivated plant species, males consumed only 3 while females consumed 11, females also consumed more of 3 planted seeds found in males. The wild seeds (6) were consumed equally by both sexes. *Bidens pilosa* and *Physalis turbinate* were found in males only while *Trema orientalis* and *Megathyrsus maximus* were consumed by only females. The remaining 4 wild seeds were consumed by both males and females. The Mann-Whitney U-test result revealed that there was no significant difference in the consumption of plant materials between male and female Double-spurred francolins ($0.27>0.05$ that is, $p>0.05$).

In the case of prey items (Table 6) females consumed 13 arthropods prey items, while male consumed 7. Hymenopteras were consumed by both sexes though in different proportions. Males consumed 3 species (*Lasius niger, Componotus sp. and Formica sp.*), out of 4 identified Hymenoptera species while the females consumed all species with higher frequency of occurrence, number and weight. *Componotus sp.* was found in females only. Males consumed *Oecophylla sp*. in larger proportion with higher frequency of occurrence, number and weight. Isoptera was consumed by both sexes in different proportions showing *Macrotermes belicosus*. Females consumed more of the insect than males. In the case of the order Coleoptera, 3 species of the order were recovered but only one *Pterostichus melanariu* was consumed by males while all species were found in females maintaining higher frequency of occurrence, number and weight of items. Both adult and larvae of the order Hemiptera were recovered from females but none from males. The orders Arachnida and Orthoptera were found in the females and not in males. Lepidopteran larvae were consumed equally by both sexes while other insect larvae were consumed more by females. The result of Mann-Whitney U-test used

in comparing the differences that existed in the consumption of animal materials revealed that significant difference existed in the consumption of prey items between sexes (0.01<0.05 that is, p<0.05).

4. DISCUSSION

The results obtained from this study (30 species of food items; plant, animal) revealed that the diets of Double-spurred francolin comprised of both plant and animal materials. These findings agreed with the assertion made by Bird Life International that the species took a wide variety of plant and insect food [13]. This view was shared by [14] that each species adapted to broad types of food items through long evolutionary process. The plant materials discovered in the crop and gizzard included 3 tubers and 15 seeds of various types (both cultivated and wild) which implied that Double-spurred francolin takes more of seeds and above ground food than underground food items. This portrayed the view of [15], that Coqui francolins (*Peliperdix coqui*) were known to feed mainly on above ground food such as seeds, shoots and small fruits and to a lesser extent on underground corms and bulbs. Among the prey items, 11 species of insects were identified in the diet of Double-spurred francolin, which showed that the diet of the bird was incomplete without animal matters, which were needed by the bird to carry out growth and reproductive activities. This also agreed with the findings of [6], who stated that francolin species consume large number of insects, their eggs and larvae.

Table 1. Plant materials recovered from the crop and gizzard of 150 Double-spurred francolins

Food items	Name of food items	Number of contents (Frequency)	Number of pieces	Weight (g)
Plant matter 805.50 (93.8%)				
Cultivated: tubers	*Manihot esculentum*	51	-	308.70
	Discorea sp.	17	-	40.58
	Colocasia esculentum	8	-	23.51
Cultivated: seeds/fruit	*Oryza sativa*	44	2005	60.44
	Zea mays	52	506	210.32
	Elaiesguineensis	15	-	8.73
	Solanum lycopersicum	2	10	0.11
	Vicia faba	3	4	0.48
	Sorghum bicolor	2	5	0.23
Wild: seeds	*Margaritaria discoidea*	45	1768	127.81
	Talinum triangulare	21	1149	Trace
	Euphorbia heterophylla	10	520	18.45
	Bidens Pilosa	1	1	Trace
	Trema orientalis	3	37	1.11
	Phylantus amarus	15	69	4.40
	Physalis turbinate	1	1	0.63
	Megathyrsus maximus	2	11	Trace

Fig. 1. Male double-spurred francolin with spurs

Table 2. Animal materials recovered from the crop and gizzard of 150 Double-spurred francolins

Animal Materials	Name of Prey items	Frequency of Occurrence	Number of Items	Weight(g)
Animal matter 53.08 (6.2%) Arthropods				
Hymenoptera (Ants)	*Lasius niger*	16	97	0.57
	Oecophylla sp.	9	16	0.18
	Camponotus sp.	4	24	1.88
	Formica sp	38	393	4.02
Isoptera (Termites)	*Macrotermes belicosus*	30	1107	38.49
Coleoptera (Beetles)	*Carabus auratus*	3	4	0.51
	Pterostichus melanariu	7	21	1.47
	Sitophilus sp.	4	24	0.96
Hemiptera (Aphid)	Aphis sp. (adult & larvae)	3	66	3.30
Arachnida (Spider)	*Araneus sp.*	3	3	1.59
Orthoptera (Grasshopper)	*Trilophidia conturbata*	2	2	0.03
Lepidoptera	Larvae	2	2	0.02
Unidentified insect	Other insect larvae	3	6	0.06

Table 3. Percentage frequency, number and weight of plant materials recovered from the crop and gizzard of 150 double-spurred francolins

Food items	Name of food items	% Frequency	% Number	% Weight
Plant materials				
Cultivated: tubers	*Manihot esculentum*	34.00	-	34.94
	Discorea sp.	11.3	-	4.72
	Colocasia esculentum	5.33	-	2.74
Cultivated: seeds/fruit	*Oryza sativa*	29.33	25.54	7.04
	Zea mays	34.70	6.45	24.5
	Elaeis guineensis	10.00	-	1.02
	Solanum lycopersicum	1.33	0.13	0.01
	Viciafaba	2.00	0.05	0.06
	Sorghum bicolor	1.33	0.06	0.03
Wild: seeds	*Margaritaria discoidea*	30.00	22.52	14.9
	Talinum triangulare	14.00	14.64	Trace
	Euphorbia heterophylla	13.33	6.62	2.15
	Bidens Pilosa	0.67	0.01	Trace
	Trema orientalis	2.00	0.47	0.13
	Phylantus amarus	10.00	0.89	0.51
	Physalis turbinate	0.67	0.01	0.07
	Megathyrsus maximus	1.33	0.14	Trace

This study revealed that food consumed had some variability between sexes. Comparing the weight of wild food items consumed, females consumed the wild seeds more quantitatively than male although the number of wild seeds found in both sexes were not different (6 types of wild seeds each). The summary of the food organisms consumed by both sexes revealed that more plant materials (16) were consumed by females than males (13). The result of the Mann-Whitney U-test revealed that there was no significant difference in the consumption of plant materials between male and female Double-spurred francolins. Thirteen animal species were consumed by females compared with 7 by males. The result of Mann-Whitney U-test suggests differences existed in the consumption of animal matter. Female consumed more animal matter than males. The significant amounts of prey items consumed by female Double-spurred francolins were vital to egg formation as well as accumulation of fat which were metabolized during incubation and chick rearing as more energy was required by females in reproductive

activities. This finding corroborates with [16], who reported a non-significant difference in the consumption of plant materials but a significant difference in the consumption of animal materials among sexes. This result also supports the findings that the females in other species of birds: Red junglefowl (*Gallus gallus spediceus),* Pintail (*Anas acuta*) and Mallard (*Anas platyrhyncos*) consumed more animal matters than their male counterparts [17,18,19,10].

Table 4. Percentage frequency, number and weight of animal materials recovered from the crop and gizzard of 150 double-spurred francolins

Arthropods	Name of prey items	% Frequency	% Number	% Weight
Hymenoptera (Ants)	*Lasius niger*	10.67	1.24	0.07
	Oecophylla sp.	6.00	0.2	0.02
	Camponotus sp.	2.67	0.31	0.22
	Formica sp.	25.33	5.01	0.47
Isoptera (Termites)	*Macrotermes belicosus*	20.00	14.1	4.48
Coleoptera (Beetles)	*Carabus auratus*	2.00	0.05	0.06
	Pterostichus melanariu	4.67	0.27	0.17
	Sitophilus sp.	2.67	0.31	0.11
Hemiptera (Aphid)	Aphis sp.(adult & larvae)	2.00	0.84	0.38
Arachnida (Spider)	*Araneus sp.*	2.00	0.04	0.19
Orthoptera (Grasshopper)	*Trilophidia conturbata*	1.33	0.03	<0.01
Lepidoptera	Larvae	1.33	0.01	<0.01
	Other insect larvae	2.00	0.08	<0.01

Table 5. Plant materials recovered from crop and gizzard of male (M, n= 69) and female (F, n=81) double-spurred francolins

Plant materials	Frequency of occurrence		Number of items		Weight (g)		Mean($\bar{X}$)	Mean($\bar{X}$)
Planted tubers	F	M	F	M	F	M	F	M
Manihot esculentum	36	15	-	-	262.47	46.23	7.29	3.08
Discorea sp.	13	4	-	-	31.56	9.02	2.43	2.26
Colocasia esculentum	6	2	-	-	19.00	4.51	3.17	0.75
Planted seeds/fruit								
Oryza sativa	28	16	1522	483	45.96	14.48	1.64	0.91
Zea may	22	30	374	132	141.90	68.42	6.45	2.28
Elaeis guineensis	9	6	-	-	5.55	3.18	0.62	0.53
Solanum lycopersicum	2	-	10	-	0.11	-	0.06	-
Viciafaba	3	-	4	-	0.48	-	0.16	-
Sorghum bicolor	2	-	5	-	0.23	-	0.12	-
Wild seeds								
Margaritaria discoidea	20	25	1017	751	80.26	47.55	4.01	1.90
Talinum triangulare	6	15	522	627	Trace	Trace	-	-
Euphorbia heterophylla	7	3	451	69	17.55	0.9	2.51	0.30
Bidens Pilosa	-	1	-	1	-	Trace	-	-
Trema orientalis	3	-	37	-	1.11	-	0.37	-
Phylantus amarus	9	6	45	24	2.95	1.45	0.33	0.24
Physalis turbinate	-	1	-	1	-	0.63	-	0.63
Megathyrsus maximus	2	-	11	-	Trace	-	-	-

Total weight of plant materials consumed by female = 609.13g or 75.6%
Total weight of plant materials consumed by male = 196.37g or 24.4%

Table 6. Prey items recovered from crop and gizzard of male (M, n= 69) and female (F, n=81) double-spurred francolins

Prey items	Frequency of occurrence		Number of items		Weight (g)		Mean ($\bar{X}$)	Mean ($\bar{X}$)
Arthropod	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**
Hymenoptera (Ants)								
Lasius niger	10	6	66	31	0.39	0.18	0.04	0.03
Oecophylla sp.	3	6	4	12	0.05	0.13	0.02	0.02
Camponotus sp.	4	-	24	-	1.88	-	0.47	-
Formica sp.	25	13	228	165	2.30	1.72	0.09	0.13
Isoptera (Termites)								
Macrotermes belicosus	18	12	966	141	31.68	6.81	1.76	0.57
Coleoptera (Beetles)								
Carabus auratus	3	-	4	-	0.51	-	0.17	-
Pterostichus melanariu	4	3	13	8	0.91	0.56	0.23	0.19
Sitophilus sp.	4	-	24	-	0.96	-	0.24	-
Hemiptera (Aphid)								
Aphis sp.(adult & larvae)	3	-	66	-	3.30	-	1.10	-
Arachnida (Spider)								
Araneus sp.	3	-	3	-	1.59	-	0.53	-
Orthoptera (Grasshopper)								
Trilophidia conturbata	2	-	2	-	0.03	-	0.02	-
Lepidopteran (larvae)	1	1	1	1	0.01	0.01	0.01	0.01
Other Insect Larvae	2	1	4	2	0.04	0.02	0.01	0.02

Total weight of prey items consumed by female = 43.65 g i.e 82.2%
Total weight of prey items consumed by male = 9.43g i.e 17.8%

Table 7. Summary of food item preferences of female and male double-spurred francolins

	Number of food items consumed		Plant materials	Animal materials
Sexes	Plant Materials (17)	Animal materials (13)	Mean ($\bar{X}$) ± S.D	Mean ($\bar{X}$) ± S.D
Female	15	13	1.74 ± 2.33	0.36 ±0.56
Male	12	7	0.76 ± 0.10	0.08 ± 0.16

Fig. 2. Female double-spurred francolin without spurs

5. CONCLUSION

The diets of Double-spurred francolins in Ekiti, Nigeria were made up of plant and animal materials. The plant materials were made up of both underground tubers and seeds of wild and cultivated plants while the animal materials were made up of insects. The attempts to domesticate the bird must consider the diverse food materials consumed as food by this species. Female double-spurred francolins consumed more animal materials than males. The disparity in animal materials consumed by females compared to that of males was vital for reproductive processes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Del Hoyo J, Elliott A, Sargatal J. Handbook of the birds of the world. In: Lynxedicions, New World Vultures to Guineafowl. Barcelona. 1994;2:412-567.
2. Fuller AR, Caroll PJ, McGown PJK. Partridges, quails, francolins, snowcocks, Guineafowl and Turkeys. Status survey and conservation action plan 2000-2004. World Partridges, Quails and Francolin Specialist Group, The World Conservation Union. Switzerland. 2000;63.
3. International Union for Conservation of Nature (IUCN). Red list of threatened species; 2004.
   Available: http://www.redlist.org
4. Madge S, McGowan P. Pheasants partridges and grouse: A guide to the Pheasants, Partridges, Quails, Grouse, Guineafowl, Buttonquails and Sandgrouse of the World. Chirstopher Helm London, UK. 2002;191-196.
5. Dickinson EC. The Howard and Moore complete checklist of the birds the world. Christopher Helm, London, UK. 2003;67-69.
6. Beg MA, Qureshi JI. Birds and their habitats in the cultivated areas of lyallpur district and vicinity. Pakistan Journal of Agric. Science. 1972;9:161-166.
7. Hagemeijer EJM, Blair MJ. The EBCC atlas of European breeding birds: Their distribution and abundance. T and AD Poyser, London. Hist. Soc., London, UK. 1997;903.
8. Aebischer NJ. Impact of hunting on the population dynamics of wild. Birds Gibier Faune Sauvage. 1997;14:183-200.
9. DeLeo GA, Focardi S, Gatto M, Isabella M. The decline of the grey partridge in Europe: comparing demographics in traditional and modern agricultural landscapes. Ecological Modelling. 2004; 177(3):313-335.
10. Swanson GA, Krapu GL, Serle JR. Food of laying female dabbling duck on the breeding ground. An Integrated Proceeding Symposium. The Wildlife Society. North Central Section, Dakota; 1979.
11. Borror DJ, De long DM, Triplehorn CA. An Introduction to the Study of Insects. Saunders College Publication., New York. 1981;17-20.
12. Ricker WE. Methods for assessment of fish production in fresh waters. Biological Programme Hand Book No.3. Blackwell Scientific Publications, Oxford and Edinburgh. 1968;197-199.
13. Bird Life International. Threatened birds of the world. Bird Life International, Bird Life Conservation Series, Cambridge; 2004.
14. Waseem AK, Babar K, Shahid I. First record of Tibetan lack (*Melanolorypha maxima*) in Pakistan Journal of Zoology. 2012;44(6):1462-1464.
15. Hockey PA, Dean WR, Ryan PG. Birds of Southern Africa, 7th edition. The trustees of the John Voelcker Bird Book Fund, Capetown. 2005;112-120.
16. Mbinkar DL, Ezealor AU, Onyie SJ. Food habits of the double-spurred francolin (*Francolinus bicalcaracus*) in Zaria, Nigeria. J. Biol. Sci. 2005;5:458–462.
17. Krapu GL. Feeding ecology of pintails hens during reproduction. The AUK. 1974;91: 278-290.
18. Krapu GL. Food of breeding pintails in North Dakota. Journal of Wildlife Management. 1974;38:408-477.
19. Muhammad IA. Mohamed Z, Ahmad SS, Ahmad I. Food and feeding habits of red jungle fowl. Pakistan J. of biological Science. 2000;3(6):1024-1026.

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