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Foods of hunter-killed Black Francolins (*Francolinus francolinus*) in Cyprus

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Abstract Using stomach content analysis, we studied the diet of the Black Francolin (*Francolinus francolinus*) on the island of Cyprus during November and December of 2004 and 2005. The purpose of this study was to estimate the most important sources of food on its diet. Stomachs of Black Francolins were obtained from two study areas on Cyprus. We sampled 53 freshly hunter-killed specimens for dietary analysis. Our results showed that dietary intake reflected a generalist and omnivorous diet with seeds of cultivated crops and insects of the Coleoptera and Hymenoptera orders being the most commonly identified. Differences in food composition between the two study areas reflected differences in land use, suggesting that human management of Black Francolin habitat is critical in understanding and managing this important game species.

Keywords Stomach content · Diet

Introduction

Game birds are usually widely researched, especially for hunting purposes. Despite the annual fluctuation in its harvest (Anon 2007), there are no comprehensive data concerning the Black Francolin, which is one of the most important game species in Cyprus. Moreover, it is well-

known that the only indigenous European population of Black Francolin (*Francolinus francolinus*) survives and breeds in Cyprus (Jourdain 1929); although several attempts have been made to reintroduce it to other European countries (Cramp and Simmons 1980), releases were not successful and breeding status is still unclear (e.g., Italy, Spain, and Portugal).

There was a dramatic decrease in its population and distribution throughout Europe after the 1950s (Hagemeijer and Blair 1997) as a result of agricultural intensification and land use changes, but it is evaluated as a “least concern” species because global populations appear to be stable (del Hoyo et al. 1994). In Cyprus, the Black Francolin is a locally common and widespread resident, particularly in the west of the island (Boye 1990; Gordon 2003) while the total Cypriot population may be 2,000–5,000 breeding pairs (Birdlife International 2004). Restricted hunting is allowed in Cyprus (see [Materials and methods](#)), although Boye (1990) suggested that hunting is the main factor associated with the species decline.

Stomach content analysis is an accurate and precise method for the study of game birds’ diet (Rosenberg and Cooper 1990) unlike feces analysis, which is quite difficult, time-consuming, and the quantity of insects may be underestimated (Sande et al. 2006). However, stomach content analysis can also lead to bias because of the tendency of the stomach to retain large hard parts and allow small soft items to pass into the intestines (Sutherland 2004).

Galliform species’ diet is subject to much research in Europe (Italy: de Sanctis et al. 2000, Portugal: Magalhaes et al. 2001, and Greece: Tsachalidis et al. 2007) with a view to species conservation and management. The francolins’ diet is composed mainly of ground-dwelling invertebrates (Swank 1977; Mbinkar et al. 2005; Sande et al. 2006) and

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Fig. 1 Map of Cyprus highlighting the study areas (Argakas and Idalio)



Table 1 Land use categories of the study areas (percentage of the total land covered; Anon 2003)

Land use	Argakas	Idalio
Non-intensive cultivations (e.g., wheat)	15	60
Citrus trees	40	12
Intensive cultivations (e.g., alfalfa, maize)	25	10
Olive groves	8	5
Others (e.g., forests, greens)	12	13
Total	100	100

seeds of cultivated and wild plants (Cramp and Simmons 1980). Its diet contains a wide variety of seeds and invertebrates, similar to other Galliforms (De Sanctis et al. 2000; Paralikidis 2005; Tsachalidis et al. 2007).

The present study focuses specifically on the diet of the Black Francolin population in the Argakas and Idalio areas of Cyprus, since there is no existing information concerning this specie. It is important to note that the population of Idalio was introduced to hunters a few years ago, but is in good condition and is still increasing.

Materials and methods

This study was conducted on Cyprus which is an island located at the eastern part of the Mediterranean Sea (Fig. 1).

Fig. 2 The most important food categories found in Black Francolin stomachs ($n=53$), during 2004 and 2005 hunting seasons, in Cyprus. Results are expressed as percentage of occurrence (P.O.)

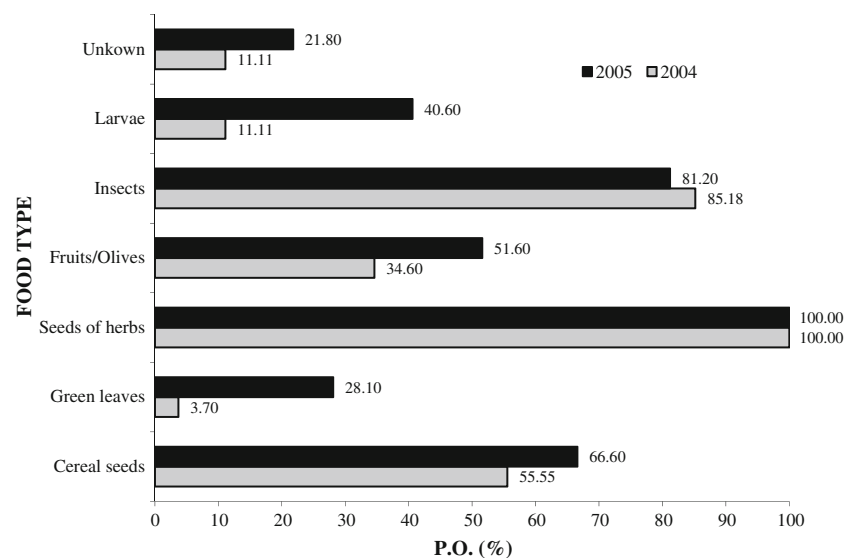


Table 2 Plant and insect families that compose the Black Francolin diet, expressed as frequency (F), dry weight (W), and importance value (IV) in the Argakas and Idalio regions, Cyprus, during 2004 and 2005

hunting seasons (November and December of each year). Plants were found as seeds or green parts, and insects as larvae or adults

	Argakas (<i>n</i> =29)			Idalio (<i>n</i> =24)		
	F (percentage)	W (percentage)	IV (percentage)	F (percentage)	W (percentage)	IV (percentage)
PLANTS (Families)						
Malvaceae	4.20	4.49	0.23	3.67	10.16	0.47
Rubiaceae	0.20	0.25	–	0.31	0.76	0.01
Moraceae	–	–	–	2.70	0.36	0.01
Amaranthaceae	10.10	1.94	0.03	30.40	6.94	0.11
Graminae	11.10	41.77	4.50	3.28	24.68	2.66
Leguminosae	7.00	9.31	1.86	0.70	1.60	0.32
Solanaceae	26.70	2.80	0.04	22.39	11.63	0.18
Punicaceae	1.00	2.13	0.03	0.26	1.15	0.02
Oxalidaceae	–	–	–	0.26	3.45	0.05
Vitaceae	1.30	3.01	0.05	0.22	0.90	0.01
Palmae	–	–	–	0.01	0.86	0.01
Dioscoraceae	1.00	0.49	0.02	0.07	0.15	–
Oleaceae	0.40	2.63	0.04	0.38	8.38	0.13
Cucurbitaceae	–	–	–	0.03	0.09	–
Asteraceae	–	–	–	0.54	2.28	0.04
Convolvulaceae	0.80	1.10	0.03	0.93	3.17	0.10
Cruciferae	1.50	1.23	0.06	0.81	0.78	0.04
Liliaceae	0.20	0.75	0.02	–	–	–
Boraginaceae	20.40	3.68	0.06	26.21	9.66	0.15
Cactaceae	1.00	0.24	–	–	–	–
Rosaceae	0.60	5.95	0.09	–	–	–
Cichoriaceae	0.20	0.56	0.01	0.16	0.56	0.01
Urticaceae	1.00	0.11	–	0.28	0.10	–
Capparaceae	0.10	0.16	–	–	–	–
Euphorbiaceae	0.10	0.06	–	3.37	2.95	0.05
Millet	0.30	0.18	–	0.32	0.95	0.01
Unknown	10.80	17.16	3.15	2.70	8.44	1.69
Total	100.00	100.00		100.00	100.00	
INSECTS (Orders)						
Heteroptera	0.74	2.38	0.08	0.65	1.01	0.08
Lepidoptera	3.10	12.71	1.75	10.94	22.71	8.52
Coleoptera	8.30	17.07	7.65	16.74	37.14	27.86
Family Curculionidae	0.37	0.63	0.02	3.43	10.11	3.79
Mantodea	–	–	–	0.43	3.19	0.27
Hymenoptera	9.79	4.13	1.57	0.86	2.44	0.41
Family Formicidae	76.21	60.13	12.44	53.65	13.82	8.06
Dermaptera	0.12	0.36	0.01	0.21	0.2	0.01
Odonata	–	–	–	0.21	0.45	0.02
Orthoptera	0.25	1.62	0.11	0.86	1.58	0.26
Diptera	0.50	0.22	0.02	–	–	–
Ephemeroptera	0.12	0.54	0.02	–	–	–
Unknown	0.50	0.21	0.11	12.02	7.35	0.31
Total	100.00	100.00		100.00	100.00	

The study areas (Argakas and Idalio) were selected because they contain good population of Black Francolin. Cyprus has a typical Mediterranean climate with dry summers and rainy winters. The mean annual precipitation is 450 mm, but it can be as much as 1.100 mm at Mount Troodos (Anon 2006). Land use in the Argakas study area (35° 04'N, 32° 29'E) is mainly dominated by citrus cultivation and in Idalio (35° 01'N, 33° 25'E) by cereal agriculture (Anon 2003; Table 1).

We collected hunter-killed Black Francolins during the 2004 and 2005 hunting seasons. During November and December, hunters are allowed to shoot Black Francolins and the permitted bag limit is one bird per hunter per hunting day (Wednesday and Sunday only).

Stomachs or both stomachs and crops from freshly killed birds were removed. Stomach content analysis took place in order to estimate the percent of occurrence (P.O.=the number of samples in which a particular food type appears), the frequency (F=the enumeration of individual food items), and the percentage of the dry weight of each food category (W %; Rosenberg and Cooper 1990). Importance value was calculated using the $F \times W\% / 100$ equation. Fruits were identified using reference material from the study area, seeds from Flood and Gates (1986) and insects from Chinery (2007) and Ponce (2000).

Results

Of the 53 stomachs we collected, 29 were from Argakas and 24 from Idalio. Overall, stomachs contained grit, seeds, and insects, 36.68%, 50.87%, and 12.45% in dry weight, respectively. Seeds of various species of herbs were the most important food, since it was contained in all stomachs (100%). In addition, insects and cereal seeds seem to play quite an important role in the Francolin diet (Fig. 2).

A total of 25 plant families and ten insect orders were found in the Francolin stomachs. Seeds of Solanaceae, Boraginaceae, Graminae, and Amaranthaceae families were the dominant choice of the Francolin in both areas (Table 2). In Argakas, Solanaceae seeds occurred with a high frequency (26.70%)

whereas in Idalio, Amaranthaceae seeds found with the highest frequency (30.40%). Graminae seeds were found to be the most substantial plant food in both areas, with the highest values of dry weight and importance (Table 2).

Overall, seeds of wheat (*Triticum* spp.) and barley (*Hordeum vulgare*) were the most commonly found from cultivated plants (Table 3). They were found in most of the stomachs, whereas ryegrass (*Lolium* sp.), and okra (*Hibiscus esculentus*) were next in presence. About 88.70% of the stomachs examined contained remains of insects. Insects from the Hymenoptera and Coleoptera were the most dominant orders in both areas. Ants made up 76.21% and 56.65% by frequency in Argakas and Idalio, respectively.

Discussion

Seeds of Graminae, Solanaceae, and Boraginaceae families constitute an essential part of the Black Francolin diet during the nonbreeding season in Cyprus, although Holland et al. (2006) suggested that Poaceae and Polygonaceae are the most important families in the farmland birds' diet for adults in breeding and nonbreeding season. However, diversity of the different food items in the Francolins' diet during the study may be correlated to the variation in food abundance and in the habitat use by the species (Magalhaes et al. 2001). Unfortunately, it was not possible to measure food availability in order to identify changes in the diet of the Black Francolin (Holland et al. 2006) or have yearly sample collection due to hunting laws, but we believe that our results testify and demonstrate that some plants and insects are necessary for Black Francolins in Cyprus and wildlife managers should pay attention to their conservation and management. Moreover, there has been so little research on this specie in Cyprus that there is no previous dietary data with which to compare our results.

Usually, farmland birds' number decrease due to the major changes in agricultural practices (Chamberlain et al. 2000) or the decline of winter food availability (Siriwardena et al. 1999). Human agricultural and other activities can modulate the diet of the Black Francolin. Cultivated land, citrus

Table 3 Seeds of cultivated plants found in the stomachs of Black Francolin in Cyprus, during 2004 and 2005 hunting seasons. Results are presented as frequency (F) and dry weight (W)

Cultivated plants	Argakas (n=29)		Idalio (n=24)	
	F (percentage)	W (percentage)	F (percentage)	W (percentage)
Wheat (<i>Triticum</i> spp.)	37.39	26.05	12.50	0.89
Ryegrass (<i>Lolium</i> sp.)	3.45	0.15	4.17	0.12
Barley (<i>Hordeum vulgare</i>)	17.24	9.98	50.00	23.52
Maize (<i>Zea mays</i>)	10.34	4.81	–	–
Okra (<i>Hibiscus esculentus</i>)	3.45	1.77	12.50	0.16
Watermelon (<i>Citrullus lanatus</i>)	–	–	4.17	0.09

plantations, and vineyards represent favorable habitats for the Black Francolin (Boye 1990) and this can explain the preference found for cultivated seeds. European quail are also attracted to wheat (*Triticum* spp.) fields in Greece (Tsachalidis et al. 2007). Seeds of millet found in the stomachs would also explain the presence of Black Francolins around urban areas.

The reduction of agricultural land and the increase of forests in Cyprus (Anon 2006) may possibly lead to a further decrease in population. Boye (1990) suggested that hunting is the limiting factor on the population, but we believe that the implementation of a national management plan for the Black Francolin in Cyprus will improve the status of the population. Further research is urgently needed to better understand the needs of the Black Francolin.

Acknowledgements We declare that all hunting procedures and field activities used in this study comply with the current Cypriot laws.

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