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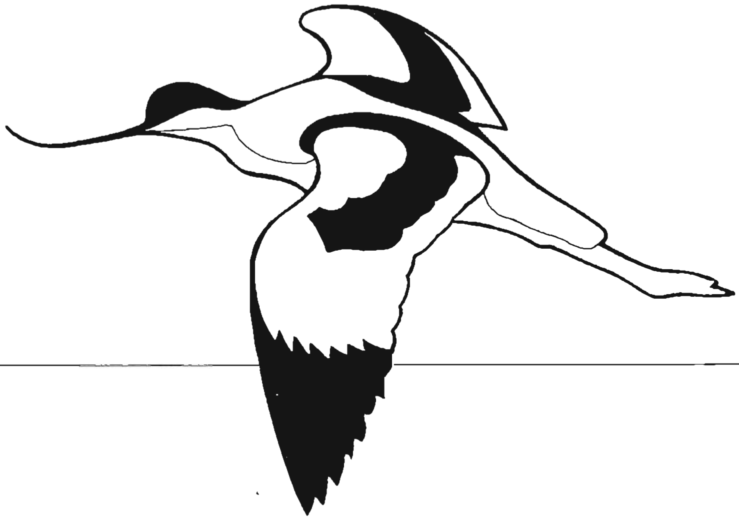

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Nest-hole selection as defence measure in breeding Swifts *(Apus apus)*

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Abstract — During the 1990-1991 breeding seasons we studied factors affecting Swift nest-hole selection, i.e. exposure, height, dimensions, type of holes and dispersion, in Pavia, Northern Italy. Exposure was not a significant factor, while in most cases Swifts nested at a height of 9-14 m in very small holes, often barely large enough to let them in. Holes were the sites selected in most cases; however a number of Swifts used the spaces under tiles, and a small number nested under eaves or behind shutters. Swifts were found nesting at 1-2 m maximum distance, confirming that nest-aggregation is another important factor in hole selection.

Introduction

The breeding range of the Swift, *Apus apus,* covers the Western Palearctic from North Africa to the Polar Arctic Circle (Cramp 1985). In Italy it is present from March-April to July-August (Farina 1980, Koller 1982, Boano 1988, Grandi and Nova 1990). It mainly breeds in colonies, selecting holes as nesting sites, where House Sparrows *Passer domesticus,* Starling *Sturnus vulgaris* and Rock Dove *Columba livia* also nest (Quadrelli 1985). Holes are occupied by the adults, but some of the young may also try to build a nest, even if they are immature (Weitnauer 1947, Magnusson and Svardson 1948, Glutz and Bauer 1980); otherwise they rest in the air (Poncy 1928, Weitnauer 1960). In Italy the Swift has been little studied (Farina 1980, Quadrelli 1985), whereas its relative, the Pallid Swift *Apus pallidus,* has received more attention, due to its rareness (Boano 1979, Cucco and Malacarne 1987, Malacarne *et al.* 1989).
The aim of our study was to investigate the main factors affecting nest-site selection and the strategies adopted by Swifts to avoid predation.

Methods

The study was carried out from April to July in 1990 and 1991 in the centre of Pavia (Northern Italy). The town is characterized by old buildings (1100-1800 A.D.), avenues, parks, private gardens, and is located along the River Ticino. The area has a sublittoral continental temperate climate; during Swift breeding season the monthly average temperature varies from 13°C (April) to 25°C (July) and the monthly average precipitation is 65 mm. A census of the colonies breeding in the study area (2 km^2) was carried out both years in the same breeding phase (early July) and at the same time of day (11-13 h). In this period the air-ranges of different colonies showed no overlap and stranger individuals were drive off. So that, the consistency of the colonies was calculated by estimating the flocks flying over buildings where Swifts were seen to enter or exit from holes. Type of building and of hole selected were recorded for each colony. An intensive study area (the Visconti Castle), was selected and monitored in both breeding seasons in order to investigate nest height, dimensions and distribution. The Visconti Castle is a fourteenth century brick building, with three facades (West, South and East) and two square-based towers. Its walls are characterized by 2272 scaffolding holes, normally 15x15 cm, 1375 on the three facades and 897 on the two towers. Drawings of the facades and towers were made, indicating the localization of the scaffolding holes. These were then classified as "obstructed", holes whith entrance that had been partially blocked, on average 3x3 cm, and "unobstructed", on average 15x15 cm, using binoculars. All the holes were 50-100 cm deep. There were 99 obstructed and 2173 unobstructed holes. Obstructed holes were distributed randomly between unobstructed ones. There are 30 lines of scaffolding holes, and the facades were subdivided into 10 levels: each level consisted of three horizontal lines of holes and was 2.4 m high. The first level started at 4 m. We performed the χ^2 goodness of fit test on the proportions of available and used holes in order to evaluate statistically the differences in the height, dimensions and exposure of the holes selected by the

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Swifts; effective nest-holes were only those into which a Swift entered completely, at least twice in more than a fortnight. Where a significant difference between availability and actual use of holes at various heights, dimensions and exposure was found, Bonferroni's simultaneous confidence intervals analysis (Neu et al. 1974, Alldredge and Ratti 1986) was used to determine which were actively selected and which rejected:

$$Pi\text{-}Za/2k\,\sqrt{Pi\,(1\text{-}Pi/n)} < P < Pi + Za/2k\,\sqrt{Pi\,(1\text{-}Pi)}/n$$

where:
Pi = percentage of nests observed at an i-th height
a = probability level (95%)
k = facade level
Z = standard table value of one tailed-probability integral of $a/2k$
n = total number of observations.

We adopted the "Nearest-Neighbour method" (Clark and Evans 1954) to evaluate nest distribution, comparing the observed distances between nearest nests with those expected from a Monte Carlo simulation, carried out on the number of nests found in 1990 and 1991 (Bekoff and Mech 1984); one thousand random distributions were effected.
The G test (Sokal and Rohlf 1981) was used to evaluate statistically the differences between observed and expected distances subdivided into six classes of frequency (0-0.5, 0.5-1, 1-1.5, 1.5-2 m ...):

$$G = 2\Sigma f_0 \ln\,(f_0/f_e)$$

where f_0 is the observed frequency of distances subdivided into six classes and f_e the expected frequency of distances.

Results

Twenty-six colonies were censused in each breeding season, and the total number of Swifts in the centre of Pavia varied from 1600 to 2400 individuals

Table 1. Estimated number of Swifts in the colonies of the centre of Pavia (Building: C = church, CA = castle, B = bridge, H = house, M = Monumental building, D = dovecote for Swifts, T = tower; Nest-site: e = eave, h = hole, t = tile).

Colony	Building	Nest-site	number of individuals min. 1990	min. 1991	max. 1990	max. 1991
1 Cathedral	C	h-t	300	300	500	500
2 Visconti Castle	CA	h	150	150	200	200
3 Leonardo da Vinci Tower	T	h	150	150	150	150
4 Belcredi Tower	T	h	150	150	150	150
5 St. Francesco	C	h-t	150	150	150	150
6 St. Maria del Carmine	C	h	100	150	100	150
7 St. Dalmazio Tower	T	h	80	100	150	150
8 St. Michele	C	h-t	70	70	100	100
9 St. Luca	C	h	50	50	80	80
10 St. Teodoro	C	t	50	50	80	80
11 Borromeo College	M-T	e-h	50	50	80	80
12 Covered Bridge	B	t	40	40	70	70
13 St. Maria di Canepanova	C	h	40	40	50	50
14 St. Tommaso	C	h	40	40	50	50
15 Pharmacology Institute	H	t	30	30	50	50
16 P. Calcinara	H	t	20	20	50	50
17 Castiglioni College	M	t	10	10	50	50
18 Cairoli College	M	h	10	10	50	50
19 St. Francesco da Paola	C	t	10	10	50	50
20 St. Primo	C	h-t	10	10	50	50
21 St. Gervasio & Protasio	C	h-t	10	10	50	50
22 Ugo Foscolo School	H	t	10	10	50	50
23 St. Pietro in Ciel d'Oro	C	e-t	10	10	30	30
24 Scaldasole dovecote	D	h	10	10	30	30
25 St. Marino	C	h-t	10	10	20	20
26 Piazza della Posta Tower	T	h	10	10	10	10
Total			1560	1630	2390	2440

including non-breeders (Tab. 1). Eleven (42.3%) colonies were located exclusively inside holes in buildings, 7 (27%) under the tiles, 6 (23.1%) utilized holes and tiles of the same building; finally, only 2 colonies (7.7%) used the spaces under eaves. Some Swifts bred isolated using the spaces behind shutters. The colony breeding at the Visconti castle consisted of 150-200 Swifts in both the years of study. In 1990, 68 Swift pairs nested inside the holes, in 1991 the number was 63. Exactly 50% of the holes selected in 1991 had also been selected the year before. The data collected showed that nest-hole selection is independent of exposure (Tab. 2), most holes selected were small holes, which is significantly more than the big ones ($\chi^2 = 1333.06$, d.f. = 1, $p<0.001$). In 1991 there was a decrease in the percentage of small holes used; however, they were significantly by selected again ($\chi^2 = 370.5$, d.f. = 1, $p<0.001$) (Tab. 3). In certain parts of the building higher concentrations of pairs were observed. In both years the birds significantly selected holes at medium height levels ($\chi^2 = 59.3$ d.f. = 9, $p<0.001$ in 1990; $\chi^2 = 31.1$, d.f. = 9, $p<0.001$ in 1991). Bonferroni's simultaneous confidence intervals analysis showed that a height from 8.8 to 13.6 m was actively selected, while levels under 6 m and over 23 m were rejected (Tab.4). Aggregation of the Swift nests was confirmed: in 1990 no distance observed was greater than that to be expected from a Monte Carlo simulation (1000 dimensions), the probability thus being less than 0.001; the G test confirmed the result (G = 40.96, d.f. = 5, $p<0.001$). In 1991 only 3 nests were located at a greater distance than that to be expected from the same simulation ($p<0.003$), and the G test was again significant (G = 15.37, d.f. = 5, $p<0.01$).

Table 2. Nest exposure at Visconti castle (χ^2 Test).

exposure	available holes	occupied holes 1990	occupied holes 1991
East	600	18	12
South	1002	30	35
West	670	20	16
significance level		ns	ns

Table 3. Hole dimension in nest-hole selection (χ^2 Test).

dimension	available holes	occupied holes 1990	occupied holes 1991
big holes	2173	4	29
small holes	99	64	34
significance level		P<0.001	P<0.001

In 1990, 69.1% of the nests were located within 1 m of another nest and 82.3% within 1.50 m; in 1991, 60.3% of the nests were less than 0.5 m from another nest and 87.3% less than 2 m (Tab. 5 and Fig. 1).

Discussion

Holes are considered the safest type of nest-sites, especially for the young trying to leave the nest while still unable to fly (Gory 1987), and this should explain the preference of the Swifts for this kind of cavity. However, in other areas (Gibraltar) Swifts mainly used spaces under eaves to breed (63% of nests), while holes in the buildings were scarcely occupied (2%), and the same was observed for Pallid Swifts (Finlayson 1979, in Cramp 1985).

Table 4. Results from Bonferroni's intervals analysis for height levels in nest-hole selection (χ^2 Test).

height (m)		available holes	expected as occupied		occupied holes		significance level	
			1990	1991	1990	1991	1990	1991
I	4.0-6.4	340	10.2	9.4	2	1	-*	-*
II	6.4-8.8	382	11.4	10.5	7	10	ns	ns
III	8.8-11.2	351	10.5	9.7	26	21	+*	+*
IV	11.2-13.6	376	11.2	10.4	25	18	+*	ns
V	13.6-16	372	11.1	10.3	8	10	ns	ns
VI	16.0-18.4	86	2.6	2.4	0	1	-*	ns
VII	18.4-20.8	88	2.6	2.4	0	1	-*	ns
VIII	20.8-23.2	100	2.9	2.8	0	1	-*	ns
IX	23.2-25.6	92	2.7	2.5	0	0	-*	-*
X	25.6-28	85	2.5	2.3	0	0	-*	-*
significance level					P<0.001	P<0.001		

* marks a significance level of $p< 0.05$; + indicates preference, - indicates avoidance.

Figure 1. Percentage differences between observed and expected frequencies, expressed as: [(observed-expected)/expected] x 100, of the nearest-neighbour distances between nests. Left: 1990 season. Right: 1991 season.

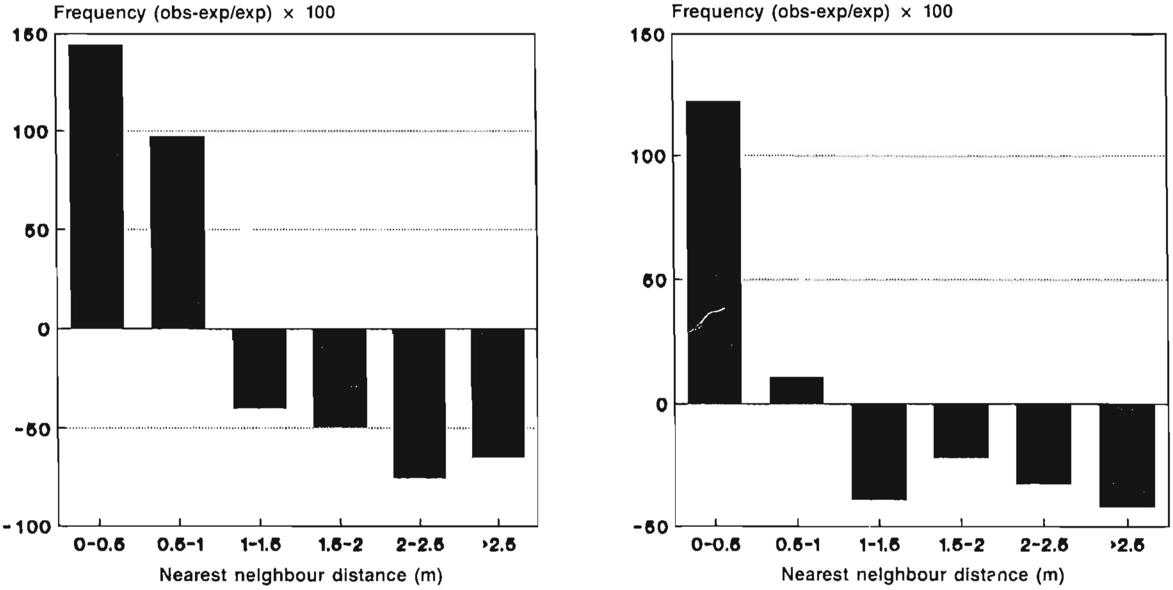

Table 5. Nest aggregation factor in nest-hole selection (G Test).

nest-hole distance classes (m)	distance frequency expected 1990	distance frequency expected 1991	distance frequency observed 1990	distance frequency observed 1991
0-0.5	7.4	9	18	20
0.5-1	14.7	16.3	29	18
1-1.5	14.9	14.7	9	9
1.5-2	11.8	10.2	6	8
2-2.5	8	5.9	2	4
>2.5	11.3	6.9	4	4
significance level			P<0.001	P<0.01

Probably this difference depends on the local availability of different nest-sites and the presence in Pavia of many ancient buildings with scaffolding holes may justify the preference for holes showed by Swifts breeding in this town.

Boano (1979) found that Pallid Swifts breeding in a colony in Torino mainly used holes 3-4 m high, while in the same building Swifts occupied higher levels, reaching the top of the towers. Cucco and Malacarne (1987) observed 50% of the pairs of this Pallid Swift colony selecting holes 8-13 m high, while Swifts built their nests higher in the same building. In our colony, Swifts occupied holes at 9-14 m levels, which is comparable to the height observed by Cucco and Malacarne (1987) for the Pallid Swift rather than for the Swift. Nest-hole competition between the two species could lead Swifts to nest higher when the Pallid Swift is present; otherwise Swifts would occupy the same levels selected by the Pallid Swift. Some degree of interspecific competition in nest-site selection might in fact be involved; recently, along the Gargano Promontory coasts, Brichetti *et al.* (1988) found that the two species were aggregated in only 5 of 39 colonies censused, and Swifts were few in mixed colonies. Indeed they concluded that the presence of other species of Apodidae in a cliff can limit the colony size of Swifts. However, the prevalence of the Pallid Swift in the competition might simply be due to a chronological factor, since it reaches the breeding areas slightly earlier than the Swift (Boano 1979). Nest-aggregation, yet found in Pallid Swift colonies

(Cucco and Malacarne 1988), has been confirmed in Swifts also, but, lacking data on communal breeding in this species, its function remains to be clarified.

Generally gregariousness is considered to be a form of protection against predators acting either by a "dilution" effect of group reducing probability of an individual being caught (Hamilton 1971) or by an enhancement of active defence. In Swifts, such a behaviour may be effective against diurnal predators catching them or their offsprings in fly like *Falco subbuteo* and *Accipiter nisus* do (Daanje 1944, Slijper 1948, in Cramp 1985) and may have therefore this kind of adaptive value in natural habitats. But in urban areas, this strategy may be ineffective against predators which prey on Swifts directly from the nests, moreover against nocturnal, resident and high memory performances predators as Tawny Owls, *Strix aluco*. In fact, 3 pairs of Tawny Owls preyed on Swifts breeding in the centre of Pavia and Swifts constituted 30% in weight of the spring diet of the pair preying on the Visconti Castle colony (Galeotti *et al.* 1991). Indeed Swift colonies are optimal and seasonally predictable feeding patches for breeding Tawny Owls, providing suitable prey (40 g) with low energy loss, since the owl's perches in Pavia are located very close to the Swift colonies. In this conditions, nest-aggregation seems to be a bad defence strategy, since it attracts potential predators and enhances their succes rate; however it is maintained, suggesting that nest-aggregation in Swifts, far from primary serve as defence, might on the contrary enable them to exchange crucial information about food sources. The diet of Swifts, based on ephemeral, scattered and unpredictable resources as flying insects, and the social modality of clumped arrivals and departures from nests we observed (Galeotti and Colombo, unpubl.data) support the information-centre hypothesis (Ward and Zahavi, 1973). If nest aggregation is adaptive in this way, selection of small holes could be a good answer in the "arms-race" beetwen Swifts and predators. Small holes, i.e. holes with a very tiny slit for entrance, are an inexpensive passive measure of defence, effective against all potential predators. The Hooded Crow *Corvus corone cornix*, was also observed exploring Swift nest-holes, with a high frequency of visits (about one every 15 min). The Hooded Crow explored only the big holes by standing at the entrance or going inside; it often visited 3-4 holes at a time in this way, and then flew away. When a Hooded Crow approached the holes, most of the Swifts rose to a high altitude in absolute silence and flew in a single flock or in two big formations. Only 3-4 Swifts remained at hole height, weakly mobbing the Hooded Crow until it flew away from the colony. The behaviour described was observed whenever a Hooded Crow explored the holes and was constant in June-July, while in April-May the Swifts' reaction was less perceptible. Even without observing the Hooded Crow actually preying on eggs or young, predation can be assumed on the basis of the Swifts' particular behaviour. In this case too, selecting small holes functions against the predator.

Acknowledgements — We wish to thank Dr L. Brocchieri for valuable suggestions on statistics.

Riassunto — Durante le stagioni riproduttive 1990-1991 abbiamo studiato i fattori che influenzano la scelta del sito riproduttivo del Rondone in una colonia localizzata sulle facciate del Castello Visconteo di Pavia (Nord Italia). Sono stati considerati esposizione, altezza, dimensioni e tipo di dispersione delle cavità occupate dalle coppie riproduttive. Mentre l'esposizione non influenza in alcun modo la scelta del sito, l'altezza e le dimensioni dei fori di ingresso costituiscono invece fattori importanti. I rondoni selezionano infatti attivamente fori di piccole dimensioni (3x3 cm) appena sufficienti a consentire il passaggio, posti ad altezze comprese tra i 9 e i 14 m . I nidi attivi non sono distribuiti in modo regolare o casuale, ma sono concentrati in gruppi; le distanze tra i nidi sono comprese tra 0.5-2 m. Le piccole dimensioni dei fori d'ingresso dei nidi costituiscono con ogni probabilità un adattamento alla predazione. Sia l'Allocco che la Cornacchia grigia esplorano infatti sistematicamente i buchi delle facciate e, nel caso dell'Allocco, il prelievo annuale di un notevole numero di individui adulti è documentato con certezza.

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Umbrella pine seeds selection by Hooded Crow, *Corvus corone cornix*

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Abstract — Probably the Hooded Crow selects longer and heavier pine-seeds to obtain bigger endosperms or to select the full pine-seeds. The old valve absence among the pine-seeds opened by the Hooded Crow also confirms the latter hypothesis.Smaller pine-seeds having a more elongated shape are opened on anvils, maybe because they are more difficult to break open, but the different techniques used to open pine-seeds on the ground and anvils still need further study.

Introduction

Various species of Corvids as Hooded Crow, adapt very easily as far as food is concerned (Goodwin 1976, Coombs 1978). Some of these species feed also on pine-seeds; because of this kind of feeding, they have acquired certain specific behaviour patterns (see Tomback and Linhart 1990). For example, Vander Wall and Balda (1977) have observed that Clark's Nutcrackers select more productive pines and cones with a greater number of seeds, and Vander Wall (1988) observed that this species, to obtain maximum energy gain, carries out a selection according to the season, both on open and closed cones and among the various species of pines.

We observed Hooded Crows feeding on pine-seeds using tree roots as anvils. The birds would take the seeds into their bills, carry them to a root of pine tree, jutting out from the ground, hold them with their feet and open them with a series of blows with their bills along the cleft of the valve. This behaviour is not too far from the cases of true tool use observed in the Hooded Crow (Rolando and Zunino 1992) and in other Corvids (James 1976, Montevecchi 1978, Beck 1980, Boswall 1985).

The first aim of this work is to investigate possible preferences that the Hooded Crow shows feeding on pine seeds of Umbrella pine *Pinus pinea*. Moreover, this study aims at investigating differences of size between the pine seeds opened by the Hooded Crow on the anvils and those opened on the ground.

Methods

The study area was an Umbrella Pine wood with an extension of 1.6 ha within the park of Villa Pamphili (Rome) (41°53'N, 12°27'E) (Battisti 1986, Manganaro *et al.* 1990). The trees have an average diameter of 70 cm and are arranged in rows: in each row, the average distance between the trees is 9.3 m, the average height of the trees is 20 m, and the average density 87 trees per ha. There is no underwood.

As to the analysis of Hooded Crow feeding, we have identified three categories of pine seeds:

a) "control sample": 1,019 pine-seeds collected on 30th September 1988 and 7th October 1988 along a 700 m transect considering the homogeneity of the study area vegetation, the average size of these pine-seeds should be the same as in the study area. The seeds fall in summer (Gellini 1973) and consequently these are the ones available for the rest of the season.

b) "ground": 560 pine-seeds collected on the same transect on 15th December 1988 opened by Hooded Crows on the ground with the technique carried out on the anvil.

c) "anvil": 501 pine-seeds collected on the same transect on the 15 December 1988 opened by Hooded Crows on the anvil.

The pine-seeds opened by Hooded Crows are easily identifiable because they are split exactly into two valves; furthermore, they are found in clusters either on the "ground" or on the "anvils", which, in the study area, were only roots of Umbrella Pine jutting out from the ground.

We measured the length and width of the valva of pine-seeds with a 0.05 mm precision gauge; the weight with a 0.01 g precision balance. We also formulated an index in order to calculate the shape of the pine-seeds: form = 100 × length/width.

The pine-seeds with a more rounded shape have values close to 100.

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From June 1984 to June 1986 fortnightly visits (3-5 hours long) to the environments of Villa Pamphili urban park were carried out in the following years, autumnal visits (6 in 1986, 4 in 1987) to the park were carried out during the latter period, feeding Hooded Crows in the study pine wood were observed for at least 30 consecutive minutes.

For statistical analysis of the data we used the z test and linear correlation.

Results

During the study period pine-seeds were a very important autumnal food element for the Hooded Crow of Villa Pamphili urban park; in this season the only feeding Hooded Crows (10-20 individuals) were generally observed in the morning in the study pine wood. In this area the Crows almost exclusively took pine seeds (e.g. 86% of 218 observed cases during the visits in 1986). In the afternoon some individuals (2-3) feeding on pine-seeds are sometimes noticed in other small pine woods.

The seeds of the control sample were significally lighter and, to a minor extent, shorter if compared to the seeds opened by the Hooded Crows, both on the ground and on the anvils (Tab. 1 and 2).

The linear correlations between weight ($r = 0.70$, d.f. 251, $p<0.001$) or length ($r = 0.61$, d.f.251, $p<0.001$) of the valve and the weight of the endosperm were highly significant.

Pine-seeds collected on the ground were wider, rounder and heavier than those opened on anvils, as shown in Tables 1 and 2.

Discussion

The period when the Hooded Crow collects the greatest number of pine-seeds, is also that of maximum availability of the Umbrella Pine seeds in the Mediterranean area (Gellini 1973). This trend is similar to the one observed in America for other species of pine trees *(Pinus flexilis* and *P. monophilla)* whose seeds also have greater energetic contents towards the end of summer (Vander Wall 1988).

The Hooded Crow might prefer heavier and longer pine-seeds to obtain larger contents or/and select full pine-seeds. An observation confirming the selection

Table 1. Mean and S.D. for length, breadth, weight and shape for three considered categories i.e. "control sample", "ground" and "anvil". (Sample sizes are shown in parentheses).

	Length	Breadth	Weight	Shape
"Control sample" (n = 1019)	18.72 ÷ 1.52	9.12 ÷ 0.93	0.29 ÷ 0.08	205.8 ÷ 20.7
"Ground" (n = 560)	18.97 ÷ 1.40	9.20 ÷ 0.85	0.35 ÷ 0.06	207.4 ÷ 18.2
"Anvil" (N = 501)	18.91 ÷ 1.29	8.93 ÷ 0.88	0.33 ÷ 0.07	212.4 ÷ 22.2

Table 2. Statistical significance (z test) of comparison, for the mean length, breadth, weight and shape of the valves between: 'control sample' and 'ground', 'control sample' and 'anvil', 'ground' and 'anvil'. (Sample sizes in Tab. 1).

Comparisons	z test	Significance
Length:		
Control sample - ground	2.17	p<0.05
Control sample - anvil	2.55	p<0 05
Ground - Anvil	0.11	N.S.
Breadth:		
Control sample - ground	1.74	N.S.
Control sample - anvil	3.87	p<0 01
Ground - Anvil	5.08	p<0 01
Weight:		
Control sample - ground	16.03	p<0.01
Control sample - anvil	9.74	p<0.01
Ground - anvil	4.83	p<0.01
Shape:		
Control sample - ground	1.59	N.S.
Control sample - anvil	5.56	p<0.01
Ground - Anvil	3.98	p<0.01

of full pine-seeds by the Crows was that no old valves (that is valves uncoloured and with old timber typical of empty pine-seeds) were found among opened pine-seeds. Ligon and Martin (1974) observed that Piñon Jay *Gymnorhinus cyanocephalus* learns to recognize good pine-seeds, i.e. those containing edible endosperm, on the basis of visual, auditory and tactile stimuli.

However, the behaviour of bill clicking (a rapid opening and closing of mandibles on the seed) used by the Piñon Jay to identify full pine-seeds (Ligon and Martin 1974) and by Clark's Nutcracker to decide which technique to adopt in order to open the pine seeds (Vander Wall 1988), was not observed in the Hooded Crow. On the other hand pine-seeds are not a usual food for this species (Goodwin 1976, Coombs 1978) but are of great importance in the feeding habits of Clark's Nutcracker (Vander Wall 1988) and the Piñon Jay (Balda and Bateman 1971, Ligon 1971), to such a point that the latter species may be genetically programmed to learn the means of identification of full pine-seeds (Ligon and Martin 1974).

As to the observed differences in shape and size between the pine-seeds collected on the ground and those on anvils, it is possible that on anvils the Crows break the pine seeds that are most difficult to open, more quickly, whereas on the ground it may be more convenient to open heavier and larger pine-seeds which are more likely to contain a larger endosperm; a seed is advantageous when it requires a short time to handle (Hespenheide 1966, Wilson 1971,1972, Grant 1981).

Consequentely it is also possible that smaller pine-seeds are not selected because they are difficult to open. Scott Johnson et al. (1987) observed that there are individual differences in Clark's Nutcracker as concerns the choice of the best technique to adopt in order to open the pine-seeds; these two techniques require a different amount of time and are used according to the kind of pine-seeds selected; in particular, to open wider pine-seeds with a thicker outer layer, this species uses the technique described above for the Hooded Crow.

However, more detailed observations are required concerning techniques used by the Hooded Crow to open pine-seeds on the ground and anvil, and, in particular, the time required, the number of bill blows and the success in finding endosperm.

Acknowledgements — We wish to thank Fulvio Fraticelli for his useful advice and Elena Maria Bezzi for her cooperation.

Riassunto — Sono stati analizzati alcuni aspetti dell'alimentazione su pinoli da parte della Cornacchia grigia, *Corvus corone cornix,* nel parco urbano di Villa Pamphili (Roma).Nel periodo autunnale i pinoli costituiscono per la specie un importante fonte alimentare.La Cornacchia grigia apre i pinoli sia sul terreno che su "incudini" naturali che nell'area studiata sono le radici emergenti dal terreno del Pino domestico *Pinus pinea.*

La Cornacchia grigia seleziona sia su incudine che sul terre-pinoli più lunghi e pesanti rispetto ad un campione di controllo, mentre pinoli meno rotondeggianti e meno larghi vengono aperti preferibilmente su incudine rispetto al terreno, forse a causa della loro maggiore difficoltà di apertura. Ulteriori studi sono necessari per approfondire le tecniche usate dalla Cornacchia grigia per aprire i pinoli sul terreno e su incudine.

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Breeding habitats of Sparrowhawks *(Accipiter nisus)* and Goshawks *(A. gentilis)* in the Southern Alps

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Abstract — The breeding habitats of Goshawks and Sparrowhawks were studied at the level of the nest site, of the area close to the nest, and of the presumed home range. The general features of the home ranges of the two hawks coincided. In contrast, both the territories and the nest sites differed sharply: compared to the Sparrowawk, the Goshawk preferred territories where trees were older, bigger, and spaced at wider distances, and where the shrub and tree cover was lower, and the grass cover was higher. These preferences may be related to the size difference, and to interference competition between the two hawks.

Introduction

The breeding habitats of European birds of prey that live in wooded environments have been described quantitatively in few instances, for Sparrowhawk *(Accipiter nisus)*, Goshawk *(A. gentilis)*, Common Buzzard *(Buteo buteo)* and Honey Buzzard *(Pernis apivorus)* in North and Central Europe (Hald-Mortesen 1974, Newton 1986, Kostrzewa 1987, Jedrzejewski *et al.* 1988), but no comparable information is available for Southern Europe. However the conservation concern for many raptors and their suscetibility to human impact call for detailed information on their habitat requirements. We investigated the breeding habitats of the Goshawk and Sparrowhawk, at the level of the nest site, of the presumed territory, and of the home range surrounding this territory.

Methods

Breeding of the two hawks was studied in the province of Trento, Central-Southern Alps, a 6300 km^2 area, 30% of which lies from 100 to 1000 m a.s.l., 50% from 1000 to 2000 m, and 20% above 2000 m. About half of the landscape is wooded, mainly with deciduous trees up to 1200 m, and mainly with conifers from 1200 to 1800 m.

We located 9 nests of Sparrowhawks and 11 nests of Goshawks in this area from 1983 to 1986; the nests were found following the indications of local bird-watchers, game-wards of forest managers.

All the nests considered were successful. For each nest, the habitat was studied at three scales:

1) Nest site, i.e. the nest and the nest tree. We measured: altitude a.s.l., nest height, tree circumference at breast height, total height of the tree, depth of the green layer of the canopy, depth of the dead layer of branches, tree species, ground slope and aspect.

2) Breeding territory, i.e. the small, strongly defended area around the nest, where little or no hunting occurs (Fischer 1983, Newton 1986). Five points were selected, one centered at the nest tree, and the other four at 50 m from the nest, along each compass direction. At each point, the nearest tree was chosen in the 4 quadrants (point center quarter method, Cottam *et al.* 1953); we took the same measurements as at the nest tree for each of these trees (except for altitude and nest height), and we recorder the distance of the tree from the central point, the cover by trees, by shrubs (from 3 to 0.5 m high), by grass (<0.5 m high) and by rocks, within 10 m from the point. The measures taken at the 4 trees around a point were averaged, and each territory was described by 5 sets of variable values.

3) Home range, i.e. the total area assumed to be used by the breeding pair. During breeding, Sparrowhawks hunt mostly within 1 km from their nest (Marquiss and Newton 1982). Detailed data on the home range of Goshawks were not available; in an area in the Southern Alps neighbouring Goshawk nests are spaced at an average distance of 5.7 km (Benussi and Perco 1984), and in a part of the Apennines their average distance was 3.6 km (Penteriani 1991).

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We adopted a conventional, fixed home range radius of 1 km from the nest for the Sparrowhawk, and of 3 km for the Goshawk, and within these distances, the cover of the main biotope types, the area of altitudinal bands, and the directions of slope were measured on 1:25,000 scale maps.

The variables expressed in percentages were normalized by trasformations before entry into the Discriminant Analysis.

Results

The nests of both species were widely scattered throughout the study area, and no geographical segregation of the two hawks was apparent.

More than two thirds of the assumed home ranges of both hawks were wooded, mainly with conifers (Table 1): woods covered 48% of the area (36% conifer and 12% broadleafed) in the entire region we investigated, hence both hawks included in their ranges a greater share of land covered by conifers than expected by random. No significant difference emerged in the proportions of biotope types within the home ranges of the two hawks, except for "Pastures", which were more abundant in the Goshawk ranges; this difference was due to the wider range assumed for the Goshawk (3 km vs. 1

Table 1. Biotope types within the home ranges of the two hawks. Means (and ranges in parentheses). Significance of the differences tested by Mann-Whitney U test.

	PERCENTAGE OF ESTIMATED RANGES COVERED BY:							
	Conifer Woods	Broadleaved Woods	Shrubs	Pastures	Crops	Rocks	Water	Human Settlements
Sparrowhawk	62.8	8.1	4.8	4.3	15.3	.04	3.6	1.0
	(0-96.7)	(0-34.9)	(0-43.4)	(0-20.8)	(0-28.7)	(0-0.3)	(0-21.2)	(0-0.6)
Goshawk	71.0	2.2	1.7	10.5	10.0	1.9	0.9	1.7
	(59.6-81.8)	(0-7.0)	(0-16.5)	(2.3-27.4)	(0-24.4)	(0-9.8)	(0-3.0)	(0-4.7)
Significance	NS	NS	NS	$P<0.05$	NS	NS	NS	NS

Table 2. Characteristics of the territory and of the nest site of the two hawks. Significance of the differences tested by Mann-Whitney U test (* $P<0.05$, **$P<0.001$). Altitude in m a.s.l., all other linear measures in cm; slope cover in percentage.

	SPARROWHAWK		GOSHAWK		SIGNIFICANCE OF DIFFERENCE			
					between the two hawks at the level of:		between the site and the territory of:	
	territory	site	territory	site	territory	site	Sparrowhawk	Goshawk
Altitude		1125		1231		NS		
Nest height		1120		2243		***		
Tree spacing	330		488		***			
Trunk circumference	74	84	122	177	***	***	*	***
Tree height	1650	1948	2424	3262	***	***	$P<0.05$	***
Canopy depth	912	1061	1256	2112	***	***	NS	***
Depth of dead branches	345	498	210	217	*	*	NS	NS
Ground slope	33	26	48	48	***	**	NS	NS
Arboreal cover	63		55		**			
Shrub cover	9		11		NS			
Grass cover	18		46		**			
Rock cover	4		6		NS			

Table 3. Discriminant analysis of the territories and of the nest sites of the two hawks. Classification results are shown as percentage of predicted vs. actual categories. The standardized discriminant function coefficients are shown for the significant variables entered in the stepwise discriminant procedure.

	TERRITORY		NEST SITE	
	PREDICTED AS:		PREDICTED AS:	
	Goshawk	Sparrowhawk	Goshawk	Sparrowhawk
ACTUAL: Goshawk	83	17	92	8
Sparrowhawk	9	91	0	100
DISCRIMINANT FUNCTION COEFFICIENTS:	tree circumference	0.97	tree circumference	0.49
	height dead branches	-0.33	nest height	0.73
	slope	0.45	slope	0.67

Table 4. Percentage of trees within the territories of the two hawks, compared with the frequencies of trees used for the nests. The different between frequencies was not significant between nest-trees and territories of the Sparrowhawk, while it was highly significant between nest-trees and territories of the Goshawk, between the nest-trees of the two species, and between their territories ($P<0.001$, chi-square test, tree species with expected frequency <5 grouped into one type for the test).

	Picea excelsa	*Abies alba*	*Larix decidua*	*Fagus sylvatica*	*Pinus silvestris and nigra*	Other species
Sparrowhawk						
territory	75	2	13	5	3	2
nest-tree	80	7	0	0	13	0
Goshawk						
territory	47	39	8	6	0	0
nest-tree	8	92	0	0	0	0

km), and to the consequent higher prabability of including mountain pastures above tree level. No difference between the home ranges of the two hawks found on the directions of slope, or in the proportions of differing altitudinal belts.

Territories and nest sites of the two species differed significantly in all the characteristics measured, except altitude, shrub cover and rock cover (Table 2). Sparrowhawk and Goshawk were descriminated almost completely at the territory scale, and completely at the nest sites scale (Table 3), by a discriminating function with only three variables (for territories: trunk circumference, depth of dead branches, and slope; for nest sites: trunk circumference, nest height, and slope). The tree species differed both at the level of territory and of nest sites (Table 4).

Sparrowhawks showed no preference for any particular tree species within their territory for nesting, while Goshawks strongly selected *Abies alba*. This preference was not attributable to size differences among the conifer species, because the *Abies alba* and *Picea excelsa* available were similar in size. It may therefore be due to a greater suitability of the structure of *Abies alba* as a support for the nest.

Both hawks selected larger trees for nest sites as compared to the trees available within their territories (Table 2), but Goshawks showed greater selectivity. This selectivity by the Goshawk within its territory was confirmed by Discriminant Analysis, applied to the trees used for nesting versus the trees available in the territories; trees used by Sparrowhawks as nest sites were not discriminated from those available on the basis of the variables of Table 2 (only 50% of the trees were correctly classified), while the trees used by Goshawks were discriminated from those available in the breeding territory (78% of the trees correctly classified).

Data from the forest management authority showed that the woods used by breeding Goshawks were older (average 113 years, range 94 to 136) than those used by Sparrowhawks (average 66 years, range 50 to 96). All the Goshawk territories were within extended stands of continuous woodland, while 2 of the 9 Sparrowhawk territories were in disjunct patches of conifers (area 37 and 70 ha). Northern slope aspects were strongly preferred by both hawks for their territories and their nest sites. Goshawk nests tended to be placed further from human activity than Sparrowhawk nests: their respective average distances were 943 and 541 m from the nearest isolated house, 2170 and 943 m from the nearest village, 619 and 554 m from the nearest road open to traffic. However, none of these differences was significant (Mann-Whitney U test).

Discussion

In North America, where 3 *Accipiter* species coexist, each species breeds in woodlands of a different structure (Reynods *et al.* 1982, Moore and Henny 1983); the Goshawk, the larger species, prefers more mature stands than the smaller species *(Accipiter striatus* and *A. cooperi).* The same preference of the Goshawk for more mature woods than those used by the Sparrowhawk also occurs in the Northern Europe (Hald-Mortesen 1974, Newton 1986), and seems a constant feature of the species' preferences. Goshawks strongly select larger trees within the territory (Speiser and Bosakowski 1987). Similar preferences were shown by the Goshawk in our study area.

Goshawks selected breeding territories with Northern aspect, both in our study area elsewhere (Reynolds *et al.* 1982, Speiser and Bosakowski 1987). The preferences for woods differing in tree-spacing (Table 2) confirm the preferences described by Newton (1986): in England and Scotland Sparrowhawks nest in woods with mean distance between trees up to 4 m, and Goshawks from 2.4 to 8 m. Other habitat characteristics were variable: ground slope was steep in our area and gentle in other regions, the preference for conifers over broadleaf trees was reversed elsewhere (Reynolds *et al.* 1982. Moore and Henny 1983, Speiser and Bosakowski 1987).

The woods used by Sparrowhawks for breeding were three times older in our study area than in England (Newton 1986), despite their similar tree spacing. The difference is explained by the slower growth of our mountain woods.

In our study area, the global features of the home ranges of the two hawks completely coincided, but territories and nest sites differed markedly: compared to the Sparrowhawk, the Goshawk preferred territories where trees were older, bigger, and spaced at wider distances, and where the shrub and tree cover was lower, and the grass cover was higher. All these characteristics were strongly correlated, and hence only one of them sufficed to discriminate the two hawks in the Discriminant Analysis. These preferences may be related to the size difference, and to interference competition between the two Hawks, as suggested by Newton (1986): the bigger species prefers more mature woods, because it needs more open flight paths and because it is not restricted to thick canopies by predation pressure.

Riassunto — Si è descritto l'habitat riproduttivo dell'Astore e dello Sparviere a livello di sito di nidificazione, area circostante il nido e home range stimato. La struttura generale delle aree famigliari nelle due specie coincide. Peraltro i siti di nidificazione e le aree circostanti il nido differiscono nettamente. L'Astore seleziona territori caratterizzati da alberi grossi e vecchi, più ampiamente spaziati e con maggiore sottobosco prativo. Queste preferenze di habitat sono interpretabili in base alla differenza di taglia e ad interazioni competitive fra le due specie.

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Breeding population and distribution of the Oystercatcher (*Haematopus ostralegus*) in Italy

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Abstract — The whole Italian population of Oystercatcher (*Haematopus ostralegus*) breeds along the north-east coastline; 36 pairs were censused in 1991 and 42 in 1992. They are mostly restricted to the barrier islands of Po Delta and to the lagoon of Grado-Marano. In the favourable breeding areas, a mean density of 1.92 (1991) and 1.84 (1992) pairs per km was recorded, with a minimum distance between nests of 45 m. Nest site fidelity in the years 1991-1992 was 58.3%. Over the last ten years the Italian breeding population, one of the most important of the Mediterranean area, has shown irregular fluctuations.

Introduction

Our knowledge of the distribution and status of the Oystercatcher *Haematopus ostralegus* breeding population in Italy is poorly known. Formerly breeding in several sites along the Tyrrhenian and Adriatic coasts, the species is now restricted to few areas of the north-eastern coastline (Tinarelli and Baccetti 1989). No confirmed breeding records have been reported outside these areas over the last ten years. In the same period several estimates have been done concerning the size of the breeding population (Pupillo and Boldreghini 1981, Tinarelli and Baccetti 1989), the most recent giving a figure of 20-25 pairs for the years 1987.

In 1991 the authors began systematic counts of breeding Oystercatchers along the north-eastern coastline (Scarton *et al.* 1993); the results of the years 1991-1992 are presented here, along with new additional information on the breeding biology of the species.

Methods

The study area consists of two separate stretches of coastline; the first sector 1 (Figure 1) extends from the Po di Volano mouth (44°46'N-12°15'E) to the Piave river mouth (45°34'N-12°38'W), a distance of about 130 km. The whole of the Po Delta and the Lagoon of Venice are included in this area. Sector 2 (Figure 1) is the coastline from the mouth of the river Tagliamento (45°42'N-13°04'E) and the mouth of river Isonzo (45°44'N-13°34'E), a distance of approximately 40 km. One of the main features of this particular stretch is the Grado-Marano lagoon.

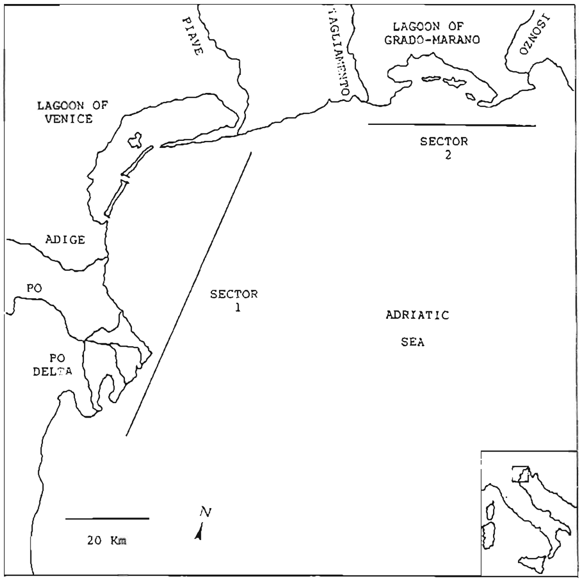

Figure 1 - Study area.

The breeding habitat consists mostly of small narrow sand barrier islands at distances ranging from several

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hundreds meters to several kilometers from the mainland. Low dunes and sandy beaches covered with psammophilous vegetation *Cakile maritima*, *Eryngium maritimum* and *Ammophila arenaria* are the most characteristic vegetation types in this habitat. Between the islands and the mainland are large shallow lagoons with tidal mudflats used as feeding grounds by the Oystercatchers. Besides the Oystercatcher other breeding species in the barrier islands of sector 1 are: *Tadorna tadorna* (a few pairs), *Charadrius alexandrinus*, *Larus cachinnans* (more than 1000 pairs), *Sterna hirundo* and *Sterna albifrons* (1500 pairs; Passarella and Benà in press, and personal observations). In sector 2, in the same areas occupied by the Oystercatcher, the following species are breeding: *Charadrius alexandrinus* (50 pairs), *Larus cachinnans* (900 pairs) and *Sterna albifrons* (250 pairs).

In both years field visits to the breeding area began at the end of February and went on until the first week of July. Data for the censuses of the Oystercatchers collected over shorter periods, approximately 30 days and chosen according to our previous knowledge of the time of laying (Scarton *et al.* 1993).

In sector 1 censuses were made between the first half of April and the first half of May; two teams were working for a total of 10 days in 1991 and 12 days in 1992. Observations were made in the morning, from 08.00 to 14.00 hours; the coastline was surveyed by boat, landing whenever a bird or a pair were observed. Sites with breeding birds were reported on maps with a scale of 1:10,000 and 1:50,000.

In sector 2 the data were collected between the end of May and the end of June, using the same methodology; three days were spent in 1991 and the same number in 1992. The censuses were made within the framework of activities of the "Osservatori Faunistici di Gorizia e Udine".

Following the standard criteria, evidence of breeding was categorised in the following way; "Confirmed breeding" when nests were found empty, with eggs or with downy young. "Probable breeding" was recorded by noting the behaviour (display or distraction) of a bird or by a pair. "Possible breeding" was recorded by the presence of birds or pairs in suitable habitat during the breeding season. In this particular study the number of breeding pairs was the total of "confirmed" and "probable" breeders. This criteria is similar to censuses made in other coastal environments such as the Camargue Delta and elsewhere. One should however be very careful when observing and recording information; on several occasions no display or alarm signals were given by the birds, but on closer examination we found the nest and eggs.

Results and discussion

In 1991, a total of 36 breeding pairs of Oystercatchers were located and 42 pairs in 1992, almost all in the barrier islands of the Po delta and the Grado-Marano lagoon (Table 1). One pair bred at the mouth of the Isonzo river in 1991; in the same year possible breeding was recorded at the mouth of the river Adige, 30 km south of Venice. In the lagoon of Venice Oystercatchers occur regularly on the barrier islands and in other areas, but breeding cannot be considered because of human disturbance and a lack of suitable breeding habitat.

Outside the census area Oystercatchers bred irregularly at the mouth of river Reno, 20 km south of Po di Volano. There were no breeding birds in 1992 (R. Tinarelli pers. comm.)

Table 1 - Distribution of breeding Oystercatchers in Italy: years 1991-1992 (C = confirmed breeding, Pr = probable breeding, Po = possible breeding).

	1991			1992		
	C	Pr	Po	C	Pr	Po
Sector 1						
Adige river			1			
Po Delta	16	16	6	26	12	3
Sector 2						
Lagoon of Grado-Marano	2	1		2	2	
Isonzo river	1					
Total	19	17	7	28	14	3

In sector 2 four pairs of Oystercatchers were found in 1991 and a similar number in 1992. In the lagoon of Grado-Marano Oystercatchers probably were breeding in the past, but the first confirmed breeding (one pair) was recorded in 1988 (Utmar 1989). In the Po delta (sector 1) 32 pairs were recorded in 1991 and 38 in 1992; the slight increase in 1992 is due probably to a better prospection of the area. The whole population can be considered as stable over the last two years.

Nevertheless a review of all the data, since 1980, concerning the Italian breeding population (Table 2) suggests that some fluctuations occurred on a longer period. In Camargue long term census figures show similar irregular variations over the years (Boutin *et al.* 1991). In this last area, the Salines of Aigue-Mortes (11,000 ha) have been monitored annually between 1980-1990, with an average of 42 pairs per year and evident variations (Walmsley pers. comm.).

Table 2 - Breeding population of Oystercatchers in Italy: years 1980-1992.

Year	No. of pairs	Reference
1980	20	(Pupillo and Boldreghini 1981)
1982	15	(Bogliani pers. comm.)
1983	40	(Tinarelli pers. comm.)
1987	20-45	(Tinarelli and Baccetti 1989)
1991	36	(this work)
1992	42	(this work)

Among the 36 sites of 1991, 21 (58.3%) were again occupied in 1992. Locally the percentage figures were much higher when we consider that on one 7 km stretch of beach we found 10 (90.9%) out of 11 pairs in 1991. A similar location of territories in subsequent years have been reported for other Mediterranean populations (Goutner and Goutner 1987, Martinez *et al.* 1983).

Breeding density in the Po delta was 1.84 pairs per km of shoreline (range: 0.5-6) in 1992, if only the islands supporting Oystercatchers are considered. This value is similar to that found in 1991 (1.92 per km), the difference is not statistically significant (Mann-Witney U-test). If the whole coastline is considered the density falls to 0.73 pairs per km (0.61 in 1991). For the Mediterranean, data is available only from the Ebro delta, where Martinez *et al.* (1983) reported a density of 0.6 nests per 10 ha, with a maximum of 3 nests per 10 ha. Cramp and Simmons (1983) report densities of over 20 pairs per km for northern Europe. On the most favourable breeding islands Oystercatcher nests were evenly spaced at 250-300 metres apart, which we assumed to be the optimal density. The minimum distance recorded between two nests was 45 m.

In both years in sector 1 the fist clutches were laid in the first half on April, as we observed also for 1990 (Scarton *et al.* 1993); this is the same period reported for Spain (Martinez *et al.* 1983) and Greece (Goutner 1986). Our data would confirm an earlier laying by the Mediterranean populations of Oystercatchers compared to those of North Europe, which lay in May and June (Cramp 1983). Nevertheless the few pairs breeding in sector 2 usually start to lay after mid May; we suppose that some local conditions (in particular climate) may be responsible for this delay in the time of laying.

The major threats to the species are the same as those recorded in other Mediterranean countries: human disturbance, tourists, egg collectors and the capture of chicks by local fishermen. Nests are also lost each year during spring storms.

Conclusions

Despite the absence of up to date information from other Mediterranean breeding sites, the Italian population of over 40 pairs is an indication that it is one of the most important in southern Europe. Further researches are needed on the breding biology of the species in Italy (i.e. reproductive success, nest site and habitat selection). We strongly recommend the total protection of these important breeding sites for the future conservation of the species.

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Riassunto — Si presentano i risultati di un censimento biennale della popolazione nidificante di Beccaccia di mare nel nord Adriatico, dove sono localizzate tutte le coppie attualmente note per l'Italia. La specie è risultata nidificare con certezza in entrambi gli anni in alcuni scanni (isolotti sabbiosi con scarsa vegetazione) del delta del Po e della laguna di Grado-Marano, mentre le foci dell'Isonzo sono state occupate solo nel 1991. Sono state registrate 19 nidificazioni certe e 17 probabili nel 1991, mentre nel 1992 si sono osservate rispettivamente 28 e 14 nidificazioni. La fedeltà al sito riproduttivo è risultata pari al 58.3%, con valori massimi del 90.9%. Sono state osservate densità ottimali pari a 3-4 coppie/km di costa, mentre i valori medi, nelle sole aree occupate dalla specie, risultano pari a circa 1.8 coppie/km. Un'analisi delle stime sulla popolazione nidificante degli ultimi anni sembra evidenziare fluttuazioni numeriche irregolari. La popolazione italiana rappresenta uno dei più importanti nuclei riproduttivi dell'intero bacino mediterraneo.

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Notes on the lek behaviour of the Little Bustard in Italy

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Abstract — The display behaviour of Little Bustard (*Tetrax tetrax*) males was studied in Sardinia and in Apulia.

Little Bustard males occured from April to June in steppe-like habitats and clustered in display centers with average density of 1.9 males/100 ha. Mean nearest neighbour distance was 450 m.

The habitat of the area exploited by the birds consisted mainly of permanent pastures grazed by sheep and cattle, secondly of oat/barley fields and fallow land.

The birds were mostly active at dawn and dusk, giving snort calls at the maximum frequency of 1 call/9.3 seconds. More elaborate courtship display, like wing flashing and jumping, occurred only in twilight.

The author compares the behaviour of Sardinian and Apulian males, finding out some differences in the pattern of display.

In Sardinia males showed complete courtship display and occurred always in relaxed groups, while in Apulia the males were never recorded wing flashing or jumping and sometimes they were so dispersed as to be considered "soloists".

Introduction

Most species of bustards show elaborate courtship systems, ranging from solitary displaying individuals, though monogamous, to communal displaying by groups of polygamous males in dispersed territories (exploded lek) or in tightly associated territories (true lek-like behaviour) (Carranza *et al.* 1989).

The mating system of the Little Bustard (*Tetrax tetrax*) is described by Schulz (1985 and 1986).

During the breeding season the males display at display centers and females visit these areas for copulation. Usually a bond is never formed and hens nest independently from males.

This paper deals with the display behaviour of Little Bustard males of two populations, in Sardinia and in Apulia.

The status of the two populations is strikingly different, since the Sardinia one is healthy and consists of 1,435-2,075 individuals (Schenk and Aresu 1985), while the Apulia one, which occurs at the eastern periphery of the species range in Europe, is on the verge of extinction and consists of a small population not exceeding 100 individuals (Petretti 1985, 1986b).

Both populations are sedentary, showing some winter dispersal from the nesting grounds (Schenk and Aresu 1985, Petretti 1986b).

Methods

The study was carried out from 1982 to 1990 and results from 110 days of fieldwork, mainly spread from April to June.

Three study areas have been surveyed, one in Sardinia and two in Apulia.

Their climate falls into a typical Mediterranean pattern, with cool and rainy autumns and winters and very dry summers. Diurnal temperature variations can be considerable. Average annual rainfall is 586 mm for Sardinia and 478 mm for Apulia. The Sardinia area lies at 170 m a.s.l., in the alluvial valley of the river Coghinas (40°45' N, 9°00' E). The two Apulia area lies on average at 150 m a.s.l. in a calcareous plateau close to the Adriatic Sea (41°30' N, 15°30' E).

Land use and habitat types were assessed through the analysis of vegetation maps, aerial photos, Landsat imagery and ground surveys.

In a both areas, the land is mainly used to rear free ranging sheep and cattle and to harvest fodder and cereal crops (Petretti 1986a).

Hunting pressure is very high in Apulia between September and March.

Data were collected from Sardinia (1984 to 1987) and Apulia (1982/1983), recording each year the number of displaying males respectively in a study area of 250 ha and two study areas of 340 (area A) and 180 ha (area B) (the latter 10 km apart).

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The three study areas have clear boundaries set up by permanent streams and paved roads which separate bustard habitats from intensive cereal cultivations, wetland and maquis.

I recorded the position of males in the display area at least six times per day, during two consecutive days each year. Each individual display territory (lek) was thus identified by 12 mapped points. Assuming that the same male occupied its own lek during the reproductive season, the polygon resulting from connecting the outer points was considered as the lek, whose center at the intersection of the diagonals was drawn to find out the mean nearest neighbour distances.

The display behaviour in Sardinia and in Apulia was recorded from fixed vantage points, with the use of a binocular and telescope.

With the help of two more observers, in Sardinia I continuosly monitored three males. For each one I made 144 10-minute sets of observations (total 4,320 minutes) from midday 24 April to midday 30 April 1985, throughout 24 hours.

I made further scattered observations on the behaviour of cocks in 1986 and 1987, spending 15 days in the study area. With the help of one more observer, in Apulia I recorded the activity of three males in the study area A from May 29th to June 1st 1982 and from May 26th to May 30th 1983 for a total of 1,800 minutes scattered throughout 24 hours.

Since in 1984 the study areas in Apulia were deserted by the bustards, I start surveying a whole district of 5,000 ha to locate displaying males and continue collecting data on habitat selection and behaviour. From 1984 to 1990 I did a further 18 days of observation on solitary displaying males outside the sudy area. In 1990 I followed a single male for three days, recording 72 sets of 10-minute observations each hour from 0600 of 20 May to 0600 of 23 May. Bright skies allowed the observers to track the males also by night.

Results

Displaying population

I was not able to cover the whole spring and summer, thus I cannot provide information on displaying phenology.

Anyway, in the whole study period I observed displaying males in Sardinia as early as April 23rd and as late as June 4th and in Apulia as early as April 19th and as late as May 30th.

The females were only seen when flushed or chased by males. On May 30th 1985 I flushed a female from the nest with eggs in Sardinia, about 100 m from the lek center of one male.

In the Sardinia study area, males were observed displaying throughout the study period, from 1984 to 1987, while the Apulia study area A was occupied only in 1982 and 1983 and the study area B only in 1982. Since then, I found only small groups of males and solitary individuals scattered in a district of 5,000 ha. The Sardinia study area was occupied by 7 males in 1984, 6 in 1985 and 1986 and 5 in 1987. The Apulia study area A was occupied by 5 males in 1982 and 7 in 1983, the study area B by 3 males in its only year of activity (1982).

Other groups of males were found outside the Sardinia study area, the closest about 2 km, while those monitored in Apulia seemed to represent the total displaying population in a district of 5,000 ha. Male density ranged from 2.0 males/100 ha to 2.8 males/100 ha in Sardinia (mean = 2.4 ±0.32; N = 4) and from 1.4 males/100 ha to 2.0 males/100 ha in Apulia (mean = 1.5 ±0.43; N = 3).

Combined mean is 1.9 males/100 ha (±0.58).

The data are too scanty be statistically tested.

The mean display ground area (lek) covered 2.17 ha ±0.60 (range 1.1-3.0) in Sardinia and 2.08 ha ±0.69 (range 0.8-3.0) in Apulia. Combined data give and average figure of 2.13 ha (±0.63; N = 39).

Mean nearest neighbour distance was 449.8 m ±129.94 in combined areas (range 175-675 m; N = 39).

The highest density of males was recorded in Sardinia in 1987 (the mean nearest neighbour distance was 225.0 m; N = 5) when the study area was partially ploughed and the males were forced to cluster in the remaining grassland.

Habitat Selection

For the purpose of the present study the habitat was classified into four main categories:

A. Permanent pastures dominated by Asphodels (*Asphodelus* spp.), Umbelliferae (*Ferula communis* and *Thapsia garganica*), Thistles (*Cardus* spp.) and Grasses (*Stipa* spp., *Poa* spp.). These grasslands are never ploughed.

B. Barley and oat fields and related fallow lands. Fields are harvested once a year in late May/early June.

C. Wheat fields. Suitable to bustards only between late autumn and early summer. Later harvesting, burning and ploughing activities turn the fields into bare grounds.

D. Small marshes, gravel pits, maquis and garigues. These habitats are not exploited by Little Bustards.

Each study area consisted of all the four main habitat types identified, but the situation was not stable during the study period, since farming activities led to a reduction of fallow land and an increase in wheat fields.

Values given in Table 1 (N = 39) refer to the mapped leks and to an arbitrarily chosen surface of 19.6 ha centred on the lek (radius 250 m). This distance represents a reasonable estimate of the movements of a single male during its display season (Schulz 1985).

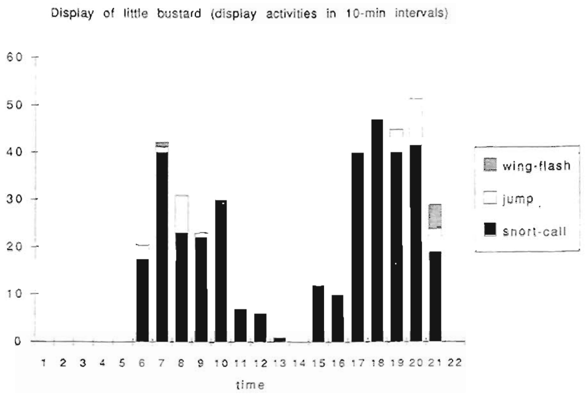

Figure 1. Display activities of males classified in snort-calling (first bar), jumping (second bar) and wing flashing (third bar). Data collected in Sardinia from midday April 24th to midday April 30th 1985, expressed as number of display activities in 10-minute intervals (1 interval per hour). Data combined from three males. Sunrise 0600. Sunset 2015.

Displaying males occurred mainly in permanent pastures, which cover 81.3% of the plotted leks and 50% of the three study areas (data combined), and avoided wheat fields which cover only 5.3% of leks against 25.0% of all the study areas.

Pattern of male activity

The males flew away from their territory only when disturbed by man or when chasing passing males or females. Cocks usually returned promptly to their lek and started displaying again.

The display was classified into three categories, according to Cramp and Simmons (1980) and Schulz (1985).

1. Snort call. This is the basic display, consisting of a brief vocalization uttered with a sharp toss of the head.
2. Wing flashing. The bird tramples its feet on the ground, ruffling its neck feathers, uttering the snort call and beating its wings, producing a characteristic whistle from the 7th primary. This is considered a territorial display by Schulz (1985).
3. Jumping. This is considered the peak courtship display. It consists of foot stamping, snort calling and finally of a jump one metre above the ground with the wings beating to enhance both the whistle and the visual signal of the white wings.

Closer observation of displaying males and slow motion film sequences showed a fourth behaviour intermediate between the snort call and the wing flash, when the male ruffled its neck feathers, stamped its feet on the ground and then uttered the snort call. I excluded it from my records, since from the vantage points it was not possible to distinguish this behaviour from the first one.

The behaviour of the males is conspicuous.

The call carries well. The mean maximum distance recorded was 470 m ± 140 (range 300-800 m, N = 20). Wing flashing and jumping males were spotted in bright night with moonlight from a maximum distance of 500 metres without binoculars.

Snort calls were uttered by all males on all monitored days, but wing flashing and jumping occurred only in few instances in Sardinia and were never recorded in Apulia.

Considering the sunrise and the sunset of six days and three monitored males in Sardinia (N = 36), jumping occurred in 17 instances at the sunrise (47.2%).

The maximum activity frequencies ever recorded in the study period, within a 10-minute sample interval, were recorded in Sardinia as follows: 1/9.3 seconds for snort calling (April 28th 1985, 2034-2044) and 1/26 seconds for jumping (April 26th 1985 0745-0755).

I recorded night display only in Sardinia on April 27th and 28th 1987, during two consecutive nights with calm weather and bright moonlight: the same male snort called, wing flashed and jumped between 2300 and 0200, but I did not record the frequency of display activities.

Table 1 - Habitat composition (%) in the three study areas, in the circular plots (radius 250 m) around lek center and in the mapped leks. Data combined from Apulia and Sardinia. Habitat composition in the three study areas represents the avarage value in the whole study period.

Habitat Category	Study areas	Circular plots	Leks
Pastures	50.0	68.6	81.3
Cat/barley	15.0	10.7	13.4
Wheat	25.0	18.0	5.3
Other	10.0	2.7	0

Discussion

Although Little Bustard males made some use of all the available habitats in the study areas, they showed a strong preference for permanent pastures, which are the more stable and rich habitats.

Small parcels of barley and oat fields were mainly used by the birds to forage at dawn and dusk, while wheat fields were visited only by flushed birds.

Little Bustard males show a similar choice of habitat in Portugal, with a marked preference for pastures and fallow lands (Schulz 1985, Cheyland 1980).

Display activity peaked around sunrise and sunset, both in snort calling and in the more elaborate behaviour: wing flashing and jumping occurred mainly in twilight. The same pattern was noted by Schulz (1985) and in other jumping bustards, like the Lesser Florican (*Sypheotides indica*) (Sankaran & Rahmani 1986).

Table 2 summarizes the density figures for different populations of displaying males in the Mediterranea. The Portuguese population reached the highest values (Ferguson-Lees 1967, Schulz 1985), matched only by the Sardinia one in few particular cases recorded by Schenk and Aresu (1985).

Table 2 - Density figures of displaying little bustard males in different studies populations data expressed as number of males in 100 hectares.

Area	**Density**	**Figure Source**
Crau (France)	2.0-6.0	Cheylan in Schulz (1985)
Loire (France)	1.5-2.7	Beaudoin in Schulz (1985)
France	0.7-1.0	Metais in Schulz (1985)
Portugal	9.0-13.8	Schulz (1985)
Portugal	13.0-16.0	Ferguson-Lees in Schulz (1985)
Sardinia	0.8-3.1	Schenk and Aresu 1985
Sardinia	2.4	This study
Apulia	1.5	This study

This seems to suggest that male density changes little in a wide range of situations and the structure of the display cluster could be density — independent and represent a stable compromise between the need for territorial males to maintain spatial segregation and the needs to gather to enhance the power of attraction for females in homogeneous and almost flat country where ground visibility is poor.

In particular conditions (e.g. Apulia), however, it is possible that the traditional communal behaviour could turn into a less conspicuous display strategy. The males of this species usually show high site fidelity (Schulz 1985), but the harassed and very thin population of Apulia showed high and unusual mobility and included solitary displaying males ("soloists").

Since different display strategies have been recorded in the Great Bustard (Carranza *et al.* 1989), according to the conservation status of the population, the same could apply to the Little Bustard.

Apulia males seem to behave differently from Sardinia ones, since they were never seen jumping or wing flashing.

Although my data are too scanty to allow any conclusion, it is possible that the low number of birds in Apulia and the fragmentation of preferred permanent grasslands among unsuitable intensive cereal cultivations (Petretti 1986b) could lead to a general decrease in the display activity and to an increase in the "soloist" activity.

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Riassunto — È stato osservato il comportamento al lek dei maschi di gallina prataiola (*Tetrax tetrax*) in Sardegna e in Puglia, in ecosistemi erbacei destinati prevalentemente al pascolo brado di pecore e mucche.

I maschi frequentano le zone di esibizione da aprile a giugno, concentrandosi in gruppi di arene con una densità media di 1,9 maschi ogni 100 ettari. In questi raggruppamenti la distanza media fra ciascun maschio è di 450 metri.

Il picco delle attività di esibizione si verifica all'alba e al tramonto, quando si raggiunge la frequenza massima di una emissione ogni 9,3 secondi. Comportamenti più elaborati, come "battito di ali" e "salto" si verificano soprattutto a basse intensità luminose.

Nel confronto fra il comportamento dei maschi in Sardegna e in Puglia sono state riscontrate alcune differenze.

In Sardegna i maschi mostrano comportamenti di esibizione completi e sono sempre associati in gruppi, mentre in Puglia non sono mai stati osservati i comportamenti di battito d'ala e di salto e sono stati trovati anche maschi solitari.

Questo fatto può essere imputabile alle esigue dimensioni della popolazione pugliese e alla bassa densità riproduttiva.

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Avocetta N° 17: 23-27 (1993)

Stress antropogenici ed evoluzione di una comunità ornitica in una zona umida artificiale dell'Italia centrale

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Riassunto — Si è studiata l'evoluzione di una comunità ornitica in un area umida dell'Italia centrale sottoposta a stress antropico. L'analisi condotta in una piccola area (25 ha) dal dicembre 1986 al gennaio 1992. Il disturbo antropico è stato correlato alla diminuzione degli uccelli; si rileva un'azione combinata di diversi fattori quali inquinanti chimici, diminuzione della vegetazione sommersa, taglio e bruciatura del canneto. La pesca e l'attività di ricreazione non solo minacciano la presenza di uccelli acquatici a causa della diminuzione dell'habitat utilizzabile ma riducono anche la capacità portante dell'ambiente. La presenza del Germano Reale e del Moriglione sono correlati con la diminuzione di *Myriophillum;* La diminuzione della Folaga sembra dovuta all'aumento di vegetazione sia sommersa che emersa. L'Airone Cenerino patisce particolarmente il disturbo antropico. Il trend negativo descritto per questa zona non è altrettanto evidente in altri ambienti umidi costieri della Regione.

Introduzione

L'avifauna delle zone umide dipende sempre più da bacini artificiali costruiti per gli usi più disparati: in Inghilterra, ad esempio, il 40-50% delle popolazioni invernali di Germani reali, *Anas platyrhynchos,* Canapiglie, *Anas strepera,* Mestoloni, *Anas clypeata* e Smerghi maggiori, *Mergus merganser,* e più del 50% delle Morette *Aythya fuligula* e Moriglioni, *Aythya ferina,* si concentrano in invasi non naturali (Owen *et al.* 1986).

Molti di questi biotopi, pur presentando caratteristiche di vera e propria insularità in quanto dispersi in aree coltivate (Bogliani e Celada 1988), sono in grado di offrire opportunità di sosta e di foraggiamento (Cody 1985).

La capacità portante e la stabilità di una zona umida non dipendono soltanto da fattori ambientali quali, ad esempio, la superficie, lo sviluppo perimetrale la complessità vegetale, ma anche dal disturbo antropico, dalla sua natura e dalla sensibilità mostrata da ciascuna specie.

Nell'indagine analizziamo la reazione di una comunità di uccelli all'insorgere di stress di origine antropica in una zona umida artificiale dell'Italia centrale.

Area di studio

La zona umida, denominata "Vasche di Maccarese", è situata a pochi km da Roma (Lat. 41°51' Nord, Long. 12°12' Est) si estende per 33 ha, 25 dei quali occupati da 5 invasi di colmata e relative arginature colonizzate da fitocenosi a *Phragmites australis.* Lungo il perimetro sono presenti filari di *Eucalyptus* sp., una breve fascia di bosco igrofilo a *Fraxinus ornus* ed esemplari sparsi di *Salix sp.* In acqua vegetano angiosperme sommerse come *Myriophyllum spicatum* e *Potamogeton sp.* La profondità delle vasche varia da pochi cm a 2 metri ed il livello dell'acqua è reso instabile da immissioni non sistematiche. La campagna circostante è intensamente coltivata e presenta numerose canalizzazioni. Dopo un precedente studio (Biondi *et al.* 1990) riferito al periodo luglio 1987-giugno 1988, l'area (tutelata come fondo chiuso) ha subito un progressivo degrado. Nell'ottobre 1988 abbiamo notato una variazione di colore nelle acque accompagnata da un massiccio decremento delle idrofite affioranti, mentre negli anni successivi abbiamo registrato un calo dei servizi di sorveglianza, una sistematica distruzione del fragmiteto ed un aumento progressivo della pressione antropica.

Metodi

Considerata la buona visibilità e la limitata estensione dell'area, abbiamo usato un metodo di conteggio assoluto facendo riferimento alle sole

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specie legate alle zone umide ed utilizzate come indicatori (Blondel 1975, Farina 1985).

Nel periodo compreso tra il 01.12.1986 ed il 31.01.1992 abbiamo effettuato 183 visite antimeridiane, della durata di circa due ore. Abbiamo trasformato il numero di individui di ciascuna specie in valore medio mensile per 10 ha e lo abbiamo usato per il calcolo della ricchezza (S) e della densità (D, numero di individui/10 ha).

Al fine di inquadrare l'impatto antropico sull'ecosistema, abbiamo annotato, per ogni visita, il numero di persone presenti, nonché il tipo di attività svolta (pesca, attività ricreativa e/o agricola). Abbiamo, inoltre, considerato i tipi di aggressione esercitati sulle fitocenosi riparie, misurandone i danni in termini di vegetazione perimetrale distrutta.

In una vasca campione della superficie di 6.16 ha abbiamo misurato, in giugno, la quantità di *Myriophyllum spicatum* affiorante espressa come percentuale rispetto al totale della superficie.

Tabella 1 - Tipologia e quantificazione del disturbo antropico nel tempo.

	1986	1987	1988	1989	1990	1991
Disturbi indotti						
n° incendi	—	—	1	5	6	8
Canneto distrutto (%)	—	—	10	50-60	60-70	70
Myriophyllum affiorante (%)	100	100	80	20	35	25
Disturbi diretti						
Presenza pescatori (% sulle visite)	0	0	7	26	62	87
Attività ricreative/agricole	—	2	1	2	3	2

Considerata la natura del biotopo e l'importanza dell'area per lo svernamento, abbiamo confrontato le densità invernali con quelle di tre zone campione:

- *Lago di Traiano:* biotopo artificiale protetto avente una superficie di 33 ha ed una profondità media di circa 3 m;
- *Castelporziano:* biotopo di origine artificiale con sponde e fondo naturale avente una superficie di circa 10 ha ed una profondità max di 2 m;
- *Parco Nazionale del Circeo:* vasta zona umida protetta con biotopi molto diversificati (lagune costiere, canali di bonifica, acquitrini temporanei, ecc.) avente una superficie di circa 1000 ha.

Risultati e discussione

In Tab. 1 evidenziamo le alterazioni delle fitocenosi attribuibili all'incremento di azioni indotte dall'attività umana. Nella Fig. 1 riportiamo gli andamenti mensili medi della ricchezza, e della densità registrati negli anni 1986-1992.

Dopo una prima alterazione dell'ecosistema (ottobre 1988) attribuibile ad un presunto inquinamento (evidenziato da valori di pH, Ossigeno Disciolto e COD molto alterati) la densità invernale subiva un decremento del 65%. In particolare *Fulica atra* e *Aythya ferina*, vegetariane in inverno (Rüger *et al.* 1986) e specie la cui componente risultava particolarmente cospicua, subivano una notevole contrazione (*Fulica atra:* $D_{1988} = 76.3$, $D_{1991} = 16.0$ ind/10. *Aythya ferina:* $D_{1988} = 13.5$, $D_{1991} = 4.5$ ind/10 ha).

La ricchezza degli svernanti, invece, non variava apprezzabilmente forse a causa della posizione dell'ecosistema, ancora idoneo alla sosta di individui in migrazione (Biondi et al. 1990).

La drastica riduzione del *Myriophyllum spicatum,* principale fonte di biomassa sfruttabile, potrebbe aver influito significativamente sul rapporto produzione/consumo. È conosciuta, infatti, la limitata capacità di reazione di una comunità, se condizionata da ecosistemi di superficie ridotta (Fuller 1982) ed a bassa diversità vegetale (Amat 1984, Rochè 1982). Per di più la lenta ripresa del *Myriophyllum spicatum* potrebbe aver ostacolato il ripristino dell'equilibrio, anche in considerazione del rapido consumo invernale. Gli inquinamenti dovuti ad agenti chimici, infatti, richiedono lunghi tempi di recupero ed incidono inizialmente proprio sui consumatori primari (Owen e Black 1990). Nel dicembre del 1989, in concomitanza di altri disturbi indotti dall'attività umana (Tab. 1), il numero di uccelli si è ridotto ulteriormente (≈75%).

La distruzione del fragmiteto con il fuoco e senza una precisa pianificazione, contraeva la riproduzione del genere *Acrocephalus*, di *Fulica atra* e di *Ixobrychus minutus* ed impediva quella di

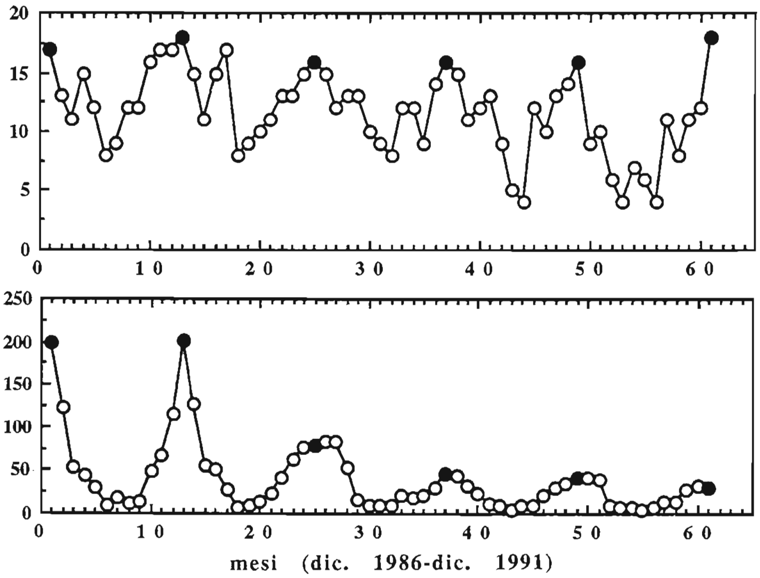

Fig. 1 - Andamenti mensili medi della Ricchezza (S) e della Densità (D). (•) = dicembre.

Tachybaptus ruficollis. In periodo invernale, inoltre, *Fulica atra* e *Aythya ferina*, pur frequentando acque aperte, in biotopi di modeste dimensioni, mostravano di gradire la protezione di canneti.
In Fig. 2 mettiamo a confronto gli andamenti della densità del genere *Anas* relativi all'area di studio con quelli delle tre zone umide di controllo. Al di là di naturali oscillazioni, dall'inverno 1988, le Vasche si sono differenziate per i costanti decrementi. Poiché il biotopo veniva utilizzato anche come luogo di riposo diurno, è logico ritenere che il disturbo umano diretto abbia agito come ulteriore fattore limitante. Nel vicino Lago di Traiano, anch'esso artificiale, ma adeguatamente protetto e nel quale le anatre di superficie non sono in grado di alimentarsi, perchè troppo profondo (3m) e privo di vegetazione riparia, queste specie hanno svernato in buon numero (Fig. 2). L'ipotesi sarebbe

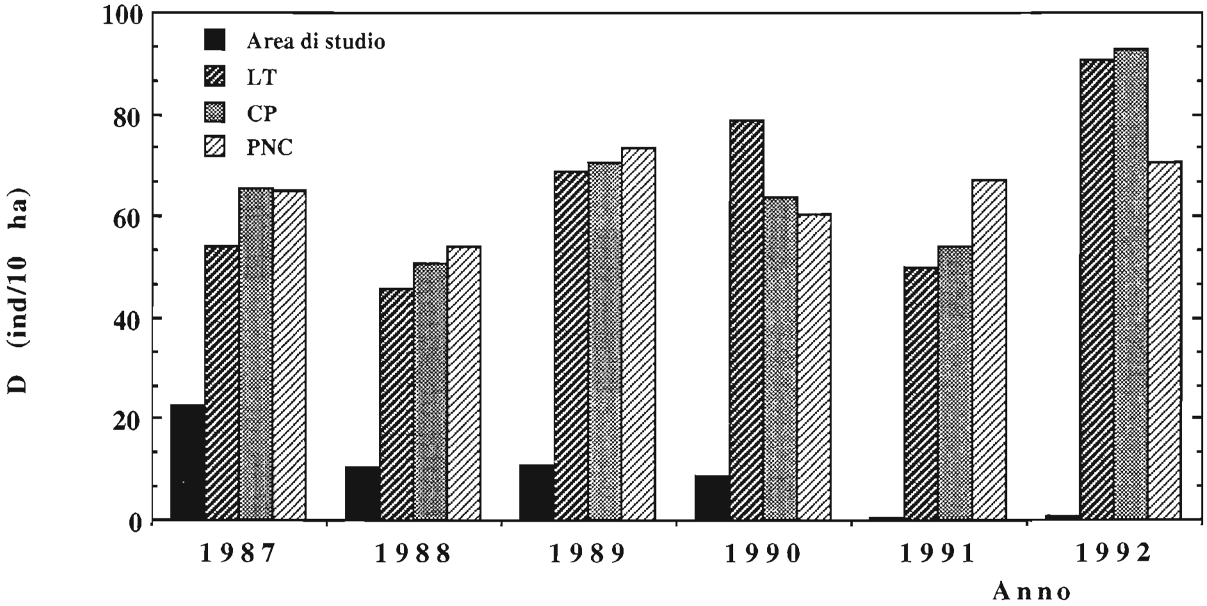

Fig. 2 - Confronto delle densità invernali (valori medi di gennaio) relative al genere *Anas* con le aree di controllo. LT = Lago di Traiano (biotopo artificiale, 33 ha), CP = Castelporziano (biotopo naturalizzato, 10 ha), PNC = Parco Nazionale del Circeo (zona umida estesa, 1000 ha).

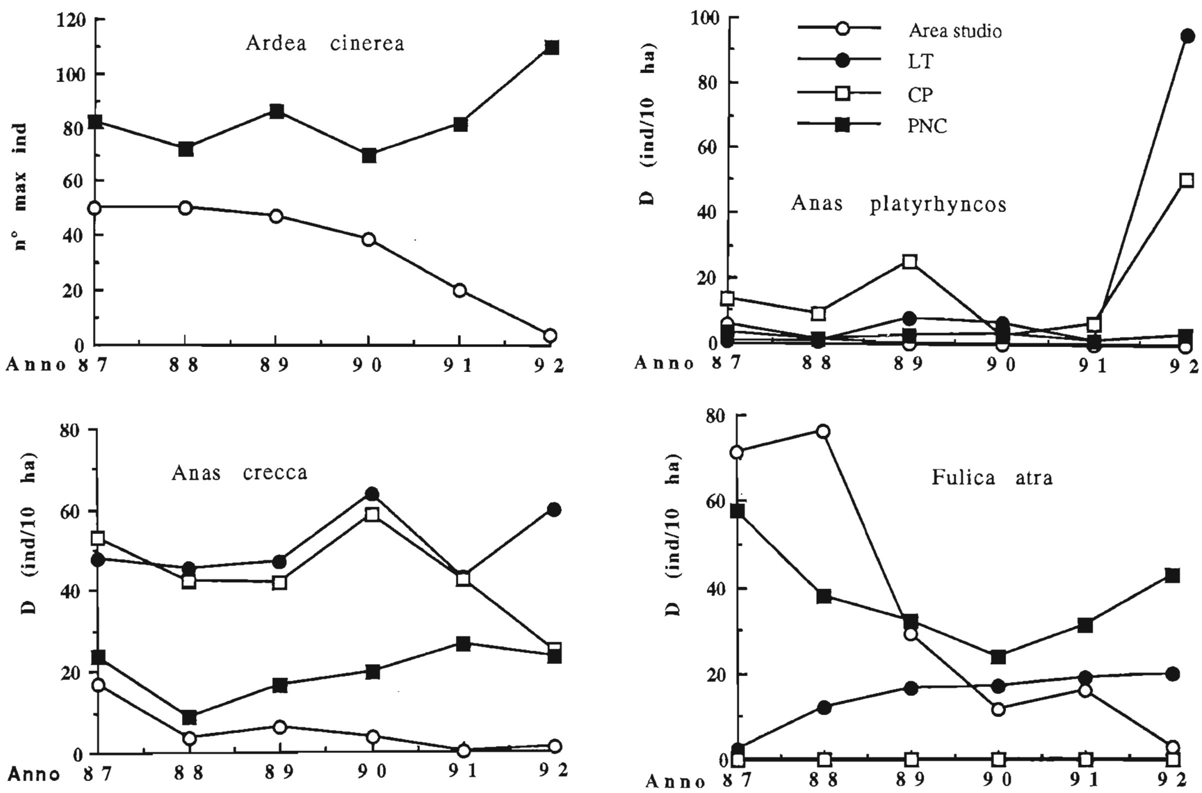

Fig. 3 - Confronto fra presenze invernali, relative ad alcune specie, registrate nell'area di studio e nelle zone di controllo. LT = Lago di Traiano, CP = Castelporziano, PNC = Parco Nazionale del Circeo.

rafforzata da una correlazione ottenuta associando le quantità di uccelli con il numero di persone presenti nell'area ($R = 0.736$, $p < 0.02$, $n = 20$) e dalla letteratura (Bezzel e Reicholf 1974, Bezzel 1975, Utschik 1976, Nilsson 1978, Owen e Black 1990). La pesca diurna e notturna, oltre al bracconaggio, hanno contribuito pesantemente alla regressione della comunità. Gli *Anseriformes,* molto sensibili al disturbo crepuscolare, tendono a disertare i biotopi sottoposti a questi stress (Parodi e Perco 1988). Il dato sarebbe sostenuto dal vistoso svernamento registrato sul Lago di Traiano, nell'inverno 1991/92 associato all'assenza di anatre di superficie nell'area di studio negli inverni 1990/91 e 1991/92.

In Fig. 3 riportiamo le densità invernali di alcune specie *(Ardea cinerea, Anas crecca, Anas platyrhyncos* e *Fulica atra)* comparate con quelle delle aree di controllo. Come è osservabile, la riduzione degli effettivi nell'area è accompagnata per lo più da aumenti nei comprensori circostanti.

Poichè durante l'indagine anche i consumatori terziari hanno subito un notevole decremento *(Ardea cinerea)* è presumibile che il disturbo umano diretto debba considerarsi deleterio almeno quanto le variazioni di biomassa autotrofa. Ciò, in particolare, quando il fenomeno si verifica in biotopi di modesta superficie perché la limitata capacità di reazione dell'ecosistema costringerebbe molti individui all'allontanamento.

In conclusione, il vincolo di protezione posto su di un'area non sembrerebbe sufficiente se non sostenuto da una gestione che garantisca il potenziamento o almeno la stabilità dei parametri fisici, chimici e biologici che lo governano.

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Abstract — The evolution of a bird community in a wet area of Central Italy exposed to anthropogenic stresses has been studied. The survey was conducted in a small (25 ha) artificial wet area from December 1986 to January 1992. The presence of the human disturbance (mainly fishermen) was recorded and correlated to the decrease of bird density. The small biotope shows a negative trend of its bird population probably due to a combined action of different anthropogenic stresses like chemical pollutants, decreasing of submerged vegetation *(Myriophyllum* and *Potamogeton sp.),* as well cutting and burning of the bank reed-bed vegetation. Fishing and recreation not only threaten waterfowl through habitat loss,

but cause disturbance to the birds and effectively reduce the carrying capacity of studied area.Data collected show that Pochard *(Aythya ferina)* and Mallard *(Anas platyrhynchos)* are correlated with the *Myriophyllum* decreasing; the negative trend of the Coot *(Fulica atra)* seems to be correlated with both emergent and submerged aquatic vegetation, while Grey Heron *(Ardea cinerea)* particularly suffers human disturbance. The found negative trend is not so considerable in other regional and coastal wet habitats.

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Variability of the entomatic diet of the Hooded Crow *Corvus corone cornix* in the western Po Valley

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Abstract — A study was performed on the entomatic food supply of the Hooded Crow *Corvus corone cornix* in two different areas of the Po Valley. Significant differences were observed in geographical, seasonal and monthly terms. The analysis of the stomach contents in terms of the abundance of a given taxon/stomach did not correspond in general with the classical analysis of the frequencies with which the various taxa were found. The data obtained confirm the broad-based behaviour of the species and reveal that the Crow takes advantage of the local availability on an and hoc basis.

Within the framework of this behavioural model, however, the species is able to select certain crop types if they are actractive (the rice-fields in spring-summer), and appears to be ready to takes advantage of the concentration of prey in given sites (Formicidae in nests, Diptera pupae in dung) and their seasonal behaviour (Staphylinidae wintering under stones).

Introduction

The food supply of the Crow *(Corvus corone)* has been extensively studied, in a number of cases even in relation to problems of environmental management. These studies, which are normally performed by analysing the frequency with which foods are found (Houston 1977, Jollet 1984, Studer-Thiersch 1984, Fasola *et al.* 1986, Silvano and Boano 1991), usually take into account all the components of the diet.

The present study has regarded the diet of the Hooded Crow *(Corvus corone cornix)*. The aim was to make a closer analysis of the entomatic component alone in relation to the season and eco-geographical conditions, combining an analysis of the frequency with which taxa are found (expressed as the number of stomachs containing the various taxonomic groups) with an evaluation of the abundance of insects per stomach. It was therefore possible to check whether or not the two methods of analysis provide the same results.

Material and Methods

The analysis was based on the stomach contents of adult Hooded Crows shot in two different areas of the Western Po Valley, namely the Ticino Natural Park (May 1989, May and June 1990) and the Province of Cuneo (from September 1987 to August 1988). Crows were only shot by authorized personnel within the framework of the population control programmes approved by the Region of Piedmont. Only those stomachs containing entomatic remains were included in the study.

Insects were identified with a binocular microscope using identification tables which are normally available in the current specialist literature (Chatenet 1986, Chinery 1987).

Data relating to the frequency of findings were compared using the chi-square contingency test, considering the total of the absolute frequency with which individual taxa were found as samples. In order to quantify the entomatic content in terms of the number of individuals per stomach, reference was made to the identifiable portions of each item (especially heads) and likewise only those stomachs containing the taxon in question were examined. Given that the exoskeleton of insects is always made of chitin, it was implicitily assumed that the degree to which the various insect groups were digested would substantially remain constant. The abundance of prey hardly ever conformed to a normal distribution and therefore parametric tests were performed following logarithmic normalization.

Results

a) Geographical differences

The results of the processing of data obtained from the examination of the stomach contents of Hooded Crow from the Province of Cuneo highlighted that

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Table 1 - Systematic list of taxa found in stomachs showing the number of stomachs containing that taxon (N) and its percentage (N/total number of stomachs).

TAXA	**TICINO NATURAL PARK**		**PROVINCE OF CUNEO**			
	Spring-Summer		**Spring-Summer**		**Autumn-Winter**	
	N	%	N	%	N	%
Orthoptera	5	4.0	9	3.6	2	2.2
Dermaptera	0	—	7	2.8	0	—
Hemiptera	4	3.2	8	3.2	1	1.1
Lepidoptera	0	—	8	3.2	0	—
Diptera adults	2	1.6	13	5.1	4	4.5
Diptera pupae	0	—	8	3.2	4	4.5
Coleoptera Carabidae	55	44.3	137	54.2	28	31.5
Coleoptera Staphylinidae	3	2.4	7	2.8	11	12.3
Coleoptera Scarabaeidae	21	16.9	69	27.3	16	18.0
Coleoptera Tenebrionidae	0	—	5	2.0	4	4.5
Coleoptera Elateridae adults	29	23.4	37	14.6	3	3.4
Coleoptera Elateridae larvae	8	6.5	4	1.6	0	—
Coleoptera Curculionidae	6	4.8	95	37.5	11	12.3
Hymenoptera Formicidae	17	13.7	17	6.7	3	3.4
Total number of stomachs	**124**		**253**		**89**	

during the spring-summer period (from March to August) the insects most frequently preyed on belonged to the order of Coleoptera which were found in 73% of the gastric contents analyzed.

Within this order, the most frequently found family was that of the Carabidae, present in 54.2% of cases, followed by the Curculionidae (37.5%), Scarabaeidae (27.3%) and Elateridae (14.6%). By calculating the mean number of individuals/stomach for each taxon, we obtained a series of data which do not reflect the same trend. The largest group was that of the Diptera (14.6 pupae/stomach) whereas within the order of Coleoptera, Carabidae were only present in gastric contents at a rate of 3.6 specimens per stomach, a finding which was lower than that of Elateridae (4.4). (Table 1).

From an analysis of the stomach contents of crows shot during the spring-summer period in the Ticino Park it again emerged that Coleoptera were the most preyed on insects: 65.3% of stomachs. The order of the frequency with which the various Coleoptera families were found only partially agreed with that found in the area around Cuneo.

Here too the most frequently found taxon was the Carabidae (44.3%), followed by the Elateridae (adults 23.4%), whereas the Curculionidae, which were fairly heavily preyed on in the area around Cuneo, were almost absent from the diet (Table 1). By calculating the mean number of specimens identified per stomach, the results obtained do not follow the same pattern as the frequency data expressed in percentage: the family with the highest mean number of individuals/stomach was that of the Elateridae (7.2) followed by the Carabidae (2.9). Hymenoptera accounted for 3.2 individuals per stomach in relation to 4.5 found in the Province of Cuneo (Table 2).

The difference between the frequency of findings in the two areas was significant ($\chi^2 = 65.6$, d.f. = 13, $P<0.01$).

The differences between the mean rates with which individual taxa were found in the two areas were never statistically significant (Student's t test).

b) Seasonal differences

The study of the seasonal differences in the food supply was only possible in the area within the Province of Cuneo given that shooting took place almost every month.

From an examination of data relating to the autumn-winter period (from September to February) it emerged that the group of insects most heavily preyed on was again that of Coleoptera which were present in 53.2% of stomachs containing insects. Dermaptera were present in lower numbers compared to the spring-summer period and Lepidoptera were completely absent. Other differences were also observed within the order of Coleoptera: Carabidae (31.5%), Curculionidae

(12.3%) and Elateridae (3.4%) fell sharply, whereas there was a steep rise in the frequency of Staphylinidae (12.3%), which had been almost absent in the spring-summer period and, to a lesser extent, that of the Tenebrionidae (4.5%) (Table 1). In general terms, however, by comparing the frequency of findings in the spring-summer period with those during the autumn and winter, it was seen that the differences were statistically significant ($\chi^2 = 41.5$, d.f. = 12, $P<0.01$).

With regard to the number of individuals per stomach, the differences between the mean rates with which individual taxa were found in the two periods were never statistically significant (Student's t test) (cfr. Table 2).

c) Monthly variations

In the area around Cuneo, where crows were also shot throughout the autumn-winter months, a detailed analysis was made by taking into account data relating to each individual month.

The frequencies with which entomatic remains were found varied throughout the course of the year and in general followed the pattern outlined by seasonal data. By comparing the different frequency of findings each month, a number of significant differences emerged even between successive months (April- May, May-June), as well as, obviously, between different seasons (chi-square test).

The only significant variations with regard to the mean number of individuals per stomach were found in relation to Curculionidae when comparing data for April with those for May (t 4.2, d.f. = 79, $P<0.01$) and data for May with those for June (t 2.3, d.f. = 27, $P<0.05$).

d) Food supply differences between sexes

Differences between sexes relating to the frequency with which the various taxa were found were in general not significant, except for the spring-summer period relating to the Province of Cuneo ($\chi^2 = 20.6$, d.f. = 9, $P<0.05$).

Discussion

As is well known, the food supply of the Hooded Crow is extremely varied (Holyoak 1968, Houston 1977, Coombs 1978, Goodwin 1986, Fasola *et al.* 1986) and demostrates, among other aspects, a differentiation between the feeding patterns of nestling and adult crows (Lockie 1956, Yom-Tov 1975, Silvano and Boano 1991).

The geographical, seasonal and monthly differences

Table 2 - Abundance of insects per stomach. Two measurements of the central tendency are reported: the mean (mean number of individuals/stomach) and the median. SE = standard error, N = number of stomachs containing that taxon. Only taxa with more than five individuals are reported.

AREA	TAXA	MEAN	SE	MEDIAN	N
CUNEO Spring-Summer	Orthoptera	1.2	0.1	1	9
	Dermaptera	1.0	0	1	7
	Hemiptera	1.6	0.4	1	8
	Lepidoptera	1.4	1.1	1	8
	Diptera adults	3.6	1.2	2	1.3
	Diptera pupae	14.6	8.3	3.5	8
	Carabidae	3.6	0.5	1	137
	Staphylinidae	1.3	0.1	1	7
	Scarabaeidae	2.4	0.5	1	69
	Elateridae adults	4.4	1.4	2	37
	Curculionidae	3.8	0.5	1	95
	Hymenoptera	4.5	1.0	4	17
CUNEO Autumn - Winter	Carabidae	5.0	1.6	2	28
	Staphylinidae	1.6	0.3	1	11
	Scarabaeidae	1.6	0.2	1	16
	Curculionidae	1.8	0.3	1	11
TICINO Spring-Summer	Carabidae	2.9	0.4	1	55
	Scarabaeidae	1.3	0.1	1	21
	Elateridae	7.2	1.9	4	29
	Hymenoptera	3.2	0.7	2	17

revealed in this study appear to suggest a variation in feeding patterns which is determined by the abundance and local availability of prey in the area. The geographical differences observed in the frequency with which certain taxa were found by comparing the two areas may in fact be explained on the basis of different local availability.

The marked differences between the two areas, for example in relation to the frequency with which Curculionidae were found during the spring-summer, may be easily explained by strongly differentiated availability.

During the spring-summer Curculionidae are more abundant in the area around Cuneo (37.5% vs 4.8%) because there are widespread meadow areas here which would provide an ideal habitat for this flower-dependent entomofauna which, on the contrary, would find fewer sites of this nature in the wooded zone of the Ticino Valley and/or in intensively farmed areas of the Po Valley which surround the Park.

Geographical variations within the Po Valley are further confirmed when our findings are compared to the data reported by Fasola *et al.* (1986) from the plain around Pavia. Here the major differences concern the non-reproductive period when Staphylinidae and Tenebrionidae are absent from the diet.

However, it is important to point out that, in spite of the differences observed between one area and another, there are also marked similarities such as, for example, the constant predominance of Carabidae, which in fact were the most heavily preyed on insect group in absolute terms during every season, both in the two area studied and in the plain around Pavia (Fasola *et al.* 1986). Geographical differences in the overall diet between plain farmed areas and mountain areas have been reported on at least two previous occasions (Studer-Tiersch 1984, Silvano and Boano 1991).

Even the marked seasonal and monthly variations found here reflect the environmental availability. For example, it is obvious that the diminution of the capture rate of many taxa during the autumn-winter period should be correlated to the effective contraction of their populations.

The abundance of individual taxa per stomach did generally not provide results in line with those obtained from an examination of the frequency with which taxa were found. In many cases, the taxon which was found most frequently was not that found in greatest abundance per stomach. This result was not completely unexpected given that only those stomachs containing at least l specimen of the taxon in question were taken into account. Moreover, certain insects which are frequently captured by crows, but in reduced numbers, as for example the Carabidae, are not very gregarious and it is therefore probable that the predator captures one at a time (in many cases the median value was in fact l). On the contrary, some groups, like Diptera, especially at the larval and pupal stages, and Formicidae, which are also not frequently preyed on, are concentrated in particular sites and when the predator discovers this source of food (carrion, dung, nests, etc.) it is clear that it takes advantage by consuming them in large numbers.

This interpretation is backed by direct observations on feeding behaviour in nature (Rolando, unpublished data) and this is therefore an ulterior confirmation of the Hooded Crow's opportunistic behaviour.

As far as concerns any trophic differences between sexes, our data indicate the existence of a different diet in one case only (spring-summer, Province of Cuneo), but its statistical significance is limited and the indication does not appear to be very convincing. However, it is worth recalling that behavioural differences linked to the different body size of the sexes have been described in relation to the Carrion Crow (Holyoak 1970).

There is no doubt that the Hooded Crow has a comprehensive food strategy. According to certain studies the species does not appear to make any choice in terms of the use of resources in the form of different types of crops (e.g., corn fields, ploughed fields, mowed grass). In other words, the frequency of use of a certain crop would solely depend on its availability within the area (Baglione *et al.* 1990). Nevertheless other observations have suggested that certain resources are positively selected or avoided (Saino 1992, Rolando and Palestrini 1993). In the Ticino Natural Park it was found that there was a tendency to use the rice-fields during the spring and summer with a frequency which was considerably higher than that expected in relation to their availability (Rolando unpublished data). It is also possible to interpret the increased use of Staphylinidae in winter (area around Cuneo) given that Hooded Crows are able to dislodge these Coleoptera from their winter quarters (stones, bark, etc.). In general it can be said that the feeding strategy of the Hooded Crow implies the use of both cultivated areas and the insects they contain in relation to their availability.

Within the framework of this behavioural model, however, the species is able to select certain crop types if they are actractive (the rice-fields in spring-summer), and appears to be ready to take advantage of the concentration of prey in given sites (Formicidae in nests, Diptera pupae in dung) and their seasonal behaviour (Staphylinidae wintering under stones).

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Valley Natural Park provided us with the Crows collected in that area.

We are also indebted to G. Franceschet, R. Ferro and P. Giachello who greatly helped us in the laboratory analyses and in the field work.

Riassunto — È stato condotto uno studio sull'alimentazione entomatica della Cornacchia grigia in due diverse aree della Pianura Padana. Sono state evidenziate significative differenze a livello geografico, stagionale e mensile. L'analisi dei contenuti stomacali in termini di abbondanza di un certo taxon/stomaco non è risultata essere congrua, in genere, con quella classica relativa alle frequenze di rinvenimento dei vari taxa. I dati ottenuti confermano il comportamento generalista della specie ed indicano che la Cornacchia sfrutta volta per volta la disponibilità locale delle prede.

Nell'ambito di tale modello di comportamento, tuttavia, la specie sarebbe in grado di selezionare certe tipologie agricole (le risaie in primavera-estate), e sembra essere pronta a sfruttare la concentrazione delle prede in determinati siti (Formicidi nei nidi, pupe di Ditteri nello sterco) ed il loro comportamento stagionale (Stafilinidi svernanti sotto le pietre).

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Bird-borne satellite transmitters: current limitations and future prospects

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Abstract — The paper provides a brief account on satellite tracking, a new promising method for studying bird migration and orientation. This method is based on two Tyros-N satellites which receive and locate the signals emitted by bird-borne transmitters. The literature on this topic is still very limited, due to the fact that this technique, which is only a few years old, has not yet left the pionieristic phase. However, technical problems concerning the weight of transmitters - and their short operative lifetime - which presently pose severe limits to experimentation, will supposedly be overcome soon by the progress of technology. New generations of transmitters, and possibly other satellite systems equipped with more advanced onboard instruments, will certainly provide relevant information on the many challenging questions related to avian migration and navigation which cannot be answered by conventional methods. Preliminary results from a satellite tracking experiment on migrating Brent Geese, recently run by the research team which the author belongs to, are briefly reported. Despite the limited operative lifetime of transmitters, this method allowed us to reconstruct a large portion of the geese' flight paths from their main staging sites in Iceland to the breeding grounds on Canadian arctic islands, and also to investigate the experimental birds' orientational strategies.

Introduction

In the last few decades, new techniques for studying bird migration have been added to traditional methods; data achieved by conventional techniques, such as ringing activity and visual observations of migrating birds, have been complemented by a wealth of new and fruitful results produced by ceilometers, radars, radio transmitters and other instruments originally devised for quite different aims. Potential possibilities offered by these new methods had not yet been fully exploited when the attention of students of bird migration was attracted to artificial satellites orbiting around our planet. Animal satellite-tracking cannot be considered a new procedure, as the first successful attempts to track large mammals date back to the early 1970s; only in recent years, however, satellite transmitters have become sufficiently small and light to be carried by large birds. The present paper aims to offer a brief review of the main results achieved so far by using this promising and fascinating technique. A preliminary report will also be given on the investigation that is currently being carried out by the reseach team which the author belongs to.

The Argos system and transmitters

Geographical coordinates of animals equipped with appropriate transmitters can be regularly localized by satellites which have been provided with specific onboard instruments. The commercial system presently used for animal tracking by satellite is the result of a co-operation between the Centre National d' Etudes Spatiales (CNES, France), the National Aeronautics & Space Administration (NASA, USA) and the National Oceanic & Atmospheric Administration (NOAA, USA). ARGOS is the name of this FrenchAmerican system, with headquarters in Toulouse, France; other commercial satellite systems will certainly be available in the near future (further details and references in Nowak and Berthold 1991).

The ARGOS space segment consists of two NOAA Tyros-N satellites with polar low-altitude orbits (830 and 870 km), each equipped with onboard location systems which record and process messages transmitted by platform transmitter terminals (PTTs) from the earth's surface. The onboard data collection systems may also be used for obtaining telemetry data (physiological and environmental information) from remote locations. The geographical position of each platform, and thus the

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locations of the animal which has been equipped with a PTT, is determined by measuring the Doppler effect on the frequency of incoming messages. Data are then transmitted from the satellite to one of the telemetry ground stations, from where the information is retransmitted to the ARGOS data processing center, in Toulouse. There the results are made available to the users within 2-6 hours from the receipt of signals.

As far as the performance of the system, the number of possible locations per day varies according to the latitude of the animal-borne transmitter (the ARGOS service guarantees a minimum of six locations per day). The minimum number is obtained close to the Equator, whereas more frequent locations (up to 28 per day) can be achieved at higher latitudes. Location accuracy varies according to circumstances: sources of errors may be related to such factors as altitude and speed of the animal-borne transmitter. The PTT is considered to be stationary at the ground level at the moment of the transmission; in these conditions, location accuracy is usually within 1 to 2 km. Fast movements or high altitudes, as those which characterize bird migration, can result in errors which however lie within an acceptable range.

The first successful attempts to track by satellite the flight paths of migrating birds were reported by Strikwerda *et al.* (1986), who used a 170 g transmitter devised by the Applied Physics Laboratory of the Johns Hopkins University in Laurel, Maryland, USA. Better levels of miniaturisation of the transmitters were subsequently achieved in Japan by Toyo Communication Equipment Co., and by other companies in Great Britain and in the USA (for further details and references on the ARGOS system and transmitters see Nowak and Berthold 1991).

Bird migration studies by satellite tracking

Due to the limits imposed by the weight of transmitters, only a few species of large birds have so far been subjected to satellite tracking experiments. Since 1984, when pilot studies of Strikwerda *et al.* (1986) on the Giant Petrel *(Macronectes giganteus)* and Trumpeter Swan *(Cignus buccinator)* were carried out, only a few papers have been published. Main papers regards five systematic groups: Sphenisciformes: *Aptenodytes patagonica, A. forsteri, Pygoscelis adeliae* (Freby *et al.* 1990, Ancel *et al.* 1992, Davis and Miller 1992); Procellariformes: *Diomedea exulans, Macronectes giganteus* (Strikwerda *et al.* 1986, Juventin and Weimerskirch 1990, Croxall 1990, Prince *et al.* 1992); Anseriformes: *Cignus c. columbianus, C. c. bewickii, C. c. jankowsky, C. buccinator* (Strikwerda *et al.* 1986, Nowak *et al.* 1990, Higuchi *et al.* 1991); Accipitriformes: *Haliaetus leucocephalus, Gyps fulvus* (Strikwerda *et al.* 1986, Berthold et al 1991); Ciconiiformes: *Ciconia ciconia* (Berthold *et al.* 1992).

It is expected that this short list of papers will dramatically lengthen in the near future due to the large number of the studies which are in progress on several species of Cranes in America and Asia, and of Accipitriformes in North America (see Nowak and Berthold 1991). Other interesting programs concern Magpie Geese in Australia *(Anseranas semipalmata,* Taplin 1992) and Hubara Bustards *(Chlamidotis undata)* in Saudi Arabia (Goriup 1990).

It is worth to point out that not all these investigations concern migratory behaviour; the fascinating study of Juventin and Weimerskirch (1990) on the Wandering Albatross *(Diomedea exulans)* at the Crozet archipelago in the Indian Ocean regards the foraging behaviour of breeding individuals. Nonetheless, the results were impressive indeed; the satellite tracking technique revealed that breeding Wandering Albatrosses accomplish extremely long foraging trips whose lenght may exceed 15.000 km - ten times longer than expected - and allowed to plot the birds' foraging routes with respect to winds, to pressure systems and other environmental factors.

Migratory routes of the Light-bellied Brent Goose

Brent Geese *(Brenta bernicla hrota)* have recently been subjected to a fruitful satellite tracking study by an international research team composed by Swedish (S. Akesson, T. Alerstam, University of Lund), Icelandic (G.A. Gudmundsson, Icelandic Museum of Natural History, Reykjavik) and Italian researchers (F.Papi and the author of this article). Brent Geese are arctic migrants whose migratory pattern is particularly interesting due to severe environmental conditions at polar latitudes, such as pronounced seasonality and extreme weather systems; these are associated with factors which may make the known orientational mechanisms totally unreliable. Stars are in fact not visible during the spring migration period of Brent Geese in the Arctic region; steep inclination angles and weak horizontal field intensities, associated with frequent magnetic disturbances, may not supply birds with reliable geomagnetic orientational information. Moreover, fast longitudinal displacement, which arctic migrants are subjected to along this particular route, may not allow the time-compensated sun compass to reset in accordance with the local time (references in Alerstam *et al.* 1990).

Five Brent Geese were netted on 25 and 26 May 1992 in western Iceland, the most important staging site for this population during the spring migration between wintering quarters in western Europe and the breeding grounds on Canadian arctic islands. The birds were equipped with PTTs produced by Toyocom (Toyo Communication Equipment Co., Tokyo, Japan; series T 2038, weight: 57 g, expected operative lifetime: 30 days). Four of the transmitters were simply glued to the birds' backs, whereas one of the instruments was also harnessed by a thin teflon tubing (weight of the harness: 18 g). Soon after the manipulation the birds were released at the site where they had been captured. Unfortunately, the birds' trip took longer than expected, as they frequently rested at stop-over sites along the migratory path. Conversely, the operative life of transmitters was significantly shorter than expected, and we were thus not able to track the birds as far as their breeding grounds. The last signals from the transmitters were received from the eastern (two birds) and western (three birds) coast of Greenland. However, data achieved from bird-borne transmitters have allowed us to reconstruct the route of the five Brent Geese along a large portion of their migratory flights, including the Greenland Inlandice - a vast and inhospitable ice barrier which rises to an altitude of over 2500 m (Fig. 1). Satellite data show that the migratory paths were neither in agreement with a rhumbline or a great circle route between western Iceland and the expected final destination (for theoretical aspects, see Alerstam et al. 1990, Alerstam and Pettersson 1991), but followed a zigzagging course which appears as a strategy 'intended' to detain the birds in unfavourable environments (the open sea and Greenland ice-cap) as little as possible. Thus, the Denmark Strait between Greenland and Iceland was traversed in a direction which minimizes the length of the flight over the open sea; the southwestward

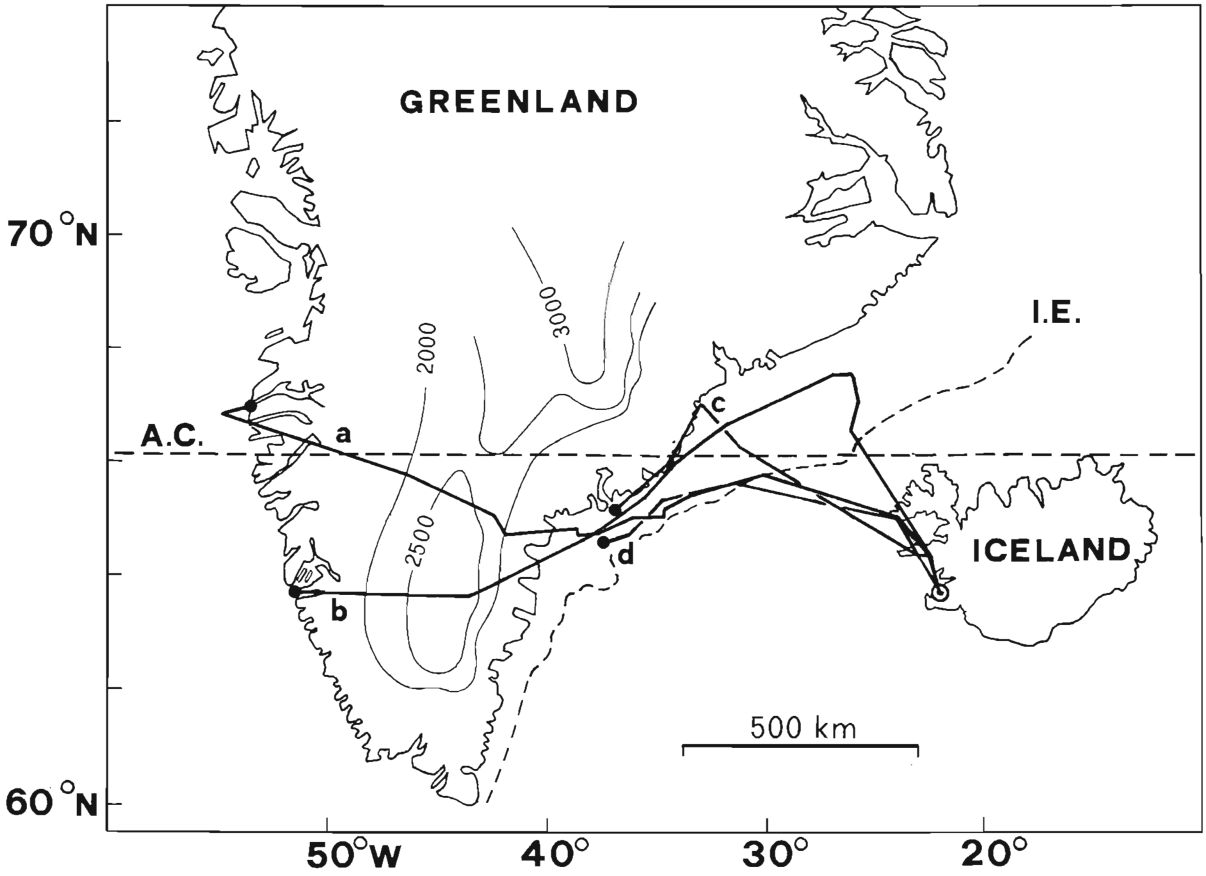

Fig. 1. The routes of five migrating Brent Geese between the capture site near to Reykjavik (circle) to the sites where transmitters sent the last signals (black dots) are shown. Only four routes are presented because two of the geese - a pair (male and female) of adult birds - flew together along the same path (a). Route b was flown by a young male, whereas c and d belong to two adult males. A.C. and I.E. = Arctic Circle and pack-ice edge.

flight along the eastern coast of Greenland, on the other hand, shortened the distance to the western coast across the Inlandice (Fig. 1). The cumulative distance flown by the birds (three individuals and a pair) ranged between 917 and 2420 km.

New satellite tracking experiments, using transmitters with longer lifetime, will be run in the future in the attempt to track migrating Brent geese as far as their breeding grounds in northern Canada.

Satellite tracking technique: current limitations and future prospects

Satellite tracking experiments on birds are still in a pionieristic phase due to severe limitations imposed by the current technology. The transmitters, in fact, are still too heavy, and can therefore only be used to study large birds. Their weight, associated with non-aerodinamic shape, may influence the behaviour of the birds by increasing the number and/or length of stops during the migratory flight. Wind tunnel studies on birds equipped with conventional radio transmitters have suggested that the weight and shape of transmitters and harness may have little effect on flight dynamic of some bird species, whereas in other cases a drastic impairment has been reported (Gessaman and Nagy 1988, Pennycuick *et al.* 1988, Walsberg 1990).

Another negative aspect of the presently available transmitters is the short operative lifetime; as the batteries constitute most of the transmitters' weight, the decrease in size and weight has mainly been obtained by reduction of batteries thereby reducing the transmitters' lifetime. A promising solution of this problem may be the use of light solar cells, which will hopefully be produced in the near future (some pilot attempts have already been carried out by Stikwerda and his coworkers in 1986), and by devising a new generation of light transmitters endowed with longer operative lifetime. Light transmitters will certainly be available quite soon, considering the rapid advances in electronic technology. Tokyo Communication Equipment Co. (Tokyo, Japan) has recently announced that a 20 g transmitter - produced by large-scale integration of the electronic components and a ultra-light power supply - will soon be put to the market (Tsutsumi 1992).

Despite the above mentioned limitations (which also include a low number of locations per day, and the high cost of transmitters and their management by the ARGOS system), bird satellite tracking is a technique which has opened a wealth of new possibilities in bird migration and orientation studies. When this method will emerge from the current pionieristic phase, it can certainly provide relevant information on many fascinating problems related to avian migration strategies and orientation mechanisms which cannot be solved by any of the conventional methods. Satellite tracking may allow researchers to reconstruct a detailed ''ecodiagram'' (or ''Ökodiagramme des Zugablaufs'', according to Nowak and Berthold 1987, Berthold *et al.* 1992) of the migratory journey of individual birds. This ecodiagram can supply important information on the migratory course with respect to weather systems and relevant topographical features, flight speed, the pattern of stop over sites and the length of resting periods. In addition, it may provide a significant basis for conservation measures in favour of endangered species.

Satellite tracking will certainly turn out to be a powerful method to investigate orientation mechanisms of birds and to provide an answer to the many questions related to this fascinating, and still obscure aspect of avian migration.

These and other crucial questions may be answered not only by simply running satellite tracking observations, but also by subjecting birds, equipped with satellite transmitters, to experimental manipulations. An interesting prospect, for example, is the possibility to carry out long-distance displacement experiments of breeding and migrating individuals in order to investigate their navigational ability. This would allow us to verify whether olfactory cues, which the navigational performance of homing pigeons is based on (references in Papi 1991), and which seem to play a role in the homing process of the Swift (*Apus apus:* Fiaschi *et al.* 1974) and Starling (*Sturnus vulgaris:* Wallraff and Hund, 1982), are also an important component of other bird species' navigational system.

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Riassunto — Viene descritta brevemente la tecnica di rilevamento via satellite: un nuovo e promettente metodo di studio delle migrazioni e delle capacità di orientamento degli uccelli. Il sistema si basa su due satelliti Tyros-N che ricevono e ritrasmettono a stazioni di rilevamento a terra i segnali emessi da speciali trasmettitori applicati agli uccelli. La letteratura in questo campo è ancora molto limitata in quanto questa tecnica, introdotta solo pochi anni fa nella ricerca ornitologica, non è ancora uscita dalla iniziale fase pionieristica; infatti, il peso e la forma dei trasmettitori, unitamente alla loro breve vita operativa, impongono severi limiti alla sperimentazione. È probabile tuttavia che il progresso della tecnologia produca entro breve tempo nuove generazioni di trasmettitori e nuovi sistemi di rilevamento basati su satelliti dotati di una strumentazione piú efficiente,

che saranno certamente in grado di fornire importanti informazioni sui molti lati oscuri presentati dalle migrazioni degli uccelli che non possono essere chiariti usando metodi di studio convenzionali.

Un esperimento di rilevamento delle rotte migratorie dell'oca colombaccio via satellite è stato recentemente compiuto dal gruppo di ricerca cui l'autore appartiene; nonostante la breve vita operativa dei trasmettitori, questo metodo ha permesso di tracciare un esteso segmento della rotta degli uccelli e di investigare sulle loro strategie di orientamento nel corso della migrazione primaverile dalle aree di foraggiamento in Islanda occidentale ai quartieri di riproduzione nelle isole artiche del Canada.

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Seasonal variations in numbers and levels of activity in a communal roost of Choughs *Pyrrhocorax pyrrhocorax* in central Spain

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Abstract — This paper presents an analysis of number and activity rates throughout year in a large communal roost of Choughs *Pyrrhocorax pyrrhocorax* in Central Spain. Number of Choughs attending the roost varied along the year, the greatest gatherings occurring during the winter. In the breeding season the roost is occupied mostly by non-breeding Choughs staying a short time in pre-roosting activities. Communal roosting in the area is interpreted as a behaviour related with socially organised foraging. After comparing variations among roosting numbers, activity patterns and duration of the roosting activities in the different periods of the year, we suggest that communal roosting may serve to facilitate mating.

Introduction

The existence of large communal roosts is a fact common to all populations across the Chough's range, provided there are individuals in sufficient number (Lovari 1978 Roberts 1985, Farinha 1988, this study). Communal roosting sites have been highlighted for their biological importance as social and information centres from where the daily activities are organized (Still *et al.* 1987, Bignal *et al.* 1989). Understanding the function and variation of communal roost is essential for interpretation of the importance of this behaviour on the structure and regulation of populations. This point is especially important for the Chough which is a rare European bird requiring specific management in most parts of its range (Bignal and Curtis 1989). Detailed information on communal roosting is very scant (Still *et al.* 1987) and we know of no analysis of numbers and activity in large roosts of Choughs throughout the year. This paper presents such an analysis in one of the main Chough roosts in southeastern Madrid, Central Spain.

Study area and methods

The Chough population in southeastern Madrid is composed of 1000-1100 individuals distributed across a wide area devoted to cereal, vine and olive cultivation. Caves, crevices and recesses in gypsum and clay river cliffs are used by Chough for nesting and roosting. A detailed description of the area and more information on the Chough population is given in Blanco *et al.* (1991). The roost is located in a sheltered, roofed vertical crevice formed by water erosion, and it is 4.3 Km from the nearest other communal roost of Choughs.

During each month in 1990, 4 to 6 (mean 4.7) censuses were made by observing the movements of Choughs from the pre-roost gathering sites. Counts were made from vantage points, the location of which changed in relation to changes in the areas selected by Choughs for feeding at different times of the year.

During the breeding period (16 March to 15 June) the start of activity in the roost was determined by recording the time when there were more than 10 individuals present, in order to avoid confusion with the activity of those birds breeding at the roosting site (5 pairs). In the non-breeding season the roosting activity was defined to have started by observing the behaviour of the birds in the roost area. At this time the presence of Choughs either entering into the cavity, making flights or simply perching on the cliff was considered signs of roost-linked behaviour. In most cases, the start of activity was instigated by the arrival in the roost area of a flock of variable size, the Choughs then returning in either a gradual or "burst" manner, depending on the time of year and weather conditions (Blanco *et al.*, in press). On a few occasions an already established roosting group left the site and then returned. We did not rerecord the roosting activity of these birds if the time elapsed before they returned was less than 5 min. The end of activity was defined as the time of arrival to the roost of the last Chough (normally pairs or solitery

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birds). On the only occasion when the roosting group returned in a single flock, we considered the time when the last Chough entered the crevice as the end of activity. Two types of sites of origin of returning flocks were considered, namely the main feeding site and other areas.

The treatment of the seasonal changes of the different parameters was made on a monthly basis, and also by grouping the data into four periods that allow a more realistic interpretation of the data (Macdonald and Whelan 1986), namely: (A) winter period (16 November to 14 February), (B) just before breeding: nuptial undulating flights, nest building and nest occupation (15 February to 15 March), (C) breeding (16 March to 15 June), and (D) offspring independence and moult (16 June to 15 November).

Results

Size and origin of the roosting group

The changes in the size of the group attending the roost are highly significant across months (Kruskal-Wallis one-way ANOVA, H = 49.7, 11 d.f., $p<0.001$; Fig. 1a), as well as across periods (H = 46.9, 3 d.f., $p<0.001$; Fig. 1b). Chough numbers varied between 52 (April minimum) and 281 (January maximum). The largest roost gatherings occurr in winter, the numbers dramatically decreasing across the prebreeding months. The lowest numbers are reached in the breeding season. The end of the breeding season marks the start of a slow but steady increase in Chough numbers in the roost. Two other communal roosts in the area, which have been surveyed less intensively, show a similar dynamics, with maximum numbers of 367 and 205 Choughs in December and January respectively. These roosts are separated 1.5 Km distant from each other and are mostly used by birds feeding in different areas (as demostrated by records of colour-ringed birds).

In any particular day almost 95% of Choughs belonging to the roosting group attended the same feeding site, with little seasonal variation (89.4-95.6%, n = 28). The percentage regularly feeding in that zone which continued flight to other roosting sites ranged from zero to 21.9%, with the highest values in December.

Activity time at the roost

The period of activity usually starts 30 to 45 min before sunset, although it can be considerably earlier on days with bad weather conditions (Blanco *et al. in press*).

Seasonal changes in the duration of the period of activity are highly significant among both months and periods (H = 32.0, 11 d.f., $p<0.001$ and H = 18.1, 3 d.f., $p<0.001$, respectively; Fig.2). Mean across-year duration was 51.5 ± 26 min; range 17-134 min, n = 52 (four censuses days excluded by the imposibility of determinate the time of activity). Earlier arrivals and increases in activity under twilight conditions are responsible for the significantly higher values in March. On all censusing days in this month, weather conditions were mild. There is a sharp decrease of activity time in the first week of April of nearly one hour compared with the average activity times in March. If the 1 st day April is included, the difference amounts to 96 min. There are no significant differences between mean values at any other time of the year.

The increase in the duration of the activity period in prebreeding time is directly related to an increase of social activity in the roost. Fighting, contests and display flights, as well as a complex array of calls, involving a sizeable fraction of the roosting group,

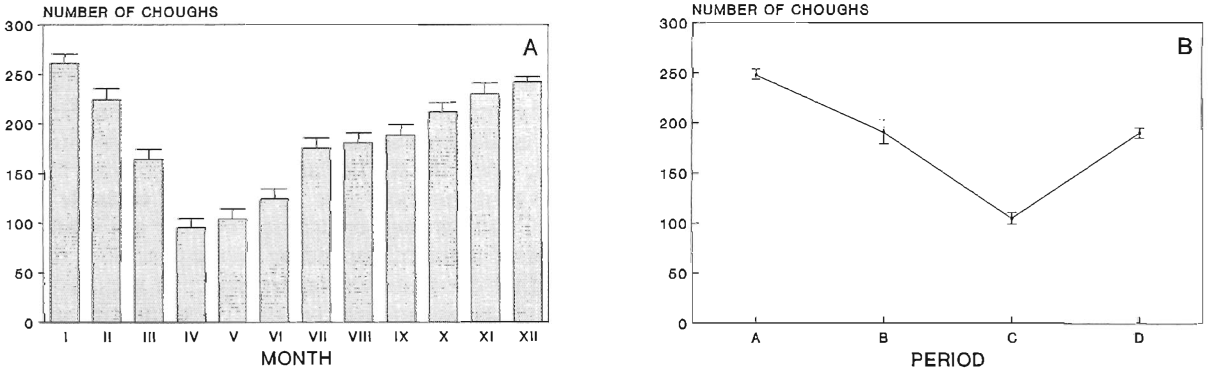

Figure 1 - Seasonal variation according to a) months and b) period (see methods) in the mean number (±SE) of Choughs attending the roost.

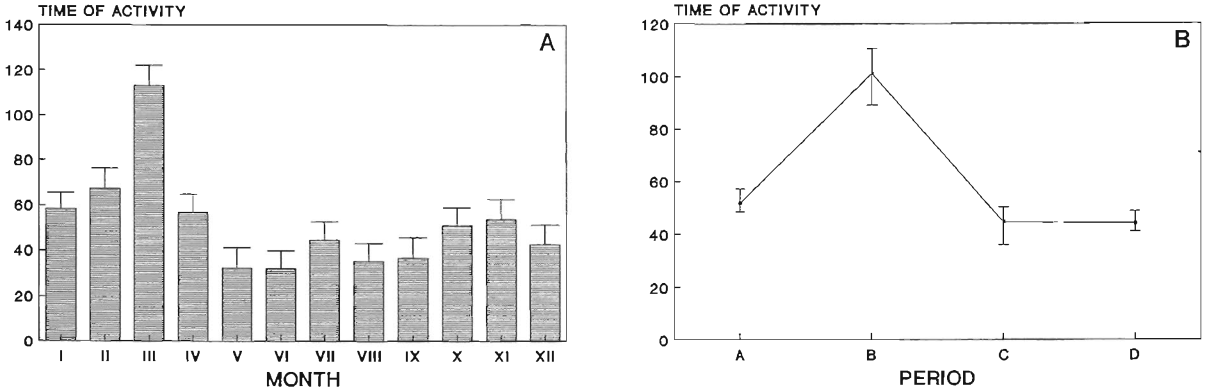

Figure 2 - Seasonal variation according to a) months and b) period (see methods) in the mean time (minutes) of activity (±SE) of a communal Chough roosting group in Central Spain.

are the rule in this period. These activities often continue after total darkness, but it is only during this prebreeding time that Chough activity continue after the last individuals have arrived. During the rest of the year, pre-roosting activity was normally confined to preening, allopreening and bill-wiping. There exists a highly significant negative relationship between the duration of the activity period and the number of birds attending the roost in January to March (Spearman's rank correlation, $r_s = -0.84$, $p<0.002$, $n = 14$).

Discussion

Communal roosting in social foraging birds has been frequently interpreted as an adaptative behaviour related to the better localization and exploitation of food resources (Ward and Zahavi 1973, Weatherhead 1983, Rabenold 1987). In Spain Choughs are gregarious birds throughout the year, but especially so during the winter months (Soler 1987; pers. obs). Although Choughs form pre-roost gatherings, average size of roosting flocks seems to vary in parallel to the size of feeding flocks (Lovari 1978; authors' data, in Blanco *et al.* in press). The size of the roosting group was highest during the winter, hence it could be argued that it is the need for socially organised foraging that is stimulating the formation of large winter roosting flocks. In the study area, Choughs feed on olives all the year round with a major peak in winter (Blanco *et al.* in press); predictability, quality and dispersion of this food resource fit well to premises that may influence large group size in birds (Pulliam and Caraco 1984).

The size of the roosting group decreases in the prebreeding season as a consequence of the dispersion of breeding pairs (Bignal *et al.* 1988, Farinha 1988). Nevertheless, some pairs stay in their home range all year as occurs elsewhere (Bignal *et al.* 1989, Tella and Torre 1993). Numbers remain roughly constant across April and May because flocks are then composed mostly by cohesive, large groups of nonbreeding birds (Lovari 1978, Bignal *et al.* 1988, Blanco *et al.* 1991). A slight increase is seen from June onwards that seems to be caused by recruitment of unsuccesful breeding birds. The increase is more patent in July due to the arrival of family groups from nearby areas. Afterwards, numbers remain constant until October, when a further increase related with the incorporation of birds nesting in more distant areas is observed (Bignal *et al.* 1989, Monaghan 1989).

Due to its mainly rocky roosting habits and the lack of suitable buildings (Tella *et al.*, in press) Choughs are dependent on the existence of inaccesible cliffs on which to spend the night (Lovari 1978). In the study area this limits the birds to the cliffs along the river courses. The bulk of the roosting group forage together over a wide main area. Choughs that fly to other roosting sites are regarded as birds which are changing roost site (Ward and Zahavi 1973, Caccamise and Morrison 1986) in response to the large distances involved between feeding areas. Dispersion of feeding flocks and changes of roosting sites in response to food availability and other factors have also been observed elsewhere (Bignal *et al.* 1989, Monaghan 1989). Furthermore, the preferred use of particular roosts forces Choughs to cover long distances (>30 Km per one-way flight) from the feeding areas (see also Zuñiga 1989). While this may be costly on energy grounds, these costs might theoretically be compensated by the benefits of flock feeding and roosting. The high constancy in use of the same roosting site (for at least the last fifty years), demostrates the over-riding importance of the choice of safe roosting site in this species and highlights the importance of roost-site protection in management programs for Choughs.

Roosting sites could also serve as a meeting point facilitating pairing (Coombs 1961, Gaston 1978, Still et al 1987). The increase in the duration of the period of activity is related to a decrease in the size of the roosting group, beginning in January and lasting till the first week of April. Chough communal roosts are mostly formed by sub-adult and pre-breeding age birds, which do not reproduce until their third or fourth year of life (Bullock et al 1983, Roberts 1985, authors unpublished), and therefore it is probable that a variable number of birds will reach sexually maturity and attempt to breed each year. As a result the activities associated with searching for a mate would increase as breeding time approaches, and this could produce the observed increase in social activity and time spent in the roosting site. The timing of dispersion of the breeding pairs from January onwards could be related to the distance to their breeding sites, and the mating dates. This activity could perhaps serve as a signal for the still unmated Choughs. It is remarkable that the duration of the activity period sharply decreases from the first week of April, this being coincident with the start of egg laying by most pairs (authors' unpublished data). This suggests that the activity of mate-searching decreases or totally cease after this time and this could either be because of the low prospects of successful breeding, or because all birds with breeding status have mated and dispersed.

Acknowledgements — We thanks Fernando Gómez, José C. Pérez, Juan Prieto, Mari C. Blanco, Tomás Velasco and the members of the Ornithological Group ALCOR for assistence in the field. We are especially greateful to Dr. Jaime Potti for valuable help, constructive comments and advice during the preparation of the manuscript and to Dr. Eric Bignal for providing helpful comments and for improving the English.

Riassunto — Sono stati analizzati, per un intero ciclo annuale, consistenza numerica e tassi di attività in un dormitorio di Gracchio Corallino della Spagna centrale. Il periodo di maggior affollamento è l'inverno. Nella stagione riproduttiva il dormitorio è occupato principalmente da Gracchi Corallini non riproduttori, che sostano per breve tempo in attività pre-riposo notturno. Questi posatoi comuni sembrano essere legati alla ricerca sociale del cibo. Dopo avere comparato le differenze di numero, attività e durata nei diversi periodi dell'anno, si deduce che le attività nel "communal roosting" possono essere considerate facilitatori sociali dell'accoppiamento.

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Avocetta N° 17: 45-47 (1993)

Homing experiments with the Domestic Dove *Streptopelia risoria*

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Abstract — A group of 4-14 months old domestic doves (*Streptopelia risoria*), which had been raised according to the procedures used in investigations on pigeon homing, was subjected to test releases at various distances (0.1 to 9.0 km) from the home loft. The results show that this tame bird species owns a strong homing drive which, however, is not supported by a true navigational mechanism. Good homing success was in fact reported only in tests carried out at sites where the doves had a direct view of the home loft, or after the birds had been given the opportunity to develop familiarity with the test area.

Introduction

Since Papi and his co-workers have shown that olfactory information plays a basic role in the pigeons' homing process (see Papi 1989, 1991 for references), attempts have been made to verify whether other species of birds rely on a similar homing mechanism (Fiaschi *et al.* 1974, Wallraff and Hund 1982). As doves, due to their close phylogenetic relationship with pigeons, appear to be the most suitable birds for this kind of comparative analysis, we carried out a series of tests to verify the homing ability of the domestic dove *Streptopelia risoria*. This bird species, which had been subjected to a long lasting process of domestication, has been taken into consideration in view of the easiness with which a tame bird can be subjected to experimental manipulation with respect to wild species (see Baillon and Benvenuti 1990, Benvenuti *et al.* 1991). This positive aspect is however counterbalanced by the risk that domestication has weakened or totally disrupted doves' homing abilities possibly present in their wild ancestors.

Methods

Doves used in our tests were offsprings of a stock purchased in a pet shop in Pisa. The fledgings, housed in a loft connected with a large aviary, in Arnino (Pisa), were subjected to the same raising procedures used for pigeon homing studies: the birds were not confined to their loft, where food and water were continuously available, but often set free to leave it for spontaneous flights.

Test sites were at 0.1, 0.5, 1.1, 1.8 and 9.0 km from the home loft (home direction: SE, E, S, NNE and SSW, respectively). Test releases were carried out in sunny days with no wind or moderate winds. The birds were mostly released singly and followed with binoculars untill they landed or, very unfrequently, vanished. Vanishing (or landing) time and bearing were recorded for each bird. Homing performances were verified by checking the birds in their loft each morning for several days after test releases.

Results

Five test releases were carried out between 26th August and 9th September 1991; 28 untrained birds, 4 to 14 months old, were tested in the first release; successive tests were run with the birds that had homed from the previous one. With the exception of the first release, carried out 100 m from the home loft, which was clearly visible at the release site, the doves tended to land soon after the toss. Our attempts to release them in pairs did not produce better results; therefore, our investigation could not be based on initial orientation, but only on homing performances, which are shown in Figure 1. It turns out that our doves exhibited good homing performances in the 1st, 2nd (all 28 birds were able to home) and 4th release [16 out of 17 (94.1%) homed birds]. On the other hand, quite poor performances were recorded in the 3rd and,

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expecially in the 5th releases in which only 17 out of 28 (60.7%), and 2 out of 16 bird (12.5%), respectively, got back home.

It is worth noting that, though the 4th test was carried out at a greater distance with respect to the 3rd one (1.8 vs 1.1 km), the birds exhibited significantly better homing performance in the former than in the latter (χ^2, p<.02). Older birds did not show better performance than younger ones.

Discussion

From our results it turns out that domestic doves may be raised and treated the same way as homing pigeons, and that they own a well developed homing drive. Contrarily to pigeons, however, doves' homing drive is not adequately supported by a true navigational mechanism. Their homing performance is apparently only guided by the ability to orientate on the basis of familiar landmarks when they have no direct view of the home loft. This hypothesis gives an account for the fact that we recorded a significantly better homing performance in the 4th test than in the 3rd one, though the former had been carried out at a longer distance from home. The 3rd test was in fact the first which was run out of direct view of home, and the rather poor homing success was probably the result of a random search for the loft area. In the 4th test, on the other hand, the search for the home loft was facilitated by the experience (familiarity with the test area) developed in the previous release by those birds which had been able to home. The birds, however, could not benefit of this experience in the 5th test which was carried out at 9 km, out of the presumable range of the area which they were familiar with.

From our results no indication can be deduced about the way in which familiar landmarks have been used by our birds, namely whether they rely on a piloting mechanism, i. e. following a chain of familiar (possibly visual) landmarks, or whether the home direction is determined as a compass direction on a map of familiar landmarks, as it seems to be the case in homing pigeons (see Füller *et al.* 1983).

The impossibility to deduce the existence of a compass mechanism in the domestic dove is due to the fact that we were not able to achieve vanishing bearings from homing tests. The released birds, in fact, tended to land soon after the toss when they had no direct view of their home loft. Thus, this bird species revealed itself to be a poor material for studies on navigational mechanisms, despite its close relationship with the homing pigeons.

As regards other homing experiments run on bird species belonging to the same family as the domestic dove (Columbidae), a short series of tests on two species of wild doves (*Streptopelia senegalensis* and *Turtur abyssinicus*) were reported by Benvenuti et al. (1991). The homing performances exhibited by these two dove species were quite poor; nonetheless, some of the tossed birds produced vanishing bearings which were used to infer their orientational strategies. Better results were achieved in studies with feral pigeons — which belong to the same species as the homing pigeons (*Columba livia*) — from urban populations (Chelazzi and Pineschi 1974, Edrich and Keeton 1977, Chelazzi et al. 1982); though their navigational performance is below the standard of homing pigeons, ferals produced significantly non-uniform distributions of their vanishing bearings which were clustered around the home direction. Similar results were achieved in navigation tests with rock pigeons (*Columba livia livia*) raised in aviaries; the rock pigeon is the species from which ferals and the various breeds of domestic pigeons, including homing pigeons, are derived (Alleva *et al.* 1975, Visalberghi *et al.* 1978).

In conclusion, the domestic dove did not exhibit any navigational performance in our homing tests, except for the ability to use familiar landmarks; it would be pure speculation to discuss whether it has been lost during domestication, or whether it was not owned by the wild ancestor.

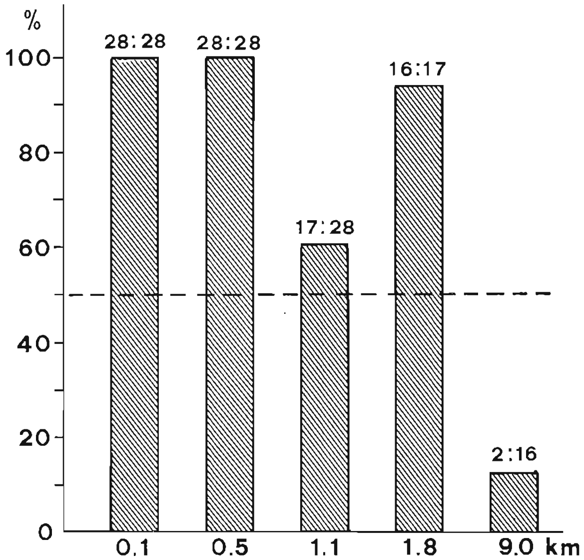

Figure 1. Summary of homing performance data: for each test release, at various distances from home, the height of the columns is proportional to the percentage of the birds which were able to home. The actual sample size (numer of birds which homed and which had been released) is given on the top of each column.

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Riassunto — Sono stati eseguiti esperimenti di rilascio con un gruppo di tortore domestiche (*Streptopelia risoria*) di 4-14 mesi di età che erano state allevate secondo i metodi adottati per lo studio dei meccanismi di homing dei colombi viaggiatori. I nostri risultati mostrano che il forte homing drive rilevato in questa specie domestica non è sostenuto da adeguati meccanismi di navigazione. Buone capacità di homing sono state infatti osservate soltanto in seguito a rilasci in luoghi in cui gli uccelli possono vedere la loro voliera, o dopo che essi hanno acquisito familiarità con l'area di rilascio.

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Avocetta N° 17: 49-54 (1993)

Diet and nest site characteristics of Eagle Owl (*Bubo bubo*) breeding in two different habitats in north-eastern Greece

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Abstract — One hundred and eighty-five pellets and prey remains of Eagle Owl (*Bubo bubo*) collected during 1990-92 in north-eastern Greece, were examined to determine the owl's food habits. The Eagle Owl took a wide range of prey, its diet consisting of about 59 species. The main food group was vertebrates (95.2% by numbers) supplemented with invertebrates (4.8%). The most important food groups were small mammals (48.9%) and birds (44.1%). Game species played an insignificant role as prey in the Eagle Owl's diet. The diet varied between habitat. In forest habitats Eagle Owls fed mainly on birds and insects, whereas in cultivated habitat they fed predominantly on small mammals. Eagle Owls nested on cliffs facing S-SW. The mean distance between neighbouring nests was 2.8 km (ranging from 2.1 to 5.5 Km).

Introduction

Much information has been published on the ecology and food habits of the Eagle Owl (*Bubo bubo*) in different parts of Europe (Willgohs 1974, Hiraldo *et al.* 1975, 1976, Olsson 1979, Mysterud and Dunker 1982, Orsini 1985, Donazar and Ceballos 1989). However, data on its feeding habits in Greece are missing.

The Eagle Owl in Greece is considered an extremely efficient raptorial bird and harmful to forest game species. It is a popular belief that Eagle Owl predation has, to a certain extent, contributed to the decline of the hare (*Lepus europaeus*) population. Consequently, all over the country persecution of the Eagle Owl has taken place in an effort to increase the abundance of hares and other game species.

The present study was carried out from 1990 to 1992 to determine the feeding habits of the Eagle Owl and assess its predation on game species.

Methods

The area studied comprises localities in the Dadia forest and its surroundings located between 40°59'-41°15' N and 2°19'-2°36' E in north-eastern Greece (Figure 1).

Dadia forest has been declared a wildlife reserve since 1980 due to its unique raptor fauna. A total of 20 raptor species breed in the reserve e.g. Black Vulture (*Aegypius monachus*), Griffon Vulture (*Gyps fulvus*), Imperial Eagle (*Aquila heliaca*), Golden Eagle (*A. chrysaetos*), Short-toed Eagle (*Circaetus gallicus*), White-tailed Eagle (*Haliaetus albicilla*) making the area not only of national but also of international importance.

The reserve covers an area of about 7.000 ha and is part of a large forest complex of about 40.000 ha. It raises from 50 m above sea level and reaches up to 800 m.

The area supports a Pinus-Quercus association. The main plant species are: *Pinus brutia*, *P. nigra*, *Quercus conferta*, *Q. pubescens* and *Q. cerris*. Other species occuring with lower frequency are: *Erica arborea*, *Phillyrea media*, *Arbutus andrachne*, *Juniperus oxycedrus*.

Apart from the raptors the fauna includes a large number of species of birds (100), mammals (20) and reptiles (21) (Vlachos and Papageorgiou 1992).

The habitat preference of Eagle Owls in the study area was determined from a vegetation map (1:5000) where a circle with a radius 1.5 km around each nest was drawn and the proportions of different types of biotopes were calculated.

The diet of the Eagle Owl was determined by analysis of pellets and prey remains found in nests, at roosts and at loafing sites. Most materials were collected after the hatching of the chicks to avoid disturbance at the nests. Active nests were located at the beginning of the breeding season and were visited at intervals of 14-21 days to collect

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after the hatching of the chicks to avoid disturbance at the nests. Active nests were located at the beginning of the breeding season and were visited at intervals of 14-21 days to collect regurgitated pellets and prey remains. Roost and loafing sites outside the breeding season were visited at irregular intervals to obtain pellets.

The identification of mammals was made using a hair key (Papageorgiou and Sfougaris 1989), while for birds, feathers, skulls and feet were used. Reptiles were identified from a scale key (Papageorgiou *et al.* 1993). Insect remains useful for identification were heads, legs and wing covers.

Skulls, beaks, sternums and legs were used to determine the number of individual mammals and birds. Unbroken wing covers were used for counting insects.

Nest-site characteristics were determined by measuring the height of the cliff, the height of the nest from the ground and the orientation of the nest. The distance between nests was measured from a topographic map (1:5000).

Results

Feeding habits

The distribution of the 6 nests found in the study area suggests that the Eagle Owls prefered the forest habitat (pine 85%, oaks 10%, agricultural land 2.7%, shrubland 1.7% rocks and small streams) to the cultivated habitat (agricultural land 46.5%, pine forest mixed with oaks 37.2%, shrubland 15%, rocks and small streams). Four nests were found in the forest habitat and two in the cultivated habitat.

A total of 185 pellets were collected over the 3-year period, yielding 630 prey individuals. The size of the pellets varied considerably depending on their structure, content and age of the Eagle Owl producing them. Their mean length was 69 ± 13.9 mm (range from 32 to 121 mm), while their mean width was 30 ± 3.7 mm (range from 25 to 36 mm).

The three years of prey data were combined for each nest and are presented for each habitat separately and together (Table 1).

The data show that overall the Eagle Owl's staple diet was of vertebrate origin (accounting for 95.2% of the total number of prey items), supplemented with invertebrates (4.8%). Mammals were the major food source (48.6%), followed by birds (44.1%), insects (4.8%), cold-blooded vertebrates (1.7%) and fish (0.5%). Below we comment on the predominant species in each prey group.

Mammals. Of the 59 identified species found in the Eagle Owl's diet, 13 were small mammals. Among them, Eastern Hedgehog (*Erinaceus concolor*) constituted the owl's staple diet (accounting for 26.6% of all mammalian food items by number). Other species found to play a significant role in the Eagle Owl's diet were Water Vole (*Arvicola terrestris*), Ship Rat (*Rattus rattus*), Fat Dormouse (*Glis glis*), Wood Mouse (*Apodemus sylvaticus*), Common Vole (*Microtus arvalis*) and Red Squirrel (*Sciurus vulgaris*) (Table 1).

Birds. Eagle Owls fed on a variety of birds. Throughout the year 278 birds belonging to 35 species were found in their diet. The most common prey species was the Jay (*Garrulus glandarius*) comprising 25.5% of the avian species by number, followed by Moorhen (*Gallinula chloropus*), Feral Pigeon (*Columba livia domestica*), *Gallus* sp, Hooded Crow (*Corvus corone cornix*), Turtle Dove (*Streptopelia turtur*) and Woodpigeon (*Columba palumbus*).

Invertebrates. The Stag Beetle (*Lucanus cervus*) constituted 33.3% by number of the invertebrates eaten by the Eagle Owl, followed by *Cerambyx cerdo* and *Oryctes nasicornis.*

Cold-blooded vertebrates and fish. In the present study cold-blooded vertebrates and fish played an insignificant role in the diet of the Eagle Owl because their occurrence by number in the total diet was only 1.7% and 0.5% respectively.

In Table 2 our data are compared with those reported from other parts of Europe.

Variation of the diet between habitats

Using the goodness of fit test on the Eagle Owl's diet in the two habitats it was found that there are significant differences among the main food groups. Birds, insects and reptiles were more important in the forest habitat than in cultivated area (47.3% vs 39.4%, 7.1% vs 1.2%, 1.9% vs 0.0% respectively). Conversely, small mammals were more abundant in the Eagle Owl's diet in the cultivated habitat than in forest habitat (57.8% vs 43.0%).

In the forest habitat Common Vole and Fat Dormouse were the most important mammalian species in the Eagle Owl's diet (68.1% and 67.4% respectively versus 13.9% and 32.6% in the cultivated habitat). Ship Rat, Moorhen and Jay were more abundant in the diet in the cultivated than in the forest habitat (66.7% vs 33.4%, 92.3% vs 7.7% and 76% vs 24% respectively) (Figure 3).

Reptiles were present only among the food remains in the forest habitat.

Nest - site characteristics

All nest found in the study area were located on cliff ledges. The data presented in Table 3 show that the Eagle Owls had selected nesting cliffs with an average height of about 38 m and that nests were located about 19 m above the ground. The chosen nesting cliffs were found to face S-SW. The mean distance between neighbouring nests was 2.8 km (ranging from 2.1 to 5.5 km).

Table 1 - Percent by number of prey found in the 185 pellets and remains in the diet of Eagle Owl.

Food items	A Forest habitat		B Cultivated habitat		A+B Both habitats	
	N	% in total prey	N	% in total prey	N	% in total prey
INSECTS						
Lucanus cervus	10	2.5	—	—	10	1.6
Cerambyx cerdo	1	0.3	1	0.4	2	0.3
Oryctes nasicornis	1	0.3	1	0.4	2	0.3
Copris lunaris	1	0.3	—	—	1	0.2
Calosima violaceus	1	0.3	—	—	1	0.2
Carabus sp.	1	0.3	—	—	1	0.2
Unknown celeoptera	12	3.1	1	0.4	13	2.0
Total	27	7.1	3	1.2	30	4.8
CRUSTACEANS						
Crabs	1	0.2	—	—	1	0.2
Total	1	0.2	—	—	1	0.2
FISHES						
Unknown	—	—	3	1.2	3	0.5
Total	—	—	3	1.2	3	0.5
AMPHIBIANS						
Frogs	2	0.5	1	0.4	3	0.5
Total	2	0.5	1	0.4	3	0.5
REPTILES						
Lacerta viridis	3	0.8	—	—	3	0.5
Nalpolon monspenssulanus	1	0.3	—	—	1	0.2
Testudo sp.	2	0.5	—	—	2	0.3
Unknown snakes	2	0.5	—	—	2	0.3
Total	7	1.9	—	—	7	1.2
AVES						
Garrulus glandarius	54	14.2	17	6.8	71	11.2
Pica pica	3	0.8	2	0.8	5	0.8
Corvus monedula	6	1.6	2	0.8	8	1.2
Corvus corone cornix	10	2.5	7	2.8	17	2.7
Columba livia domestica	8	2.0	13	5.2	21	3.3
Streptopelia turtur	10	2.5	2	0.8	12	1.9
Columba palumbus	8	2.0	3	1.2	11	1.7
Gallinula chloropus	36	9.5	3	1.2	39	6.1
Fulica atra	—	—	1	0.4	1	0.1
Haematopus ostralegus	—	—	8	3.2	8	1.2
Recurvirostra avosetta	—	—	2	0.8	2	0.3
Athene noctua	6	1.6	5	2.0	11	1.7
Tyto alba	4	1.2	3	1.2	7	1.1
Strix aluco	1	0.3	—	—	1	0.1
Accipiter gentilis	1	0.3	—	—	1	0.1
Accipiter nisus	4	1.2	1	0.4	5	0.8
Buteo buteo	1	0.3	1	0.4	2	0.3
Unknown Falconidae	1	0.3	—	—	1	0.1
Alectoris chukar	1	0.3	4	1.6	5	0.8
Gallus sp.	3	0.8	2	0.8	5	0.8
Picus viridis	1	0.3	6	2.4	7	1.1
Dentrocopus syriacus	—	—	2	0.8	2	0.3
Sturnus vulgaris	3	0.8	1	0.4	4	0.6
Bombycilla garrulus	—	—	1	0.4	1	0.1
Turdus merula	5	1.3	1	0.4	6	0.9
Anas platyrhynchos	—	—	3	1.2	3	0.5
Egretta garzetta	—	—	1	0.4	1	0.1
Numenius arquata	2	0.5	1	0.4	3	0.5
Oriolus oriolus	3	0.8	—	—	3	0.5
Cuculus canorus	—	—	1	0.4	1	0.1

Coracias garrulus	3	0.8	1	0.4	4	0.6
Fringilla coelebes	1	0.3	—	—	1	0.1
Unknown Frigillidae	2	0.5	3	1.2	5	0.8
Galerida cristata	1	0.3	—	—	1	0.1
Carduelis chloris	1	0.3	—	—	1	0.1
Lanius senator	1	0.3	—	—	1	0.1
Erithacus rubecula	—	—	1	0.4	1	0.1
Total	180	47.3	98	39.4	278	44.1
MAMMALS						
Erinaceus concolor	43	11.3	39	15.7	82	13.0
Talpa europaea	1	0.3	—	—	1	0.2
Croridura suaveolans	2	0.5	—	—	2	0.3
Rhinolophus ferrumequinum	1	0.3	—	—	1	0.2
Sorex araneus	1	0.3	—	—	1	0.2
Lepus europaeus	4	1	20.0	5	1.6	
Sciurus vulgaris	5	1.3	4	1.6	9	1.4
Arvicola terrestris	32	8.4	15	47	15.3	
Unknown Microtinae	1	0.3	2	0.8	3	0.5
Microtus arvalis	9	2.4	22	8.9	31	4.9
Apodemus sylvaticus	16	4.2	17	33	10.7	
Rattus rattus	15	3.9	30	12.0	45	7.1
Glis glis	29	7.6	14	5.6	43	6.8
Unknown Gliridae	5	1.3	—	—	5	0.8
Total	164	43.0	144	57.8	308	48.6
Grand Total	**381**	**100.0**	**249**	**100.0**	**630**	**100.0**

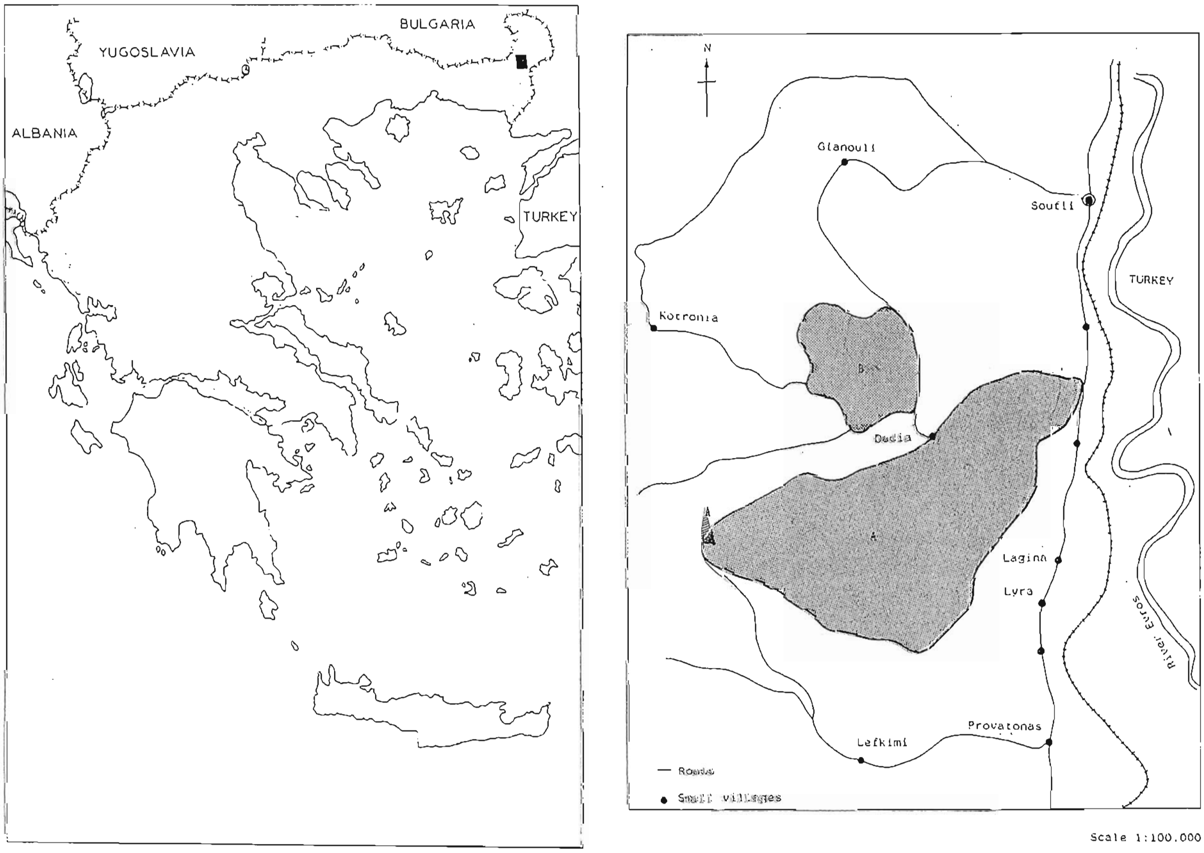

Figure 1 - Study area.

Table 2 - Percent by number of prey groups in the diet of Eagle Owl in different European countries compared with those of the present study.

Food group	**West Balkans**[1]		**Bulgaria**[1]		**Spain**[3]		**Norway**[4]		**Sweden**[5]		**Finland**[6]		**Norway**[7]		**Present study**	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Mammals	410	60.4	388	43.2	2271	64.9	670	83.0	3314	51.4	3305	78.2	1581	41.4	308	48.6
Aves	234	34.4	459	51.1	887	23.3	94	11.6	2913	45.2	748	17.7	2282	50.9	278	44.1
Reptiles	—	—	—	—	28	0.8	—	—	2	0.1	—	—	—	—	7	1.2
Amphibians	35	5.2	15	1.7	12	0.4	34	4.2	110	1.7	122	2.9	286	6.4	3	0.5
Fishes	—	—	—	—	92	2.7	9	1.2	100	1.5	21	0.5	37	0.8	3	0.5
Insects	—	—	36	4.0	209	5.9	—	—	7	0.1	30	0.7	20	0.5	30	4.8
Crustaceans	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	0.2
TOTAL	**679**	**100**	**898**	**100**	**3499**	**100**	**807**	**100**	**6446**	**100**	**4226**	**100**	**4476**	**100**	**630**	**100**

Sources: 1, 2 Baumgart (1975)
3 Hiraldo, Andrada, Parareno (1975)
4 Mysteruo, Dunker (1983)
5 Ollson (1979)
6 Suomalainen (1915) (From Mikkola, 1983)
7 Willgohs (1974)

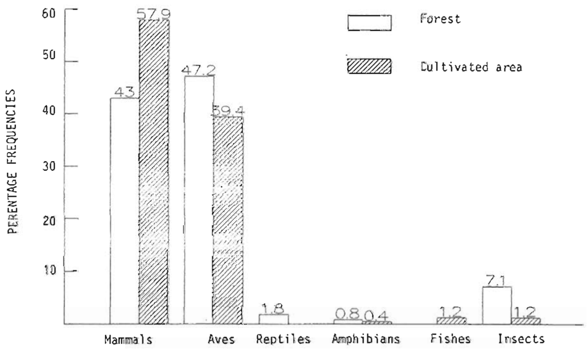

Figure 2 - Percent by number of the most important food groups in the Eagle Owl diet in the two habitats.

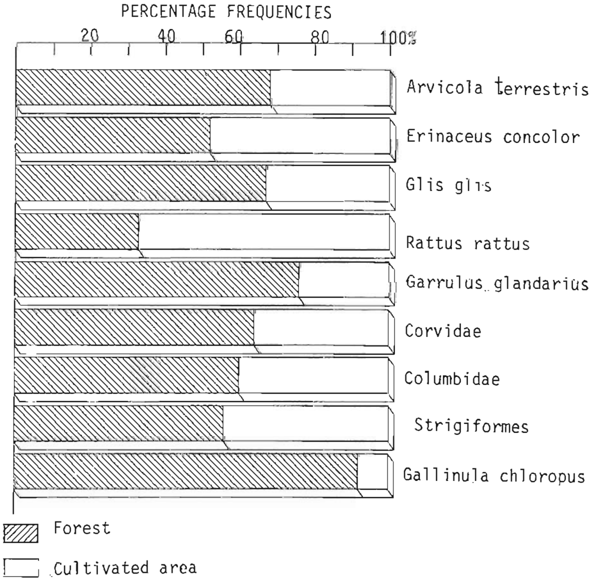

Figure 3 - Percent by number of the most important prey species found in the Eagle Owl diet in the two habitats.

Table 3 - Nest-site characteristics of six Eagle Owl's nests in NE Greece.

NESTS	**1**	**2**	**3**	**4**	**5**	**6**
Height (m)	21	15	32	4	11	20
Direction of nest-sites	304°	230°	120°	268°	240°	273°
Direction of cliff	W	S	SE	SW	SW	W
Elevation (m)	140	110	105	212	141	138
Height of cliffs (m)	53	47	34	13	35	47
Distance from road (m)	750	300	385	150	735	775
Distance from water (m)	435	215	130	500	625	500

Discussion

The wide range of prey making up the Eagle Owl's diet suggests that it is an opportunistic predator, even though it feeds mainly on birds and small mammals. Other authors have come also to a similar conclusion (Baumgart 1975, Hiraldo *et al.* 1975, Mysterud and Dunker 1983, Olsson 1979, Suomalainen 1915, Willgohs 1974).

Our results show that the staple food of Eagle Owls in our study area is small rodents, making Eagle Owl a valuable species in biological control of rodent populations. The low occurence of game species in the diet suggests that Eagle Owl predation on such species is slight since only in a few cases were found remains of hares, chukars and ducks.

The low proportion of cold-blooded vertebrates in the diet can be explained by the fact they are active only during the warmest time of the day making them invulnerable to Eagle Owl predation, as the Eagle Owl hunts during the night and early morning hours.

Small prey species, such as insects, were found in an unexpectedly high proportion in the Eagle Owl's diet. Probably they were taken during their seasonal irruptions, partly they may have been consumed taken together with other prey species, or large prey were not available in the study area in adequate quantities. However, it is questionable if this kind of prey provide a positive energetic yield to a large size predator, such as the Eagle Owl. Our data, supported by those of other workers in Spain (Hiraldo *et al.* 1975) and Bulgaria (Baumgart *et al.* 1973) suggest that insects play a more significant role in the Eagle Owl's diet in South Europe than in northern regions, such as Norway (Willgohs 1974, Mysterud and Dunker 1983), Finland (Suomalainen 1915) and Sweden (Olsson 1979), where their abundance and distribution are limited.

The presence of other raptors remains in the diet reveals that Eagle Owls feed on a number of other predatory birds (*Athene noctua*, *Tyto alba*, *Accipiter nisus*, *Strix aluco*, *Buteo buteo*) and therefore may influence their spatial distribution and abundance.

More Eagle Owls were found to nest in forest (pine mixed with oak) than in cultivated habitat. The data on diet in the two types of habitat showed that Eagle Owls preyed more heavily on small mammals in the cultivated habitat, while in the forest they fed on birds, reptiles and invertebrates (Figure 3).

The Eagle Owl's choice of nesting cliffs facing S-SW indicates that this direction favours its breeding success. The S-SW direction of the nests in the study area provides a more favourable microclimatic environment ensuring more heat from the sun during the incubation and rearing of the young.

From this study it can be concluded that the Eagle Own: a) is an opportunistic predator; b) its predominant food is vertebrates, mainly small mammals and birds; c) its predation on game species is very slight; d) prefers forest than cultivated areas and e) nest mainly in cliffs facing S-SW.

Riassunto - Questo studio riguarda l'analisi di 185 borre e resti di predazione di Gufo reale raccolti tra il 1990 e il 1992 nella Grecia nord-orientale. La dieta si compone di 59 specie. Il gruppo maggiormente rappresentato è quello dei vertebrati (95.2%) con scarsa presenza di invertebrati (4.8%). Nella dieta del Gufo reale sono presenti piccoli mammiferi (48.9%) ed uccelli (44.1%); le specie di interesse venatorio hanno un ruolo insignificante. La dieta varia notevolmente in funzione dell'habitat: in foresta il Gufo reale mangia soprattutto uccelli ed insetti, mentre in abienti agricoli, piccoli mammiferi. Le coppie individuate nidificano su pareti verticali esposte S-SW. La distanza media tra nidi è di 2.8 km con un intervallo compreso tra 2.1 e 5.5 km.

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Changes in the numbers and interspecific interactions of Red Grouse *(Lagopus lagopus scoticus)* and Black Grouse *(Tetrao tetrix)*

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Abstract — Numbers of Red Grouse *Lagopus lagopus scoticus* and Black Grouse *Tetrao tetrix* fluctuated over the years on three Scottish moors where both lived. Black Grouse tended to peak in numbers at, or one or two years after, a trough in Red Grouse numbers. During interspecific disputes in the wild and in captivity, the smaller Red Grouse usually dominated the Black Grouse. We discuss the possibility that Red Grouse at high densities depress Black Grouse numbers on moorland through aggressive competition, and speculate whether such interactions have adaptive value.

Introduction

Inverse relationships between densities of closely-related species are often explained as results of interspecific competition. This generalization, fundamental to avian community ecology, has been based largely on patterns observed in short-term comparative studies of multi-species assemblages, and short-term experiments. Wiens (1989) recommended that a long-term perspective might provide additional insights into the processes involved. Here, we present long-term data on densities of two related species, Red Grouse *Lagopus lagopus scoticus* and Black Grouse *Tetrao tetrix,* on three moors in north-east Scotland.

At two of the moors, we noticed some interspecific interactions between Red and Black Grouse in which the smaller Red Grouse usually dominated. This was unexpected since bigger species usually dominate small ones (eg Willow Ptarmigan *Lagopus lagopus* dominated Rock Ptarmigan *Lagopus mutus* (Moss 1972)). Such aggression between the two species suggested that there might be interspecific competition. We therefore compared the numbers of Red and Black Grouse to see if there was an inverse relationship. To check the pattern of disputes further, we made experimental observations of aggressive interactions between the two species in captivity.

Study areas and methods

Wild birds

All three study areas were on moorland dominated by heather *Calluna vulgaris.* Glen Esk (460 ha) comprised the 'low' study area of Jenkins *et al.* (1963) and Kerloch the 'intensive' study area (177 ha) of Watson *et al.* (1984). At Rickarton, experimental manipulation of part of the Red Grouse population was followed by a difference in their densities between experimental (north, 202 ha) and control (south, 243 ha) areas (Watson *et al.* 1988) and so data from each are presented separately here. Glen Esk, Kerloch and Rickarton lay respectively 39 km south-west, 21 km south-west and 11 km south-east of Aberdeen. Red and Black Grouse were counted as described by Jenkins *et al.* (1963), Watson and Miller (1976) and Parr and Watson (1988).

The areas were originally chosen for studying Red Grouse, which lived for much of the winter and spring on relatively small territories (Watson and Miller 1971) almost entirely on the heather moorland. Black Grouse, however, used woodland as well as heather moorland and had much bigger home ranges than Red Grouse (e.g. 303-689 ha for individual Black Grouse in Glen Dye, 6 km west of Kerloch (Robel 1969)). Therefore, it was reasonable to regard the Red Grouse on each area as a population for demographic purposes (Jenkins *et al.* 1963, Watson *et al.* 1984, Watson *et al.* 1988). Although some Black Grouse did breed and rear young on the study areas, it is probable that many of the birds we studied spent relatively more time off the areas than Red Grouse, and we claim only to describe their use of our moorland study areas.

Captive birds

Captive birds used in the experiments were reared as in Moss *et al.* (1981). The Black Grouse comprised our entire stock of captives, whereas the

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Red Grouse were birds, more than one year old, selected at random from stock. Interactions were studied in spring when the hens of both species were about to, or had just started to, lay and cocks were displaying intensely. The aim was to find if one species usually dominated the other. Since dominance can be site-specific, the ideal was to study interactions between birds which were showing territorial behaviour on the boundaries of their own territories. However, because of the different social organization of the two species, it was difficult to replicate in captivity the circumstances of natural encounters.

In the wild, individual Blackcocks (Black Grouse cocks) defend territories which can be as small as a few m^2 (Cramp 1980) on a communal display area (a lek) which forms a tiny proportion of their home range. In captivity they established realistic territories with defended boundaries in a large sectional run with small sliding doors in each intemal partition (Fig. 1). Red Grouse, on the other hand, have a territorial social system and defend territories typically of several ha in the wild (Watson and Miller 1971), a size which it is not practicable to provide in captivity. Nevertheless, cocks do show typical territorial displays along the boundaries of small, enclosed runs in captivity. We could therefore have an experimental layout which simulated the intrusion of territorial Red Grouse on to a Black Grouse lek.

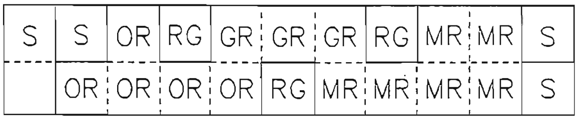

Figure 1 - Experimental run layout in 1988. ———— solid partitions (sliding doors shut except during bouts); — — — — — — — — partitions with open doors; S subordonate Blackcock; GR, OR and MR territorial Blackcocks; RG Red Grouse.

The two experiments (1987 and 1988) were each done in four stages. First, in late March to early April eight or nine Greyhens (Black Grouse hens) were released into the run (Fig. 1), with all the sliding doors open. Second, two days later, seven or eight Blackcocks were introduced. The Greyhens coexisted with few aggressive interactions throughout either experiment, but the Blackcocks fought and chased each other vigorously during the first few days, until (in each experiment) three cocks had established territories and were displaying frequently. The remaining cocks were clearly subordinate, did not display during this initial period, avoided or hid from the territorial cocks and in some cases had feathers missing from their napes following beatings. In 1987, one subordinate cock lived peaceably within the territory of one of the territorial cocks. In both years, other subordinate cocks were shut off in separate sections of the run to avoid unnecessary stress. Once they had been shut off, the subordinate cocks did eventually begin to display.

Stage three, in mid-April, involved introducing three Red Grouse cocks (1987) or pairs (1988) into single sections of run, within the Blackcock territories but shut off by closed doors. The Red Grouse cocks soon showed territorial behaviour and displayed mutually with Blackcocks along the partitions. Both species frequently showed "walking-in-line" displays (Watson and Jenkins 1964, Cramp 1980) and attempted to peck and to beat each other with their wings. In stage four (late April to early May), the door separating one of the Red from the Black Grouse was opened and interactions recorded from a tower hide. When one or more decisive encounters had occurred (usually in less than an hour), the Red Grouse was again shut off in his run. This was done for each Red Grouse on 1-3 occasions. To check dominance relationships between Red Grouse, two sliding doors were opened. When this was done, the Red Grouse usually disputed with each other and largely ignored the Black Grouse.

Results

Numbers of wild birds

Fluctuations in numbers of Red Grouse often show non-random, cyclic patterns (Watson and Moss 1979, 1980) with periods of increase following periods of decline (Fig. 2). At Glen Esk, Kerloch and Rickarton, Black Grouse, when they occurred, tended to peak in numbers at, or one or two years after, a trough in Red Grouse numbers (Fig. 2). This happened in 1961 at Glen Esk, in 1965 and 1971 at Kerloch, in 1981 at Rickarton south and possibly in 1980 at Rickarton north. The peak in Black Grouse numbers at Rickarton south in 1985, however, did not fit this generalization. More precisely, when present on Red Grouse study areas, Black Grouse tended to (i) increase during cyclic-type declines of Red Grouse and also (ii) to increase during the early stages of cyclic-type increases, but then (iii) declined as Red Grouse increased towards peak densities.

Overall, 23 out of 27 observed annual changes in Black Grouse numbers fitted this pattern ($P < 0.001$ by a binomial test). Three of the four years data which did not fit the generalization were at Rickarton south in 1985-88. Red Grouse densities were generally lower at Rickarton than at Glen Esk and Kerloch, and so the same relationships between Red and Black Grouse might not have been expected. If data from Rickarton are excluded, then 15 out of 16 changes in Black Grouse numbers fitted the above generalization ($P < 0.001$, binomial test). At Glen Esk (1958-62) and Kerloch (1966-73) the

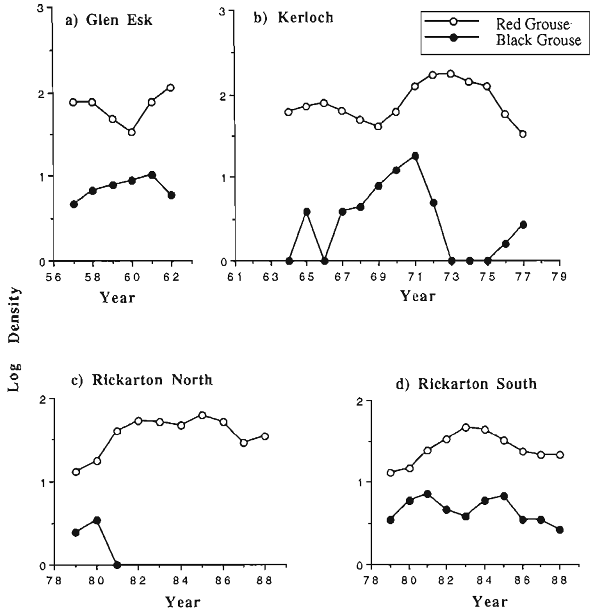

Figure 2 - Densities (birds/km^2 in spring) of Red (log D) and Black (log D + 1) Grouse at a) Glen Esk, b) Kerlock, c) Rickarton north and d) Rickarton south.

relationships between Black Grouse densities in spring t (B_t) and Red Grouse densities in spring t - 1 (B_{t-1}) were very similar:

Glen Esk $B_t = 11.53 - 0.069R_{t-1}$ ($R^2 = 0.71$)
Kerloch $B_t = 11.67 - 0.046R_{t-1}$ ($R^2 = 0.33$)

Although the above regressions were not significant separately (two-tailed $P = 0.072$ and 0.169 respectively) their similarity made it reasonable to apply a one-tailed probability estimate to the second result (Kerloch, $P = 0.085$) and then to combine the two probabilities according to $\chi^2_4 = -2\ \Sigma \log_e P = 10.19$, (combined $P<0.05$). This indicated a delayed density-dependent relationship in which Black Grouse densities tended to follow Red Grouse densities with a lag of one year. No simple inverse correlation between B_t and R_t was observed.

Behavioural interactions between species

Interspecific disputes between wild Black and Red Grouse (Appendix I) were seen in years of high Black Grouse numbers at Glen Esk, and in years when numbers were increasing at Kerloch. Cock Red Grouse dominated Blackcocks and Greyhens in 11 out of 12 encounters. No interactions involving Red Grouse hens were seen.

In captivity, the territorial Blackcocks were two or three years old while the subordinate cocks were one (young), two and four years old (Table 1). This dominance over young by old cocks is also observed in wild Black Grouse (Johnstone 1969) but not in Red Grouse, either in the wild (Watson and Miller 1971) or in captivity (Moss et al. 1984). Therefore, the fact that the Red Grouse were all old birds (two or three years) would have had no bearing on the results of the experiment.

Table 1 - Status and age in years of captive Blackcocks.

	1987			1988		
	Bird	Territory*	Age	Bird	Territory	Age
Territorial	PR	7	3	MR	6	2
	GR	6	2	GR	3	3
	OR	2	2	OR	5	3
Non-territorial	ML	—	1	ML	—	2
	BR	—	1	BR	—	2
	MR	—	1	PR	—	4
	NR	—	1	OL	—	1

* Number of sections defended.

The results from the two years were broadly similar (Table 2). Of the seven dyadic Red-Black Grouse relationships studied in 1987, six involved "away" wins by Red Grouse on Black Grouse territories, with one draw at a boundary door. The Red Grouse cock involved in the draw had been dominated by both the other Red Grouse in interactions following the opening of two sliding doors. In 1988, all five Red-Black Grouse dyadic relationships observed involved dominant Red Grouse on Black Grouse territory. Since the Blackcocks involved in these encounters all dominated the non-territorial Blackcocks, it is reasonable to infer that the Red Grouse would also have dominated the latter. If one assumes a linear hierarchy involving both species (including the subordinate Blackcocks), the results for 1987 and 1988 were: Mann-Whitney $U_{3,7} = 0$, $P = 0.008$; and $U_{3,8} = 0$, $P = 0.002$.

In addition, there were 11 interactions involving Red Grouse cocks (four individuals) and Greyhens (eight individuals); and three interactions involving one Red Grouse hen and three Greyhens. In each case, the Red Grouse were dominant.

Discussion

One of the patterns often used to infer interspecific competition between closely related species is an inverse relationship in densities. The present work provides an example of this, but with low Black Grouse numbers tending to lag a year behind high

Table 2 - The results of disputes between captive Red and Black Grouse in 1987 and 1988.

Year	Red Grouse	Black Grouse		
		GR	PR	OR
1987	A	chase	draw*	—
	B	chase/peck**	chase/peck	chase/peck
	C	—	chase/peck	chase/peck (2)
		GR	MR	OR
1988	D	chase (2) chase/peck (2)	chase/peck peck/retreat retreat	— —
	E	—	—	chase (4) chase/peck peck
	F	—	retreat/peck (2)	—

(n) number of encounters of this type if>1.

Red Grouse dominated (except*) Black Grouse inside Black Grouse territories except (**) which was inside a Red Grouse territory. Black Grouse retreated. No reverse situation were observed during the experiments.

Red Grouse densities. This lag could occur if Red Grouse tend to inhibit young Black Grouse recruits from settling on an area, while having little effect on established adults. Peaks in shooting bags of Red and Black Grouse in Scotland have usually occurred within 2-3 years of one another (MacKenzie 1952). However, peaks in bags of Black Grouse have tended to come before those of Red Grouse (MacKenzie 1952), which is consistent with the suggestion that Red Grouse at high densities may reduce numbers of Black Grouse.

Wiens (1989) emphasised that inverse relationships between the densities of different species may be due to various processes and need not involve competition. For example, some aspect of the environment may change to the relative advantage of one species and the detriment of another. Certainly, Black Grouse on heather moors are generally found where the heather is on average taller than where high densities of Red Grouse occur (Parr and Watson 1988). However, the changes in numbers of both species in the present study were much too rapid to be explained by changes in the heather sward.

In the wild, Red Grouse are on their territories while Black Grouse are away from their display grounds. This idea is reinforced by the fact that the more closely matched encounters between Red and Black Grouse (Appendix I, (iv)) were observed in a field near a Blackcock lek. This was not so in captivity, however, where the mechanism seemed to be that Red Grouse were readier to attack and were better fighters. This relationship is consistent with the observations that Black Grouse densities tended to decline at high Red Grouse densities, but not vice versa, and allows one to postulate that aggressive interactions contributed to declines.

Interspecific aggression, however, does not necessarily imply competition as usually understood in the context of avian community ecology. Most definitions of competition also imply limitation of shared resources as a precondition of competition. This might be the case here, as heather is the main food of Red Grouse (Watson and Miller 1976), and is also one of the main foods of Black Grouse in Scotland (Johnstone 1969). The evidence suggests that "exploitation" competition is unlikely, but "interference" competition remains a possibility. It is possible that excluding Black Grouse from part of their range will reduce their performance.

Discussions of competition often involve assumptions that the birds' behaviour is in some sense optimal. It could be that driving Greyhens off the moor in spring, when good nutrition is critical (Moss 1977), allows Red Grouse hens greater access to the best food. Alternatively, the Red Grouse cocks' aggression might in some way enhance their social status and consequent access to resources and mates. More plausible, perhaps, is the suggestion (Murray 1971, 1976) that this behaviour is largely a consequence of misdirected aggression towards individuals of other species that are similar in behaviour. Certainly, some behaviour by tetraonids seems misdirected. Cock Capercaillie *Tetrao urogallus* sometimes attack humans, cock Willow Ptarmigan court Rock Ptarmigan hens (Moss 1972) and in the present study captive cock Red Grouse courted Greyhens. Relevant to this is the suggestion by Cramp (1980) that Black Grouse may interbreed with Red Grouse, Capercaillie and Pheasant *Phasianus colchicus*, and Capercallie with pheasant. In captivity, we have found that Red Grouse will interbreed with Rock Ptarmigan producing viable offspring.

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Riassunto — Il numero di Pernici bianche di Scozia e di Galli forcelli, in tre aree simpatriche di brughiera della Scozia, varia notevolmente di anno in anno. I Galli forcelli raggiungono i massimi numerici in corrispondenza dei minimi nella Pernice bianca di Scozia, o uno-due anni dopo. Durante interazioni competitive sia in campo che in aree recintate, la Pernice, più piccola, normalmente domina sul Gallo Forcello, più grosso. Si discute l'eventualità che la Pernice bianca di Scozia, ad alta densità, deprima la popolazione di Forcelli attraverso competizione aggressiva e del possibile ruolo adattativo di tali comportamenti.

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Appendix I

Disputes between Red and Black Grouse

At Kerloch we noted interspecific disputes between Red and Black Grouse on seven out of 32 occasions when they were within 5 m of each other; all seven were in 1968-71 when both species were increasing. Three encounters at Glen Esk were in 1961 and two in 1986, both years of high Black Grouse numbers there. All Red Grouse involved were cocks, which dominated in all encounters but one.

(i) Threat, once. - A Red Grouse raised his head and combs when a Blackcock walked within 4 m.

(ii) Short encounter, four times. - (a) A Red Grouse with stretched neck and raised combs, and a Blackcock with fanned tail faced each other 2 m apart. After half a minute the Blackcock broke off. (b) A Red Grouse gave a song flight, landing near a Blackcock which flew off after a few seconds. (c) A Red Grouse ran towards a Greyhen feeding on oats outside a wire-netting trap and she immediately flew off (d) A Blackcock flew for 3 m at a Red Grouse which then flew away.

(iii) Attack, four times. - (a) With heads forward and combs raised, two Red Grouse ran towards two Blackcocks and a Greyhen feeding on heather. The Greyhen flew off with one Blackcock; the other Blackcock then walked away, in a submissive posture. (b) A Red Grouse gave a song flight to land 5 m from two Greyhens, which ran away, and he chased them, with raised combs. (c) A Red Grouse approached a Greyhen caught in a trap on oat stubble, scratched at the wire with his feet, walked round the trap following her, and then jumped on top of the trap with combs raised, whilst she fluttered trying to escape. (d) A Red Grouse gave a song flight, landing near a Black cock which flew a few metres, chased by the Red Grouse. They landed and briefly faced each other, but when a second Red Grouse gave a song flight nearby, they broke off and all three started feeding.

(iv) Prolonged encounter for several minutes, three separate occasions - A Red Grouse and Blackcock faced each other 1 m apart and stepped sideways along a line; the Red Grouse bobbed his head with combs raised, showing a posture and calls indicating attack intention (Watson and Jenkins 1964); the Blackcock fanned his tail, drooped his wings, took up a horizontal posture (Johnstone 1969), and hissed. In all three encounters the Blackcock broke off first, and showed a submissive posture while walking away.

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Predazione ai danni di popolazioni, trapiantate nell'Appennino pavese, di *Formica lugubris* Zett. ad opera del Picchio verde, *Picus viridis*

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Riassunto — Abbiamo valutato sotto vari aspetti i danni arrecati a popolazioni di *Formica lugubris* Zett. ad opera del Picchio verde, *Picus viridis* L.. Le indagini, eseguite in periodo di fine inverno del 1992 sull'Appennino Pavese in località Monte d'Alpe (Pavia) dove il Picchio verde è svernante e le popolazioni di *Formica lugubris* di origine alpina e prealpina sono ormai insediate in modo stabile, hanno riguardato 5 aree boschive con differenti condizioni ecologiche e 128 acervi di formiche. L'attività di predazione del Picchio verde è stata considerata sotto l'aspetto della gravità e tipologia del danno subito dai formicai e del ruolo che tale comportamento gioca sulle popolazioni della specie predata. Si può affermare che il Picchio verde tende a contenere la proliferazione dei piccoli nidi di *Formica lugubris* che si formano durante l'estate per distacco da acervi di milioni di operaie, senza però essere in grado di compromettere la vitalità di queste grandi e importanti colonie di formiche.

Introduzione

Per iniziare a conoscere la reale incidenza in Italia della predazione operata dal Picchio verde (*Picus viridis* L.) ai danni delle popolazioni di formiche del gruppo Formica rufa abbiamo esaminato gli acervi presenti in cinque aree-campione, con differenti caratteristiche ambientali, incluse nella Riserva naturale biogenetica "Monte d'Alpe" ed in ambiti immediatamente limitrofi ad essa dell'Appennino Pavese, dove tale specie ornitica risulta essere nidificante (Brichetti e Fasola 1990) ed è svernante (ril. pers.).
In questo territorio sono state a più riprese introdotte dagli ambienti alpini e prealpini d'origine, a partire dal 1951, popolazioni di *Formica lugubris* Zett. che vi si sono da tempo insediate in modo stabile, con finalità di controllo biologico di larve fitofaghe di Lepidotteri e principalmente della Processionaria del Pino *Thaumetopoea pityocampa* (Schiff.) (Lepidoptera, Thaumetopoeidae).

Metodi

I sopralluoghi sono stati eseguiti alla fine dell'inverno (7 febbraio e 3 marzo 1992), con suolo ancora parzialmente innevato. È stato scelto il periodo di inattività delle formiche per evitare che la riparazione dei danni agli acervi "mascherasse", più o meno fortemente, i danni causati dalla predazione del Picchio verde (*Picus viridis* L.), particolarmente intensa in questa stagione. Questo Picide infatti, considerato l'unico in grado di scavare caratteristici fori per il prelievo invernale di formiche negli acervi (Bezzel, 1989; Blume *et al.*, 1971; Cramp, 1985; Gösswald, 1989; Groppali, 1992), le cattura nel corso dell'intero anno, ma in periodi di piena attività dei formicai i danni vengono riparati immediatamente (Gösswald, 1989), divenendo pertanto difficilmente rilevabili.
Le aree-campione sono state scelte per rappresentare efficacemente le differenti situazioni ambientali della Riserva biogenetica "Monte d'Alpe" e degli ambiti ad essa limitrofi popolati da formiche di trapianto, e vi sono stati conteggiati tutti gli acervi presenti, per un totale di 128, suddivisi in categorie dimensionali, rilevandovi i danni, la loro tipologia e la loro entità approssimata. Le aree-campione scelte per l'indagine sono state le seguenti:

- Monte d'Alpe = parte interna di una pineta pura di Pino nero d'Austria, a quota di 1.220-1.250 m s.l.m., con osservazione di 41 acervi
- Zona Nord di Monte d'Alpe = tratto marginale di pineta con ricca presenza di Larice, limitrofo ad un ampio prato-pascolo, a quota di 1.180-1.240 m s.l.m., con osservazione di 25 acervi
- Poggioli d'Alpe = parte interna di bosco misto di Pino nero e Larice, con abbondanti latifoglie (principalmente Carpinello e Faggio), al margine

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di un faggeto puro, a quota di 1.150-1.180 m s.l.m., con osservazione di 19 acervi

- Costa Castelvecchio = parte interna di bosco misto di Larice, Faggio e Pino nero, a quota di circa 1.170 m s.l.m., con osservazione di 29 acervi
- Monte Calenzone = parte interna di bosco misto dominato dall'Abete bianco, con Pino nero, Larice e scarso Faggio, al margine di un faggeto puro, a quota di circa 1.110 m s.l.m., con osservazione di 14 acervi.

I formicai sono stati raggruppati in base alle loro dimensioni espresse in litri, per avere dati rapidamente traducibili sulle loro popolazioni (Ronchetti et al., 1986), considerando che un formicaio di 200 litri contiene circa 150.000-200.000 operaie e 200 regine (Gösswald, 1971). Le categorie impiegate sono state le seguenti:

- acervo piccolo = volume inferiore ai 150 l
- acervo medio = tra 151 e 900 l
- acervo grande = oltre 901 l.

I danni agli acervi, la cui entità è stata approssimativamente stimata in "grave" e "modesta", sono stati suddivisi nelle seguenti categorie, con la misurazione della distanza dal suolo per i prelievi laterali di formiche:

- asportazione di zolla in posizione laterale
- asportazione di zolla in posizione sommitale
- scavo di foro in posizione laterale
- scavo di foro in posizione sommitale.

Per quanto riguarda l'asportazione di zolle, sempre facilmente distinguibile dai danni arrecati agli acervi da altri animali (come ad esempio il Cinghiale), crediamo si sia trattato dell'impiego del becco come di una leva, incuneata sotto parti compatte della superficie di un formicaio, per scalzarle scoprendo punti ricchi di prede.

Non figurano invece nell'indagine i fori di dimensione minima (osservati molto di rado proprio per la facilità di una loro cancellazione dovuta al normale assestamento dei materiali dell'acervo), provocati dalla sola introduzione del becco nel formicaio per prelevarvi formiche con l'impiego della lingua. Abbiamo infatti considerato che simile azione possa essere valutata come virtualmente ininfluente sulle popolazioni predate, oltre che — ovviamente — di impossibile rilevazione sistematica.

Risultati

Come riportato nella Tabella 1 le aree nelle quali è stata maggiore l'incidenza della predazione operata dal Picchio verde sono Costa Castelvecchio (58,6% di formicai danneggiati) e Monte Calenzone (78,5%), nelle quali la vegetazione forestale sembra essere più adatta alle esigenze della specie ornitica (bosco misto costituito da conifere e latifoglie) e gli acervi, abbondantemente popolati, sono posti a breve distanza tra loro. L'area dove la predazione è stata invece più contenuta è la Zona Nord di Monte d'Alpe, che pur affacciandosi al margine di un'ampio prato ha avuto soltanto il 32% dei formicai danneggiati: tale fatto potrebbe suggerire che il Picchio verde, almeno durante l'inverno, privilegi le aree ricche di fonti di cibo, indipendentemente dalla loro prossimità a spazi aperti (dove i piccoli formicai sono visibili massimamente dopo lo scioglimento della copertura nevosa).

Per quanto riguarda le preferenze accordate in base alle categorie dimensionali abbiamo (Tabella 2) che gli acervi maggiormente attaccati sono quelli di dimensioni maggiori (oltre 901 l di volume), con 58,1% nidi danneggiati sui 43 censiti, seguiti dai medi con 38,9% su 23 censiti, ed infine dai piccoli con 34,6% su 26 censiti. Sembra pertanto evidente che la maggior attività predatoria si rivolge agli acervi più facilmente visibili nel bosco, oltre che dotati di maggiori popolazioni. In senso inverso va invece la percentuale di acervi danneggiati gravemente (valutata soltanto sugli acervi utilizzati come fonte alimentare), con i piccoli maggiormente rappresentati (23%), seguiti dai medi (3,3%) ed infine dai grandi (2,3%): il Picchio verde è in grado di sconvolgere profondamente i formicai di minori dimensioni, quasi sempre neoformati nel corso della precedente stagione estiva, ancora privi di un'efficiente parte ipogea e pertanto con formiche catturabili in qualsiasi parte del nido.

Le modalità di prelievo di formiche dagli acervi possono essere così riassunte (Tabella 1):

- nei formicai piccoli è sempre preferita l'asportazione di zolle sommitali, in grado di garantire il rapido raggiungimento del "cuore" della colonia, mentre non sono mai stati riscontrati fori sommitali (tecnicamente forse meno validi del sollevamento di ampie zolle)
- nei formicai medi è ancora l'asportazione di zolle sommitali la tecnica preferita, ma ad essa si affiancano (in quantità leggermente più contenuta) gli scavi di fori laterali e sommitali, mentre è molto poco impiegata l'asportazione di zolle laterali
- nei formicai grandi è maggiormente impiegato lo scavo di fori, con una leggera preferenza per quelli laterali, ed ha luogo spesso l'asportazione di zolle laterali, mentre ha minor rilievo quella operata nelle parti sommitali dell'acervo.

Tabella 1 - Risultati dell'indagine sui nidi di *Formica lugubris* Zett. danneggiati dal Picchio verde in 5 aree campione (Monte d'Alpe, Appennino Pavese, Italia).

Nidi censiti per categoria dimensionale	Nidi danneggiati	Tipo di danno					
		Fori*		Zolle*		Danni gravi	Danni totali
		F. S.	F. L.	Z. S.	Z. L.		
AREA 1 (Monte d'Alpe)							
▲ 14	7	—	2	5	1	5	6
◆ 25	8	3	2	3	—	2	8
■ 2	—	—	—	—	—	—	—
Totale 41	15 (36.6%)					7	
AREA 2 (Nord di Monte d'Alpe)							
▲ 8	2	—	1	2	—	1	3
◆ 15	4	1	2	1	—	—	4
■ 2	2	—	2	—	1	—	3
Totale 25	8 (32.0%)					1	
AREA 3 (Poggioli d'Alpe)							
▲ —	—	—	—	—	—	—	—
◆ 7	3	1	—	1	1	—	3
■ 12	4	1	3	1	1	1	6
Totale 19	7 (36.8%)					1	
AREA 4 (Costa Castelvecchio)							
▲ 3	—	—	—	—	—	—	—
◆ 10	6	2	3	1	2	—	8
■ 16	11	8	2	—	1	—	11
Totale 29	17 (58.6%)					—	
AREA 5 (Monte Calenzone)							
▲ 1	1	—	—	—	1	—	1
◆ 2	2	—	—	2	—	—	2
■ 11	8	—	6	1	5	—	12
Totale 14	11 (78.5%)					—	

Categorie dimensionali (espresse in litri) degli acervi di *Formica lugubris* Zett.:

▲ da 0 a 150 litri
◆ da 151 a 900 litri
■ oltre 901 litri

* Il danno, inteso come scavo di FORO dell'acervo in posizione sommitale (F.S.) e in posizione laterale (F.L.) e come asportazione di ZOLLA dall'acervo in posizione sommitale (Z.S.) e in posizione laterale (Z.L.) viene quantificato assegnando il valore 1 ad ogni evento di danno.

Per quanto riguarda infine la distanza dal suolo preferita per lo scavo di fori laterali negli acervi medi e grandi, il Picchio verde ha dimostrato di prediligere le aree prossime alla base oppure a breve distanza da essa (fino a 30 cm dal terreno in acervi medi e fino a 50 in grandi), con rispettivamente il 71,4% ed il 66,6% dei fori laterali.

Discussione

Risulta evidente una notevole azione predatoria da parte del Picchio verde ai danni delle popolazioni introdotte di *Formica lugubris* Zett., anche se nel corso dei frequenti sopralluoghi, effettuati a partire dal 1951 nell'area di Monte d'Alpe e negli ambiti

Tabella 2 - Preferenze del Picchio verde in base alle dimensioni dei nidi di *Formica lugubris* Zett..

Nidi censiti in totale		Nidi danneggiati in totale			
		numero	percentuale di danno	danni gravi	
▲ da 0 a 150 litri	26	10	34.6%	6	23%
◆ da 151 a 900 litri	59	23	38.9%	2	3.3%
■ oltre 901 litri	43	25	58.1%	1	2.3%
Totale	128	58	45.3%	9	7%

limitrofi, non sono mai state riscontrate popolazioni eliminate o seriamente danneggiate per questa causa. Il ruolo locale del Picchio verde sembra semmai essere quello di contenere parzialmente la proliferazione dei piccoli acervi, che vengono seriamente danneggiati in quantità a volte piuttosto rilevanti, senza però essere in grado di compromettere la vitalità complessiva delle colonie di formiche trapiantate e soprattutto dei grandi formicai. Questi ultimi subiscono frequenti prelievi di formiche, ma la loro vitalità non risulta in alcun modo compromessa dal sacrificio di una piccola parte delle popolazioni.

Una forma di difesa passiva degli acervi di maggiori dimensioni, nei quali le formiche devono essere cercate (soprattutto durante l'inverno) a profondità anche rilevanti, è sicuramente la loro inaffidabile stabilità: il materiale impiegato per la loro costruzione è infatti costituito da aghi di conifere ed altri residui vegetali, assolutamente non legati tra loro. Può quindi capitare che un Picchio verde che si è addentrato troppo profondamente in un acervo vi rimanga intrappolato per il crollo della galleria scavata, finendo per morirvi: abbiamo infatti rinvenuto, nel corso di operazioni di trapianto nella Riserva Monte d'Alpe, lo scheletro di un Picchio verde all'interno di un grande acervo, dal quale non era più riuscito ad uscire.

È pertanto possibile che si costituisca nell'area, originariamente non popolata da queste formiche, un nuovo equilibrio con il loro maggior predatore, che così può disporre di una valida fonte di cibo, senza danneggiarne in modo rilevante la stabilità.

Abstract — Damage caused by Green Woodpeckers to populations of *Formica lugubris* has been investigated. Data have been collected during late winter at Monte d'Alpe (Appennino Pavese, Northern Italy) where the Green Woodpecker is a wintering species and where population of *Formica lugubris* from the Alps and Prealps have been transplanted and are nowadays firmly settled.

Data have been gathered from 5 woody areas differing in their ecological peculiarities for a total of 128 ant-hills.

Predation by the Green Woodpecker has been evaluated according to the degree of damage suffered by ant-hills, the tipology of damage caused and the role played by the Green Woodpecker's behaviour upon prey populations.

From our research it appears that the Green Woodpecker tends to limit proliferation of small (new) ant-hills originating by the splitting apart from the larger (old) ant-hills during summer without nontheless impairing the overall vitality of these large and important colonies of ants.

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Biologia riproduttiva di una popolazione di Passera d'Italia, *Passer italiae*, nidificante in una "colombaia" della pianura lombarda

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Riassunto — Vengono presentati i risultati di una ricerca condotta nel 1991 sulla biologia riproduttiva di una popolazione di *Passer italiae* nidificante nella "colombaia" di una cascina della pianura lombarda. L'inizio della costruzione dei nidi è compreso tra il 15 marzo e il 28 luglio. I nidi sono stati terminati in un tempo medio di 6,7 giorni (2-14). Tra l'ultimazione del nido e l'inizio della deposizione trascorrono in media 2,4 giorni (1-8). L'inizio delle deposizioni è compreso tra il 27 marzo e il 13 agosto. Nello stesso nido si sono avute fino a 4 deposizioni consecutive. La dimensione media della covata è 5,3 uova (2-8), con differenze statisticamente significative tra covate e mesi. Le uova misurano in media mm 21,7 × 15,4 e pesano g 2,7 (n = 133). La durata media dell'incubazione è 11,9 giorni (11-15), con valore modale di 11, quella dell'allevamento dei pulli di 13,2 (11-17), con valore modale di 13; in entrambi i casi si sono rilevate differenze statisticamente significative tra covate e mesi. Il numero medio di pulli/covata alla schiusa è 4,4 (1-7), quello dei pulli/nidiata all'involo di 3,5 (0-7). I tassi di schiusa e d'involo, rispettivamente del 75,5% e dell'81,2%, sono più alti nelle covate numerose. Il successo riproduttivo è del 61,3%. La produttività annua per nido è in media di 7,3 pulli involati, con un max di 20 pulli in 4 deposizioni. I risultati evidenziano l'influenza svolta dalle condizioni meteorologiche sull'andamento della nidificazione e soprattutto sul successo riproduttivo.

Introduzione

La Passera d'Italia, *Passer italiae*, è specie sedentaria e nidificante in Italia, localmente dispersiva o erratica nel periodo autunno-invernale. Nelle zone alpine è sostituita totalmente o in parte dalla Passera europea o oltremontana *Passer domesticus*, con la quale si ibridizza (Schifferli e Schifferli 1980, Niederfiniger *et al.*, in Brichetti 1986, Summers-Smith 1988). Le popolazioni italiane di passera, riconosciute come ibridi stabilizzati tra *Passer domesticus* e *Passer hispaniolensis* dovrebbero essere considerate al rango di specie (*Passer italiae*) (Johnston 1969, Cova 1977, Massa 1989).

In Italia, la biologia riproduttiva di questa specie non è ancora stata oggetto di ricerche, anche se l'abituale nidificazione in condizioni sinantropiche offre numerose opportunità di studio. Gli unici lavori riguardano date di deposizione e dimensioni delle covate di coppie nidificanti in nidi artificiali nel Lazio (Sorace, in stampa), date di riproduzione precoce o tardiva (Bordignon 1985, Mostini 1987), preferenze nell'occupazione di cassette nido (Cianchi e Sorace 1992) e nidificazioni in associazione con *Milvus migrans* (Petretti 1991). Alcuni dati sulla biologia riproduttiva di *Passer hispaniolensis* sono noti per la Sicilia (Massa 1985) e le Is. Maltesi (Sultana e Gauci 1982). Nel resto dell'areale *Passer hispaniolensis* e soprattutto *Passer domesticus* sono stati oggetto di numerosi studi, sia nelle zone di distribuzione originaria sia in quelle ove sono state introdotte (cfr. lavori citati in Summer-Smith 1963, 1988).

Metodi

Nella stagione riproduttiva 1991 abbiamo effettuato una ricerca sulla biologia riproduttiva di numerose coppie di Passera d'Italia (*Passer italiae*) e di Storno (*Sturnus vulgaris*) nidificanti nella "colombaia" (conosciuta anche come "torre passerera") della Cascina San Paolo, sita a Borgo San Giacomo (BS). I risultati della ricerca sullo Storno sono stati pubblicati a parte (Brichetti *et al.* 1993).

L'area di studio si trova in una zona intensamente coltivata della bassa pianura bresciana, a c. 70 m di quota (45°20' N-10°00' E), a prevalenti coltivazioni cerealicole e foraggere. La colombaia (localmente "colombéra") ha pianta quadrata, superficie di circa 25 mq e occupa la parte superiore del cascinale. Le pareti contenenti i fori hanno un'altezza di 3 m e sono orientate verso i quattro punti cardinali. L'intero edificio è alto circa 12 m, mentre la fascia dei fori è compresa tra 9 e 11 m.

Accettato 11 settembre 1993

A fine febbraio 1991 tutte le cavità-nido sono state completamente ripulite dai materiali dei vecchi nidi. Le 338 cavità-nido hanno una base di 16 × 20 cm e altezza di 16; il foro di ingresso ha un diametro di circa 5 cm. Le cavità-nido, distribuite in file verticali di 8, sono chiuse verso l'interno da assi di legno apribili per l'ispezione. Ogni cavità-nido è stata numerata progressivamente per il riconoscimento. Sulle pareti esposte a S e O, le file di fori più basse si trovano a breve distanza (30-80 cm) dal tetto del cascinale, per cui risultano vulnerabili all'azione di potenziali predatori.

I controlli alla colombaia sono stati effettuati dal 10 gennaio al 20 settembre 1991, con periodicità settimanale fino al 10 marzo e dopo il 31 luglio, e a giorni alterni nel periodo centrale della riproduzione, impiegando complessivamente 260 ore di ricerca.

Durante il periodo di studio, oltre alle temperature medie giornaliere, sono state registrate le condizioni meteorologiche generali (in particolare presenza o assenza di venti e di precipitazioni). Si è misurato e pesato un campione elevato di uova e seguito l'accrescimento ponderale dei pulli di differenti covate. Ogni controllo è stato effettuato da almeno due ricercatori.

Risultati e discussione

Occupazione delle cavità-nido e covate annue

La popolazione nidificante è risultata prevalentemente sedentaria, in quanto l'80-90% degli individui stimati a stagione riproduttiva ultimata, era presente durante i controlli effettuati dal 10 gennaio a fine febbraio; gli individui sembravano già accoppiati e utilizzavano i vecchi nidi come dormitori, apportandovi frequentemente materiali. Nell'intera stagione riproduttiva sono state occupate e/o rioccupate, con apporto di materiale, 245 cavità-nido (72,5%; n = 338), ma solo in 236 (70%) si è avuta deposizione di uova e in 230 (68%) presenza di covate complete. I nidi costruiti ex novo sono stati 104 (31%), ma solo in 101 la covata è stata completata. L'orientamento della parete ha un'influenza significativa sull'occupazione delle cavità-nido: il 45% delle coppie ha utilizzato cavità esposte a E e il 40% a N, contro il 10% a O e il 5% a S (test χ^2, $p<0{,}01$). L'ipotesi che le pareti esposte a N e E siano maggiormente protette dagli agenti atmosferici sfavorevoli (venti tesi, pioggia battente) e dai potenziali predatori (gatti, ratti), e quindi considerate come ottimali, è confermata dal fatto che il 53% e il 43% dei nidi terminati entro marzo era ubicato in cavità esposte rispettivamente a E e N (test χ^2, $p<0{,}05$). Le altre due pareti, considerate quindi sub-ottimali, vengono occupate solo quando le altre sono sature. I primi a occupare le cavità-nido e a scegliere i siti migliori sono generalmente ritenuti gli individui più anziani (cfr. Summers-Smith 1988). In mancanza di marcaggio degli animali è risultato impossibile il riconoscimento individuale delle coppie. Per tale motivo, la ripartizione del periodo riproduttivo e degli altri parametri riproduttivi in 4 covate annue è basata sui nidi e non sulle coppie. Per *Passer domesticus* sono noti casi di bigamia o di utilizzo di nidi di altre coppie dopo l'involo dei pulli; alcuni studi hanno evidenziato che l'86% dei maschi e il 45% delle femmine rioccupano gli stessi nidi per l'intera stagione, mentre *Passer hispaniolensis* si ritiene riutilizzi lo stesso nido per le deposizioni successive (cfr. Summers-Smith 1988). Le I covate riguardano quindi deposizioni in nidi costruiti ex novo, le successive (compresi eventuali rimpiazzi) deposizioni ripetute negli stessi nidi. In base a tale distinzione, le 230 covate complete sono così ripartite: I covate = 43,9%, II = 29,6%, III = 19,1%, IV = 7,4%.

Per *Passer hispaniolensis* sono note da 1 a 4 deposizioni annue, con sensibili variazioni tra anni dovute alle disponibilità alimentari e soprattutto alla dinamica invernale (per es. mortalità). In Sicilia la II covata è quasi la prassi, mentre in alcuni anni la III può non avere luogo e in altri può essere deposta perfino una IV covata (B. Massa, com. pers.). In generale la percentuale di coppie che depongono una II covata varia dal 21% al 46%. Per *Passer domesticus* si è notata una correlazione negativa tra il numero di covate annue e la latitudine (Summers-Smith 1988). Nel Lazio si è rilevato un 21% di II covate (Sorace, in stampa).

Periodo di costruzione e descrizione dei nidi

Escludendo saltuari apporti di materiali a partire dalla prima settimana di marzo, l'inizio della costruzione sistematica dei nidi della I covata è risultato compreso tra il 15 marzo ed il 28 luglio. In questo periodo si è avuto un picco principale in corrispondenza del 15-20 marzo, che ha riguardato il 53% delle coppie; l'84,4% dei nidi è stato iniziato entro il 31 marzo. I cali di attività nella costruzione dei nidi sono da mettere in relazione a contingenti situazioni meteorologiche sfavorevoli. Il nido più precoce è stato terminato il 20 marzo. In generale il periodo di inizio della costruzione dei nidi varia con la latitudine: aprile (Val d'Aosta: Bocca e Maffei 1984), seconda decade di marzo (Toscana: Dinetti e Ascani 1990), fine febbraio-marzo (Sicilia: Iapichino e Massa 1989) e febbraio (Is. Maltesi: Sultana e Gauci 1982).

Il tempo impiegato per la costruzione del nido è risultato in media di 6,7 giorni (D.S. 3,1; 2-14; n = 56), considerando i soli nidi costruiti senza interruzioni ed escludendo quelli terminati in più di 14 giorni. I nidi sono stati considerati terminati quando gli adulti non vi hanno più apportato materiali e hanno iniziato a deporre.

Riguardo alla forma, il 68% dei nidi era sferico con ingresso laterale o verso l'alto, il 32% semi-sferico con o senza innalzamento di una parte del bordo. I nidi risultavano voluminosi e costituiti da steli erbacei secchi con l'interno della coppa rivestito da penne, peli, radichette, lanuggine e, in alcuni casi, da steli erbacei verdi, pezzetti di carta, corde e filamenti plastici. Il foro di ingresso dei nidi sferici non è mai risultato orientato verso quello della cavità. In 10 casi i nidi sono stati costruiti su altrettanti abbandonati da *Sturnus vulgaris*.

Calendario delle deposizioni

Tra l'ultimazione dei nidi e le deposizioni del primo uovo si è rilevato un periodo medio di 2,4 giorni (D.S. 2,3; 1-8; n = 32, escludendo i casi con oltre 8 gg. di intervallo tra le due fasi). Considerando l'intero ciclo riproduttivo (n = 230 covate), le date estreme di inizio deposizione sono comprese in un lasso di tempo di 140 giorni, tra il 27 marzo e il 13 agosto, con il 58% delle I covate deposto entro il 30 aprile e il 63% delle II tra il 29.IV e il 31.V. Le IV covate sono iniziate il 7.VIII. Le date di deposizione, riferibili ovviamente al solo anno della ricerca, risultano anticipate rispetto a quelle rilevate nel Lazio (data più precoce: 27.IV; Sorace, in stampa), ma sono in accordo con quanto noto in Europa, dove risulta evidente una correlazione negativa con la latitudine. In Sicilia prime deposizioni all'inizio di aprile (Iapichino e Massa 1989), in Toscana (Firenze) verso la metà di aprile. È inoltre noto che le coppie che utilizzano cavità protette iniziano a nidificare prima (Summers-Smith 1988). Da ritenersi eccezionale il caso di deposizione in gennaio riscontrato da Bordignon (1985).

Tra l'involo dei pulli di una covata e la deposizione del primo uovo della successiva sono trascorsi in media 5,2 giorni (1-14; n = 83, escludendo 6 casi oltre i 15 gg. e considerando che in 3 casi il primo uovo è stato deposto lo stesso giorno dell'involo e, in altri 3, il giorno prima; tali eventi sono già noti in letteratura per altre specie del genere (cfr. Summers-Smith 1988).

Dimensioni delle covate

Il numero medio di uova/covata completa è risultato di 5,3 (D.S. = 1,1; 2-8; n = 230), con valori più elevati nel periodo centrale della riproduzione, corrispondente alle II-III covate e ai mesi di maggio-giugno (cfr. Tabella 1). Si sono rilevate differenze significative (test di Student, p<0,05) tra I e II e tra II e IV covate. Considerando le deposizioni mensili, differenze significative tra aprile e maggio-giugno-agosto (p<0,01), tra giugno-luglio (p<0,005), tra

Tabella 1 - Parametri produttivi divisi per covate e mesi.

covate		dimens.		durata		tasso	dim. nidiata		dimensione nidiata				durata		tasso	succ.
		covata		incub.		schiusa	alla schiusa		all'involvo				allev.		involvo	ripr.
mese deposiz.		**X**	**DS**	**X**	**DS**	%	**X**	**DS**	**X***	**DS**	**X****	**DS**	**X**	**DS**	%	%
I	(n = 101)	5,1	1,1	12,3	1,1	67,6	4,1	1,3	2,7	1,9	3,6	1,8	13,6	1,3	70,3	47,6
II	(n = 68)	5,5	1,0	11,8	1,1	81,3	4,8	1,3	4,1	1,8	4,4	1,5	13,1	0,9	84,6	68,8
III	(n = 44)	5,4	1,1	11,2	0,5	79,9	4,6	1,3	4,5	1,5	4,7	1,1	12,9	0,6	94,8	75,7
IV	(n = 17)	4,9	1,0	11,5	0,7	84,5	4,2	1,1	3,5	1,5	3,7	1,4	13,4	0,7	83,1	70,2
Aprile	(n = 61)	5,1	1,0	12,7	1,0	65,3	3,9	1,2	2,0	1,8	3,1	1,3	14,0	1,4	50,2	32,8
Maggio	(n = 58)	5,6	1,0	11,9	1,1	80,0	5,0	1,2	4,0	1,9	4,4	1,4	13,0	0,9	80,0	64,0
Giugno	(n = 57)	5,6	1,1	11,5	0,9	76,8	4,8	1,3	4,7	1,3	4,7	1,3	13,0	0,8	98,0	75,2
Luglio	(n = 43)	4,9	1,0	11,3	0,6	77,7	4,0	1,2	3,6	1,5	3,8	1,2	13,2	0,8	90,2	70,1
Agosto	(n = 11)	4,2	0,8	11,1	0,3	76,1	3,5	1,0	3,0	1,8	3,8	0,9	13,4	0,5	85,7	65,2
Totali		5,3	1,1	11,9	1,0	75,5	4,4	1,3	3,5	1,9	4,1	1,4	13,2	1,0	81,2	61,3
(n)		(230)		(205)			(205)		(205)		(177)		(177)			

* Calcolata su tutte le nidiate; ** calcolata sulle nidiate con almeno 1 pullus.

giugno-agosto ($p<0,001$) e tra luglio-agosto ($p<0,05$). Il valore modale è di 5 uova, come nelle I e IV covate, mentre risulta di 6 nelle II e III, che si collocano nel periodo centrale della riproduzione maggiormente favorito dalle condizioni climatico-ambientali. Il numero cumulativo di uova deposte per nido (o "presunta" coppia) è risultato in media di 12 uova (n = 101).

Nel Lazio la dimensione media delle I covate di 5 diverse località è risultata di 5,2 (3-7; n = 44; valore modale = 5), con minimo di 4,9 e massimo di 5,4 (Sorace, in stampa). Per *Passer hispaniolensis* sono noti valori medi di 4,5 (3-6) (Massa 1985), 4,3 (Tunisia), 4,4 (Kazakhstan, n = 1079) e 5,9 (Macedonia, n = 57) (AA.VV. in Summers-Smith 1988). La covata completa varia tra 2-8 uova, con intervallo più stretto (4-6) nelle Is. Maltesi (Sultana e Guaci 1982). Per *Passer domesticus* la covata completa varia normalmente tra 2-5 uova (eccezionalmente fino a 10 per il probabile concorso di due femmine) con valore modale di 4 in Gran Bretagna e di 5 in Nord-America e Europa continentale, dove la dimensione media della covate aumenta con la latitudine e da Ovest verso Est. Il numero annuo di uova/coppia varia da 7,3 a 16,4 (AA.VV. in Summers-Smith 1988).

Descrizione delle uova e durata dell'incubazione

Le uova hanno forma variabile da ovale-corta a subellittica, guscio liscio leggermente lucido e colorazione di fondo da bianca a bianco-grigia, bianco-verdognola o bianco-azzurrognola. La macchiettatura, di colore grigio, bruno, violaceo o nerastro, è molto variabile nella forma, distribuzione e intensità: vi sono uova molto "chiare", con macchiettatura grossolana e rada, altre completamente "scure" per la densa e fine macchiettatura che copre la tinta di fondo. Generalmente la macchiettatura è concentrata o più fitta al polo ottuso. La colorazione e il tipo di macchiettatura variano anche nell'ambito della stessa covata. L'80% delle uova "chiare" aveva forma ovale allungata.

Un campione di 133 uova misurava in media mm 21,7 (D.S. 0,9; 19,5-23,8) × 15,4 (D.S. 0,6; 13,5-16,8) e pesava g 2,7 (D.S. 0,3; 2,1-3,7) (Brichetti 1992). Per la Sicilia sono indicati valori medi di 22,4 × 16,1 mm (Massa 1985).

La durata dell'incubazione, calcolata dalla deposizione dell'ultimo uovo alla schiusa del primo pullus, è risultata di 11,9 gg. (D.S. 1,0; 11-15; n = 205), con valore modale di 11 gg. per tutte le covate (cfr. Figura 1). L'intervallo più ampio (11-15 gg.) si riferisce ad aprile-maggio, quello più stretto (11-12 gg.) ad agosto. Si sono rilevate differenze significative (test di Student) tra covate: I-II e III-IV ($p<0,05$), I-III e II-III ($p<0,001$) e tra mesi: aprile-maggio ($p<0,001$), maggio-giugno e maggio-

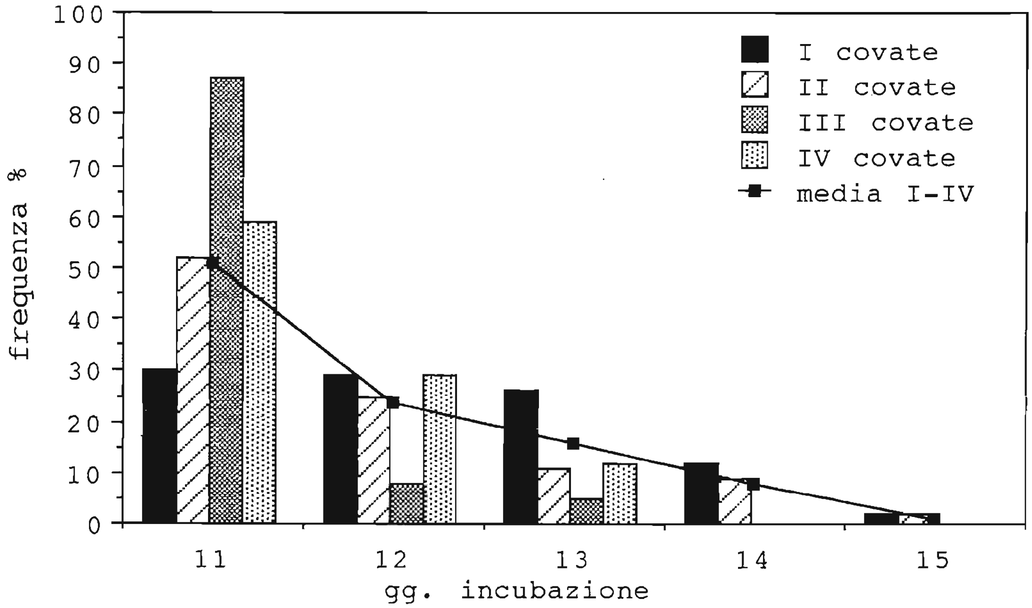

Figura 1 - Distribuzione della durata dell'incubazione delle uova.

agosto ($p<0,05$), maggio-luglio ($p<0,01$) (cfr. Tabella 1). La diminuzione della durata dell'incubazione con il progredire della stagione riproduttiva conferma quanto noto in letteratura (cfr. Summers-Smith 1988) e andrebbe collegata all'aumento progressivo della temperatura. Il valore più elevato riguarda in effetti I covate (12,3) e aprile (12,7), mese caratterizzato da piogge e freddo persistenti.

Per *Passer hispaniolensis* l'incubazione, calcolata dalla deposizione dell'ultimo uovo alla schiusa del primo pullus, varia tra 10-14 gg (Is. Maltesi), 11-14 e 11-11,5, per *Passer domesticus* tra 10-17 gg., con medie di 11-14 nei vari studi. In realtà l'incubazione inizia prima che la covata sia completa (Sultana e Gauci 1982, Summers-Smith 1988).

Tasso di schiusa e durata dell'allevamento dei pulli

Le uova si sono regolarmente schiuse nell'87% delle 236 covate iniziate; delle 31 covate abbandonate (13,1%), 6 sono state solo iniziate e 25 completate. Le perdite più elevate si sono avute in cavità-nido esposte a S (66,7%) e O (26,1), maggiormente esposte alle intemperie e ai predatori, le più basse a N (12,6%) e E (5,7%).

Il numero medio di pulli/nidiata alla schiusa è risultato di 4,4 (D.S. 1,3; 1-7; n = 205); i valori più bassi riguardano il periodo iniziale della riproduzione (cfr. Tabella 1) caratterizzato da situazioni meteorologiche sfavorevoli. Si sono rilevate differenze significative (test di Student) tra covate: I-II ($p<0,001$) e I-III ($p<0,05$) e tra mesi: aprile e maggio-giugno ($p<0,001$), maggio-luglio ($p<0,001$) e giugno-luglio $p<0,05$).

Il tasso di schiusa è risultato del 75,5%, con valori più bassi nelle I covate e nel mese di aprile (cfr. Tabella 1); in relazione alle dimensioni delle covate i valori più elevati si rilevano nelle covate numerose: min 47,6 nelle covate di 3 uova, max 79,6 in quelle di 7, escludendo quelle di 2 e 8 in quanto rappresentate da un campione troppo piccolo (cfr. Tabella 2).

Per *Passer domesticus* il tasso di schiusa varia dal 50% al 95%, per *Passer hispaniolensis* dall'84,8 al 91,5% (AA.VV. in Summers-Smith 1988).

La durata media dell'allevamento dei pulli è risultata di 13,2 gg. (D.S. 1,0; 11-17; n = 177), con valori più alti all'inizio e al termine del periodo riproduttivo (cfr. Tabella 1). Non è da escludere che alcuni controlli possano avere causato un involo precoce (ca. 1 giorno) dei pulli. Si sono rilevate differenze significative (t di Student) tra covate: I-II e III-IV

Tabella 2 - Parametri riproduttivi in relazione alle dimensioni delle covate e delle nidiate.

Dimens. covate	covate	no. covate	uova deposte	cov. abband.	uova schiuse	tasso schiusa % Parz.	tot	no. nidiate	nid. abband.	pulli involati	tasso involvo % invol/nati parz.	tot.	successo riproduttivo % involati/uova dep. parz.	tot.
2	I	1	2	—	2	100	100	1	—	2	100	100	100	100
3	I	7	21	4	9	42,9		3	—	8	88,9		38,1	
	II	2	6	2	—	—		—	—	—	—		—	
	III	3	9	1	6	66,7		2	—	6	100		66,7	
	IV	2	6	—	5	83,3	47,6	2	—	5	100	95,0	83,3	45,2
4	I	19	76	5	42	55,3		14	6	19	45,3		25,0	
	II	10	40	—	31	77,5		10	—	30	96,8		75,0	
	III	6	24	1	16	66,7		5	2	12	75,0		50,0	
	IV	2	8	—	7	87,5	64,9	2	—	7	100	70,8	87,5	45,9
5	I	40	200	4	147	73,5		36	10	90	63,4		45,0	
	II	19	95	2	77	81,1		17	1	70	90,9		73,7	
	III	12	60	1	49	81,7		11	—	44	89,8		73,3	
	IV	8	40	—	33	82,5	77,5	8	1	27	81,8	75,5	67,5	58,5
6	I	25	150	3	103	68,7		22	4	92	89,3		61,3	
	II	25	150	1	126	84,0		24	2	95	75,4		63,3	
	III	15	90	1	74	82,2		14	—	73	98,.6		81,1	
	IV	5	30	—	26	86,7	78,3	5	—	20	76,9	85,1	66,7	66,7
7	I	8	56	—	39	69,6		8	1	29	74,4		51,8	
	II	12	84	—	71	84,5		12	1	63	88,7		75,0	
	III	8	56	—	46	82,1	79,6	8	—	46	100	88,5	82,1	70,4
8	I	1	8	—	5	62,5	62,5	1	—	4	80,0	80,0	50,0	50,0
Tot.	I-IV	230	1211	25	914	—	75,5	205	28	742	—	81,2	—	61,3

(p<0,05), I-III (p<0,005), e tra mesi: aprile e maggio-giugno (p<0,001), aprile-luglio (p<0,005). Il valore modale è di 13 giorni per tutte le covate (cfr. Figura 2), mentre l'intervallo più ampio (11-17 gg.) si riferisce ad aprile e quello più stretto (13-14 gg.) ad agosto.

Per *Passer domesticus* sono noti valori di 12-18 gg., con medie di 14-16 gg. nei vari studi, per *Passer hispaniolensis* di ca. 14 (Is. Maltesi), 11-12, 11-15 e c. 15 gg. (Sultana e Gauci 1982, Summers-Smith 1988).

Dimensione della nidiata e successo riproduttivo

Il numero medio di pulli per nidiata all'involo è risultato di 3,5 (D.S. 1,9; 0-7; n = 205), considerando tutte le covate, e di 4,1 (D.S. 1,4; 1-7; n = 177) considerando covate con almeno 1 pullus (cfr. Tabella 1). Si sono rilevate differenze significative (t di Student) tra covate: I e II-III (p<0,001) e III-IV (p<0,05), e tra mesi: aprile-maggio e giugno-luglio (p<0,001), maggio-giugno (p<0,05). Il valore più basso si situa all'inizio del periodo riproduttivo caratterizzato da condizioni sfavorevoli alla crescita dei pulli (scarsità di cibo dovuta a piogge persistenti e temperature molto basse). La nidiata più tardiva si è involata il 5 settembre. Da ritenersi eccezionale il rinvenimento di pulli a metà-novembre (Sultana e Gauci 1982) e in dicembre (Mostini 1987). Considerando i soli nidi in cui sono state deposte 4 covate (n = 16) e suddividendo i pulli in due gruppi (0-3 e 4-7), si è rilevato che nelle covate estreme (I e IV) il numero degli involati è significativamente più basso ($\chi^2 = 12,56$, p<0,01) di quello delle covate centrali (II e III); al contrario non si è rilevata una differenza significativa considerando il numero di uova deposte. Ciò confermerebbe che i fattori climatico-ambientali hanno un'incidenza maggiore nel periodo dell'allevamento dei pulli.

Il tasso d'involo (% di pulli involati su nati) è risultato dell'81,2%, mentre il successo riproduttivo (% pulli involati su uova deposte) del 61,3%. Escludendo i casi estremi, rappresentati da un campione troppo piccolo, il tasso d'involo e il successo riproduttivo aumentano con la dimensione delle nidiate (cfr. Tabella 2) e raggiungono i valori massimi nel periodo centrale della riproduzione (cfr. Tabella 1). La produttività annua per nido (o "presunta" coppia), riferita al numero cumulativo dei pulli portati all'involo, è risultata in media di 7,3 (n = 101), con un massimo di 20 pulli ottenuto in 4 covate.

In *Passer domesticus* il tasso di schiusa varia dal 28% all'89%, il successo riproduttivo dal 25% (media di 4 studi in India) all'85% (media di 4 studi in Polonia), con un valore medio del 48,5% in 33 studi e la produttività annua per coppia da 2,6 a 7,7 pulli/coppia. Il successo riproduttivo sembra variare da un anno all'altro e aumentare con la latitudine. Per *Passer hispaniolensis* gli scarsi dati a disposizione indicano tassi di schiusa variabili dal 53,5% al 62,3% (Summers-Smith 1988).

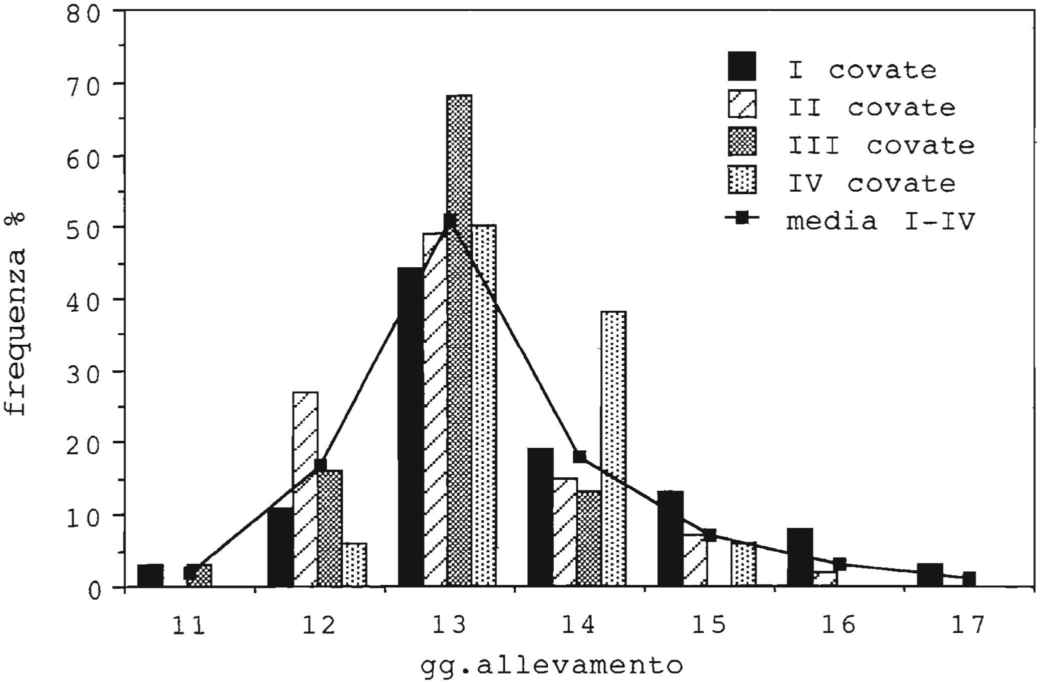

Figura 2 - Distribuzione della durata dell'allevamento dei pulli.

Ringraziamenti — Si ringraziano i fratelli Mensi di Verolavecchia per averci permesso di accedere alla "colombaia" della Cascina S. Paolo, Stefano Gellini e Bruno Massa per la lettura critica del manoscritto.

Abstract — Breeding Biology of Sparrow in a Dovecote of the Lombardy plain Results are given concerning a research conducted in 1991 on the reproductive biology of a population of *Passer italiae* breeding in a farm dovecote in the central Po river plain. Nest building began between 15 March and 28 July. Nests were completed within an average period of 6.7 days (2-14). An average period of 2.4 days (1-8) elapsed from nest completion to the beginning of egg laying. The clutches (1-4 per nest) started between 27 March and 13 August. The average clutch size was 5.3 eggs (2-8), with a significant difference between clutches and months. The average egg size was 21.7 × 15.4 mm, with an average weight of 2.7 grams (n = 133). The average incubation period was 11.9 days (11-15), with a modal value of 11 days, the average nestling feeding period took 13.2 (11-17) days, with a modal value of 13 days, and a significant difference between clutches and months. The mean number of nestlings per clutch at hatching was 4.4 (1-7); the mean number of fledgling youngs per clutch was 3.5 (0-7). The hatching rate was 75.5% and fledging rate 81.2%; in both cases the highest values correspond to more numerous clutches. The average breeding success was 61.3%, the average productivity per nest was 7.3 fledged nestlings, with a max of 20 in 4 clutches. The results show the remarkable influence of weather conditions upon breeding progress and, chiefly, upon breeding success.

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L'alimentazione del Nibbio bruno *(Milvus migrans)* nella Tenuta di Castelporziano (Roma)

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Riassunto — Nella Tenuta di Castelporziano (Roma) nidifica una popolazione di Nibbi bruni *(Milvus migrans)* composta nel 1991 da almeno 16 coppie, e nella stagione riproduttiva 1992 da 9 coppie. Durante il 1991 sono state collezionate le borre rinvenibili sotto i posatoi comuni usati anche come dormitori e dopo l'involo, avvenuto intorno alla metà di luglio, è stato raccolto il materiale all'interno di 15 nidi. Le prede identificate e le relative percentuali sia numeriche che in biomassa sono mostrate in Tabella 1: la più alta percentuale numerica é rappresentata dagli Insetti con il 39.5%, ma in biomassa non costituiscono che lo 0.2 % della dieta. Al contrario i Mammiferi pur essendo il 20.8% in numero, forniscono ben il 37.3% della biomassa totale consumata.

Introduzione

La Tenuta Presidenziale di Castelporziano (Roma) ospita la più densa popolazione di Nibbi bruni *(Milvus migrans)* dell'Italia Centrale.

La popolazione risulta più numerosa rispetto alle coppie censite un decennio fa (Tinelli e Tinelli 1983) e nidifica in una situazione semi-coloniale, con nidi situati anche a pochi metri di distanza l'uno dall'altro. Questo lavoro si propone come un contributo alle conoscenze della nicchia alimentare di questo rapace dotato di notevole adattabilità, fornendo indicazioni oltre che qualitative anche sulla biomassa del cibo ingerito.

Area di studio

La Tenuta di Castelporziano si estende per 4,784 ha sul sistema dunale nella zona compresa tra il mare e la città di Roma e i suoi confini sono rappresentati a sud-ovest dalla linea di costa, a ovest da Castelfusano, a nord-ovest dalla via C.Colombo, e a sud-est dalla Tenuta di Capocotta.

Il terreno è per la maggior parte pianeggiante, salvo modesti rilievi nella fascia nord-orientale che non superano gli 85 m s.l.m.

La copertura forestale, pari all'85% dell'intera area, comprende boschi di alto fusto misti di latifoglie, con predominanza di farnia *(Quercus robur)*, accompagnata da varie altre essenze quali cerro *(Quercus cerris)*, acero *(Acer campestre)*, olmo *(Ulmus minor)*, leccio *(Quercus ilex)*, sughera *(Quercus suber)*, farnetto *(Quercus frainetto)* e pini domestici *(Pinus pinea)*.

In corrispondenza della costa vi sono ambienti palustri costituiti da un piccolo sistema di zone umide, ove predomina la vegetazione igrofila.

Le zone non coperte da boschi comprendono aree aperte destinate al pascolo e all'agricoltura nonché insediamenti residenziali. Nell'ambito dei rapaci diurni, le osservazioni effettuate in Tenuta in questi ultimi anni hanno evidenziato la presenza di varie specie nidificanti: oltre al Gheppio *(Falco tinnunculus)*, esiste una popolazione di alcune coppie di Poiana *(Buteo buteo)* (Bruni 1992) e sembra probabile, in base agli avvistamenti primaverili e estivi, la nidificazione del Falco pecchiaiolo *(Pernis apivorus)*.

Materiali e metodi

Sulla base di un lavoro eseguito da Tinelli e Tinelli (1983) e tramite le osservazioni effettuate nel corso di questi ultimi anni, si è proceduto a completare la ricerca dei nidi.

La loro localizzazione è avvenuta nell'inverno 1990-91 e in primavera (aprile-maggio 1991), tramite gli avvistamenti degli uccelli in volo.

Il materiale alimentare esaminato consiste in 70 borre raccolte sotto i posatoi comuni e resti di vario genere rinvenuti al di sotto o all'interno di 15 nidi. Sono stati determinati 273 reperti che sono stati

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Accettato 12 settembre 1993

confrontati con le collezioni già esistenti (Museo Civico di Zoologia di Roma e Museo di Anatomia Comparata) e con le chiavi diagnostiche riportate da Di Palma e Massa (1981), Toschi (1965), Toschi e Lanza (1959).

L'analisi delle borre dei rapaci diurni rispetto agli Strigiformi pone però delle problematiche riguardo le metodologie da adottare, in quanto gli Accipitriformi e i Falconiformi di solito non inghiottono la preda intera e completamente e inoltre i succhi gastrici più potenti sarebbero in grado di digerire anche ossa di notevoli dimensioni (Marti 1987); una certa percentuale delle borre è perciò costituita di solo pelo.

Per questo si è reso opportuno cercare di identificare il Mammifero predato attraverso il disegno cuticolare e la sezione dei peli, specie-specifici.

I peli estratti dalle borre sono stati metallizzati e osservati al Microscopio Elettronico a Scansione (S.E.M.) e confrontati con gli Atlanti già esistenti o con materiale appositamente preparato e proveniente dalle collezioni del Museo di Anatomia Comparata dell'Università di Roma "La Sapienza" (Day 1966; Keller 1978 e 1980; Débrot 1982; Teerink 1991).

Per il calcolo della biomassa è stato applicato il metodo del peso fresco attribuendo a ogni preda il suo peso medio ricavato dai dati bibliografici (Delibes 1975; Yalden 1977; Contoli e Sammuri 1981; Di Palma e Massa 1981; Bustamante Diaz 1985), ma quando questo eccedeva i 100 grammi, è stato attribuito quest'ultimo valore (Bustamante Diaz 1985; Espina 1984).

Nel caso di prede ritrovate all'interno del nido e eccedenti i 100 g (es. Lepri o carogne) è stato attribuito un valore di 300 g in quanto considerato cibo necessario a nutrire la femmina e due pulli (Espina 1984).

Risultati

I primi arrivi dei Nibbi bruni si registrano nella Tenuta nella seconda metà di marzo ma è dai primi di aprile che si possono osservare i voli nuziali al di sopra del sito scelto per la nidificazione. I nidi rinvenuti furono 37 fino al 1991 e nel corso di quella stagione riproduttiva soltanto 16 vennero effettivamente occupati; durante l'estate 1992 ne sono stati localizzati altri 8 (solo 5 occupati) e sono state censite in totale 9 coppie nidificanti. Pertanto considerato che i nidi rinvenuti costituiscono solo una parte dei realmente esistenti e che generalmente una parte della popolazione è costituita da individui immaturi e/o non nidificanti (Makatsch 1953; Brown e Amadon 1968; Glutz *et al.* 1971; Cramp e Simmons 1980; Johnson 1981), si può stimare in 80-100 il numero dei Nibbi presenti nella Tenuta durante il mese di aprile 1992. I nidi sono situati nella zona più a nord della Tenuta, in un'area di 58 ha circa (1 nido/0.3 Km^2, n = 16), a una distanza media di 103 m l'uno dall'altro (d.s. = 174, n = 16) (cfr. Petretti 1992).

Le partenze iniziano piuttosto precocemente e già nella seconda metà del mese di agosto i Nibbi hanno abbandonato definitivamente la zona.

Nel corso delle osservazioni è stata individuata la presenza di posatoi comuni utilizzati anche come dormitori, occupati soprattutto da individui immaturi e/o non nidificanti, popolati da decine di uccelli (es. 80 ind. di cui il 70% immaturi, il 30 luglio 1991) anche durante il periodo di nidificazione; i posatoi comuni, tipici di questa specie, normalmente costituiti da individui non nidificanti sono stati descritti in Makatsch (1953), Glutz *et al.* (1971), Cramp e Simmons (1980).

Il dormitorio più densamente popolato è costituito da 5-6 alberi (*Quercus sp.* di circa 15-20 m di altezza) situati ai margini di una radura e distanti poche centinaia di metri dalla zona nord della Tenuta in cui si trovano gran parte dei nidi (De Giacomo *et al.* in stampa).

Le zone di nidificazione e la relativa localizzazione dei nidi e dei posatoi sono riportate nella cartina di figura 1.

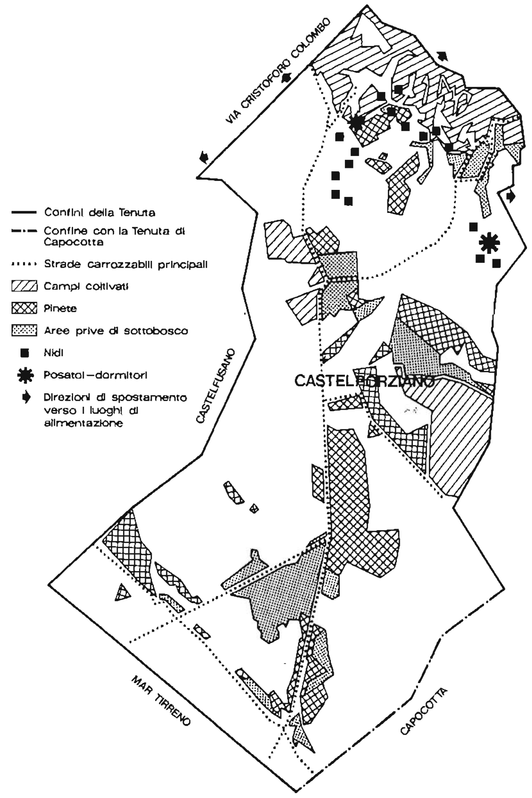

Figura 1. Nella cartina è mostrata la localizzazione dei nidi e dei posatoi, nonché le direzioni di spostamento verso i luoghi di alimentazione.

Tabella 1. Composizione dell'alimentazione del Nibbio bruno a Castelporziano. g = peso in grammi di un individuo; PNi = % in numero; PBi = % in biomassa; PFi = % di ritrovamento nei campioni esaminati

	n	g	PNi	PBi	PFi
MAMMIFERI	**57**	—	**20.8**	**37.3**	**35.2**
Erinaceus europaeus	4	100	1.4	3.2	
Talpa sp.	8	90	2.9	5.8	
Lepus europaeus	19	100	6.9	15.4	
Muscardinus avellanarius	2	27	0.7	0.4	
Microtus savii	2	21	0.7	0.3	
Rattus sp.	11	60	4.0	5.3	
Apodemus sp.	4	27	1.4	0.8	
Mustela nivalis	1	100	0.3	0.8	
Non identificati	6	100	2.1	4.8	
UCCELLI	**16**	—	**5.8**	**7.0**	**18.8**
Coturnix coturnix	1	100	0.3	0.8	
Apus apus	1	100	0.3	0.8	
Parus caeruleus	1	20	0.3	0.1	
Non identificati	13	50	4.7	5.3	
RETTILI	**15**	—	**5.4**	**9.9**	**20.0**
Colubridae	14	80	5.1	9.1	
Testudo hermanni	1	100	0.3	0.8	
ANFIBI	**2**	—	**0.7**	**0.4**	**2.3**
Bufo bufo	2	25	0.7	0.4	
PESCI	**40**	—	**14.6**	**16.3**	**20.0**
Rutilus rubilio	29	50	10.6	11.8	
Leuciscus cephalus cabeda	8	50	2.9	3.2	
Non identificati	3	50	1.0	1.2	
INSETTI	**108**	—	**39.5**	**0.2**	**61.1**
Orthoptera	8	1	2.9	0.06	
Coleoptera	87	0.3	31.8	0.2	
Non identificati	13	0.2	4.7	0.02	
RIFIUTI E CAROGNE	**35**	100	**12.8**	**28.5**	**21.1**
TOTALE	**273**		**99.6**	**99.6**	

$H' = 1.02$

$J = 0.53$

$H'_{mamm} = 1.63$

Nella tabella 1 sono mostrati i risultati relativi ai reperti alimentari identificati: si tratta di materiale di vario genere, come ossa, scaglie di Rettili e Pesci, vere e proprie borre; queste ultime rinvenute nel 90% dei casi sotto i posatoi comuni.

Oltre all'elenco sistematico delle prede e il relativo numero di quelle identificate, viene indicata la percentuale numerica (PNi) che varia tra lo 0.7% degli Anfibi e il 39.5% degli Insetti; la percentuale in biomassa (PBi) più elevata è rappresentata dai Mammiferi con il 37.3%, mentre gli Insetti non rappresentano che lo 0.2%. Sono stati calcolati l'indice di diversità di Shannon che risulta avere un valore piuttosto elevato H' = 1.02, e l'indice di equiripartizione di Pielou J = 0.53, nonchè l'indice di diversità relativo ai soli Mammiferi H'_{mamm} = 1.63 (Shannon e Weaver, Pielou in Marti 1987, Herrera 1974).

Nel grafico di figura 2 è visualizzato l'indice globale di importanza relativa IGRi (Herrera 1978), che risulta essere l'area del quadrilatero avente i lati PNi + PBi e PFi riportati in Tabella 1.

Discussione

Il Nibbio bruno viene descritto come specie opportunista e in grado di sfruttare un'ampia varietà di ambienti e risorse (Cramp e Simmons 1980); lo studio della dieta di un rapace diurno comporta delle fonti di errore dovute alle diverse possibilità di conservazione e rinvenimento dei diversi tipi di preda (es. le grandi ossa dei Mammiferi si conservano più a lungo degli esoscheletri degli Insetti) che possono determinare una sovrastima di alcune categorie e una conseguente sottostima di altre (es. gli Anfibi), e inoltre il 20-35% del cibo catturato o raccolto non verrebbe consumato (Blondel 1967). Tuttavia nella dieta della popolazione studiata sono rappresentate ben 6 categorie sistematiche (Classi) con una ricchezza (singole specie, escludendo i rifiuti e le carogne) pari a 18 e con un indice di diversità H' = 1.02 e equiripartizione J = 0.53 che ben rappresentano l'ampia varietà delle prede; l'indice di diversità relativo ai soli Mammiferi H'_{mamm} è in realtà poco

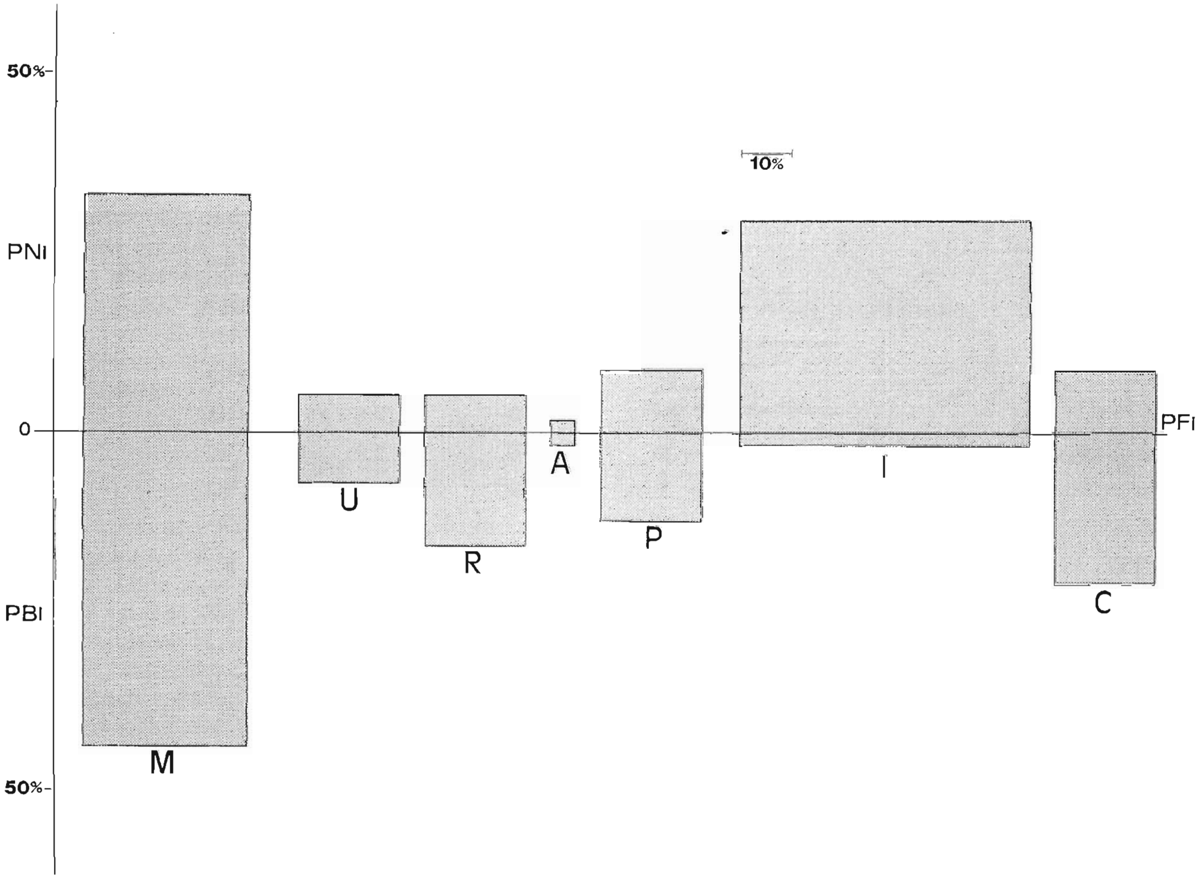

Figura 2. Nel grafico è visualizzato l'indice globale di importanza relativa IGRi = (PNi + PBi) x PFi, calcolato per le diverse Classi di prede e per la categoria "rifiuti e carogne": M = Mammiferi, U = Uccelli, R = Rettili, A = Anfibi, P = Pesci, I = Insetti, C = carogne.

indicativo perchè è lecito supporre che almeno alcune delle prede (es. le Lepri) andrebbero inserite nella categoria dei rifiuti e carogne poichè il Nibbio bruno sembra non essere in grado di catturare animali della taglia maggiore di un Ratto (Brown e Amadon 1968).

L'ampio spettro alimentare, già riscontrato in alcune località della penisola Iberica (Fernandez Cruz 1974; Delibes 1975; Veiga e Hiraldo 1990), della Francia (Thiollay 1976), ma anche dell'Italia centrale (Minganti e Panella 1991), ben si accorda con la diversa varietà di habitat frequentati per la ricerca di cibo: prati e radure sia all'interno che all'esterno della Tenuta, fiume Tevere, strade limitrofe, discarica dei rifiuti di Malagrotta (circa 11 Km in linea d'aria dal confine della Tenuta e dove, soprattutto nella tarda mattinata, è stato possibile osservare anche 35-40 Nibbi contemporaneamente, es. il 12 luglio 1991); questi luoghi vengono esplorati con un volo a bassa quota ininterrottamente dall'alba al tramonto, ma più frequentemente durante le ore più calde della giornata. (cfr. Petretti 1976).

Al contrario, popolazioni più strettamente legate a un singolo ambiente sono ovviamente condizionate nella scelta delle prede e alcune vengono persino definite 'monofaghe' (es. prevalenza di Lagomorfi in una località della Spagna centrale in Arroyo 1980; quasi esclusivamente pesce nelle colonie lacustri, come indicato da Petretti 1992, per il lago di Bracciano).

La popolazione di Castelporziano non sembra risentire del generale declino registrato in Europa (Cramp e Simmons 1980) e in Italia (Petretti 1992) di questa specie negli ultimi anni, ma anzi sembra mantenersi stabile nel tempo; evidentemente non soltanto per la possibilità di reperire siti idonei per la nidificazione, ma anche per la notevole capacità di potersi procurare le risorse trofiche necessarie anche in un ambiente fortemente compromesso dalle attività umane.

Ringraziamenti — Alla Direzione della Tenuta per aver rilasciato la necessaria autorizzazione a effettuare la ricerca; al Prof. C. Consiglio, A. Bruni, G. Marangoni, A.P. Martucci, R. Nati, per aver contribuito in vario modo; al Dott. Fernando Hiraldo della Estación Biológica del Coto Doñana per i suoi preziosi suggerimenti per il calcolo della biomassa; al Prof. A. Fanfani per averci costantemente seguito durante tutte le fasi della ricerca.

Abstract — The Castelporziano Reserve (Rome) hosts a breeding population of Black Kites *(Milvus migrans),* which may be the most dense in Central Italy, consisting of a least 16 pairs in 1991 and 9 pairs in 1992.

The nests are located in an area of 5.8 square km and the average distance between them is 103 m (s.d. = 174; n = 16). In 1991 some communal roosts were found in which up to 80 Black Kites were counted altogether during the breeding season.

Daytime activities mainly consit of searching for food and hovering inside and outside the Castelporziano Reserve; the birds reached the Tiber river, 2 km away from the Reserve boundary, and the garbage dump at Malagrotta, 11 km away from Castelporziano.

In 1991, after fledging, 70 pellets dropped under the communal roosts were collected, as well as a large amount of food remains under and inside 15 nests.

273 prey items were identified through bones, Reptile and Fish scale, Insect fragments and Mammal hair by means of the cuticular patterns observed by the Scanner Electronic System. THe results are shown in Table 1; the total prey item figure percentile sharing is as follows: Mammals 20.8%, Birds 5.8%, Reptiles 5.45%, Amphibians 0.7%, Fishes 14.6%, Insects 39.5%, Carrions 12.8%.

The biomass percentile sharing is given by: Mammals 37.3%, Birds 7.0%, Reptiles 9.9%, Amphibians 39.5%, Fishes 16.3%, Insects 0.2%, Carrions 28%.

With regard to the population which constitutes the subject of this study, the Shannon's diversity index value, H' = 1.05 (eveness index J = 0.63), properly represents the broad food niche typical of these birds, which are often described as scavengers and predators feeding on various kinds of prey.

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Avocetta N° 17: 79-80 (1993)

Short communications

Breeding populations of gulls and terns in northern Egypt

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The status of seabirds in Egypt has relatively recently been summarized by Meininger and Baha el Din (1986) and by Goodman and Meininger (1989). However, new data on the breeding populations of gulls and terns in northern Egypt justify an update of previous estimates. Most data were collected during extensive field work in northern Egypt between early March and mid-June 1990 (Meininger and Atta in prep.), at Lake Manzala, in the northeastern Nile Delta, and Suez Bay. Additional visits were paid to El Malaha and Lake Bardawil in northern Sinai, to Wadi el Natrun and Lake Qarun in the Western Desert of Egypt, and to Lake Burullus (the latter area in spring 1992). Four species of gulls and terns breed in northern Egypt.

Slender-billed Gull *Larus genei* - On 26 May 1990, 5688 nests were counted, and 143 chicks ringed, in a breeding colony at El Malaha, just east of Port Said. Four sub-colonies could be distinguished, all situated on small earth islands resulting from canal digging in the lagoon. The sub-colonies held 1650, 900, 3100, and 38 nests, respectively. The nests in the first two sub-colonies contained many small chicks, the latter two held no chicks at all, and there were many nests with only one or two eggs. These variable stages of breeding, and the presence of recently destroyed eggs and abandoned nests in the first sub-colony, suggested that the colony had been disturbed, presumably by local fishermen. Foraging flights of Slender-billed Gulls were mainly directed towards Lake Manzala. Based on regurgitations, Chironomid larvae seemed to be the most important food for the chicks.
El Malaha is the only known breeding site of Slender-billed Gull in Egypt, where breeding has been known since 1938 (Goodman and Meininger 1989). 200 nests were found in this area in 1979 (Meininger and Mullié 1981), and 2000 adults on 4 July 1986, including concentrations of several hundred birds on islands, during an aerial survey (Goodman and Meininger 1989). The 1990 survey suggests that a considerable increase has occurred. This is the largest known breeding population of Slender-billed Gull in the Mediterranean Sea. Fasola (1986) estimated the total breeding population in the Mediterranean Sea (excluding Egypt) at 5200 pairs, and the total population in the Western Palearctic at over 30 000 pairs (mainly in the Black Sea).

Yellow-legged Gull *Larus cachinnans* - The only known Egyptian breeding site of this species is situated in a lagoon east of El Alamein. Apparent breeding of a few pairs was noted here in 1982, in 1985 a colony of 10-15 pairs was found at this site, and in 1986 this colony held 25 pairs (Goodman and Meininger 1989). No signs of breeding were noted in any of the areas visited in spring 1990.

Common Tern *Sterna hirundo* - Hitherto, Common Terns were only known from Egypt as passage visitors and as non-breeding summer visitors. On 26 May 1990 a nest with two eggs was photographed and 11 alarming adults observed at El Malaha, suggesting at least five breeding pairs. The nest was situated in the periphery of the Slender-billed Gull colony. This is the first known breeding of Common Tern in Egypt (Goodman and Meininger 1989).

Little Tern *Sterna albifrons* - A previous estimate of the total Egyptian breeding population of Little Tern was 2000 pairs, of which 1000 pairs in the Nile Delta and 800-1200 pairs in northern Sinai (Goodman and Meininger 1989).
Observations in Lake Manzala in spring 1990 suggested a breeding population of 1200-1500 pairs in this lake alone. At El Malaha 60-100 pairs were found breeding near the colony of Slender-billed

Gull on 26 May 1990, including some with newly hatched chicks. On the same date 20-50 pairs were found at Port Fuad. In the mid-1980s the breeding population at Lake Bardawil was estimated at 800-1200 pairs (Dunnet *et al.* 1986, Meininger and Baha el Din 1986). On a dike in the fishponds in Abuksa Bay, Lake Qarun, 64 scrapes and 25 nests with eggs were found on 15 May 1990; at least 85 adults were present. The total population at Lake Qarun was estimated at 100-150 pairs. Over 500 pairs of Little Terns were found during a survey of the southern part of Lake Burullus during 29 May-2 June 1992 (G.A.M.A. and George Wintermans). Several hundreds of pairs probably breed in other parts of this lake, resulting in a total estimate of 600-800 pairs. Some 50-100 pairs are believed to breed at Lake Maryut, while the species is probably absent from Lake Idku (Meininger *et al.* 1986). About 55 birds were seen in Lake Nasser near Abu Simbil, in the extreme south of Egypt, on 10 July 1990. On 17 June 1990, Baha el Din and Baha el Din (1990) found six pairs of breeding Little Terns, "perhaps *S. a. guinea*" on a low sandy island to the north of Abu Simbil.

Although Little Terns have a low site fidelity, and the estimate is based on censuses in different years, a conservative estimate of the total Egyptian breeding population is 2900-3800 pairs.

Fasola (1986) estimated the total Western Palearctic population at 20 000 pairs, of which 10 600 in the Mediterranean Sea (including 2000 pairs in Egypt). It is clear that Egypt holds a significant proportion of this population.

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Riassunto — Vangono forniti dati relativi al Gabbiano roseo *Larus genei*, al Gabbiano reale *Larus cachinnans*, alla Sterna comune *Sterna hirundo* ed al Fraticello *Sterna albifrons* nidificanti nell'Egitto settentrionale.

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Avocetta N° 17: 81-83 (1993)

Osservazioni preliminari sulla biologia riproduttiva del Picchio dorsobianco *Picoides leucotos lilfordi* in Italia Centrale

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I limitati studi sulle popolazioni italiane di Picchio dorsobianco *Picoides leucotos lilfordi* sono rivolti principalmente a definirne la distribuzione (Moltoni 1959, Di Carlo 1972, 1978, Castiglia *et al.* 1976, Costantini e Melletti in stampa).

Alcuni contributi alla conoscenza dell'ecologia e della biologia riproduttiva di questa specie sono stati apportati da autori nord-europei (Aulén 1988, Franz 1937, Wesolowski and Tomialojc 1986) ed asiatici (Matsuoka 1979); i risultati di questi lavori sono tuttavia difficilmente confrontabili con la situazione italiana a causa delle sostanziali differenze di habitat. Inoltre le popolazioni meridionali, che appartengono alla sottospecie *P. l. lilfordi*, sono ancora meno studiate dalla nominale (Purroy 1972, Zunino 1983, Bernoni e Ianniello 1989, Grange 1991, Bernoni in stampa).

Il Picchio dorsobianco è inserito nella Lista Rossa degli uccelli d'Italia come specie rara (Frugis e Schenk 1981); specifici programmi di conservazione basati su una attenta valutazione dell'ecologia di questa specie sono dunque auspicabili. Il presente lavoro si propone di contribuire alla conoscenza di alcuni aspetti della biologia riproduttiva della specie in Italia; vengono qui riportati i primi risultati di osservazioni al nido effettuate durante la stagione riproduttiva su coppie localizzate al di fuori del nucleo del Parco Nazionale d'Abruzzo.

Durante la stagione riproduttiva 1990 è stata seguita la nidificazione di una coppia di Picchio dorsobianco sui Monti Ernici in provincia di Frosinone (coppia N. 1); il nido era situato a quota 1100 m slm nella fascia ecotonale di una faggeta matura coetanea, strutturalmente omogenea. Erano presenti diversi alberi morti e/o marcescenti e la zona non era sottoposta a tagio da almeno 8 anni. Il nido, posto sul tronco di un faggio morto di 60 cm di diametro (DBH) ad un'altezza di circa 8 metri, aveva una esposizione a Nord-Ovest.

Nel 1992 è stata individuata una seconda coppia in una faggeta del versante orientale della Val Roveto, nel Comune di Collelongo, a ridosso della fascia di protezione esterna del Parco Nazionale d'Abruzzo (coppia N. 2). La zona di nidificazione era caratterizzata da un popolamento arboreo adulto con struttura di tipo disetaneo a gruppi alternato a densi nuclei di rinnovazione. Gli alberi morti erano quasi del tutto assenti. La cavità nido era situata a quota 1530 m slm su di un faggio vivo di 32 cm di diametro (DBH); l'altezza dal suolo era di 8,2 m e l'esposizione a Nord Nord-Est.

Le osservazioni sono state svolte per la prima coppia dal 27 aprile al 23 maggio 1990, mentre la seconda coppia è stata seguita dal 6 maggio al 12 giugno 1992.

Per ciascuna coppia sono stati registrati i seguenti parametri: ora di arrivo e di uscita dal nido, numero, posizione del becco (trasversale o longitudinale), dimensioni relative alla lunghezza del becco (4 classi dimensionali: <1/3, 1/3-2/3, 2/3-1, >1) e tipo (larve o imagini) delle prede portate ai nidiacei.

Il 27 aprile la coppia N. 1 trasportava imbeccate al nido di nidiacei la cui età stimata sulla base della conoscenza del tempo di sviluppo, era di 4-8 giorni. L'involo è infatti avvenuto tra il 17 e il 22 maggio. Durante i primi giorni di osservazioni i due sessi si alternavano nella ricerca del cibo e nella cova, inizialmente dividendosi equamente i compiti (il 27/04 il maschio ha covato per il 47,2% del tempo totale di cova, la femmina il 52,8%); successivamente la frequenza percentuale di cova della femmina è aumentata (il 2/05 il 66,2% del tempo totale di cova contro il 33,8% del maschio, $\chi^2 = 33,3$ g.l. = 1, $p<0.0001$). Il tempo dedicato alla cova della coppia è diminuito dal 67,6% sul totale dei minuti di osservazione il 27/04 al 31,2% il 2/05.

La coppia N. 2 era in cova il 6 maggio e la schiusa è avvenuta tra il 16 e il 17 maggio (il 17 la femmina ha gettato un guscio fuori dalla cavità). I nidiacei si sono involati tra il 12 e il 14 giugno, con un periodo di involo di 26/28 giorni. La cavità nido era già definitivamente scavata il 22 aprile.

La frequenza d'imbeccata è aumentata nel corso della stagione riproduttiva per entrambe le coppie (Figura 1); la differenza nel tasso d'imbeccata è statisticamente significativa (test di Kruskal-Wallis $H_c = 9.14$, $p<0.05$ $n = 237$ per la coppia N. 1; $H_c = 81.88$, $p<0.0001$, $n = 460$ per la coppia N. 2). La frequenza d'imbeccata media è significativamente maggiore nella coppia N. 2 (Mann-Whitney $Z_c = -2.84$, $p<0.01$).

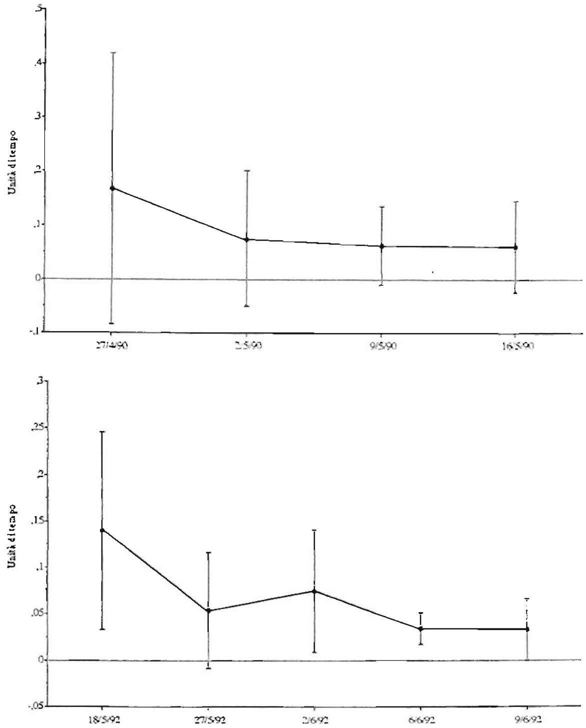

Figura 1 - Medie e deviazioni standard degli intervalli di tempo tra una imbeccata e la successiva (tasso d'imbeccata) nel corso della stagione riproduttiva per la coppia N. 1 (in alto) e la coppia N. 2 (in basso).

La composizione percentuale delle dimensioni relative delle prede (Figura 2) differisce tra le due coppie ($\chi^2 = 8.06$, g.l. = 3, $p<0.05$ $n = 235$); la coppia N. 1 mostra una distribuzione più omogenea, con un numero maggiore di prede che cade nelle classi dimensionali superiori. È inoltre evidente per entrambe le coppie la scarsa quantità di prede di dimensioni eccedenti la lunghezza del becco dell'uccello.

Il tipo di preda portata ai nidiacei differisce significativamente tra i due sessi ($\chi^2 = 15.58$, g.l. = 3, $p<0.0001$, $n = 247$); nel maschio più del 88% delle prede sono larve, mentre per la femmina la percentuale delle larve si riduce al 66%. Non sono state evidenziate differenze tra i due sessi né nelle dimensioni, né nel numero e nella posizione nel becco delle prede.

La frequenza percentuale degli stadi larvali ed imaginali portati al nido da ambo i sessi della coppia N. 1 cambia significativamente nel corso della stagione riproduttiva (test di Kruskal-Wallis $H_c = 45.65$, $p<0.0001$, $n = 159$); gli stadi imaginali aumentano in percentuale con l'età dei pulli. Un simile andamento non si è potuto evidenziare per la coppia N. 2 a causa della scarsità di dati disponibili. L'intervallo medio tra una imbeccata e la successiva differisce significativamente se si considerano le larve e le imagini separatamente (Student's t-test su trasformazione logaritmica dei dati $t = 1.65$, $p<0.005$, $n = 235$).

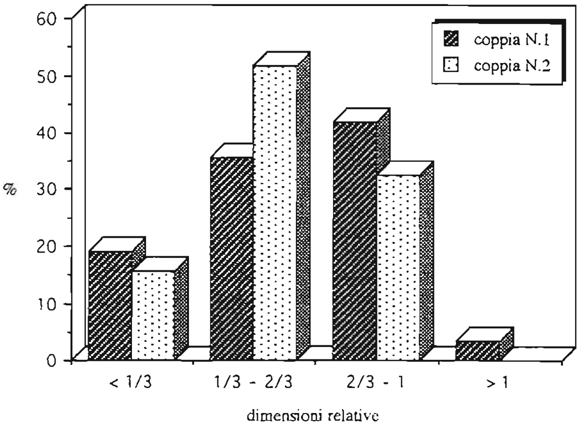

Figura 2 - Frequenze percentuali delle dimensioni delle portate ai nidiacei dalle due coppie di Picchio dorsobianco. Le dimensioni sono espresse in rapporto alla lunghezza totale del becco dell'uccello.

Per la coppia N. 1 in più dell'80% dei casi non venivano portate nel becco più di 2 prede contemporaneamente e carichi multipli erano portati in misura maggiore trasversalmente ($\chi^2 = 38,54$ g.l. = 4, $p<0.0001$, $n = 124$); il grado di associazione tra il numero di prede trasportate al nido e l'età dei pulli mostra un'aumento significativo nel corso della stagione riproduttiva (coefficiente di correlazione di Spearman $r_s = -0.24$, $p<0.01$, $n = 146$). Le prede di dimensioni maggiori venivano trasportate di preferenza longitudinalmente rispetto a quelle di dimensioni minori ($\chi^2 = 25.86$, g.l. = 3, $p<0.0001$ $n = 102$. Figura 3).

Il campione ridotto su cui le osservazioni sono state effettuate non consente la generalizzazione dei risultati ma mostra la variabilità a livello intraspecifico nei parametri ecologici di questa specie, come altri autori hanno già messo in evidenza (Aulén 1988).

Le due coppie su cui sono state condotte le osservazioni si trovano in situazioni forestali strutturalmente differenti; questo può aver influito sulle differenze di dimensioni delle prede. Inoltre la nidificazione della coppia N. 2 indica che questa specie può nidificare su alberi completamente vivi e

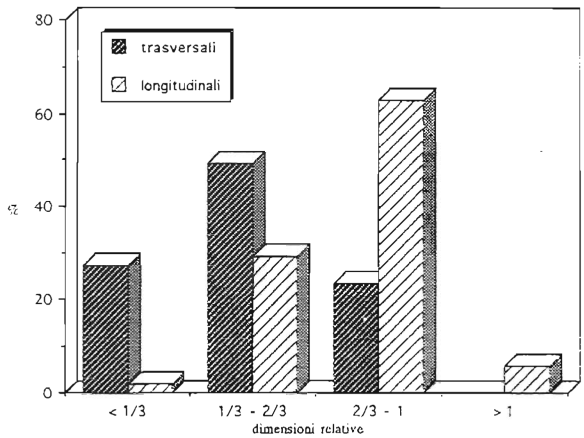

Figura 3. Frequenze percentuali delle dimensioni delle prede portate al nido dalla coppia N. 1 in relazione al metodo di trasporto nel becco.

di limitate dimensioni diametriche (come riportato anche da Zunino 1983) in faggete pressoché prive di tronchi morti, diversamente da quanto rilevato da Bernoni nel P. N. d'Abruzzo (Bernoni in stampa). Differenze significative tra i due sessi in alcuni parametri della nicchia trofica sono state riscontrate per il Picchio tridattilo (Hogstad 1976a, 1976b, 1977), ed il Picchio dorsobianco (Aulén 1988, Grange 1991); i nostri dati non possono dare indicazioni conclusive in merito, ma le divergenze osservate nel tipo di preda portata al nido possono far ipotizzare l'utilizzo di tecniche di caccia differenti nei due sessi.

Le variazioni nel numero e nelle dimensioni delle prede portate al nido nel corso della stagione riproduttiva tendono a compensarsi reciprocamente, e l'aumento nel numero di prede è forse dovuto ad una maggiore disponibilità di stadi imaginali a stagione avanzata. Gli insetti adulti sono inoltre presumibilmente più semplici da reperire in quanto non richiedono, nella maggior parte dei casi, dispendiose attività di scavo nel legno. Sarebbe necessario comprendere in che modo l'attuale gestione forestale influisca sulla distribuzione e sulla biologia riproduttiva del Picchio dorsobianco nella prospettiva di studiarlo come indicatore biologico di faggete caratterizzate da una struttura e da una naturalità tali da permettere la presenza di una stabile e vitale popolazione di questa specie.

Ringraziamenti — Desideriamo ringraziare il personale del Comando-Stazione del Corpo Forestale dello Stato di Collelongo (AQ) per la gentile ospitalità e Angelo Meschini per la rilettura critica del testo.

Abstract — We followed two pairs of White-backed Woodpecker breeding apart the main population of Abruzzo National Park (N. 1: Monti Ernici, FR; N. 2: Val Roveto, AQ). They were located in structurally different Appennine beechwoods. Observations lasted from 27.4 to 23.5. 1990 (N. 1) and from 6.5 to 12.6. 1992 (N. 2). We recorded the following parameters for each pair: time of entrance and exit in the nest; prey position in the bill (transverse or longitudinal), relation between prey size and bill length and type of prey (larvae or imago) brought to the nestlings. The feeding rate increased during the breeding season for both pairs. Prey type brought to the nestlings differed in a significant way between sexes. Imago stages increased percentually with respect to nestling age. Differences in the prey type permit us to hypothesize different hunting techniques between sexes. Even if the observation sample is small, this species shows variability in ecological parameters.

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Avocetta N° 17: 85-87 (1993)

Book reviews

Sonobe K. and Usui T. 1993. A field Guide to the Waterbirds of Asia. *Wild Bird Society of Japan. Kodansha International,* Tokio, 224 pp.

Le zone umide comprendono ambienti tra i più importanti e minacciati del nostro pianeta. Come le foreste tropicali, esse sono continuamente sottoposte a distruzione e pressioni causate dallo sviluppo delle attività umane e all'aumento degli abitanti. Sollecitata da questi problemi la Società ornitologica giapponese, in collaborazione con l'"Asian Wetland Bureau" e la "Tokai Foundation", ha realizzato questa guida al riconoscimento degli uccelli acquatici dell'Asia; scopo principale dell'opera è fornire ai ricercatori in campo i mezzi necessari al riconoscimento delle specie e informazioni da utilizzare per la protezione degli ambienti umidi.

Nella guida vengono trattate famiglie di uccelli acquatici comprendenti poche specie, come strolaghe, svassi, pellicani, cormorani, aninghe, fenicotteri, aironi, cicogne, rallidi, e gruppi molto numerosi, come anatidi, limicoli, gabbiani e sterne. La presentazione è quella tipica delle guide di campo, con tavole affiancate da testo descrittivo. I disegni, opera di Takashi Taniguchi, sono molto ben fatti, anche se in un'opera così specifica avrebbe forse potuto trovare spazio qualche tavola aggiuntiva rappresentante individui immaturi e piumaggi di transizione in gruppi difficili (gabbiani, ecc.).

Sorprendentemente, la guida non presenta le classiche e comode carte della distribuzione geografica per le varie specie; in modo più semplice, al termine dell'opera, viene riportata una check-list indicante lo status (nificante, non nidificante, migratore, poco noto, in pericolo) in ognuno dei 24 Stati dell'Asia.

Marco Cucco

Fraissinet M. e Milone M. 1992. Migrazione e inanellamento degli uccelli in Campania. *Ass. Studi Ornit. It. Meridionale, Regione Campania Ass. Agricoltura,* Napoli, 165 pp.

Il volume presenta l'attività di inanellamento svolta nella regione Campania, tra il 1980 e il 1991, dal gruppo eco-etologico dell'Università di Napoli. Nelle prime pagine vengono brevemente descritte la tecnica dell'inanellamento e la storia dell'attività del gruppo partenopeo. Il corpo dell'opera (pagine 35-102) è rappresentato dalla descrizione delle stazioni di cattura, distinte in abituali (Vivara, Capri, ecc.) e non abituali. Per ogni località viene riportata una descrizione geografico-ambientale, un commento alle catture realizzate e l'elenco degli inanellamenti effettuati. La parte relativa alle stazioni principali risulta di interesse anche per il lettore non campano. La trattazione delle stazioni non abituali appare invece un po' troppo estesa, soprattutto per quelle località nelle quali sono state inanellate solamente 1-3 specie, con meno di dieci soggetti.

Nella parte finale dell'opera vengono brevemente trattati altri argomenti relativi all'inanellamento, quali il recupero e la riabilatazione dell'avifauna selvatica, le riprese in Italia e all'estero di soggetti catturati in Campania, gli studi relativi a muta, biometria e parassitologia. Risultano molto gradevoli, infine, le tavole in bianco e nero disegnate da Antonio Lubrano Lavadera.

Marco Cucco

Rigacci L. 1993. Il Gufo reale in Toscana. Studio per la reintroduzione. *WWF Delegazione Toscana. Editori dell'Acero,* Empoli, 95 pp.

Si è assistito, in questi ultimi anni, a un rapido cambiamento di mentalità e considerazione riguardo agli uccelli rapaci. Ritenuti in passato "nocivi" per la selvaggina e gli animali domestici e, come tali, attivamente cacciati e distrutti, sono ora protetti dalla legislazione e inseriti nelle Liste Rosse degli animali vulnerabili o minacciati di estinzione. È sempre più comune la sorveglianza dei siti di nidificazione da parte di gruppi o associazioni di volontariato, sono sorti centri di recupero per rapaci feriti, i più diversi aspetti della loro biologia riproduttiva sono stati oggetto di alcuni tra i migliori studi di ecologia ed etologia apparsi recentemente sulle riviste specializzate.

Il volume sul Gufo reale in Toscana esamina in particolare il problema della reintroduzione della specie. Il testo è stato diviso in tre parti: nella prima vengono sintetizzate le osservazioni effettuate da ricercatori, in natura, su alimentazione, riproduzione, habitat e mortalità, nella terza vengono indicate le tecniche di allevamento, riproduzione e rilascio. Gli studi citati si riferiscono principalmente all'area centro e nord europea. La seconda parte dell'opera è quella maggiormente interessante per l'ornitologo italiano; in essa sono presentati i risultati di un'indagine effettuata nel 1991-1993 su tutto il territorio toscano. Nel periodo indicato sono stati effettuati 238 sopralluoghi crepuscolari e notturni, con ascolto del canto o utilizzo della tecnica del play-back, in siti idonei dell'area toscana, comprese le isole. Sono stati inoltre considerati 146 controlli acustici aggiuntivi, effettuati in anni precedenti o da altri collaboratori, e 169 ispezioni con metodologia diversa (ricerca di tracce, interviste, ecc.). Il risultato dell'indagine è chiaro: "... in Toscana non esiste una popolazione vitale del Gufo reale... questo dato sgombra il campo da presenze immaginarie... riportate da alcuni Autori..." (pag. 78).

Anche per quanto riguarda la possibile reintroduzione i risultati sembrano molto netti: "... l'unica area apparentemente idonea... è il comprensorio del Mugello..." (pag. 82).

L'opera risulta nel suo complesso un buon esempio di studio condotto con metodi scientifici, ma accessibile ai non addetti ai lavori, e ben inaugura la collana "Serie Scientifica" del W.W.F. Italia.

Marco Cucco

Spanò S. 1993. Il punto sulla beccaccia. *Editoriale Olimpia, Firenze,* 215 pp.

Le monografie ornitologiche sono in genere libri altamente ricercati da amatori e professionisti poiché in essi si ritrovano condensati moltissimi dati di biologia ed ecologia di una singola specie o di un genere. Molti di noi custodiscono gelosamente in casa testi di Géroudet, di Lack o di altri autori e ne hanno fatto largo uso quale fonte per articoli, divulgazione, relazioni etc. Recentemente poi la bibliografia anglosassone ci presenta collane di specialisti di fattura davvero pregevole. Ad esempio della casa editrice Crom-Helm si possono ricordare tra i tanti i volumi Tim Birkhead sulla Gazza o di Rauno Alatalo sulla Balia nera, della Cambridge University Press il volume di Nick Davies sulla Passera scopaiola. Ad esaminare la specifica realtà libraria italiana non mi sembra ci sia da stare molto allegri; di recente pubblicazione non viene in mente molto, oltre il testo di Fasola *Aironi e gabbiani* su ardeidi e laridi nel bacino del Po (mancanza di autori o colpa degli editori?).

È benvenuto dunque in questo scarno panorama nazionale il volume sulla Beccaccia di Silvio Spanò, docente di Zoologia presso la Facoltà di Scienze di Genova, appassionato ornitologo, faunistica e cacciatore. Il volume è un aggiornamento completo rispetto ad un precedente testo del 1982. Le 215 pagine del testo si leggono con piacere e si ha occasione di conoscere, in un quadro espositivo ordinato, una quantità notevole di dati su questo affascinante scolopacide. L'indice comprende, oltre ai fondamentali capitoli di base, alcuni di uso pratico: la valutazione dell'età, la determinazione del sesso, la ricerca scientifica, la caccia, la conservazione. È un libro utile su più fronti: è infatti adatto a quei cacciatori che, volendo crescere culturalmente e naturalisticamente, diverranno gli unici interlocutori seri del mondo faunistico moderno. Sarà fruibile anche dall'ornitologo alle prime armi che troverà descritti i problemi e le tecniche di studio valide per questa specie e in parte estensibili ad altre. Inoltre gli ornitologi non di estrazione venatoria troveranno parecchi spunti di interesse ed aggiornamento. Certamente in questa "ottica allargata" ciascuno secondo la propria preparazione può trovare motivi di mugugno. Il principiante che Legge *ex abrupto* di analisi discriminante nello studio della scelta dell'habitat può essere un po' sconcertato, ma forse questa difficoltà sarà uno sprone ad informarsi sull'utilità di questa analisi statistica multivariata in ecologia. Parimenti l'addetto ai lavori noterà che accanto ad un'impaginazione di qualità, certi grafici e schemi sono un po' artigianali. Il risultato rimane globalmente di qualità e diamo atto a Spanò di aver costruito un libro ricco che nel capitolo finale: *la beccaccia nell'immaginario collettivo* ha alcuni spunti felici tra cui ci piace citare l'ultimo capoverso: "... Si tratta di un rapporto esoterico, da iniziati, metapsichico, che si instaura tra un beccaciaio e la sua preda, o meglio tra la sua anima e l'anima "cosmica" che la beccaccia incarna, piccolo cuore-cervello piumato, dai grandi occhi, che percorre le vie stellate del nostro emisfero e che noi a volte riusciamo ad intercettare, magicamente, purtroppo uccidendolo, viscerale coinvolgimento sacrificale con una parte di quel che resta del mondo vivente ancor genuino".

Giorgio Malacarne

Glutz von Blotzheim U.N. e Bauer K.M., 1993. Handbuch der Vögel Mitteleuropas. Passeriformes. Band 13/I Muscicapidae-Paridae (808 pp.), 13/II Sittidae-Lanidae (557 pp.) e Corvidae-Sturnidae 13/III (813 pp.) - *AULA-Verlag*, Wiesbaden. Illustrazioni al tratto, sonogrammi, diagrammi, carte di distribuzione e tavole a colori.

La pubblicazione dei volumi dedicati ai Passeriformes, iniziata nel 1985 con il volume 10° (I/Alaudidae-Hirundinidae II/Motacillidae-

Prunellidae) e proseguita nel 1988 e nel 1991 con l'11° (I-II/Turdidae) e il 12° (I-II/Sylviidae), continua regolarmente: è infatti recentissima l'uscita di tre nuovi volumi che trattano 39 specie in 2178 pagine, con una media di circa 56 pagine per specie. L'importanza di questa ormai classica opera ha superato abbondantemente i confini dell'Europa centrale, area di riferimento dei primissimi volumi, soprattutto dopo l'inclusione, come campo geografico di trattazione, delle parti nord-ocidentali e meridionali del continente. Questa provvidenziale "espansione territoriale" ha determinato, per quanto ci riguarda in particolare, l'inclusione dei versanti meridionali delle Alpi e la Padania. Ampia e approfondita è, infatti, la trattazione di specie maggiormente diffuse nell'Europa centro-meridionale, come Rampichino, Picchio muraiolo, Pendolino, Averla canerina, Averla capirossa, Gracchio alpino e Gracchio corallino. Maggiore respiro viene ovviamente riservato a specie più tipicamente europee, come i 7 Paridi (di cui uno accidentale), trattati in circa 450 pagine.

Alla Cinciallegra, certamente una delle specie più studiate e meglio conosciute è dedicata una monografia di ben 130 pagine, di cui 12 contenenti circa 400 citazioni bibliografiche. Sono da aggiungere: 18 pagine di sonogrammi, 7 carte di ricatture di inanellati, 19 disegni al tratto a carattere etologico, 1 tavola a colori, 1 carta degli areali mondiali e numerosi diagrammi. Al Corvo sono riservate 124 pagine e ben 73 disegni al tratto.

L'estrema completezza delle singole monografie, costruite sulla base di minuziose ricerche bibliografiche e di numerosi dati originali, fanno di quest'opera uno strumento di lavoro essenziale per quanti si interessano dell'avifauna europea e, più in generale, di quella paleartica.

Pierandrea Brichetti

Avocetta N° 17: 89-90 (1993)

Newsletter

Con questo numero prende inizio la rubrica Newsletter di Avocetta. Il primo e forse più importante obiettivo di questa rubrica è quello di fornire agli ornitologi italiani informazioni sui futuri convegni, simposi, seminari e corsi (italiani ed internazionali) che trattino non solo argomenti strettamente ornitologici ma anche di interesse più generale come l'eco-etologia, la bioacustica, i metodi di ricerca, ecc.

Si intende in tal modo contribuire alla massima circolazione delle informazioni nella convinzione che la comunità ornitologica italiana debba essere avvertita del dibattito scientifico in atto e nella speranza che possa acquisire una mentalità più dinamica ed aperta al confronto con i ricercatori degli altri paesi.

Non sempre saremo in grado di fornire tutte le informazioni necessarie (come costi, date precise, pernottamenti o altro), ma riporteremo sempre l'indirizzo della persona o Ente con cui mettersi in contatto per ulteriori dettagli.

In questa rubrica troveranno spazio anche presentazioni di nuove riviste scientifiche, relazioni su convegni, conferenze e workshop, lettere ed opinioni intorno agli argomenti più dibattuti e attuali della ricerca ornitologica in particolare ed eco-etologica in generale. Chiunque volesse contribuire o proporre ulteriori argomenti per arricchire la rubrica è pregato di mettersi in contatto con Paolo Galeotti, Dipartimento di Biologia Animale, Piazza Botta 9, 27110 Pavia. Tel. 0382/386301. Fax 0382/386290.

CONVEGNI, SIMPOSI & SEMINARI

Anatides 2000.
Conferenza Internazionale organizzata dal Bureau International de Recherche sur les Oiseaux d'Eau et les Zones Humides e dall'I.W.R.B.
Luogo: Strasburgo (Francia). Date: Febbraio 1994.
Argomenti: conservazione, gestione dell'habitat e utilizzo razionale degli Anseriformi (anatre, oche e cigni).
Per informazioni: BIROE Anatides 2000, Slimbridge, Gloucester GL2 7BX UK, tel. 0044-453-890624; Fax 0044-453-890697.

XIII Symposium of the International Bioacoustic Council (IBAC).
Simposio internazionale di Bioacustica.
Luogo: Field Station of Natural History Museum University di Aarhus, Mols (Danimarca). Date: 7-10 aprile 1994.
Argomenti previsti: nuovi equipaggiamenti e tecniche di registrazione in natura, uso di computer portatili per esperimenti di playback, registrazioni subacque, comunicazione ultrasonica.
Il termine per presentare contributi è già scaduto.
Per informazioni: Dr. P. Hansen, Natural History Museum, Universitetsparken, Bygning 210, DK - 8000 Aarhus, Denmark, fax (01045) 86130882.

Evolution of signallings.
Meeting estivo organizzato dall'ASAB (Association for the Study of Animal Behaviour).
Luogo: Berna (Svizzera). Date: 20-21-22 luglio 1994.
Argomenti: evoluzione e significato dei segnali (vocali, chimici, morfologici, comportamentali).
Relatori invitati: John Endler (Santa Barbara), Anders Pape MØller (Uppsala), Andrew Pomiankowsky (Londra), Amotz Zahavi (Tel Aviv).
Possibilità di presentare brevi contributi sotto forma di comunicazioni orali o poster.
Spedire un abstract (max 15 righe) agli organizzatori entro il 28 febbraio 1994.
Per informazioni: Manfred Milinski e Heinz Richner, Università di Berna, Sektion Ethologie, Wohlentrasse 50a, CH - 3032 Hinterkappelen, Switzerland.

V Congresso internazionale di Behavioral Ecology.
Luogo: Università di Nottingham (Gran Bretagna). Date: 14-20 agosto 1994.
Per informazioni su iscrizione e presentazione contributi scrivere a: ISBE Congress, Conference Nottingham, The Business Information Centre, 309 Haydn Road, Nottingham NG5 IDC, UK.

XXI International Ornithological Congress.
Congresso Internazionale di Ornitologia.
Luogo: Hofburg Congress Center, Vienna (Austria). Date: 20-25 agosto 1994.
Argomenti: sono previsti 48 Simposi su argomenti che spaziano dall'ecologia di comunità di uccelli forestali, alla memoria e intelligenza, alla sistematica, ai sistemi riproduttivi. Possibilità di proporre tavole rotonde o workshop su argomenti di interesse specialistico e di presentare contributi sotto forma di poster o poster talk (poster + comunicazione orale di 3 min.). Termine ultimo per la presentazione dei contributi: 31 maggio 1994. Per informazioni: XXI IOC, Interconvention,

Freiedrichstrasse 7, A-1043 Vienna, Austria. Tel. 0043 1 58800106. Fax 0043 1 5867260.

V Nacional Congress and II Latin American of Ethology.

Congresso spagnolo e latino-americano di Etologia. Luogo: Valencia (Spagna). Date: 25-30 luglio 1994. Possibilità di presentare contributi sotto forma di comunicazioni orali o poster; sono previste letture a invito, tavole rotonde ed escursioni.
Per informazioni: Organising Committee of Congress, Departament de Biologia Animal, Unitat de Fisiologia Animal, Facultat de C. Biologiques, Universitat de Valencia, 46100 Burjassot (VA). Tel. (96) 386 4387. Fax (96) 386 4372.

4th Medmaravis Symposium, 11-16 April 1995.

The 4th Scientific Symposium of MEDMARAVIS will be held close to Tunis, Tunisia, during the week before Easter 1995.
The theme is *Seabird Ecology in the Mediterranean Region.* A one-day colloquium will be organized on North African Seabird studies and coastal biodiversity.
An excursion is planned on Easter 16th April 1995 to the island of ZEMBRA, holding the largest Cory's Shearwater colony in the world. Conference languages are English and French. The conference Proceeding will be puiblished by MEDMARAVIS. Scientific papers and posters are invited on the themes outlined above. Write for Registration Form:

MEDMARAVIS, B.P. 2,
83470 SAINT-MAXIMIN, France.

Symposium della CIESM, 27-31 marzo 1995, Malta.

La "Commission Internationale pour l'Exploration Scientifique de la Mer Mediterrannée" organizza il XXXIV Congresso, presso il Mediterranean Conference Centre de La Valletta, Malta.
Saranno affrontati 12 temi, tra cui sono di interesse ornitologico: Comunità degli stagni salati e delle lagune; Lotta contro l'inquinamento marino; Isole mediterranee; Vertebrati marini.
Per informazioni: rivolgersi entro il 30.9.1994 a:
CIESM, 16 boulevard de Suisse,
MC-9800 Monte Carlo, Monaco.

Avocetta N° 17: 91 (1993)

Notices

Richiesta di informazioni sul Picchio dorsobianco Request of information about White-backed Woodpecker *(Picodeis leucotos lilfordi)*

È in corso, per conto dell'Ente Autonomo Parco Nazionale d'Abruzzo, una ricerca sul Picchio dorsobianco o Picchio dalmatino *(Picoides leucotos)* nell'Appennino centrale. Sono dunque interessato a tutte le informazioni relative a questa specie, particolarmente agli esemplari preparati in possesso di Musei pubblici o di collezionisti privati, per poterli misurare e fotografare, ed a tutte le osservazioni compiute su queste specie relative al territorio nazionale. Chiunque sia in possesso di informazioni sulla specie è pregato di comunicarle a:

Mauro Bernoni
Scaletta di Piazza Padella 6
00062 Bracciano (Roma)

Richiesta di informazioni su *Passer sp.*

Per aumentare le conoscenze sulla biologia riproduttiva dei Passeri (*Passer* sp.) presenti sul territorio italiano si richiede il contributo di tutti coloro intendano collaborare inviando anche solo una parte dei dati richiesti all'indirizzo sotto riportato. I nomi dei corrispondenti saranno menzionati in eventuali pubblicazioni.

Dati richiesti per una colonia (stagioni riproduttive 1994-95): specie - località - data delle prime osservazioni alla colonia - data delle ultime osservazioni alla colonia - collocazione dei nidi - numero di nidi attivi - la data più anticipata in cui è stato osservato un adulto con l'imbeccata - la data più tardiva in cui è stato osservato un adulto con l'imbeccata - la data più anticipata in cui sono stati osservati i giovani in grado di involarsi. Per le colonie di due specie riportare separatamente i dati di ogni specie.

Dati richiesti per ogni nido della colonia o per nidi isolati (per quest'ultimi indicare la specie e la località): collocazione del nido - orientamento foro d'entrata - data di deposizione - dimensione della covata - la data più anticipata in cui è stato osservato un adulto con l'imbeccata - data più anticipata in cui sono stati uditi i piccoli nel nido - data d'involo - successo di schiusa - successo di involo.

Alberto Sorace
Via R. Crippa, 60
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Primavera sullo Stretto di Messina, 1994

Lungo le coste dello Stretto di Messina si radunano nella stagione primaverile grandi quantità di uccelli rapaci; nella primavera 1993 ne sono stati osservati più di 25.000 con punte di 5.000 Falchi pecchiaiolo in un solo giorno. Purtroppo un intenso bracconaggio viene esercitato nei confronti di queste specie migratrici. Da 13 anni c'è però chi si batte per eliminare questa attività di cui ci dobbiamo vergognare a livello internazionale.

Quest'anno il campo di sorveglianza sul versante siciliano dello Stretto di Messina sarà interamente gestito dal WWF Italia.

Per avere informazioni sul progetto, denominato "Primavera sullo Stretto" e sulle modalità di partecipazione rivolgersi a:

WWF Italia - Ufficio Campi,
Via Donatello 5/B, 20100 Milano,
tel. 02/29404260.

Errata Corrige

Nell'articolo di Renzoni *et al.* 1992 (Avocetta 16: 104) aggiungere nelle citazioni bibliografiche:

Renzoni A., Focardi S., Fossi C., Leonzoni C. and Mayol J. 1986. Comparison between concentrations of mercury and other contaminants in eggs and tissues of Cory's Shearwater *Calonectrics diomedea* collected on Atlantic and Mediterranean islands. Environmental Pollution (Series A) 40: 17-35.

Norme per gli autori

AVOCETTA pubblica articoli originali, brevi note, sintesi di aggiornamento, commenti, corrispondenze e recenzioni, su argomenti che coprono l'intero campo dell'ornitologia. Verrà tuttavia data la preferenza a lavori sperimentali sull'ecologia, l'etologia, la zoogeografia della fauna ornitica della regione mediterranea e delle zone alpine.
I lavori sottoposti saranno valutati da referees e, in conseguenza dei suggerimenti da loro effettuati, saranno accettati, rinviati agli autori con proposte di modifiche, o respinti. tale decisione è competenza definitiva degli *editors*.
I lavori sottoposti in italiano, inglese o francese, devono essere dattiloscritti con interlinea 2, ampi margini, su una sola facciata e devono essere forniti in **tre** copie, complete di illustrazioni. L'autore indicherà a matita sul margine sinistro del dattiloscritto la posizione in cui illustrazioni e tabelle vanno inserite nel testo.
Il testo degli articoli dovrà essere diviso come segue:

— Titolo
— Cognome e nome dell'Autore
— Indirizzo dell'Autore
— Testo del manoscritto, diviso nei seguenti capitoli: Riassunto, Introduzione, Metodi, Risultati, Discussione, Ringraziamenti, Riassunto in lingua diversa da quella dell'articolo, Bibliografia
— Tavole e figure

Il **riassunto iniziale**, di un massimo di 40 righe, elencherà schematicamente tutti i problemi trattati ed i risultati ottenuti senza riferimento diretto al testo e senza ripetere l'informazione contenuta nel titolo. Nel riassunto non devono comparire abbreviazioni e simboli specialistici.

Il problema principale affrontato nel lavoro va esposto chiaramente nell'**introduzione** senza eccessivi dettagli storici. La continuità con altre ricerche va posta in evidenza con gli opportuni riferimenti bibliografici evitando la ricapitolazione di questi stessi lavori. I metodi devono essere espressi con chiarezza ma senza introdurre dettagli particolareggiati, tranne quando si tratti di un lavoro metodologico innovativo.

I nomi di **genere e di specie** e le parole da evidenziare devono essere sottolineati (per il carattere corsivo). I nomi comuni di animali vanno scritti maiuscoli.

Le **citazioni bibliografiche** nel testo possono essere date come: Mayr (1963), Andrewartha e Birch (1984), Fasola *et al.* (1987) o alla fine della frase (Mayr 1963, Fasola *et al.* 1987).
Le citazioni devono conformarsi ai seguenti esempi:

Capitolo:	Baldaccini N.E., Benvenuti S., Fiaschi V., Ioalé P. e Papi F. 1982. Pigeon orientation: experiments on the role of olfactory stimuli perceived during the outward journey. In: Papi F. e Wallraff H.G., Edits. Avian navigation. *Springer, Berlin* pp. 160-169.
Libro :	Lack D. 1954. The natural regulation of animal numbers. *Clarendon Press, Oxford.*
Rivista :	Papi F. 1986. Pigeon navigation: solved problems and open questions. *Monit. Zool. ital. (N.S.)* 20: 471-517.

I titoli delle riviste devono essere abbreviati secondo l'ultima edizione (quarta) del World List of Scientific Periodicals (1960) e i supplementi della British Union-Catalogue of Periodicals o le Serial Publications in the British Museum (Natural History) Library. Nel dubbio scrivere il riferimento in estenso. Non includere materiale non bubblicato tra le citazioni.

Le **Tavole** devono essere numerate consecutivamente con i numeri arabi e battute su un foglio separato con una chiara ed esauriente legenda.

Illustrazioni. Il massimo del formato (legenda inclusa) è 178×241 mm. Le illustrazioni devono essere 1.5-2 volte più grosse del formato definitivo. Anche le figure vanno numerate con numeri arabi. Scritte, lettere e numeri delle figure devono essere sufficientemente grosse da essere lette dopo riduzione del formato. Disegni grafici in china nera devono essere fatti su carta bianca o da lucido. Assieme nell'originale vanno spedite tre copie.
Sono richieste quattro copie di fotografie.
Legende di fotografie e figure vanno scritte su foglio separato.

Cinquanta estratti di ciascun articoli sono inviati gratis. Ulteriori copie possono essere acquistate con buono d'ordine allegato alle bozze di stampa.
I manoscritti vanno spediti a:

Redazione di AVOCETTA,
Dipartimento di Biologia Animale,
via Accademia Albertina 17 - 10123 TORINO.

Instructions to authors

AVOCETTA publishes original articles, short communications, reviews surveys, comments and correspondence on all topics of ornithology. However, preference will be given to original works in the ecology, ethology and zoogeography of the ornithological fauna in the Mediterranean region and the Alpine area.

Manuscripts, conforming to the journal's scope, are subject to the review process, and the final decision concerning acceptance or rejection will be made by the Editors.

Manuscripts shoud be submitted in triplicate preferably in English (Italian and French are also accepted). They must be typewritten double spaced with wide margins. Position of figures and tables should be marked on the margin.

Manuscripts should be arranged as follows:

- Title
- Author's names and initials
- Address of author's institution
- Text of the paper, divided into the following sections: Abstract, Introduction, Methods, Results, Discussion, Acknowledgements, Abstract (in a language different from that of the text), References
- Tables and illustrations

The **abstract**, of max 40 lines, should give concise but exhaustive information on the problem and the results, and be intelligible without reference to the main text. Abstract need not repeat information given in the title.

Abbreviations and special symbols must not appear in the abstract.

The main problem should be outlined briefly in the **introduction**, and detailed historical introductions should be avoided. Continuity with earlier work on the subject should be established by reference to recent papers, which need not themselves be summarized. Experimental methods must be clearly set out, but detailed descriptions of methods are of value only if they convey substantially new information.

Genus and species names and words to be emphasized should be underlined once (for italics). The common names of animals should be capitalized.

Literature citations in the text should be given as: Mayr (1963), Andrewartha and Birch (1984), Fasola *et al.* (1987) or, at the end of a sentence, (Mayr 1963, Fasola *et al.* 1987).

References at the end of the paper should be listed in alphabetical order by the first author's name; all work referred to in the text should be listed, and only those.

References should be conformed to the following examples.

Chapter: Baldaccini N.E., Benvenuti S., Fiaschi V., Ioalé P. and Papi F. 1982. Pigeon orientation: experiments on the role of olfactory stimuli perceived during the outward journey. In: Papi F. and Wallraff H.G., Edits. Avian navigation. *Springer, Berlin* pp. 160-169.

Book : Lack D. 1954. The natural regulation of animal numbers. *Clarendon Press, Oxford.*

Journal: Papi F. 1986. Pigeon navigation: solved problems and open questions. *Monitore Zool. Ital. (N.S.)* 20: 471-517.

Titles of journals should be abbreviated according to the last (4th) edition of the World List of Scientific Periodicals (1960) and following supplementary lists issued by the British Union-Catalogue of Periodicals or the Serial Publications in the British Museum (Natural History) Library. If in doubt, give the title in full. Do not include unpublished material among the references.

Tables must be numbered consecutevely in arabic numerals and typed on a separate sheet together with a clear descriptive legend.

Illustrations. The maximum dimensions of published figures (including the legend) are 178 × 241 mm. Authors are requested to submit illustrations 1.5-2 times larger than the final format. Illustrations should be numbered in Arabic numerals.

Lettering should be big enough to remain clearly visible after reduction. Drawings should be in black ink on drafting paper. The original and three copies should be submitted.

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