THE DIET OF THE HOUBARA BUSTARD *Chlamydotis undulata fuertaventurae* IN THE CANARY ISLANDS

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ABSTRACT. The diet of the Houbara Bustard *C.u.fuertaventurae* in Fuerteventura was studied over two consecutive winter/spring periods by analysing remains in 106 faeces. The main foods identified were insects (especially the beetle Zophosis plicata and the ant Messor maurus), annual plants, the flowers of Launaea arborescens and the fruits of Lycium intricatum. Although there was some indication that the diet varied between individuals, most variation was seasonal. Findings were generally in line with previous studies, although the importance of snails in the diet was not confirmed.

INTRODUCTION

The Houbara Bustard is divided into three subspecies, all of which inhabit semi-desert areas. All are threatened, but the subspecies with the smallest population is *Chlamydotis undulata fuertaventurae* which is an endemic resident restricted to the eastern Canary Islands of Lanzarote and Fuerteventura.

The small amount of available descriptive information about the diet of *C.u.fuertaventurae* was summarised by Bannerman (1963). He listed cultivated peas and beans, snails, beetles (including dung beetles), caterpillars, lizards, a trefoil, and the fruits of *Lycium intricatum* (described). Hooker (1958) gave the specific names of the snails as *Helix pisana* and *Helix sarcostema.* In addition, Meade-Waldo (1889) said that the Houbara was very fond of the plant *Mesembryanthemum.*

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Rather more is known about the diet of the other two subspecies (see Cramp and Simmons, 1980). Those foods which are eaten by the Asiatic subspecies *C.u.macqueenii* are largely absent from the Canary Islands, though the types of food appear to be similar. From an analysis of stomach contents, Alekseev (1985) found that the Houbara in the North-west Kyzylkum had a predominantly animal diet during the breeding season, with tenebrionid beetles being particularly important.

The diet of the North African subspecies *C.u.undulata* is necessarily closer and includes *Lycium* fruits and *Launaea* flowers, the latter being a particular favourite (Valverde, 1957). Valverde found the stomach of a young bird to contain the following - ants (30%), beetles (20%), green plants (40%) and *Lycium* fruits (10%). Heim de Balsac and Mayaud (1962) found that the diet was based upon insects, but that a large quantity of plant matter was also consumed, and that in the dry season Houbaras subsisted on the fruits of *Argania spinosa*, an oil rich plant of the Sapotaceae family which is confined to North Africa, and whose fruits are also eaten by Cattle (Willis, 1966; Good, 1974). This species does not occur in the Canary Islands. Heim de Balsac and Heim de Balsac (1954) considered that they ate more vegetable than animal food during the spring, when breeding takes place. Other foods are Barley Hordeum sp., grasshoppers, arachnids, reptiles and snails (Cramp and Simmons, 1980).

The available literature therefore shows that the Houbara is omnivorous, with invertebrates (especially beetles and ants) and plant matter (especially fruits and berries) forming a large part of the diet. However, quantitative information concerning the diet is scarce, and there is no such information for *C.u.fuertaventurae*.

Before conservation measures are drawn up for any species, it is important to obtain as much information as possible about the requirements of that species. A survey of the Houbara population in the eastern Canary Islands was carried out in April 1979. This showed that up to 100 Houbaras were still present in Fuerteventura (Collar and Goriup, 1983). Collar and Goriup suggested that Fuerteventura would therefore be an excellent place to study the ecology of the species, and recommended that such a study should be undertaken. The investigation into the diet of the Houbara which is reported on here, formed a part of the thesis (Collins, 1984) which was carried out as a direct result of this recommendation.

The aims of the study of the diet were to obtain as much quantitative and qualitative information as possible concerning foods eaten and, if possible, to establish whether or not the Houbara depended on different foods during different seasons.

METHODS

During the periods December 1979 - April 1980 and January-April 1981, the diet of *C.u.fuertaventurae* was studied in Fuerteventura. This was achieved by analysing a total of 106 faeces. Many of the faeces were collected from roosts or from birds which were flushed. Some were found by observing the swarms of dung flies which congregated at fresh faeces. Most faeces were located in a study area to the west of La Oliva in northern central Fuerteventura, but faeces were also found in other parts of the island.

The faeces were stored in plastic bags, labelled, and later analysed in the laboratory. In order to identify the remains, reference collections of invertebrates (using pitfall traps), and flowers and fruits were made. Insects collected by this method were identified by staff at the British Museum, while plants and flowers were identified using floras, and by reference to the Reading University herbarium.

In the laboratory, faeces were soaked and then teased apart in water. Animal heads floated to the surface of the water, where they were collected for identification and counting. The only invertebrates whose heads did not remain intact were the grasshoppers, for which it was necessary to use hind legs for identification. Fruits were also counted. For identification of remains, a low power binocular microscope was used.

In most cases, the majority of the plant remains were mashed and unidentifiable. For this reason, the percentage of plant matter by volume was estimated to give some idea of the amount of vegetation consumed.

In an attempt to relate the diet to plant growth, two permanent plant transects were set up. The number of individual plants crossing these transects was usually recorded monthly in the dry season, and every two weeks after rain.

RESULTS

Food items identified in the faeces can be grouped into four main categories. These were insects (found in 85% of faeces), annual plants (found in 79% of faeces), the flowers of *Launaea arborescens* (55% of faeces) and the fruits of *Lycium intricatum* (49% of faeces).

Numerically, the most important animal prey were *Messor maurus* of which more than 620 (and probably about 1,000) were found and the tenebrionid beetle *Zophosis plicata*, of which there were 445. The weevil *Conorhynchus conicirostris* was also an important prey item. Larger species such as grasshoppers (Orthoptera) and large beetles (especially the scarabeid beetle *Ootoma bipartita*) were less numerically important, but would have represented a larger proportion of the food intake in terms of weight. Table 1 gives the numbers of animals found in faeces and the percentage of faeces in which they were found.

Table 1. Animals found in faeces

species	no. recorded	% of faeces in which found
Conorhynchus conicirostris	150	53
Ants (mainly *Messor maurus*)	>620	47
Zophosis plicata	445	40
Ootoma bipartita	>17	9
Orthoptera	16	13

The plant species identified in faeces are listed in table 2. The flowers of *Launaea arborescens* were often present in very large quantities, as were the seeds of *Lycium intricatum*. Amongst annual plants, the two crucifers *Lobularia lybica* and *Notoceras bicorne* were often present in large quantities.

Table 2. Plant species identified in faeces

species	% of faeces in which the species was found
Launaea arborescens	55
Lobularia lybica	54
Lycium fruits	49
Medicago minima	43
Notoceras bicorne	43
Calendula aegyptiaca	20
grasses	14
unidentified Compositae	13
Erodium cicutarium	10
unidentified Cruciferae	4
Plantago spp.	3
Mesembryanthemum spp.	2
Astragalus hamosus	1

Individual differences

Although many of the faeces which were collected were from unknown individuals, 48 were collected from the roost site of a known male (referred to hereafter as male 2). The faeces of this bird can therefore be compared with the remaining faeces. Table 3 gives the numbers of the main prey species in faeces of male 2 and other birds. Most differences were not significant, but weevils formed significantly less of male 2's diet than the diet of other birds combined (for 1979/80, $X^2 = 6.07$, $p<0.01$; for 1980/81, $X^2 = 46.72$, $p<0.001$). This difference might result from a relative scarcity of weevils in male 2's territory, or it may reflect a difference in searching technique or prey selection by this individual.

It may be that the Houbara develops a search image for particular foods. For example, fresh faeces of a single bird collected on 13th April 1980 contained over 4,000 *Lycium* seeds (representing about 600 fruits) and the remains of about 150 *Zophosis* beetles, but virtually nothing else except the remains of 10 weevils. This indicates that this bird had visited *Lycium* bush after *Lycium* bush in search of its fruits, picking up any beetles which it found running across the ground in between, and virtually ignoring other potential foods such as herbaceous plants and ants, both of which were plentiful at the time.

Table 3. Numbers of the four main arthropods found in the faeces of male 2 and other birds

	male 2				other birds			
	1979/80		1980/81		1979/80		1980/81	
	no.	%	no.	%	no.	%	no.	%
Zophosis	178	53	81	24	157	51	29	11
Conorhynchus	24	7	20	6	40	13	66	26
Messor	131	39	232	69	105	34	152	60
Orthoptera	2	1	2	1	6	2	6	2

Seasonal variation

More rain fell in 1979/80 than in 1980/81 and there was correspondingly more plant growth (figure 1). Comparison of the faeces in the two years shows that relatively more *Zophosis* beetles ($X^2 = 182.3$, $p<0.001$) and fewer *Messor* ants ($X^2 = 100.9$, p,0.001) were found in faeces in the wetter year. Thus, *Zophosis* constituted more than 50% of invertebrates in faeces in the wetter year, but less than 25% of invertebrates in faeces in the dryer year, whilst *Messor* constituted less than 40% of invertebrates in faeces in the wetter year and more than 60% of invertebrates in faeces in the dryer year (table 3).

Table 4. Percentage of plant matter (by volume) in faeces of male 2 and other birds in the two seasons

	% plant matter					
	10%	25%	50%	75%	90%	>90%
male 2, 1979/1980	0	2	6	3	6	3
other birds, 1979/80	0	1	3	3	4	1
total, 1979/80	0	3	9	6	10	4
male 2, 1980/81	2	2	3	5	8	8
other birds, 1980/81	0	1	6	9	10	16
total, 1980/81	2	3	9	14	18	24

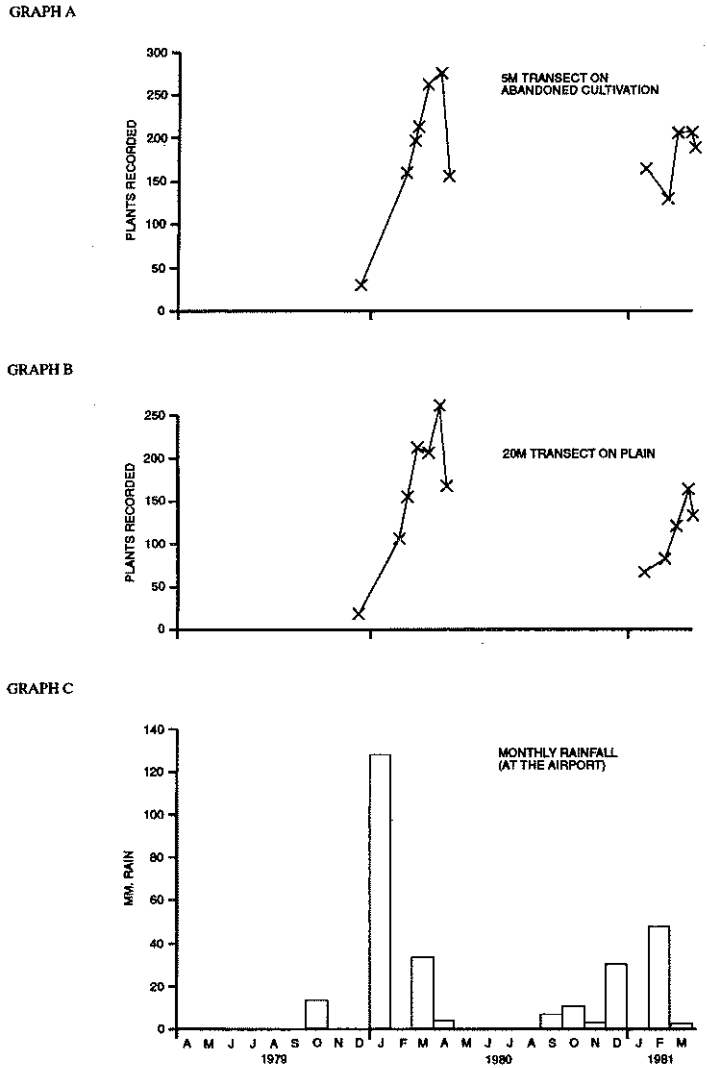

Figure 1. Transect results and rainfall figures.

Zophosis was not found in faeces until mid-March in 1981, when plant cover was greatest. Faeces of male 2 collected immediately after the rain (20th February and 5th March) contained large quantities of ants. Subsequent faeces contained very few ants, but quantities of *Zophosis* beetles (figure 2). It appears

that male 2 shifted from ants to beetles as soon as possible. This provides some evidence that *Zophosis* may be a preferred food of the Houbara in the Canary Islands, since ants are numerous throughout the growing season.

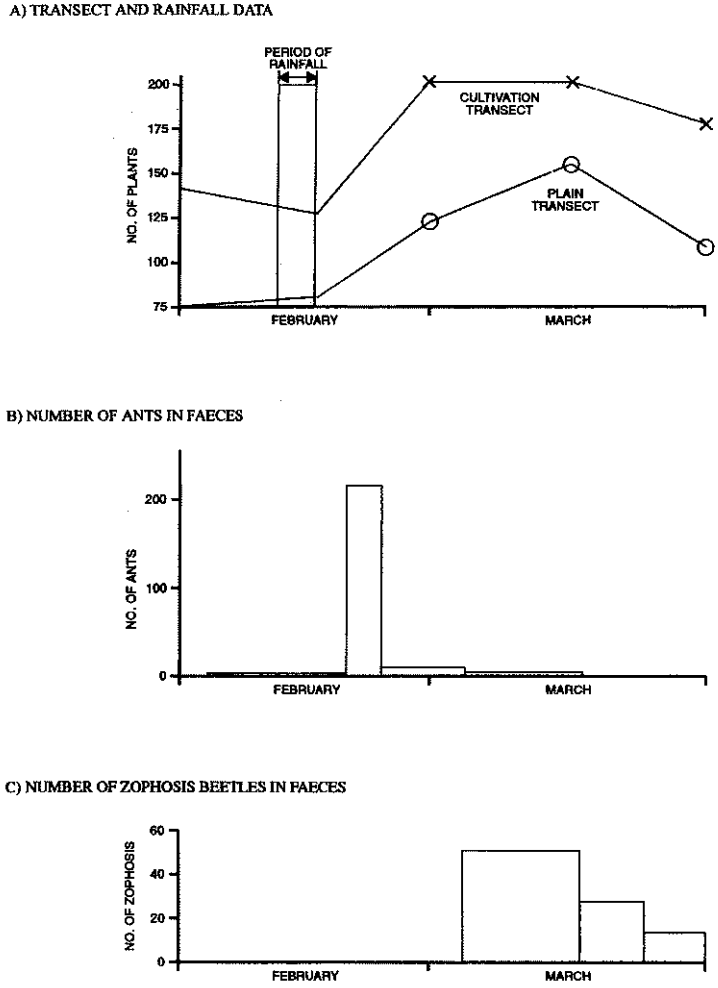

Figure 2. The changes in the insect composition of the diet of Male 2 in relation to plant growth and rainfall (1981).

Table 4 shows that there was apparently a greater percentage of plant material in faeces in the drier year (1980/81). However, a Mann-Whitney U test was not significant (n1 = 6, n2 = 6, U1 = 11, U2 = 25). The first heavy rain of the year fell on 12th February. The average plant content per faeces was 82% before that date and only 58% afterwards. This difference was significant (using Student's 't' test; t = 2.27, p = 0.05-0.02). This indicates that the Canarian Houbara is largely dependant upon plant foods during the dry season, and takes large amounts of animal foods as they become available.

DISCUSSION

The evidence provided here suggests that the Houbara switches to eating more profitable foods when these are available. The availability of more nutritious foods is strongly dependent upon heavy rainfall, which in the eastern Canary Islands, is almost entirely restricted to the period between October and March (Carracedo et al, 1980). It seems likely that the availability of more nutritious foods determines the timing of the breeding season.

Athough snails are said to form a part of the Canarian Houbara's diet, no snail shell fragments (or radulae) were found in the faeces. However, snail shell fragments were often found adhering to the outside, having been impressed (together with small stones) on the wet faeces when they fell to the ground, which in many areas is abundantly littered with shell fragments. On the other hand, the bustards were sometimes seen to take objects from bushes, place them on the gound and then peck at them. These may have been snails, and several of the local people told me that the Houbara does eat snails in this way. In many other instances, information supplied by locals was found to be correct.

It should be mentioned that some animals get into the faeces after they have been deposited and live within them. The most notable of these are the Dipterans. Occasionally, fresh faeces were located simply by disturbing a number of dung-flies. Whole beetle larvae have also occasionally been found amongst the remains and are also likely to have found their own way into the faeces. Tape-worm segments were found in three of the faeces of one bird.

A study of the diet of a bird solely from remains found in faeces clearly has its limitations. In particular, it is quite impossible to judge the relative proportions of plant species ingested, since some species have resistant parts which are detectable in faeces, whereas others do not. However, the method

has the advantage of being non-destructive, and it is able to provide some quantitative information about the diet when crop and gizzard analysis is not possible.

Information on the calorific value/ nutrient content of the different food items would provide valuable evidence for interpreting the choices which the Houbara makes in selecting its diet through the seasons.

CONCLUSIONS

The diet of the Houbara Bustard in Fuerteventura was found to contain most of the items which had been listed by previous authors. However, there was no evidence that snails were an important part of the diet. The most important animal prey were ants and beetles. Grasshoppers were also widely eaten. Vegetation also formed an important part of the diet.

Although there was some indication that different birds consumed foods in different quantities, the main differences which were observed were seasonal. More beetle remains were found in faeces in the wetter year than in the dryer year, and the reverse was true for ants. Relatively more plant matter was found in faeces during the dry season than was the case after heavy rain.

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