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Winter Diet of Eurasian Stone-curlew, *Burhinus oedicnemus* (L., 1758) (Aves: Charadriiformes) in a Mediterranean Area (Tuscany, Central Italy)

Pietro Giovacchini[1], Marco Dragonetti[2], Fabrizio Farsi[2] & Fabio Cianferoni[3,4]

[1]Regione Toscana, Direzione Ambiente e Energia, Settore Tutela della Natura e del Mare, Via Trieste 5, I-58100 Grosseto, Italy; E-mail: pietro.giovacchini@regione.toscana.it
[2]Gruppo Ornitologico Maremmano - Studi Naturalistici "A. Ademollo", c/o Museo di Storia Naturale della Maremma, Strada Corsini 5, I-58100 Grosseto, Italy; E-mails: dragom1@alice.it, fabriziofarsi@gmail.com
[3]Museo di Storia Naturale dell'Università degli Studi di Firenze, Sezione di Zoologia "La Specola", Via Romana 17, I-50125 Firenze, Italy; E-mail: fabio.cianferoni@unifi.it
[4]Istituto di Biologia Agroambientale e Forestale, Consiglio Nazionale delle Ricerche (CNR-IBAF), Via Salaria km 29,300, I-00015 Monterotondo Scalo (Roma), Italy.

Abstract: The winter diet of the Eurasian stone-curlew (*Burhinus oedicnemus*) was analysed through the study of 47 faeces collected from five roosts in the Grosseto Province (Tuscany, Central Italy) between 2009 and 2011. Insects were the most common group, with coleopterans being the most significant group (100%, n = 47 faeces). Harvestmen (Opiliones) and earwigs (Dermaptera) were newly detected prey items for the species. Ultimately, according to our samples, the winter diet of the stone-curlew encompassed a wide range of prey taxa: mainly invertebrates and, in particular, insects belonging to the orders Dermaptera and Coleoptera.

Key words: *Burhinus oedicnemus*, feeding habits, Mediterranean, Grosseto Province, Italy, winter diet

Introduction

The stone-curlew, *Burhinus oedicnemus* (Linnaeus, 1758), is a secretive and cryptic bird with largely nocturnal habits. This bird is classified as "Least Concern" in the IUCN Red List (BirdLife International 2014). In Northern and Eastern Europe, the bird is migratory: in winter a low number of individuals is observed in France, whilst it is frequent in Southern Europe where, probably, the population is partially resident (Cramp & Simmons 1983). In Central Italy, the stone-curlew seems to show a preference for olive groves, pastures, croplands and river beds during the winter (Giovacchini et al. 2012) where it is possible to find diurnal roosts. In Europe, very little published information is available about these sites and the same is valid for large parts of Italy. Conversely, in the Grosseto Province (Tuscany, Central Italy), the roosting behaviour of the stone-curlew was recently well studied (Dragonetti et al. 2014). The feeding habits of the wintering stone-curlew is poorly known except for the Canary Islands where its prey is dominated by Diplopoda, Carabidae, Arachnida (spiders) and plant material as revealed by the analysis of 57 faecal samples (Giannangeli et al. 2004). Spena et al. (2011) have published preliminary results on the diet of the stone-curlew from a site in Eastern Sicily but no specific results on its winter diet have been included.

The aim of our work is to give the first contribution on the winter diet of the stone-curlew in a Mediterranean area.

Materials and Methods

The study was carried out in the Grosseto Province (Tuscany, Central Italy) from early December to late January in 2009-2011. The five roosts were located

in farmlands of various anthropogenic agricultural land uses (arable lands, croplands, pastures and vineyards), from 35 to 250 m a.s.l.

The stone-curlews left the roost for their feeding grounds after sunset. Totally, 47 faeces (= samples) were collected during 11 visits to all the roosts. Each sample was analysed with a 90× magnification stereomicroscope. The first step was the separation of the fragments belonging to animals from other debris with the aid of metal tweezers and preparatory needles. The combination of a grinding gizzard and strong acids used in the stone-curlew's digestive performance could result in finding no hard evidence of consumption of invertebrate taxa with soft bodies (e.g. earthworms, molluscs, etc.) remaining in faeces of this species. Conversely, vertebrates present in the diet can be easily detected by the presence of their bones (e.g. Green & Tyler 1989). The number of prey individuals of each identified species was estimated for each sample on the basis of the found fragments. Four numerical categories based on the number of fragments were used for the quantitative presence of every identified taxon in the respective dropping (0 = absence of fragments; 1 = fragments belonging to a single specimen; 2 = fragments belonging to 2-4 specimens; 3 = fragments belonging to 5 or more specimens). A Chi-squared test was applied to the most frequent families of the Coleoptera, i.e. Carabidae and Curculionidae, to verify if these taxa were in the same occurrence category (as explained above).

In most cases, the determination was limited to the order or family level, even in the few cases where it would have been possible to determine the genus with the help of specialists. The rare instances of species-level identification are discussed below.

Results

The feeding range of wintering stone-curlews contained mostly invertebrates (100%, n = 47 faeces; Table 1). Small rodents were very rare (10.6%) while vegetation material was absent. This result is consistent with the data for feeding with mainly terrestrial invertebrates (Giannangeli et al. 2004). Prey insects were most frequently beetles (Coleoptera), thus being the most significant taxon (100%). Weevils (Curculionidae), ground beetles (Carabidae) together with earwigs (Dermaptera) dominated the diet in terms of their high occurrence and quantitative presence in the diet (Table 1). Curculionids and carabids were the only groups that were significantly more frequently with the higher number of individuals than the expected one per dropping (Table 1).

Dermapterans were almost always present in the faeces (97.87%; Fig. 2). In one case, an almost intact specimen of earwig was found and it was possible to identify it as *Forficula auricularia* Linnaeus, 1758 (Forficulidae). However, according our findings, the Coleoptera as a whole was the most significant taxon (occurring in 100% of the samples;

Table 1. Winter diet of stone-curlew, *Burhinus oedicnemus*, in Tuscany, Central Italy, 2009 – 2011. Percentage occurrence (% O) in faeces (n = 47); new taxon in the diet (*)

Prey				% O	Number of faeces with the respective number of individuals		
					1 ind.	2–4 ind.	≥ 5 ind.
Arthropoda	Arachnida	Opiliones *	Phalangiidae	25.5	12	0	0
	Insecta	Dermaptera *		97.9	13	7	26
		Coleoptera	Carabidae	87.2	5	19	17
			Staphylinidae	19.1	4	0	0
			Cantharidae *	6.4	9	0	0
			Curculionidae	93.6	14	16	14
			unidentified	6.4	3	0	0
		Coleoptera subtotal		100	2	7	38
		Hymenoptera	Formicidae	4.2	2	0	0
			Non-Formicidae	2.1	1	0	0
	Insecta subtotal			100	2	7	38
Arthropoda subtotal				100	1	8	38
Mollusca	Gastropoda	Pulmonata	Helicidae	8.5	4	0	0
***Invertebrates* subtotal**				100	1	8	38
Chordata	Mammalia	Rodentia	Muridae	10.6	5	0	0
***Vertebrates* subtotal**				12.8	6	0	0

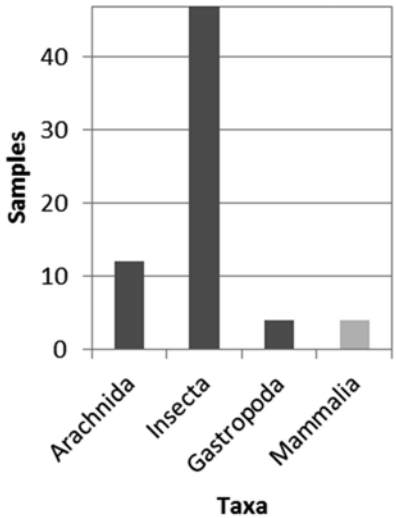

Fig. 1. Occurence of the classes in the samples. Dark grey = invertebrates; light grey = vertebrates.

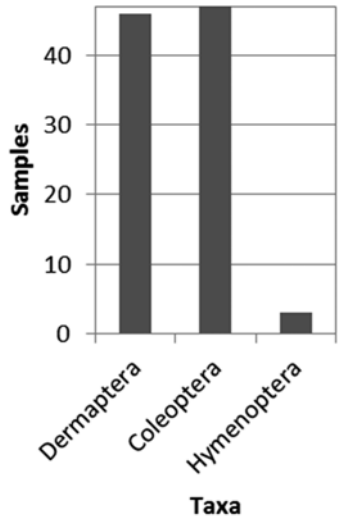

Fig.2. Occurence of the insect orders in the samples.

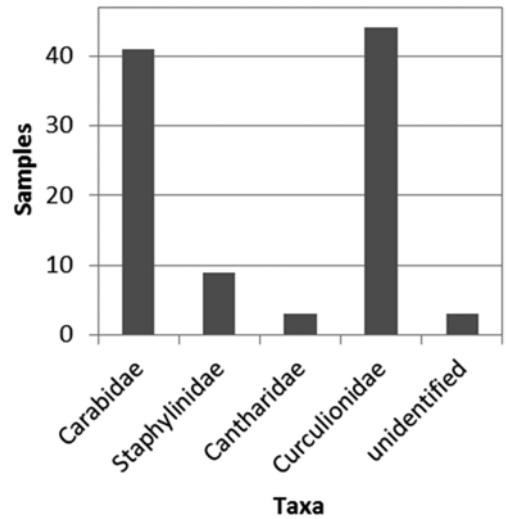

Fig. 3. Occurence of the families of the Coleoptera in the samples.

Fig. 2). Among beetles, Carabidae (several species, belonging to at least five genera) were present in 87.2% of the samples (Fig. 3), with the most represented classes being 2 found in 19 samples and 3 in 17 samples ($\chi^2 = 13.511$, df = 3, p = 0.004). They were followed by Curculionidae (mainly species of medium size or between 5-10 mm, e.g. *Otiorhynchus* s.l.) occurring in 93.6% of the samples (with only three samples as class 0 and the remaining classes almost uniformly represented; ($\chi^2 = 9.167$, df = 3, p = 0.027), Staphylinidae (e.g. *Ocypus* sp., but these were probably strongly underestimated because of their less sclerotised body) and, sometimes, members belonging to other families (e.g. Cantharidae). In very few cases, fragments belonging to the Hymenoptera were found, especially Formicidae. Shells belonging to members of the family Helicidae (Gastropoda, Pulmonata) were rare in our samples.

Parts of vertebrates were found in few samples (Table 1): mandibles belonging to the wood mouse, *Apodemus* cf. *sylvaticus* (Linnaeus, 1758), plus a vertebra of unidentifiable taxonomic origin.

Discussion

The present study examined for the first time the winter diet of the Eurasian stone-curlew in a Mediterranean area, outlining a different diet composition (Figs. 1-3) as compared to the previous study from the Canary Islands (Giannangeli et al. 2004). Further, we recorded harvestmen (Opiliones) and earwigs (Dermaptera) as new prey items for the stone-curlew's winter diet. Among beetles (Coleoptera), the family Cantharidae was found for the first time in the winter diet of the stone-curlew. According to Giannangeli et al. (2004), the diet of the stone-curlew from the Canary Islands includes rove beetles (Staphylinidae) but only in the winter season.

In some samples, the presence of Opiliones (Arachnida) of the family Phalangiidae was confirmed through the finding of their chelicerae, which were hard enough to survive passage through the digestive system of the stone-curlew. This order was not present in the winter diet studied in the Canary Islands (Giannangeli et al. 2004).

According to our results, the winter-diet of the stone-curlew encompassed a wide range of prey taxa: mainly invertebrates and, in particular, insects belonging to the orders Dermaptera and Coleoptera. Among arthropods, a preference for prey of considerable size can be observed: insects such as Staphylinidae of the genus *Ocypus*, medium-large Curculionidae like *Otiorhynchus* s.l., or medium-large size arachnids, such as the large body harvestmen (Opiliones) of the family Phalangiidae, instead of those of small size. Earwigs (Dermaptera), always found in high number, seemed to form a very important part of the diet, with accordance with the observed nocturnal feeding habits of the stone-curlew.

However, we must not forget the possibility that small fragments are not easy to find. Our sampling and analysis methods make it difficult to detect taxa with soft bodies (e.g. molluscs, earthworms). Other studies on the diet of the stone-curlew also remark that molluscs are poorly represented (e.g. Mienis 1990) as well as earthworms, both groups probably disadvantaged by the low winter temperatures and the dry soil conditions (see Kollmannsperger 1955).

Grazing activity of herbivorous mammals and the low impact of traditional management systems in agriculture are very important for maintaining short vegetation in semi-natural areas, suitable for the stone-curlew (Cramp & Simmons 1982, Vaughan & Vaughan-Jennings 2005). This seems to agree well with the community of animals living near the soil surface (e.g. harvestmen, earwigs, ground beetles, etc.) found in the examined samples.

Concerning vertebrates, it is difficult to establish whether they were live animals preyed upon by the stone-curlew, or carrion, or remains of meals of other animals.

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