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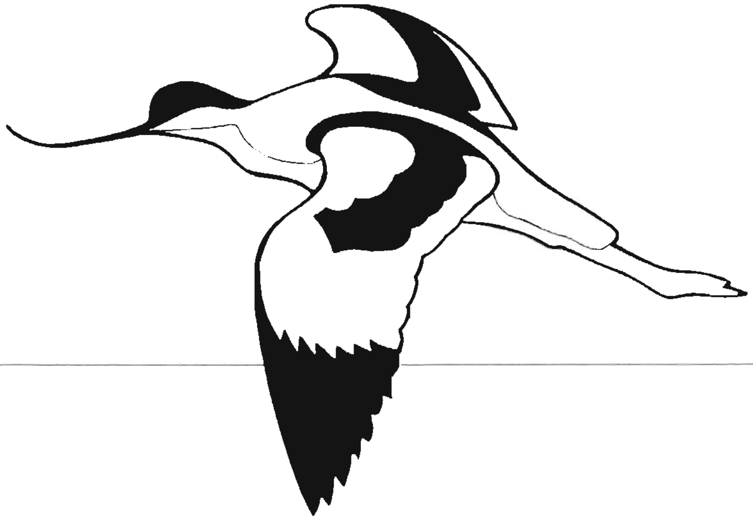

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The diet of the Chough *Pyrrhocorax pyrrhocorax* as indicated by analysis of digested prey remains

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Abstract - The largely invertebrate food of Red-billed Choughs, *Pyrrhocorax pyrrhocorax*, living on the maritime cliffs and hinterland of West Wales and Cornwall was investigated by analysis of prey remains in pellet and faecal samples. Undigested material was identified to varying taxonomic levels dependent upon the degree of fragmentation and the skeletal units recovered. This was carried out as part of a study aimed at conserving the species at the southern edge of its British range, and assessing the feasibility of re-establishment in Cornwall.

Direct observation showed that, in the breeding season, ants were a major resource, but their absence from faecal samples suggested that they are fed exclusively to nestlings. Otherwise, beetles and dipterous larvae, especially tipulids, were predominant foods. The majority of the prey identified in this study are associated with well-grazed rough pasture and maritime cliffs. Dung fauna apparently guarantees a food supply through lean periods. The importance of earthworms is ambiguous: direct observation and faecal evidence suggest it was a regular and important source of winter protein, possibly when cereal grain was unavailable.

Introduction

The nominate sub-species of the Red-billed Chough *Pyrrhocorax pyrrhocorax pyrrhocorax* was once widespread in Britain, but it has declined markedly in both distribution and abundance during the last two centuries, becoming finally extinct as a breeding bird in Cornwall, its last stronghold in England by the late 1960s (Goodwin 1986). While occasional vagrants do appear in Cornwall (e.g. Meyer 1990) the southern extent of the current breeding population in Britain is in coastal Dyfed, West Wales; a relict population of *ca.*20 pairs, further isolated by Cornish extinction, survives in NW France (Guermeur and Monnat 1980). The British and Irish population was estimated at *ca.*1,000 pairs in 1982 (Bullock *et al.* 1983) and has possibly increased slightly since then (Gibbons *et al.* 1993).

The reasons for the species' decline are probably anthropogenic: disturbance and persecution exacerbated the land-use change which caused low grazing-intensity pasture, rich in their epigaeal invertebrate food, to be replaced by intensive arable land. To ensure that appropriate management regimes are undertaken to maintain and enhance the British Chough population, detailed information on dietary requirements is needed from a variety of locations since it is clear that there is considerable variation in prey species availability and therefore selection between Choughs living in regions as climatically and topographically diverse as the Mediterranean in the south and Scottish islands in the north. In this study in West Wales, the Chough's diet was investigated by combining an examination of faecal and pellet material with direct observation and prey sampling. Comparative data were also collected on a vagrant pair in Cornwall. For conservation purposes, dietary study is useful in providing, by extrapolation from the prey species habitat preferences and behaviour, information on the habitat selection of the predator, and in improving our understanding of seasonal and climatic influences on diet.

In this paper we present the results of faecal and pellet analyses and compare these data with studies undertaken in other areas. It must be appreciated that the population under study was very small and fragmented. In West Wales, unlike Scotland, where a similar study has taken place (McCracken *et al.* 1992), the species nests at very low density. Only 7 breeding pairs of choughs occupied a total discontinuous study coastline in West Wales of >100km, and it was very rare to observe flocks greater than a family party.

Whilst the examination of cast pellets from both raptors and corvids has been quite widely practised (*cf.* Howes 1975, Yalden and Warburton 1979), even to the extent of identifying fossilised remains (Girling

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1977), much less research has been carried out on faecal material (*cf.* Ralph *et al.* 1985). Moreby (1987) has applied the technique to examine the diets of game birds, Green and Tyler (1989) have studied the faecal content of a captive Stone Curlew *Burhinus oedicnemus*, and McCracken *et al.* (1992) have investigated the use of multivariate analysis in interpreting faecal material from Choughs in Islay, at the northern extremity of the species' range. To some extent, progress has been limited by the problems inherent in the identification of fragmentary material, but even limited diagnostic results help to build up a more complete picture of predator diet, either by enabling specific identification of taxa or in a fuller quantitative assessment of food selection.

Methods

To minimise disturbance, faecal samples were collected whenever possible after on-going behavioural observation and the birds' departure from feeding sites. Nearly 450 faecal and pellet samples were collected (see Figure 1 for West Wales locations, and Appendix 1a-c for distribution of samples within study areas) during 1988-89. Usually only fresh samples were collected to prevent the possibility of confusion with faeces from other species.

Additional samples were collected during the course of a smaller scale investigation on two birds at Rame, Cornwall, during winter 1986-87 (Meyer 1990), on Ramsey Island (off the Pembrokeshire coast) during three days in July 1989; a few faecal samples from Stackpole to the south of the Welsh region were also examined (Table 1). The only pellets available in the study were collected from the roost of the Cornwall pair. Since no accessible roost site was found in Wales, pellets were not available from the Welsh population.

The study areas (Figure 1) are described fully in Meyer (1991). It should be noted that W1 and W2, to

Table 1 Proportions of adult and larval Coleoptera present within the faecal material (n=no. of samples with beetle evidence) in Wales (all seasons) and Cornwall (winter only).

	Wales (n=233)		Cornwall (n=67)	
Taxon	Adults	Larvae	Adults	Larvae
Carabidae	.36	.13	.43	.06
Staphylinidae	10	.02	0	0
Elateridae	.06	.01	0	0
Tenebrionidae	.09	0	.30	0
Scarabaeidae /Geotrupidae	.25	.06	.48	0
Curculionidae	.15	0	.06	0
Other	.22	.05	.04	0
All	.88	.24	.97	.06

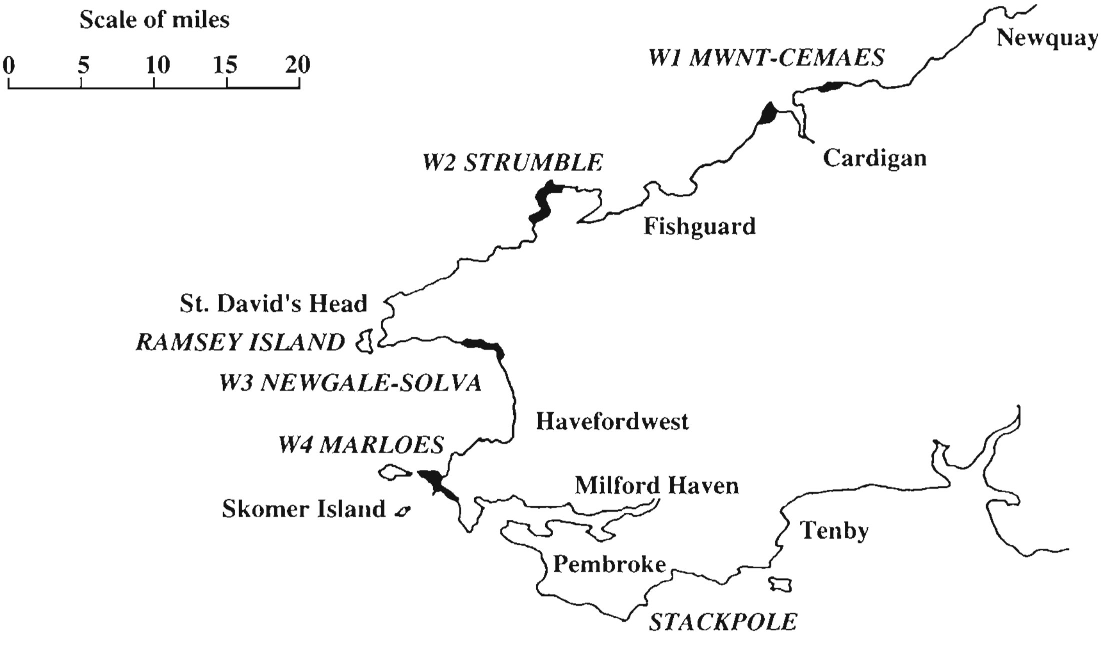

Figure 1. West Wales: location of faecal collection sites shown in upper case italics.

the north of the study region, have essentially an upland, pastoral and non-intensive agriculture whilst W3 and W4, to the south, are predominantly lowland, arable and, agriculturally, more intensified. The northern sites have coastlines with northerly aspects which reduce the exposure and insolation they receive, resulting in a scrubbier vegetation and a lower available invertebrate biomass, whilst W3 and W4 face the south and consequently receive more exposure and sunshine. Ramsey Island, lying off St. David's Peninsula, is a rugged area of maritime heath and grass, grazed by rabbits, sheep and red deer. The Rame Peninsula in Cornwall lies immediately across the Tamar estuary west from Plymouth; it is an area of mixed farming with some rough pasture; the cliffslopes are mainly scrub covered but with patches and zones of low, sparse cliff vegetation.

Faecal samples were usually examined within 24 hours; when this was not possible, they were dried and stored for later examination. The collected samples were teased apart in water with the aid of dissecting needles using a binocular microscope. Magnification of x6.25, illuminated by incident light, was usually found to be sufficient for retrieving larger fragments of chitin and other durable prey remains; this had to be increased to x12.5 - 25.0, with transmitted light, in order to locate earthworm chaetae and, occasionally, the spiracle processes of dipteran larvae. The fragments were sorted, dried on filter paper, and stored in sealed polythene bags.

Identification relied upon direct comparison of the fragments with the extensive entomological collections housed in the University of Sheffield and Doncaster Museum. Legs could usually be identified only to family level amongst most of the Coleoptera, whilst thoraces, elytra and, occasionally, heads could be taken to generic or species level. For some groups, e.g. the Lepidoptera, insufficient data are available to facilitate identification based upon larval head capsules, and no attempt was made to speciate lumbricid or dipterous processes.

Table 2. Seasonal frequency of prey (all ages) in West Wales as represented by percentage of faeces where present; W=winter (November-February), B =breeding (March-June), PB =post-breeding (July-October).

	% Frequency in region per			
	Season			
Taxon	W	B	PB	Year
OLIGOCHAETA	29	10	20	20
ARACHNIDA	3	3	0	2
CRUSTACEA	3	0	4	2
MYRIAPODA	4	1	2	3
DERMAPTERA	9	10	4	8
DICTYOPTERA	0	0	2	-
HEMIPTERA	1	2	0	1
LEPIDOPTERA	1	4	2	2
COLEOPTERA (all)	81	89	95	84
Carabidae	37	30	62	39
Staphylinidae	11	4	22	10
Elateridae	1	16	0	6
Tenebrionidae	4	9	13	8
Geotrupidae/Scarabaeidae	12	37	24	24
Curculionidae	13	15	9	13
Other families	5	7	5	3
Indet. beetles	36	15	5	22
HYMENOPTERA	4	0	36	9
DIPTERA	15	49	18	29
CEREAL GRAIN	49	2	9	23
OTHER	3	2	0	2
Total no. samples	117	105	55	277

Results

Prey spectrum

A total of 434 faecal and 15 cast pellets (latter all from Cornwall) were collected; of these 335 (75%) were of Welsh origin. A wide variety of invertebrates was identified (Appendix Ia-c), including most of the taxonomic groups noted by Goodwin (1986) as food items of the Chough. The common earwig *Forficula auricularia* formed a varying proportion of the prey items, up to 15%, at all main study areas. In contrast, the Dictyoptera were represented by only a single ootheca of the cockroach *Ectobius* sp., and there were no Orthopteran remains. Overall, the prey are relatively immobile. The only adult dipteran found, a Yellow dung-fly, *Scatophaga stercoraria*, was possibly consumed within its puparium during dung associated feeding. Dipterous larvae, however, including many tipulid head capsules, occurred in more than one third of the samples from the two northern, more pastoral study areas. Other Diptera were represented by unidentifiable puparial fragments and parts of the puparium of the muscid *Morellia cf. hortorum*, which breeds in dung (Skidmore 1985).

Coleopterous material, both larval and adult (Table 1), was remarkably frequent, occurring in 84% of all Welsh samples. Numerically, the dung beetles (Geotrupidae/Scarabaeidae), as imagines and larvae, were exceeded only by the ground beetles. Seasonal variations for all taxa in the West Wales assemblage are summarised in Table 2. The seasonality within study areas is summarised in Table 3.

The most frequent species in the Ramsey assemblage was a chafer beetle, either *Amphimallon solstitialis* or *A. ochraceus*. It proved impossible to separate these species on the fragments available; both are largely coastal in their distribution, and restricted to southern England and Wales, the latter species being the rarer (Jessop 1986).

Table 3. Seasonal frequency of prey (all ages) in West Wales study areas (= range of study birds) as represented by percentages of faeces where preset; W1 = Mwnt-Cemaes, W2 = Strumble, W3 = Newgale-Solva, W4 = Marloes, W winter (November-February), B = breeding (March-June), PB = post-breeding (July-October).

	% Frequency in study areas											
	W1			W2			W3			W4		
Taxon	W	B	PB	W	B	PB	W	B	PB	W	B	PB
OLIGOCHAETA	7	8	33	56	10	50	64	9	9	18	25	50
ARACHNIDA	3	0	0	0	0	0	5	18	0	2	0	0
CRUSTACEA	0	0	11	0	0	0	0	0	0	8	0	0
MYRIAPODA	0	0	0	0	5	0	23	0	3	0	0	0
DERMAPTERA	3	10	0	19	10	50	9	18	3	6	0	0
DICTYOPTERA	0	0	0	0	0	0	0	0	3	0	0	0
HEMIPTERA	0	0	0	0	5	0	0	9	0	0	0	0
LEPIDOPTERA	0	5	0	0	5	0	0	0	3	2	0	0
COLEOPTERA (all)	66	89	83	81	76	100	95	100	100	70	100	100
Carabidae	48	31	72	19	29	0	59	45	65	26	17	0
Staphylinidae	3	5	0	0	0	50	18	0	33	16	8	0
Elateridae	3	18	0	0	5	0	0	18	0	0	25	0
Tenebrionidae	0	2	0	0	10	0	23	55	21	0	0	0
Geotropidae/ Scarabaeidae	3	30	22	0	10	50	5	82	18	24	83	100
Curculionidae	0	7	14	13	24	0	14	36	9	20	25	0
Other families	0	2	0	0	0	0	0	0	3	6	0	0
Indeterminates												
- adults	66	10	0	50	10	0	18	18	9	10	8	0
- larvae	14	7	0	6	5	0	0	0	0	2	0	0
HYMENOPTERA	0	0	44	0	0	0	18	0	36	2	0	0
DIPTERA	21	48	28	6	62	0	9	27	15	18	50	0
CEREAL GRAIN	34	0	6	25	0	0	14	0	12	80	17	0
OTHER	0	0	0	19	0	0	0	0	0	0	8	0
TOTAL NO. OF SAMPLES	29	61	18	16	21	3	22	11	33	50	12	3

Figure 2 shows the annual diet as represented by percentage seasonal occurrence of prey types in Wales compared with winter data from Cornwall. There is close agreement between the Welsh and Cornish winter beetle evidence but the Cornish component of earthworms is much greater, balanced by less evidence of cereal grain. Grain, largely barley and wheat (+ occasional other seeds), appeared in 64 Welsh samples (23%), 77% of these being in the winter: almost 50% of all winter samples contained evidence of cereal feeding. In Cornwall, cereal grain appeared in <10% of the winter Cornish samples (Appendix Ib). In addition, one sample included the kernel from a wild or ornamental cherry *Prunus* sp. In 120 samples with grain/earthworm evidence only 11 contained both, and there was a very strong separation of the two components (grain 49%, earthworms 42%, grain + earthworms 9%, $X^2 = 32.55$, d.f. 2, N = 120, $P<0.001$). The frequency of earthworm evidence across the study region varies considerably, ranging from 6% in faeces from Ramsey Island (Appendix Ic), collected during dry summer conditions, to 74% in winter Cornish material (Appendix Ib). The lowest Welsh (mean = 20%) value of 12% at Mwnt-Cemaes contrasts with a high of 31% at Strumble, one of the few times that faecal data values from these two otherwise similar study areas diverge (cf. Diptera, Coleoptera and cereal component ranges of only 0-2%). The main variation between these areas was found within the winter season, when birds at Cemaes took more tipulids.

Mollusc evidence was infrequent: only a single terrestrial gastropod (*Discus rotundatus*) and fragments of the common marine mussel *Mytilus edulis* were found; the latter was possibly a result of Choughs scavenging along cliffs frequented by gulls. Crustacean evidence was limited to a few woodlice remains of indeterminate species origin.

Pellet and faeces comparison

The absence of cast pellets from Welsh sites raises the possibility that faecal and pellet prey assemblages are not directly comparable. While the majority of taxa found in pellets in Cornwall were recorded from faeces collected in the same area, there are some discrepancies (Appendix Ib); for example Lepidoptera were unrecorded in faeces while Diptera were unrecorded in pellets; Hymenoptera, Geotrupidae/Scarabaeidae and Curculionidae were all under-recorded in faeces as compared with pellets.

The available evidence does not suggest serious discrepancies between the taxa represented in pellets and faeces, although the possibility of identification to species level is clearly better from the less fragmented remains in pellets. Some of the differences may also be size-related: the larger species of ground beetle (*Pterostichus melanarius* and *P. niger*) and the large Dumbledor beetle *Geotrupes spiniger* were more evident in the pellets. But smaller taxa, for example identified lepidopterous larval head capsules, also occurred (Appendix I).

Comparison of Cornish and Welsh faecal samples

By applying Sorensen's (1948) quotient of similarity (*QS*):

$QS = 2j / (a+b)$

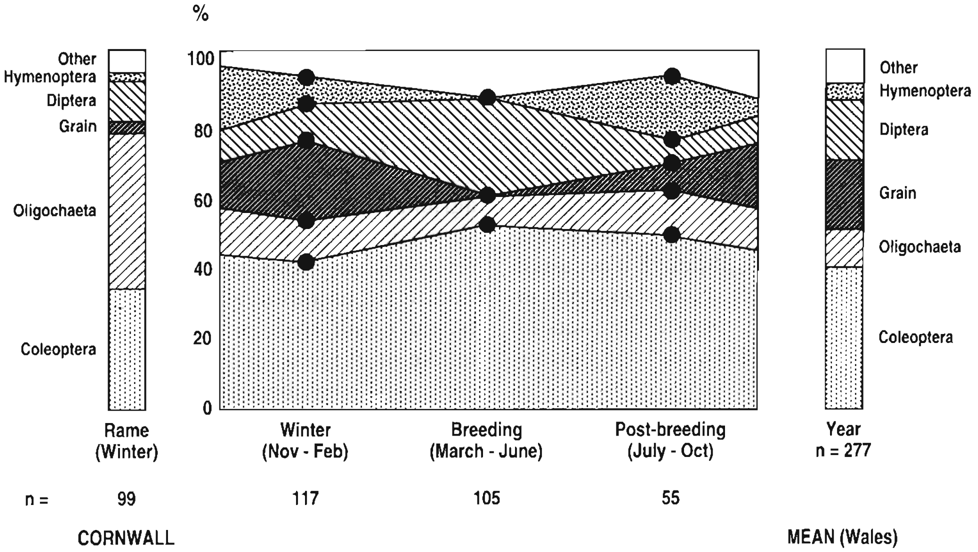

Figure 2. Adult annual diet of Choughs in West Wales (with comparison of two birds in Cornwall in winter) as indicated by faecal analysis.

where *a* = number of taxa recorded from region A, *b*=number of taxa recorded from region B, and *j* = the number of taxa recorded from both regions, the *QS* between the regions is 3.14. If the number of taxonomic groups in each region is divided by the total number of samples, the result is Wales = .332, Cornwall = .307, showing relatively little difference between the two areas.

There were, however, bigger differences within taxonomic groups: earthworms were clearly a more important element in the (winter) diet of the two immigrant Cornish birds (74% occurrence in 99 samples) than recorded for Welsh birds (winter = 29%, n = 117).

Discussion

In contrast to many bird species, whose decline is recent and related to the mechanisation of farming and heavy use of biocides (O'Connor and Shrubb 1986), the decline of the Chough has been taking place for at least two centuries (Coombs 1978). Dietary evidence helps to explain why, suggesting a shift of habitat away from permanent close-cropped grassland to rocky cliffs. It has been shown that Choughs are more successful, certainly in terms of foraging economics, where cliff conditions are more favourable (*i.e.* on south to west facing cliffslopes where scrubbing-over is prevented by exposure and where insolation is highest) even if the agricultural hinterland is non-pastoral.

There remains, however, a clear link with old established, undisturbed pasture. The close relationship between density of breeding Choughs and grazing pressure has been identified by several workers (*e.g.* Bullock and del Nevo 1983). Whilst the majority of the fauna, from the faecal evidence, could have been taken from well-grazed rough pasture, there is also a significant element from other habitats. The number of *Opatrum sabulosum* (from W3 throughout the year, and from Rame in Cornwall in the winter) was unexpected. Brendell (1975) does not record this tenebrionid beetle from Cornwall, although it occurred in 17% of 99 samples from there. It is found in sandy or 'waste' areas, principally on the coast at the roots of plants (Brendell, 1975; Harde, 1984), and will burrow in dry, sandy grassland (R. Crowson pers. comm.). The fossil record also suggests that the present restriction of this species to sandy soils and coastal localities is a result of major changes in land management (e.g. extensive ploughing and chemical application), which would also have affected Choughs, if present. Osborne (1969) found the beetle with several other apparent psammophiles in a late Bronze Age well at Wilsford on the Wiltshire Chalk, in a landscape which largely consisted of permanent, short-grazed grassland, potentially good Chough habitat.

The large ground beetle *Cychrus caraboides* (from W4) is primarily a woodland species (Lindroth 1973), although it has been found by one of us (PCB) feeding upon snails on the machair of the Outer Hebrides. The large carabid *Abax parallelopipedus*, recovered from Ramsey Island (Appendix Ic), is also normally regarded as a woodland species (Lindroth 1973), although it has been recorded by PCB also from the Hebrides. There is evidence of hunting near wetlands, possibly resulting from scavenging while drinking: a Chough was observed in this study in such a habitat at Strumble, where the weevil (Curculionidae) *Notaris bimaculatus* could occur on aquatic sedges (Cyperaceae). The hydrophilid *Hydrobius fuscipes* might similarly have been taken from a mere at Marloes. Weevils, though featuring prominently in faecal samples and also from some collected in the Stackpole area (Meyer, unpubl.), were not encountered during live invertebrate sampling.

The Chough's relatively long decurved bill, by enabling it to probe into pupal cavities and brood chambers beneath dung, allows it to exploit a resource denied to other corvids. But this element of specialisation leaves it particularly vulnerable to changes in management which reduce the supply of dung fauna. Almost in parallel with the Chough, dung beetle faunas have shown a pattern of decline and species change since collecting began in the early C19 (Hammond, 1974), and this pattern is shared by many other species associated with old established pasture, including two species, *Opatrum sabulosum* and *Amphimallon solstitialis/A. ochraceus*, present in the Chough faeces. Ploughing up of old pasture and the use of insecticides have virtually removed chafers, including *A. solstitalis*, described by both Jones and Jones (1964) and Edwards and Heath (1964) as a pest of both arable and pasture land. Increasing use of agrichemicals has led to its progressive restriction to surviving areas of old grassland, thereby largely removing it from the diet of many birds. The traditional unimproved yet grazed habitat of Ramsey Island could well provide a massive, if seasonal, intake of chafers for Choughs, as they emerge from their pupal chambers in the soil. In a single cast pellet, probably from a Chough (N. Thew, pers. comm.), from the west of Ireland, where much old grassland still survives, the chafer, *Phyllopertha horticola* (L.), occurred in large numbers; this species also was once so common in England as to be accorded pest status (Raw 1951).

Previous studies have demonstrated that Coleoptera are a major Chough prey (*e.g.* Roberts 1982), and the present study confirms this. Beetle evidence occurred in more than three-quarters of faecal samples from all areas. Species selection altered: at W3 more ground and rove beetles (Staphylinidae) were taken, but at W4 more dung beetles (mainly of the *Aphodius* genus) were taken. This latter fact is surprising given the greater pastoralism at W1 and W2. The increased emphasis on Diptera by Choughs at W1 might have affected the dung beetle intake, and it could in part also be explained by the reduced sample size at W4 and a larger proportion of unidentified beetles, including possibly chafers of various species, which were known to occur frequently on the cliffs.

The life-cycles of beetles will affect their availability/ accessibility at different times of the year. Different habitats are occupied by various larval stages and flighted adults. Availability peaks from March through June but this is not reflected in faecal analysis (Table 1). The most important family (Carabidae) falls quite sharply in the Chough breeding season, when the bulk of the adult diet is dipterous (occurrence 49%) and scarabaeids (37%) (Table 1). Seven species, available from cow dung, might represent the 'cheapest' (i.e. least effort) adult food at this time of year.

Ants have frequently been noted as an important item in Chough diet, in Wales, Cornwall and the Isle of Man (Holyoak 1967, Cowdy 1973, Coombs 1978) but not in Islay, Scotland (McCracken *et al.* 1992). During the Chough breeding season, ant populations were a major influence on habitat selection. Since no remains occur in any of 105 faecal samples from Wales at this time, they must be selected preferentially for feeding to young in the form of a bolus. Outside the breeding season, all identified ants were alates, suggesting predation on swarming ants (notably *Lasius flavus*) before flight although the catching of flying insects by a flock of Choughs has been witnessed in the Isle of Man in September (Batten *et al.* 1973). The Ramsey ants are supplemented by a mobile heathland species *L. alienus* (Brian 1977). Ants were taken in Cornwall in November and December, and in West Wales in November and February (Meyer 1990).

In winter, when small active prey are scarce, the Chough relies upon large foci of invertebrates centred on dung: adult and larval beetles, dipterous larvae and earthworms. Tipulid larvae have also been noted to aggregate beneath old dung (P. Skidmore pers. comm.). Even though dung fauna is not specific to particular species of large herbivore (Landin 1961), sheep dung is less favoured by the larger dung beetles. The progressive reduction of out-wintered horses and cattle will have contributed to the decline of invertebrates and Choughs.

Direct observation and the pattern of faecal evidence (Figure 2) showed that earthworms were a regular and important prey of Choughs in West Wales, and this could also apply in Cornwall. Taken in isolation, earthworm chaetae in faeces will over-estimate the importance of earthworms to a greater extent than with any other prey taxon. In a small captive experiment, it was found that chaetae from just one earthworm can appear in at least 12 subsequent faeces (Meyer 1991). The sampling protocol helped to counter this by ensuring that faecal sampling occurred on separate days in each study area during each visit. Choughs are known to consume some plant food: oats are a very important component on Islay in the Hebrides, occurring in nearly all winter faecal samples recorded in an unpublished study by Warnes in 1982. This seems to decline southwards and they "are extremely abundant in the diet from October to April" (McCracken *et al.* 1992). If earthworms and cereal grain are interchangeable as a source of winter protein, availability of cereal, given its lower collection costs, would reduce earthworm intake. Earwigs (Dermaptera) had, like earthworms, a generally high background abundance (Meyer 1991). Again, faecal evidence suggests that they are an important Chough food, and this is certainly so on Bardsey Island (Roberts 1982) and on Islay where McCracken *et al.* (1992) recorded them from seven out of eight taxa classes (= pseudo species).

Diptera were fairly evenly distributed within feeding areas across the study range, a fact confirmed by faecal analysis even though their larval remains do not survive well in the residue. It is very probable, therefore, that their value is underestimated.

The diversity of actual prey, as represented by faecal evidence, does not support the hypothesis that availability of a wider prey spectrum in a particular area is reflected in the diet: W1 possessed the greatest potential prey spectrum but revealed by far the fewest prey taxa. The key to Chough distribution, in fact, is probably not diversity of prey species but the availability of certain taxa at specific times of the year. In the case of Choughs in West Wales, this might be summarised: autumn and winter=cereals/earthworms; spring= tipulids; summer=other Diptera; and breeding season and summer=ants (for pulli). The Coleoptera, with their great taxonomic variety and association with dung, form a year- round resource. It is therefore essential that land management regimes for the Chough take account of the need to maintain high coleoptera, tipulid and dung densities, and also ensure, by means of short vegetation and earth exposures, especially on cliffs and cliff slopes, their accessibility to the birds.

Appendix 1a. List of prey as identified from faecal samples. Yearly frequency prey (all ages) in Welsh study areas as represented by percentage of faeces where present. W1 =Mwnt-Cemaes, W2 =Strumble, W3 =Newgale-Solva, W4 =Marloes; Age: indeterminate full-grown except where stated: A =adults, Y =larvae. Taxonomy follows Kloet & Hincks (1977) revised from Lucht (1987) where appropriate. and Kerney & Cameron (1979).

	% Frequency in study area			
Taxon	W1	W2	W3	W4
OLIGOCHAETA	12	31	27	20
ARACHNIDA				
indet. spiders	1	3	5	0
Indet. Opilones	0	0	0	2
CRUSTACEA				
indet. woodlice	2	0	0	6
MYRIAPODA	0	3	9	0
DERMAPTERA				
Forficula auricularia (L.)	8	15	8	5
DICTYOPTERA Blattidae				
Ectobius sp.	0	0	2	0
HEMIPTERA (A)				
Coreidae Enoplops scapha (F.	0	3	0	0
Pentatomidae Dolycornis baccorum (L.)	0	0	2	0
LEPIDOPTERA (Y)	3	3	2	2
DIPTERA (Y, all)	37	36	15	23
NEMATOCERA				
Tipulidae	30	33	14	20
Bibionidae	4	0	0	0
BRACHYCERA				
Tabanidae	0	0	0	2
CYCLORRHAPHA				
Phoridae	0	0	2	0
Indet. Diptera	4	3	0	2
HYMENOPTERA (A, all) Formicidae	7	0	24	2
Myrmica scabrinodis (Nyl.)	0	0	6	0
Myrmica sp.	0	0	9	0
Lasius flavus (F.)	5	0	8	2
Lasius niger (L.)	0	0	3	0
Indet. Formicidae	3	0	0	0
Indet. Symphyta	0	0	0	0
COLEOPTERA (all)	81	79	98	77
CARABIDAE (all)	43	23	61	23
Cychrus caraboides (L.) (A)	0	0	0	2
Carabus problematicus (Hbst.) (A)	0	0	3	0
Nebria sp. (A)	2	0	0	0
Loricera pilicornis (F.) (A)	1	0	0	0
Trechus obtusus (Er.) (A)	0	0	0	2
Bembidion lampros (Hbst.) (A)	0	0	0	3
Pterostichus ?madidus (F.) (A)	0	0	5	0
Pterostichus sp. (A)	0	0	15	2
Calathus erratus (Sahl.) (A)	0	0	2	0
Calathus fuscipes (Goez.) (A)	0	0	5	0
Agonum dorsale (Pont.) (A)	2	0	0	0
Agonum sp. (A)	2	0	0	0
Amara aenea (Deg.) (A)	0	0	5	0
Amara similata (Gyll.) (A)	0	3	0	0
Amara tibialis (Payk.) (A)	0	0	5	0
Amara spp. (A)	4	8	9	13
Harpalus affinis (Schr.) (A)	2	0	2	0
Harpalus spp. (A)	0	0	3	0
Indet. (A)	14	3	15	3
Indet. (Y)	20	10	6	0
HYDRAENIDAE				
Helophorus sp. (A)	0	0	0	3

	% Frequency in study area			
Taxon	W1	W2	W3	W4
HYDROPHILIDAE (A)				
Cercyon sp.	0	0	0	3
Hydrobius fuscipes (L.)	0	0	0	2
SILPHIDAE (A)				
Thanatophilus sp.	1	0	0	0
Silpha sp.	0	0	2	0
STAPHYLINIDAE (all)	4	3	23	14
Stenus sp. (A)	0	0	2	0
Philonthus sp. (A)	0	0	2	5
Staphylinus ?aenocephalus (L.) (A)	0	0	5	3
Staphylinus ?olens (Mull.) (A)	0	0	2	0
Staphylinus sp. (A)	0	0	11	3
Staphylinus sp. (Y)	0	0	3	0
Indet. (A)	0	3	2	3
Indet. (Y)	4	0	0	0
ELATERIDAE (all)	11	3	3	5
Agrypus murinus (L.) (A)	0	0	0	2
Athous sp. (A)	1	0	2	2
Agriotes ?obscurus (L.) (A)	0	0	2	0
Agriotes sp. (A)	2	3	0	2
Indet. (A)	6	0	0	0
Indet. (Y)	2	0	0	0
TENEBRIONIDAE (all)	1	5	27	0
Opatrum sabulosum (L.)	0	0	21	0
Cylindronotum laevioctostriatus (Goez.) (A)	0	5	0	0
Cylindronotum sp.	1	0	6	0
SCARABAEIDAE/GEOTRUPIDAE (all)	21	8	24	38
Geotrupes sp. (A)	2	3	3	3
Aphodius contaminatus (Hbst.) (A)	1	0	0	0
Aphodius rufipes (L.) (A)	0	3	11	0
Aphodius rufipes (L.) (Y)	0	0	0	9
Aphodius sphacelatus (Panz.) (A)	1	0	0	5
Aphodius sp. (A)	14	3	6	20
Aphodius sp. (Y)	3	0	2	0
Onthophagus joannae (Golj.) (A)	0	0	3	0
Onthophagus similis (Scr.) (A)	1	0	0	0
Onthophagus sp. (A)	0	0	0	2
Cetonia aurata (L.) (A)	0	0	0	3
Cetonia sp. (A)	0	0	2	0
Indet. (A)	2	0	0	0
Indet. (Y)	2	0	0	0
CURCULIONIDAE (all)	6	18	15	20
Otiorhynchus ligneus (Ul.) (A)	1	3	6	11
Trachyploeus sp. (A)	0	3	2	0
Barypeithes ?pellucidus (Boh.) (A)	0	0	2	0
Sitona ?cylindricollis (Fahr.) (A)	0	0	0	2
Sitona hispidulus (F.) (A)	0	0	0	3
Sitona sp. (A)	1	3	0	2
?Hypera sp. (A)	1	0	0	0
Notaris bimaculatus (F.) (A)	0	5	0	0
Indet. (A)	3	8	6	3
Indet. beetles (A)	23	26	14	9
Indet. beetles (Y)	7	5	0	2
GASTROPODA				
BIVALVIA				
Mytilus edulis (L.)	1	0	0	0
Endodontidae				
Discus rotundatus (Mull.)	0	0	2	0
INDET. FRAGMENTS	0	8	0	2
CEREAL GRAIN	10	10	11	67
Total no. samples	108	39	66	64

Appendix 1b. Frequency of winter prey at Rame, Cornwall as represented by percentage occurrence of remains in faecal samples and cast pellets; Age: indeterminate full-grown, except A =adult, Y =larvae

Taxon	% Frequency	
	Faeces	Pellets
OLIGOCHAETA indet.	74	40
ARACHNIDA indet.	1	0
MYRIAPODA indet.	2	0
DERMAPTERA Forficula auricularia (L.)	6	7
HEMIPTERA	0	7
LEPIDOPTERA (all)	0	20
Indet.	0	13
?Lasiocampa sp.	0	7
COLEOPTERA (all)	55	80
Indet. (A)	6	0
Indet. (Y)	0	7
CARABIDAE (all)	24	53
Pterostichus niger (Schall.) (A)	0	13
Pterostichus melanarius (Ill.) (A)	0	7
Pterostichus madidus (F.) (A)	2	0
Amara aenea (Deg.) (A)	1	0
Amara aulica (Panz.) (A)	2	0
Amara sp. (A)	5	0
Trichocellus sp.	0	7
indet. (A)	16	20
indet. (Y)	1	7
TENEBRIONIDAE (A)		
Opatrum sabulosum (L.)	17	20
GEOTRUPIDAE/SCARABAEIDAE (A, all)	25	67
Geotrupes spiniger (Marsh.)	0	60
Geotrupes sp.	7	7
Aphodius sphacelatus (Panz.)	1	0
Aphodius sp.	18	7
Oxyomus silvestris (Scup.)	1	0
CURCULIONIDAE (A, all)	1	20
Brachysomus echinatus (Bons.)	1	7
Sitona ?waterhousei (Wall.)	0	13
HYMENOPTERA (A, all)	2	13
Indet. ants	2	7
Indet. wasps	0	7
DIPTERA (all)	14	0
Indet.	2	0
NEMATOCERA (all)	10	0
Tipulidae	8	0
Bibionidae	2	0
CYCLORRHAPHA (all)	2	0
Muscidae		
Morellia ?hortorum (Fall.)	1	0
Scatophagidae		
Scatophaga stercoraria (L.)	1	0
INDET. FRAGMENTS	1	0
CEREAL GRAIN/SEEDS	8	7
Total no. samples	99	15

Appendix 1c. Frequency of prey taken by Choughs on Ramsey Island in July 1989 as represented by percentage occurrence of remains in faecal samples; Age: A =adult, L =larva

Taxon	% Frequency
OLIGOCHAETA	6
LEPIDOPTERA (L)	2
HYMENOPTERA (all)	8
Myrmica sp.	4
Lasius ?alienus (Foest.)	6
Lasius flavus (F.)	2
Lasius sp.	2
DIPTERA (L) (all)	29
NEMATOCERA	
Tipulidae	20
CYCLORRHAPHA	
Syrphidae	2
Indet.	6
COLEOPTERA (A, all)	98
CARABIDAE (all)	35
Pterostichus nigrita (Payk.)	2
Pterostichus sp.	18
Abax parallelepipedus (Pill. & Mitt.)	4
Calathus fuscipes (Guez.)	6
Amara aenea (Deg.)	2
Amara sp.	10
Harpalus sp.	2
indet.	8
STAPHYLINIDAE	
Staphlinus ?aenocephalus	6
ELATERIDAE	
indet.	2
BYRRHIDAE	
Byrrhus sp.	14
COCCINELLIDAE	
Scymnus sp.	2
SCARABAEIDAE (all)	76
Amphimallon ?solstitialis (L.)	76
Cetonia ?aurata (L.)	2
CURCULIONIDAE (all)	12
Otiorhynchus ligneus (Ol.)	10
indet.	2
GASTROPODA	
Helicidae	
Trichia striolata (Pfeif.)	2
CEREAL GRAIN	4
Total no. samples	49

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Riassunto - L'alimentazione dei Gracchi corallini *Pyrrhocorax pyrrhocorax* delle aree costiere ed interne del Galles occidentale e della Cornovaglia è stata studiata attraverso l'analisi delle deiezioni e delle borre. Il materiale indigerito, composto prevalentemente da invertebrati, è stato identificato a vari livelli tassonomici, a seconda del grado di frammentazione delle parti esoscheletriche rinvenute. La ricerca fa parte di uno studio finalizzato a garantire la conservazione della specie nella porzione più meridionale del suo areale distributivo britannico,

valutando nel contempo le possibilità di un suo ristabilimento in Cornovaglia.

Le osservazioni dirette indicano come durante la riproduzione le formiche siano una risorsa importante per la specie; tuttavia la loro assenza nelle deiezioni suggerisce che vengano riservate esclusivamente ai pulli. A parte le formiche, coleotteri e larve di ditteri, specialmente Tipulidi, risultano essere le prede dominanti nella dieta.

La maggior parte delle prede identificate sono associate con aree ben pascolate e scogliere marine. La fauna di invertebrati legata allo sterco vaccino ed equino sarebbe un'importante risorsa trofica durante i periodi di scarsità generalizzata di cibo.

L'importanza dei lombrichi è ambigua: l'osservazione diretta e l'analisi delle deiezioni suggeriscono comunque che possano essere un'importante e regolare fonte di proteine in inverno, probabilmente in concomitanza con l'assenza di semi di cereali.

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Distribution and population-size of colonies of Yellow-legged Gull *Larus cachinnans michahellis* breeding in North-Eastern Adriatic sea

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Abstract - The distribution of colonies of *Larus cachinnans michahellis* in the North Adriatic is related to the vegetation and the presence/absence of human interference. Strong increases in recent years are noted and an estimate for the Northern Adriatic population (40,000 - 50,000 pairs) is given.

Introduction

The present knowledge about status of nesting populations of *Larus cachinnans michahellis* in the Adriatic is scarce and fragmentary.

As far as Italy is concerned the results of a census of Laridae and Sternidae taken in 1983-84 (Fasola 1986) are known, as are annual counts for Valli di Comacchio (P. Brichetti and U. Foschi pers. obs.), Grado and Marano lagoons (P. Utmar pers. com., Parodi *et al.* 1993), and of a study of colonies in the city of Trieste (Benussi *et al.* 1993, Benussi *et al.* in press).

For the Slovenian and Croatian areas (Istria and Dalmatia), the ringing of pulli on the islands of Murkan and Bobara, Southern-Dalmatia, has been carried out (Štromar 1967), as have a census of population and breeding biology in the Kornati archipelago (Štromar 1970), the distribution of colonies on Krk and its satellite islands (Lovrič 1971), the distribution and size of colonies on some islands of Eastern Quarnero (Štromar 1977), Istria and Northern Dalmatia (Benussi 1986) and a study of breeding biology in Sečovlje salt-pans (Škornik 1992).

Methods

Censuses of the colonies were carried out in 1989 on the coast of Istria and Northern Dalmatia islands, down to Ilovik (areas n.1 and 2), in 1991 on Pag's satellite islands (area n.3) and in 1992 in the area between Olib and Skarda (area n. 3). Partial counts were made in 1991 in the Kornati archipelago down to the island of Samograd (Figure 1).

The censuses were carried out in the period between April 15th and June 15th using a motor boat. Collected data was obtained through a direct count of nests (Table 1) or by an assessment of the number of nesting pairs on islands where landing was forbidden, difficult to walk on or with a low nesting density.

Groups of more than 4 nesting pairs (n=78) were considered as "colonies", while the islands with less than 5 pairs or with single pairs were excluded from data processing (n=6).

Annual counts were made from 1988 to 1992 on 4 sample islands (areas n.1 and 2), heterogeneous from a morphological point of view (Lunga, Fenoliga, Galijola, Palacol).

Results

Status and populations trend

Censuses taken from 1988 to 1992 in areas n. 1-3 gave a total count of 12,257-14,167 nesting pairs, spread over 78 out of 227 islands, with a percentage of occupation of 34.3% (area n. 1: 52.3%, n =44; area n. 2: 21.5%, n= 19; area n. 3: 27.2%, n= 15). Eight colonies with a total number of 641-1,041 pairs were counted in the partial census of area n.4 (Kornati archipelago) in 1991.

In the 4 surveyed areas the whole population is at least 12,898-15,208 nesting pairs spread over 86 different islands.

Six colonies with less than 5 pairs were found in areas n.1-3 and 2 in area n.4 (Figure 1). A previous count (1982-1985) of 16 colonies in Istria and Northern

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Table1 - General outline of the number of nesting pairs for each colony in the various censuses showing the subtotal for each area. Six islands with less than five pairs are excluded. Denomination of islands is drawn from: Male Karte 1:100000, Drzavni Hidrografski Institut, Split, Rev.1993.

Localities	1988	1989	1990	1991	1992
Regata		22			
Altijež		36			
Fržital		27			
V.Školj		91			
Galopun		35			
Hr.Orlandin		10			
Reverol		7			
Galiner		10			
Sv.Juraj		17			
Lunga	331	339	344	346	376
Banjol	20/30	21			
Sv.Katarina		17			
Sturag		16			
Sv.Ivan		200/250			
Pulari	50/60	30/40			
Revera	20	37			
M.Sestrica		100/130			
V.Sestrica		145			
Gustinja		100/130			
Pisulj	54	33			
Kolona		17			
Porer		27			
Sv.Marko	120/140	150/180			
Gaz	500/600	500/600			
Obljak	400/450	450/550			
Supin	100/150	150/170			
M.Brijuni	100/120	150/200			
Supinić		17			
Galija		200/250			
Grunj	350/400	230/280			
Pusti		200/250			
Vrsar		100/150			
Sv.Jerolim		20/30			
Fraškerić		32		33	
Fenoliga	89	94	97	118	126
Fenera	60/80	180/200			
Šekovac		37			
Bodulaš		80/100			
Ceja		100/120			
Trumbuja		13			
Premanturski		17			
Pomerski		65			
Levan		200/220			
Levanić		60/70			

Area 1 (census 1989): 4,382/5,102

Localities	1988	1989	1990	1991	1992
Galijola	134	147	172	221	243
Samunćel		100/120			
Školjić		32			
Unije		600/800			
Mišnjak		160/190			
Hr.Mišar		12			
Zeča		600/700		600/800	
Zaglav		24			
Galun		630/730			
Zečevo		988			
Kormati		580/630			650/700
Palacol	74	97	108	119	127
Oruda		300/350			400/500
Trstenik		300/350			
Ćutin		400/500			
Dolfin		450/550			
Hr.Ostar		15			
M.Laganj		12			
V.Laganj		20/30			

Area 2 (census 1989): 5,467/6,277

Localities	1988	1989	1990	1991	1992
M.Sikavac				97	
Lukar				105	
V.Brušnjak				300/400	
M.Ražanac				248	
V.Ražanac				100/150	
Morovnik					180/200
Hr.Kurjak					18
Pohlib					100/130
Planik					400/450
Planičić					80/100
Greben-Južni					160/180
Greben-Srednji					20/30
Greben-Zapadni					180/200
Kamenjak					20/30
Lutrošnjak					400/450

Area 3 (census 1991-92): 2,408/2,788

Total (1,2,3 areas; census 1989/92): 12,257/14,167

Localities	1988	1989	1990	1991	1992
Purara				200/250	
Samograd				100/150	
Mrtovnjak				100/200	
Smokvica Mala				10	
V.Zernicovar				4	
Brusak				10	
V.Babugliasi				17	
Mezanj				200/400	

Area 4 (partial census 1991): 641/1,041

Dalmatia, corresponding to the main islands of areas n. 1 and 2, resulted in a population of 3,200-3,600 pairs (Benussi 1986). At least 585 pairs, 400 of which nesting in Vela Balabra were found in 1968 on 9 islands of Kornati archipelago (Štromar 1970).

The results of counts made in consecutive years (1988-1992) in the 4 sample islands (Figure 2) show an increase of 38.8% throughout five years, with an annual average increase of 8.5% (min. 6.5% in 1989-90; max. 11.5% in 1990-91).

If we consider the islands with colonies consisting of more than 200 pairs (n=8) censused in 1982-85 (Benussi 1986) there was an increase of 45% by 1989 (n=8) and of 68.7% by 1992 (n= 3).

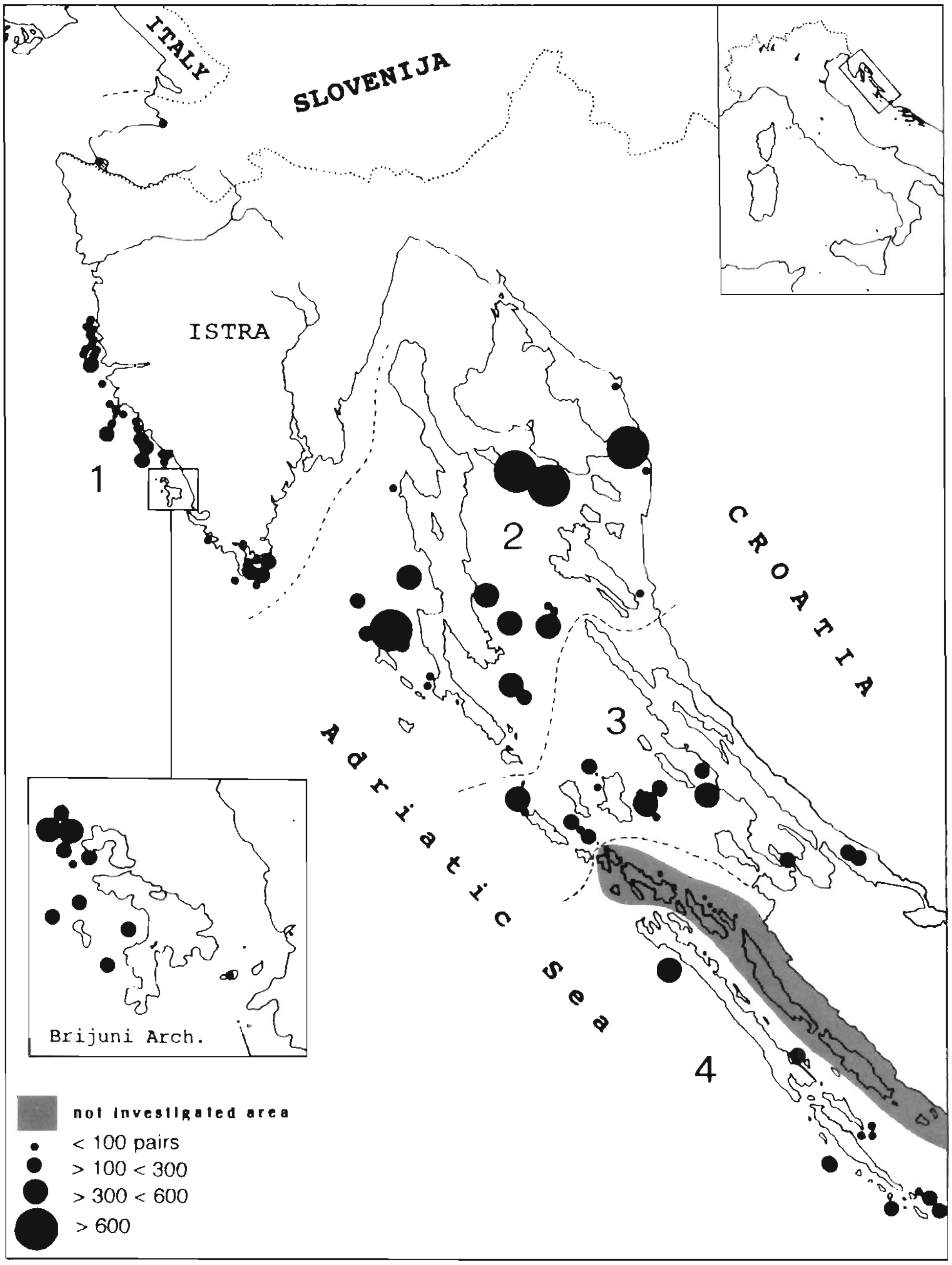

Figure 1 - Distribution and size of colonies of *Larus cachinnans michahellis* in North-East Adriatic for each censused area: n. 1-2, censused 1989; n. 3, 1991-92. Area n. 4 was partially censused in 1991. Also 6 islands with less than 5 nesting pairs have been mapped.

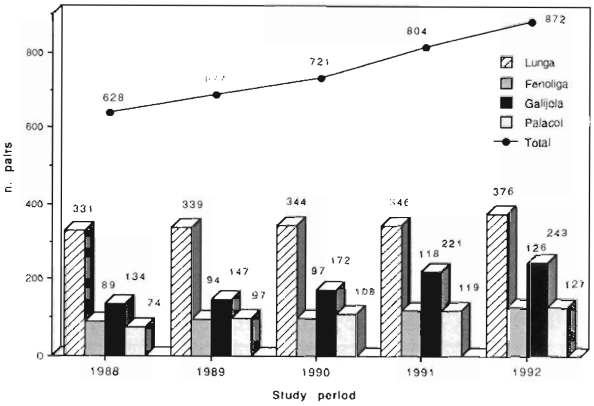

Figure 2 - Evolution of nesting population in 4 sample colonies from 1988 to 1992 (area n.1: Lunga and Fenoliga; area n. 2: Galijola and Palacol.

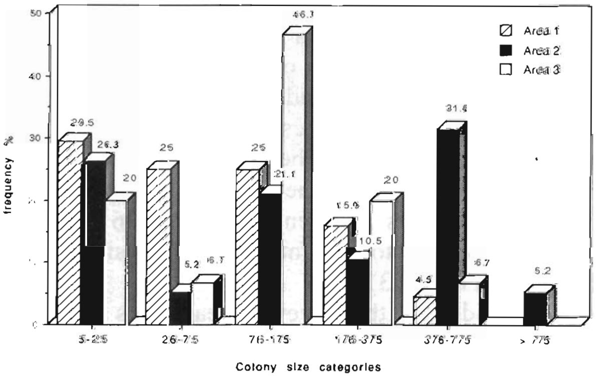

Figure 3 - Distribution of frequency by size-class of the colonies for the areas n. 1,2,3.

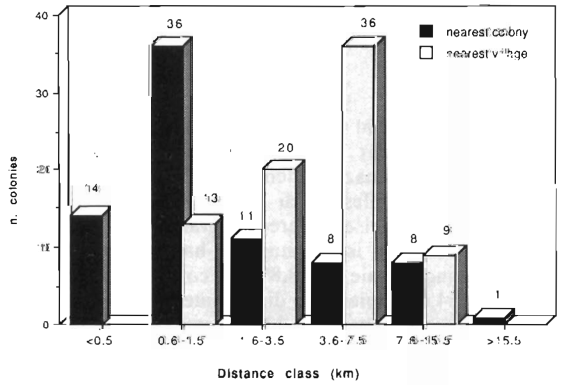

Figure 4 - Distribution of frequency by distance class (km) of the colonies between colonies and human settlements.

In the Italian Adriatic area, 97% of the 3,442 pairs censused in 1983-84 (Fasola 1986) were located between Valli di Comacchio (Emilia-Romagna) and Grado lagoon (Friuli-Venezia Giulia).

Colony-size

The average size of 78 colonies with more than 5 pairs was of 164.4 pairs for each colony (median 97), with the highest value in area n.2 with the presence of 4 colonies of more than 600 pairs (Figure 1 and Table 1). In area n. 1 the colonies occupied 52.3% of the islands, while in areas n. 2 and 3 the values of occupation were of 21.5% and 27.2%. The 26.9% of colonies had a number of colonies from 5 to 25 (n= 21) and 28.2% of colonies of average size (75-175 pairs, n= 22). The largest colony (899 pairs in 1989) was located in area n. 2 on Zečevo island. Small colonies were everywhere evenly distributed throughout the islands (Figure 3); the medium-sized colonies (75-175 pairs) were on the whole more frequent, expecially in area n. 3 where they reach 46.7%. In area n.2 colonies with more than 376 pairs reached 36.8%.

Distance between colonies and human settlements

The distance between two closest colonies is 2.54 km (median 1.25) on average.

The distance between colonies and the closest human settlements is on average 4.13 km (median 3.90). Both these average values rise in relation to the size of the colonies, expecially in the second case where a significant difference (t-test=5.11; $p < 0.001$) has been highlighted between colonies <100 pairs (2.94 km; n=40) and > 200 (5.4 km; n=20). The 46% of colonies stand at a distance of 3.5-7.5 km from settlements and 46% are concentrated between 0.6 and 1.5 km (Figure 4). These results are obviously influenced by the geographical distribution of islands, towns, and villages.

Vegetative cover and typology of islands

The amount (ratio) of vegetative cover is on average 54.42%.

The highest value is in area n. 1 (61.59%), the lowest in n. 3 (35.33%) (Table 2). The ratio of vegetative cover does not seem to influence the colony-size: 52.4% for colonies with more than 100 pairs, 56.8% for colonies with more than 200 pairs.

The 38.5% of colonies are situated on islands with herbaceous vegetation, 33.3% with tall Mediterranean garrigue, 17.9% with maquis and 10.3% on islands without any vegetation. The impact of the traditional presence of sheep in an almost wild state on most Dalmatian islands and the Bora, a cold wind blowing, often very strongly, from N-NE influence the evolution and the difference in distribution of vegetation.

Table 2 - Summary table of parameters of the colonies. The areas are the ones shown in Figure1; in the counts of colonized islands those with less than 5 nesting pairs have been excluded; distances between colonies and the closest built up areas are in kilometres.

Area	tot. isl.	isl. with colony	mean colony size (S.D.; range)	mean dist. from nearest colony (S.D.; range)	mean dist. from nearest village (S.D.; range)	% vegetation coverage (S.D.; range)
1	81	44 (54.3%)	107.6 (123.78; 7-150)	1.34 (1.19; 0.4-5.6)	3.20 (2.19; 0.7-8.3)	61.59 (25.08; 5-90)
2	73	19 (26.0%)	309.1 (302.03; 12-988)	5.42 (5.10; 0.1-16.4)	5.69 (2.42: 1.3-11.6)	52.89 (27.60; 5-85)
3	67	15 (22.4%)	147.6 (119.41; 17-425)	2.40 (1.95; 0.8-8.2)	4.91 (1.98; 2.1-9.1)	35.33 (25.74; 5-80)
tot.	221	78 (35.3%)	164.4 (198.85; 7-988)	2.54 (3.23: 0.1-16.4)	4.13 (2.45; 0.7-11.6)	54.42 (27.40; 5-90)

In fact most of the tall Mediterranean vegetation is situated on islands sheltered by the Istrian coast, where sheep-farming is totally absent, or on the larger islands close to Cres and Lošinj. On the contrary, most of the islands without vegetation are in the windy Dalmatian coastal parts of Velebitski Kanal and Kvarnerić.

Discussion

The results have shown high concentration of colonies of *Larus cachinnans michahellis* in the North-East Adriatic and an even distribution in all the censused areas.

All the colonies (n=75) are situated on little islands (min. Hr. Orlandin 0.0002 km^2; max. Planik 0.7 km^2), with the exception of the larger Mali Brijuni (1.3 km^2), Zeča (2.5 km^2) and Unije (17 km^2), while colonies are absent from large islands, even in their uninhabited and potentially suitable parts.

Colonies are located on islands either uninhabited or with only the presence of lighthouses, apart from the large colony on the island of Unije, which is however stationed on the side opposite to the little town and with difficult access by land because of the thick Mediterranean vegetation. These preferences highlight the strong insularity of this species and its tendency to colonize islands not subjected to any direct human disturbance and with the absence or scarce presence of land predators. In fact colonies with more than 200 pairs are further from settlements than the ones with less than 100 pairs.

The choice of breeding sites can certainly be related to the geographical distribution of the islands and does not seem influenced by climatic conditions, morphology of islands or their vegetative cover. The presence of sheep in many islands of areas n. 2 and 3 does not seem to affect colonization. The largest colonies are in area n. 2 where suitable islands for breeding are widespread, while in Istria the concentration of little islands causes the presence of smaller colonies.

The total population seems evenly spread in the various surveyed areas and to be steadily increasing. For this reason a progressive colonization of suitable coastal sites on large islands and of some coastal towns seems likely to occur in the future.

The traditional collection of eggs for domestic use, carried out on various islands during the period immediatly following laying, does not seem to influence the population trends seen at these colonies. This conclusion is confirmed by the recent colonization of Sečovlje salt-pans (Slovenia) since 1986 (Škornik 1992) and of the town centre of Trieste since 1987 (Benussi et al. 1993).

If we consider that the surveyed area covers about one third of all the Dalmatian islands and that in Italy 3,442 pairs were counted in the Adriatic during the census made in 1983-84 (Fasola 1986), an assessment of the total Adriatic population (N of the 42nd parallel) of 40,000-50,000 pairs seems reasonable.

Acknowledgements -The Authors are grateful to Loris Dilena, Silvia Gandini, Fulvio Genero, Umberto Mangani, Alfredo Montina and Anastasia Puric for help during field visits.

Riassunto - Dal 1988 al 1992 è stato condotto un censimento delle colonie di *Larus cachinnans michahellis* nelle isole dell'Istria e della Dalmazia settentrionale dal quale è risultata una popolazione complessiva di 12.898-15.208 coppie distribuite in 78 isole suddivise in 4 aree geografiche.

Conteggi annuali in 4 isole campione hanno evidenziato un incremento quinquennale del 38,8%. Le colonie sono composte in media da 164,4 coppie, sono distanziate tra loro in media di 2,54 km e dai centri abitati di 4,13 km, con valori differenti tra aree e colonie. Il grado di copertura vegetale, in media del 54,4%, e la tipologia ambientale delle isole non sembrano influenzare presenza e consistenza delle colonie. Si ipotizza per l'intero settore adriatico (a N del 42° parallelo) una popolazione complessiva di 40.000-50.000 coppie nidificanti.

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Avocetta N°18: 115-118 (1994)

Winter sympatry of two Reed bunting (*Emberiza schoeniclus*) subspecies in the Venetian lagoon

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Abstract - Morphometric data were taken on 403 specimens of Reed bunting, mist-netted during a 7 year period on the northern border of the Venetian lagoon. Two morphs could be clearly identified on the basis of bill depht and wing lenght. The large-billed, short-winged morph (*E. schoeniclus intermedia*) was caught year round, while the other (*E. schoeniclus schoeniclus*) was caught only from October to March. The distributions of bill depth of the two morphs showed some overlap that may suggest hybridization: birds of intermediate bill size, however, were never caught in summer months and their wing lenght was that of *E. s. schoeniclus*.

Introduction

The Reed bunting, *Emberiza schoeniclus*, occupies a very wide paleartic range, with three groups of subspecies differing in dimensions, coloration, but mainly in the size and shape of the bill. The extreme bill size polymorphism of this species is uncommon among passerines. The *schoeniclus* group extends (breeds) over the northern part of the range and is largely migratory, whereas the *intermedia* and *pyrruloides* groups are mostly resident or nomadic in the southern areas of the range. In Italy, *E. s. schoeniclus* is a regular migrant and wintering species, while several isolated resident populations of *E. s. intermedia* are found in some of the wetland areas still present in the country. Formerly (Arrigoni 1929), the large bill individuals were tentatively considered a different species (*E. palustris*), but, at the same time, it was claimed that the range of bill size of *schoeniclus* showed continuity with that of *palustris*, a statement unsupported by quantitative data. More recent surveys (Brichetti and Cova 1976, Meschini and Frugis 1993) indicate that *schoeniclus* breeds sporadically and locally in the western Po valley and by some of its northern tributaries, while *intermedia* breeds regularly in the eastern part of northern Italy, bordering the Adriatic sea. Some isolated populations still breed also in the italian peninsula. Individuals of intermediate bill size (hybrids?) are reported for the intermediate region (lake Garda, lake of Mantua, etc.), where the two forms could cohexist. Again, no quantitative biometric data are given.

To define whether a clear distinction could be made between the forms of *E. schoeniclus* found in nortern Italy, we started a systematic study of specimens caught by the northern border of the Venetian lagoon, where both the aformentioned forms are frequent. The large-billed form (*intermedia*) is present year round and reproduces locally. The small-billed form (*schoeniclus*) is frequent during the autumn and spring migrations, is present in winter with variable numbers of individuals, which share the same territories with the local *intermedia* population, but has never been observed to breed.

Methods

Birds were captured with 12 x 2.5 m mist nets, set in several locations of an approximately 200 ha area on the northern border of the venetian lagoon, in the course of a different study (Brocchieri *et al.* 1992). The area includes a few buildings (factories) but consists mainly of uncultivated grassland and dry flats with few trees (mainly *Salix*) and several ponds of fresh water, bordered by reedbeds, mainly *Phragmites* and *Typha*. The same number of nets (10) was set at least once per month for a period of 7 years (1987-93). A total of 407 birds were netted. For most of these, total body weight was taken with a 100 g Pesola balance to the nearest 0.1 g; subcutaneous fat deposits were estimated according to Busse and Kania (1970); wing lenght (maximum chord) and tarsus lenght were measured to the nearest 0.5 mm. Bill lenght was

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Table 1. Morphometric characteristics of the large-billed Reed buntings (*E. schoeniclus intermedia*) breeding in the Venetian lagoon. Males are significantly larger than females for all the characters considered, except for bill length (Analysis of Variance).

	males			females				
	mean ± SD	range	*n*	mean ± SD	range	*n*	F	*p*
wing length	80.57±2.51	76-86	31	74.89±1.85	71.5-79	32	74.9	<0.001
bill length	13.06±0.47	12-14	28	12.86±0.32	12.5-13.5	21	0.05	ns
bill depth	6.77±0.29	6.1-7.4	31	6.40±0.27	6-6.9	32	15.6	<0.001
bill width	5.24±0.35	4.5-5.9	31	5.02±0.38	4.4-5.7	30	9.47	0.004
body mass	21.25±1.65	17.7-24	30	18.44±1.10	16.5-20.6	31	66.3	<0.001

measured from tip to skull with calipers to the nearest 0.5 mm; bill depth at nostrils and bill width at base were taken with a dial caliper to the nearest 0.1 mm. Birds were sexed according to Svensson (1992), ringed with numbered aluminium rings and promptly released.

Results

Table 1 gives some biometric data for all birds netted during the breeding season (April-September), when only the intermedia form is present. Figure 1 shows

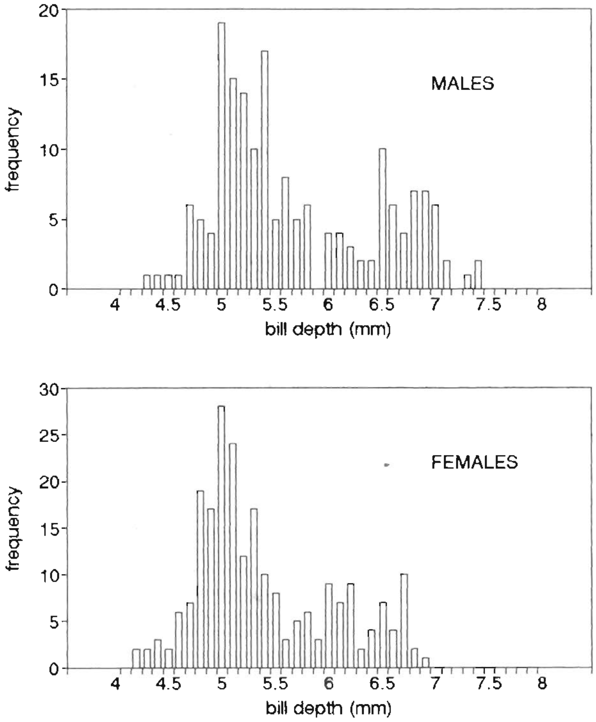

Figure 1. Frequency of bill depth in male and female Reed buntings captured year round in the Venetian lagoon.

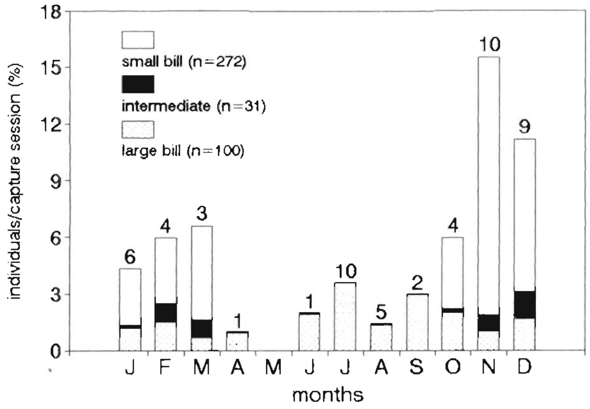

Figure 2. Frequencies of capture (standardized as number of individuals captured per netting session) of large-billed (bill depth >6.0 mm for males and >5.9mm for females), small-billed (bill depth <5.8 mm for males and <5.7 mm for females), and intermediate-billed Reed buntings in different period of the year. Numbers indicate netting sessions in which at least one specimen of Reed bunting was captured.

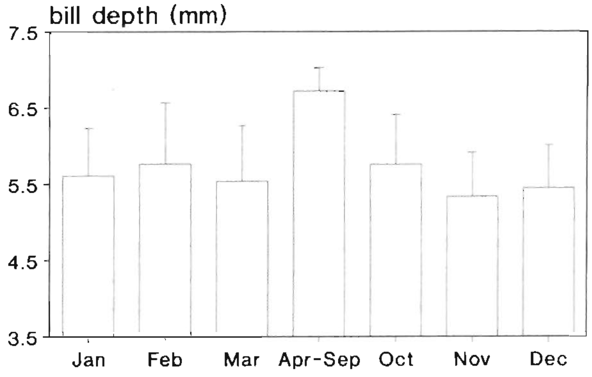

Figure 3. Variation of mean bill depth of male Reed buntings captured in different periods of the year (bars indicate SD). In April-September mean bill depth is significantly larger than in the rest of the year (ANOVA, F6,171=25.7; P<0.0001). The same pattern was also observed for females (F6,222=31.9; P<0.0001). Note the smaller standard deviation observed during the breeding season, when only E. s. intermedia was captured.

Table 2. Analysis of variance of the morphometric characteristics of Reed buntings captured in the Venetian lagoon, subdivided in three groups on the basis of their bill depth (large, small, and intermediate bill size)

Males	Large-billed (bill depth>6 mm)		Small-billed (bill depth <5.8 mm)		Intermediate			
	mean ± SD	n	mean ± SD	n	mean ± SD	n		
bill depth	6.68 ± 0.32	56	5.17 ± 0.29	112	5.88 ± 0.10	10		
bill length	12.86 ± 0.54a	51	12.32 ± 0.46b	108	12.72 ± 0.44a	9	F=22.4	p=0.001
bill width	5.21 ± 0.41a	56	4.24 ± 0.44c	112	4.71 ± 0.31b	10	F=95.9	p=0.001
wing length	80.82 ± 2.71b	55	81.83 ± 2.31a	95	81.95 ± 2.55a	10	F=3.1	p=0.048
body mass	21.50 ± 1.50	54	20.92 ± 1.80	101	21.13 ± 1.55	10	F=1.97	ns
Females	(bill depth >5.9 mm)		(bill depth <5.7 mm)		Intermediate			
bill depth	6.37 ± 0.28	55	5.02 ± 0.29	160	5.79 ± 0.08	14		
bill length	12.56 ± 0.43a	42	12.18 ± 0.41b	154	12.25 ± 0.43b	13	F=13.8	p<0.001
bill width	4.98 ± 0.36a	53	4.09 ± 0.38c	160	4.71 ± 0.31b	14	F=116	p<0.001
wing length	74.57 ± 2.09c	54	76.75 ± 1.46b	136	77.79 ± 1.64a	12	F=13.5	p<0.001
body mass	19.34 ± 1.61	54	18.97 ± 1.34	150	19.76 ± 0.71	14	F=3.05	p<0.05

Different indices (a, b, c) above the means refer to significant differences between groups of data (according to a least significant difference range test)

the distribution of bill depth in males and females of birds caught throughout the year. The distributions are very wide, hinting bimodality. From the data in Table 1 we considered 6.0 mm (males) and 5.9 mm (females) as the minimum values for bill depth characterizing the *intermedia* form. If we take 5.8 mm (males) and 5.7 mm (females) as the maximum values for bill depth for the *schoeniclus* form (Svensson 1992), some of the individuals caught show intermediate values. In Table 2 the same biometric data given in Table 1 for the birds caught in summer, are reported for all three classes (large, small, and intermediate bill) and Figure 2 shows their frequency distribution in catches year round. It can be seen from Table 2 that small-billed birds (*schoeniclus*) are somewhat lighter but have significantly longer wings than the large-billed individuals (*intermedia*), as expected from their migratory habits. In the two forms bills differ mainly in depth, less in width and hardly in lenght. The bill's upper profile also differs: straight in *schoeniclus* and slightly curved in *intermedia*. Figure 3 shows the mean bill depth of birds caught in different periods of the year. Birds with bills of intermediate depth have the same wing lenght as the small-billed individuals, and are caught only when these are also caught. It is thus likely that they belong to the migrant group.

It should be noted that our morphometric data do not agree entirely with those of Dementiev and Gladkow (1954), reported by Blümel (1982), which, to our knowledge, are the only other published with some detail for this species.

Discussion

Biometric data of Reed buntings caught in the study area allow a distinction to be made between the *intermedia* form and the *schoeniclus* form, mainly on the basis of bill depth and body weight values, which are higher in *intermedia*, and wing lenght values, which are higher in *schoeniclus*. Some individuals have intermediate bill size but long wings, which suggests that they belong to the *schoeniclus* group, as confirmed by their being caught only when *schoeniclus* individuals are also caught (non- summer months). The continuity in the distribution of bill sizes suggests that the two forms are not genetically isolated: if the intermediate individuals are hybrids, however, it suggests that the migratory habit and its associated long-wing trait are dominant, while bill size's genetic determination is likely to be quantitative (Boag and van Noordwijk 1987).

The bill size polymorphism of this species is rather unique. Other extreme cases of bill size polymorphism in passerines are the well known Darwin's finches of the Galapagos (*Geospiza*) (Grant 1986) and the

African finch *Pyrenestes ostrinus* of Cameroon (Smith 1987). In the latter the trait's variation was shown to be genetically determined, possibly by one or a small number of genes (Smith 1993), and related to diet: large-billed birds feed on harder sedge seeds than small-billed individuals (Smith 1990). The two forms of *Pyrenestes* are sympatric, and may thus represent a case of disruptive selection leading to the occupancy of a new trophic niche (Smith 1993). In the case of *E. schoeniclus* it has been claimed (Stegmann 1956) that large-billed forms (*pyrrhuloides*) have the ability to crack the stems of *Phragmites* and feed on insects hiding in them (mainly dipteran larvae), a food source not available to *schoeniclus*. If this observation is confirmed it would show a case where a heavier bill in a passerine leads to a more insectivorous diet, rather than to the exploitation of harder seeds, as in *Geospiza* (Grant 1986) and *Pyrenestes* (Smith 1987). It cannot be said, however, that one form is more narrowly specialized in its diet than the other: quantitative data are simply not available. The only indirect suggestion for trophic specialization is the fact that the habitat of *intermedia* is more strictly dependent on *Phragmites* reedbeds than is that of *schoeniclus* (Witherby *et al.* 1943, Vaurie 1959). Since *schoeniclus*' bill size and shape are closer to that of most other paleartic species of the genus *Emberiza*, it is likely to be the ancestral morph. It is puzzling that large billed forms of Reed bunting are prevalently sedentary or nomadic and occupy the southernmost areas of its vast range, while most paleartic species of genus *Emberiza* tend to be migratory, and breed mostly in the northern part of the paleartic region (Blümel 1982).

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Riassunto - Sono stati raccolti dati morfometrici su 403 esemplari di Migliarino di palude (*Emberiza schoeniclus*), catturati con mist-nets durante un periodo di 7 anni lungo il margine Nord della Laguna di Venezia. Si sono potute identificare chiaramente due forme sulla base dell'altezza del becco e della lunghezza dell'ala. La forma a becco grosso ed ala più corta (*E. s. intermedia*) è risultata presente tutto l'anno, mentre l'altra (*E. s. schoeniclus*) veniva catturata solo da ottobre a marzo. Le distribuzioni dell'altezza del becco delle due forme mostrano una sovrapposizione molto limitata che potrebbe suggerire l'occorrenza di ibridazione: tuttavia esemplari con becco di altezza intermedia non sono stati mai catturati nei mesi estivi e inoltre presentavano una lunghezza dell'ala simile a quella di *E. s. schoeniclus*.

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Some comparative aspects of the breeding biology of Black-headed Gull (*Larus ridibundus*), Common Tern (*Sterna hirundo*) and Little Tern (*Sterna albifrons*) in the Lagoon of Venice, NE Italy

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Abstract - During the years 1989-1992 three species of Laridae and Sternidae breeding in the lagoon of Venice were studied. The breeding population of *L. ridibundus* increased steadily through the period of study, whereas *S. hirundo* was stable and *S. albifrons* decreased. Almost all of the colonies were closely clustered in the southern lagoon, where human disturbance is less heavy. Colonies were located on a few of the apparently favourable sites. Colony size was significantly higher in *S. hirundo* (90.8 ± 80.1, n=45) than in *S. albifrons* (51.9 ± 72.3, n=12) and in *L. ridibundus* (26.3 ± 42.5, n=20). *S. hirundo* was significantly associated with *L. ridibundus*, whereas *S. albifrons* avoided the occurrence of the latter species. Site tenacity did not differ among species, with the majority of sites being occupied only for one or two years. Suggestions for the protection of the colonies are proposed.

Introduction

The status, distribution and breeding biology of gulls and terns in the Lagoon of Venice, the largest coastal lagoon of Italy and one of the most important in the whole Mediterranean, are poorly known. Only in 1984 data were systematically gathered (Fasola 1986) and showed that four species were breeding; Black-headed Gull (*Larus ridibundus*), Yellow-legged Gull (*Larus cachinnans*), Common Tern (*Sterna hirundo*) and Little Tern (*Sterna albifrons*). In more recent publications dealing with seabirds breeding in Mediterranean wetlands no new data were presented for the Lagoon of Venice (Fasola et al. 1989).

In 1989 we began a comprehensive survey of the colonies of Black-headed Gull, Common Tern and Little Tern occurring in the Lagoon of Venice, aimed to:

- follow the populations trend over the years;
- analyse differences on some aspects of the breeding biology (colony size, site occupancy, species association) among the three species;
- propose measures for conservation and management of the colonies.

This note presents the results for the 1989-1992 period.

Methods

The Lagoon of Venice is a coastal lagoon between the mouths of the rivers Brenta and Piave (45°11'-45°34' N, 12°18'-12°38' E), along the Adriatic Sea in northeastern Italy. Its surface is some 550 km2 wide; the lagoon is bordered by two barrier islands and it exchanges water with the sea through three entrance channels.

There is an extensive, central waterbody (about 400 km2) with bottoms that are partly covered with *Ulva laetevirens* and *Zostera marina*, tidal mudflats (mostly bare and exposed at low tide) and hundreds of muddy islets covered with halophilous vegetation (mainly *Limonium serotinum*, *Salicornia* sp. pl., *Halimione portulacoides* and *Spartina stricta*) that are usually flooded at high tide. Peripheral small waterbodies, with low salinities, are used for fish farming and hunting and totalize about 130 km2, the remaining area (about 20 km2) being occupied by the town of Venice and surrounding islands. Only a very small part of the Lagoon is protected, while the remaining part is threatened by pollution, disturbance by tourism and hunting.

Field data for the Black-headed Gull, Common Tern and Little Tern were gathered during direct censuses of the whole central waterbody which were carried out from 1989 through 1992. Besides the three species

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mentioned above, only the Yellow-legged Gull (*Larus cachinnans*) nests in the lagoon, with two monospecific colonies (780 nests in 1989; S. Amato, pers.comm.). A colony was defined (Goutner 1990) as any aggregation of two or more nests situated more than 200 m from another group of nests; nine single nests of Common Tern were excluded by all the computations. Site, or colony site, refers to a place where a group of birds breeds, whereas colony size is the number of breeding pairs (=nests found, in our study) in a colony (Burger and Gochfeld 1991).

Each colony was mapped on maps at 1:10,000 scale and visited at least twice from May to July. The figures presented refer to the highest number of nests that were found per each species during the breeding season.

Since the frequency distribution of several parameters did not appear normally distributed, we used non-parametrical tests. All statistical tests were performed with the SPSS statistical package. The significance of the association between two species in the same colonies was tested pairwise using chi-square test; the strength of the association was studied using the index of association (Krebs 1972 in Goutner 1990). This coefficient varies from +1 (complete association) to -1 (complete avoidance), and is 0 for random occurrence (Fasola and Canova 1992). Colony turnover rates (T) between two years were calculated as in Erwin *et al.* (1981): $T = 1/2(S1/N1 + S2/N2)$, where S1=number of sites occupied only on the first census, N1=total number of sites during first census, S2=number of sites occupied only on second census, and N2=total number of sites on the second census.

Results

Black-headed Gull *Larus ridibundus*

In 1984, only one colony with 70 nests (Barbieri 1986) was found. This was also the first breeding record for the species in the Lagoon of Venice. During our census the number of nests increased at a regular rate (Table 1); 20 colonies were found on 15 different sites (Table 2). In Table 3 the distribution of sites number according to the years of occupancy is shown. None of the sites was occupied for all the four years, whereas most of the sites were abandoned after only one year.

The turnover rate (0.61) was the highest among the species studied; nevertheless. no significant difference on site occupancy was found among *L. ridibundus*, *S. hirundo* and *S. albifrons* (chi-square=2.73; d.f.=6, P>0.05). Moreover, the size of colonies did not differ significantly among sites occupied in different years (Kruskal-Wallis test, chi-square=3.64, d.f.=3, P=0.16).

In all four years, most of the pairs gathered in only one colony, but a few other pairs were scattered in several small colonies. There were no statistical differences in colony size among different years (Kruskal-Wallis test, chi-square=1.20, d.f.=3, P=0.75). A comparison of the colony size among the three species studied showed statistically significant differences (Kruskal-Wallis test, chi-square=17.49, d.f.=2, P<0.001); *S. hirundo* nested in the largest colonies, and *L. ridibundus* in the smallest.

All the colonies, except one in 1991, were in the southern lagoon. Sixteen (80%) were mixed, all with Common Tern whereas Little Tern was observed only in three (15%).

The association with *S. hirundo* was significantly positive (index of association: +0.19, chi-square=6.95, d.f.=1, P<0.01). At the opposite, *L. ridibundus* is significantly non-associated with *S. albifrons* (index of association: -0.33, chi-square=10.25, P<0.01).

Monospecific colonies of *L. ridibundus* did not differ significantly in size from those with either one or both the other species (Kruskal-Wallis test, chi-square =5.70, d.f=2, P=0.05).

Among other species of Charadriformes nesting in the same sites, Redshank (*Tringa totanus*) was recorded in all the colonies, with Black-winged Stilt (*Himantopus himantopus*) observed in only one colony.

Common Tern *Sterna hirundo*

In 1984, 29 colonies were recorded, with a total of 982 nests, accounting for the 21.3% of the Italian breeding population (Bogliani 1986).

Throughout the period of our study, the number of nests regularly increased until 1991, with a slight decrease in the following year (Table 1). Apart from one, all the colonies were located in the southern Lagoon, in an area of some 30 km^2 which supports almost all the colonies of breeding gulls and terns found in the study. Common Terns breed here along with Little Terns. Black-headed Gulls and Redshanks. This area is unprotected, but human presence is restricted to professional fishermen.

Common Tern was the most common breeding species, being recorded in 45 out of the 55 colonies found in the 1989-1992 period (Table 2). It nested in 27 different sites; only three sites (11.1%) have been occupied without interruption during the study period and gathered the 39.5% of the pairs, over the four years. Turn over rate of the colonies was lower (but not statistically significant) than in *L. ridibundus*, and similar to that of *S. albifrons* (Table 2). Size of colonies among sites occupied for different years did not differ significantly (Kruskal-Wallis test, chi-square=4.58, d.f.=3, P=0.20).

Table 1. Number of nests and of colonies (in brackets) in the Lagoon of Venice.

Species	1989		1990		1991		1992	
L. ridibundus	101	(4)	111	(6)	154	(6)	160	(4)
S. hirundo	832	(12)	1037	(17)	1209	(10)	1008	(6)
S. albifrons	258	(3)	200	(1)	78	(6)	89	(2)

Table 2. Characteristics of the colonies in the lagoon of Venice: years 1989-1992 (T=mean turnover rate of the colonies).

Species	n. of sites	n. of colonies	Colony size	Mean ± s.d.	Median	T
L. ridibundus	15	20	2-138	26.3±42.5	5	0.6
S. hirundo	27	45	3-256	90.8±80.1	62	0.4
S. albifrons	8	12	2-200	51.9±72.3	23	0.41

Table 3. Colony sites distribution (percentages; n= total n. of sites) according to the years of occupancy: years 1989-1992.

		Years occupied			
		1	2	3	4
Larus ridibundus	(n=15)	73.4	20	6.6	0
Sterna hirundo	(n=27)	62.9	18.5	7.5	11.1
Sterna albifrons	(n= 8)	75	12.5	0	12.5

Colony size differed significantly among years (Kruskal-Wallis test, chi-square=10.8, d.f.=3, $p<0.05$). Twenty colonies (44.4%) were mixed with the other two species; Black-headed Gull was observed in 18 colonies (40.0%) and Little Tern in 6 colonies (13.3%). The index of association with *S. albifrons* was negative (-0.12) but not statistically significant (chi-square=1.0, d.f.=1, $p>0.05$). No differences were observed among size of monospecific colonies and that with *L. ridibundus*, *S. albifrons* or both (Kruskall-Wallis test, $p>0.05$ in each case).

Other breeding species were Redshank (observed in all the colonies), Black-winged Stilt and Yellow-legged Gull, in one colony each.

Little Tern *Sterna albifrons*

Nine colonies were censused in 1984, and totalized 512 nests. In the same year the Italian breeding population totalized 5980 nests, i.e. the 30% of the whole Western Palearctic population (Fasola 1986). During the 1989-92 census the number of nests was well below the 1984 value (Table 1), showing an almost linear decrease through the period of study. Over the whole period 12 colonies were settled on 8 different sites (Table 2). Only one site has been occupied for four years (Table 3), whereas the majority was abandoned after only one year. No differences were observed among the size of colonies on sites occupied for different years (Kruskal-Wallis test, chi-square=3.57, d.f.=3, $p=0.16$), and no differences were observed among colony size in each year (Kruskal-Wallis test, chi-square=5.8, d.f=3, $p=0.12$). Six colonies (50.0%) were mixed; Common Tern was observed in all of them and Black-headed Gull in 2 (16.6%). Redshank was observed in 8 colonies (66.6%). There was no relationship between *S. albifrons* colony size and occurrence of *L. ridibundus*, *S. hirundo* or both (Kruskall-Wallis test, $p>0.05$ in each case).

In the lagoon of Venice the Little Tern bred both on salt-marshes and on barrier islands. In the former case colonies were always in the southern lagoon, where breeding sites were shared with Common Terns, Black-headed Gulls and Redshanks. These colonies were always small- or medium-sized, and they were apparently smaller than those on barrier islands (but the difference was not significant: Mann-Whitney U-test, z=3.17, p=0.06). The salt-marshes colonies were unstable; for istance, in 1990 any colony was present in this area. On the barrier islands there is only one colony site, but it has been occupied continuously since 1989; in 1989-1991 it hosted the largest colony (up to 200 nests) of Little Tern. It is protected since 1989, but it is reported to suffer from heavy predation due to feral cats. Every year very few pairs start breeding in other sites scattered on barrier islands, but these nests are invariably destroyed by tourists and vandals.

Discussion

Censuses carried out between 1989 and 1992 confirmed that only four species of Laridae and Sternidae breed in the Lagoon of Venice. The main results are the following:

- the population of Black-headed Gull has been gradually rising up, whereas the Common Tern population is stable (1000 to 1200 nests over the last three years). Little Tern population showed year-to-year variations. but should be considered as decreasing over the last four years. Almost all the colonies of gulls and terns were clumped in a small area, which should be protected; this area is of outstanding importance also for Redshank (the most important breeding site in Italy and one of the most important in the whole Mediterranean; Valle *et al.* in press).
- in the Lagoon of Venice *S. hirundo* and *L. ridibundus* are significantly associated in the breeding sites, as found by Fasola and Canova (1992) for the northern Adriatic area of Valli di Comacchio. Moreover, in this last area *S. albifrons* tends to avoid the occurrence in the same colony of *L. ridibundus*, as it happens in our colonies. The non-significant association between *S. hirundo* and *S. albifrons* is in agreement with the results of Goutner (1990) for the Evros Delta (Greece) and those of Fasola and Canova (1992).
- *L. ridibundus*, *S. hirundo* and *S. albifrons* did not show significant different level of site tenacity: most of the sites were abandoned after only one year, and only 4 (12.9%) were occupied continuously over four years. These "usual" sites hosted a remarkable percentage (30.9%) of the total population. Only one of these sites (in a barrier island) is protected, but the hatching success of the Little Tern breeding there is severely limited by predation. Fencing should be adopted in order to limit terrestrial predator movements into this colony; this method has been proved successful against terrestrial predators in numerous sites for different gulls and terns species (see Rimmer and Deblinger 1992). Moreover, since many other sites are occupied by gulls and terns only one year, at the beginning of each breeding season a preliminary survey of all the sites would be required before protecting the most important of them with specific measures of conservation (i.e. restrictions to boat passage in the surroundings, landing and walking forbidden, posting educational signs).
- despite hundreds of potential breeding sites, islets occupied at least once by terns and gulls were only 31, and the largest colonies were always mixed. These results may be interpreted as attraction between species, or common preference for specific type of sites, or both (see Gotmark 1982). Characteristics of possible breeding sites (size, distance from foraging zone, vegetation cover) play an important role in habitat selection by seabirds (Burger and Lesser 1978, Fasola and Canova 1992).
- for other species occurring in spring-summer in the Lagoon of Venice (Mediterranean Gull *Larus melanocephalus*, Sandwich Tern *Sterna sandvicensis* and Black Tern *Chlidonias niger*) no evidence of nesting was found. In comparison, nine species occur in the 110 km^2 coastal lagoon of Valli di Comacchio (Fasola and Canova 1991); in the Camargue, which is comparable in size to the Lagoon of Venice, eight species were breeding in 1988 (Boutin *et al.* 1991). We suggest that human impact is responsible for such scarcity of breeding species in our area. It is well known that human disturbance can affect habitat quality for seabirds (Gochfeld 1983); it is worth observing that all the species breeding in the lagoon, except Yellow-legged Gull, are either restricted to a small area of the southern part, where human presence is limited, or nest in protected sites. In contrast the northern lagoon. with its many islets apparently favourable as breeding sites, is heavily affected by human activity (mostly tourism and non-professional fishing) and supports just one colony. Other possible causal factors should be investigated for better explanations of this observation.
- a major long term threat to the occurrence of breeding gulls and terns is posed by the loss (mostly due to the natural compaction of sediments and erosion. this one being man-induced) of salt-marshes islets, the area of which has fallen from 91 km^2 at the beginning of this century to less than 40 km^2 at present (Favaro 1992). In 1989 a project of salt-marshes recreation using dredged material was launched by the Ministry of Public Works. Since in USA similar sites have been heavily used by nesting seabirds (see Parnell *et al.* 1986), a monitoring program will be performed in the Lagoon of Venice to investigate about the occurrence of colonies on these new islands.

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Riassunto - Durante gli anni 1989-1992 sono state compiute osservazioni su tre specie di Laridae e Sternidae nidificanti in laguna di Venezia. La popolazione nidificante di *L. ridibundus* è aumentata gradualmente, mentre quella di *S. hirundo* è rimasta stabile e quella di *S. albifrons* è diminuita. Le colonie studiate si concentravano nella laguna Sud, dove la presenza antropica e' minore. La maggior parte (56.8%) delle colonie erano miste ed hanno occupato solo alcuni dei potenziali siti di nidificazione. Le dimensioni delle colonie erano significativamente maggiori per la Sterna comune (90.8 ± 80.1, n= 45) che non per il Fraticello (51.9 ± 72.3, n=12) o il Gabbiano comune (26.3 ± 42.5, n=20). La fedeltà ai siti riproduttivi è risultata bassa in tutte e tre le specie, senza differenze significative; la maggior parte dei siti è stata occupata soltanto per uno o due anni.

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Su una collezione di Mallofagi dei Caradriformi: 8 taxa nuovi per l'Italia e review delle specie

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Riassunto - Da 41 esemplari di uccelli appartenenti a 22 specie di Caradriformi, di cui 19 osservate in Italia e 3 in Somalia, sono stati raccolti 99 esemplari di Mallophaga riconducibili a 23 specie (5 Amblycera, 18 Ischnocera), di cui almeno 8 risultano essere nuove per la fauna d'Italia: *Actornithophilus pustulosus* (Piaget 1880), *A. totani* (Schrank 1803), *A. umbrinus* (Burmeister 1838), *Carduiceps meinertzhageni* Timmermann 1954, *Cummingsiella ovalis* (Scopoli 1763), *Koeniginirmus eugrammicus* (Burmeister 1838), *Quadraceps fissus* (Burmeister 1838), *Q. similis* (Giebel 1866).

Introduzione

Fra le specie epizoe o ectoparassite molte sono quelle che. dopo il loro preadattamento, acquistarono il carattere di "permanenti", legandosi sempre più strettamente all'ospite che divenne per esse abituale.

La dipendenza biologica di tali specie dai rispettivi ospiti, tanto più stretta quanto più remota, fa di esse i migliori esempi di alta specificità parassitaria e di coevoluzione, sicchè non pochi studiosi hanno cercato di servirsene per disporre di reciproci tests nella filogenesi e nella distribuzione delle due entità legate da tale tipo di relazione interspecifica.

Per quanto riguarda gli uccelli non v'è dubbio che le specie notoriamente ad esse più strettamente associate sono quelle dei Mallofagi, la cui presenza e distribuzione, se ben interpretate, possono essere utili elementi per l'ornitologo che indaghi non solo sulla evoluzione ma anche sui fenomeni di migrazione degli ospiti.

La maggiore difficoltà che s'è frapposta finora al raggiungimento di tale obbiettivo è stata rappresentata dalle carenze nella sistematica dei due sottordini (Amblycera e Ischnocera) di tali insetti, soprattutto dopo la loro revisione ad opera di Hopkins e Clay (1952), che riconobbero solo 5 famiglie: 3 Amblycera (Menoponidae, Laemobothriidae, Ricinidae) e 2 Ischnocera (Philopteridae ed Heptapsogasteridae), dalle quali esclusero oltre 140 generi, relegandoli in sinonimia con altri spesso ricchi di specie diverse associate al medesimo ospite.

Si deve ai più sofisticati criteri sistematici proposti da Eichler (1941, 1949. 1963) e quindi sviluppati e perfezionati dalla più nota studiosa moderna di Mallofagi, cioè la polacca Zlotorzycka, se oggi la sistematica, con la riabilitazione di molti fra i generi disconosciuti dagli Autori inglesi e la creazione di altri nonchè la suddivisione delle famiglie in più sottofamiglie. di molti generi in diversi sottogeneri e anche di molte specie in sottospecie, appare più rispondente al criterio di specificità parassitaria che caratterizza questi epizoi permanenti.

Adeguandoci a tali criteri, abbiamo esaminato una collezione di Mallofagi giacente presso l'Istituto Nazionale per la Fauna Selvatica di Ozzano Emilia, sia per controllare la validità delle nuove teorie tassonomiche sia per aggiornare le conoscenze sulla mallofagofauna italiana. In questa nota si riferisce sugli esemplari rinvenuti su uccelli Caradriformi e s'è colta l'occasione per tracciare una review di tutti i dati italiani esistenti al riguardo (Tabelle 1, 2).

Metodi

Nell'arco degli anni Ottanta, ed in minor misura successivamente, presso l'I.N.F.S. è stato possibile ottenere una discreta raccolta di Mallofagi, conservando in alcool a 70% campioni prelevati da uccelli selvatici catturati a scopo di inanellamento, prevalentemente nelle località costiere dell'Italia centro-settentrionale. Le raccolte sono state effettuate con criterio occasionale, esaminando con cura solo un numero variabile degli uccelli inanellati. Non sono pertanto ricostruibili parametri di frequenza dei parassiti rinvenuti. L'intero materiale riguarda uccelli adulti (o giovani

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già atti al volo), ad esclusione di un singolo campione relativo ad un pullus di *Larus ridibundus*.

I preparati in vitro dei Mallofagi sono stati allestiti secondo le tecniche di Palma (1978), cioè previa macerazione e decolorazione in soluzione acquosa al 20% di KOH e successiva neutralizzazione con soluzione acquosa al 10% di acido acetico. Dopo colorazione con fucsina altamente concentrata,i campioni sono stati disidratati con alcool etilico al 70% e chiarificati con essenza di garofano. Infine sono stati montati con balsamo di Canada neutro e lasciati in termostato a circa 50°C per tre settimane.

Risultati

Le specie rinvenute sono state suddivise per sottordini e quindi elencate in ordine alfabetico.Per ciascuna di esse si riportano gli ospiti, il numero degli uccelli trovati infestati, le località e le date di raccolta, con brevi note di commento.

AMBLYCERA

1. Actornithophilus pustulosus (Piaget 1880)
(= *Colpocephalum pustulosum*)
Materiale esaminato: 2 femmine, 1 maschio su *Philomachus pugnax* (2 femmine immature), Zavelea, Comacchio (Ferrara) : 31.III.1988; 1.IV.1988 (leg. N. Baccetti).
Note: prima segnalazione in Italia della specie, che in Europa è stata finora segnalata sul Combattente in Francia (Seguy 1944), Polonia (Zlotorzycka 1976), Spagna (Martin-Mateo *et al.* 1980) e Cecoslovacchia (Literak 1983).

2. Actornithophilus totani (Schrank 1803)
(= *Pediculus totani*)
Materiale esaminato: 1 femmina, 2 ninfe su *Tringa totanus* (1 ind). Lago di Massaciuccoli (Lucca), 20.V.1981; maschio su *T. totanus*, Bocca d'Ombrone (Grosseto), 7.III.1987 (leg. N. Baccetti).
Note: prima segnalazione di specie per l'Italia. Altrove essa è stata segnalata, oltre che sulla Pettegola, su altri Tringini, quali *Tringa erythropus, T. flavipes*.
Zlotorzycka (1959, 1961) ha suddiviso la specie in due sottospecie: *Actornithophilus totani totani*, strettamente associata alla Pettegola e *A. t. affinis* (= *Colpocephalum affine* Nitzsch 1874), propria, invece, del Totano moro, che risultano diffuse in Eurasia, Africa e N-America.

3. Actornithophilus umbrinus (Burmeister 1838).
(= *Colpocephalum umbrinum*)
Materiale esaminato: 1 femmina su *Calidris ferruginea*. Lago di Massaciuccoli (Lucca), 28.IV.1983 (leg. N. Baccetti).
Note: prima segnalazione di specie in Italia. Sul Piovanello (citato come *Tringa subarquata*, *Erolia testacea* o *Calidris testacea*), la specie è stata segnalata da Hopkins e Clay (1952), Zlotorzycka 1976, Literak (1983) e da Zlotorzycka e Modrzejewska (1988); per questi ultimi AA essa è presente sia nell'Europa centrale che in Nord America.

4. Austromenopon durisetosum (Blagocshtchensky 1948).
(= *Menopon durisetosum*)
Materiale esaminato: 4 femmine, 2 maschi su *Gallinago gallinago* Val Campotto (Ferrara), 15.VIII.1982 (1 ind.); Orbetello (Grosseto), 23.III.1986 (1 ind., remiganti secondarie) (leg. N. Baccetti).
Note: in diverse zone umide dell'Eurasia centrale la specie è stata più volte segnalata sul Beccacino. Su questo è stata osservata anche in Italia nelle zone paludose del Comune di S. Omero (Teramo), nel novembre 1979 (Manilla e Cicolani 1983).

5. Austromenopon transversum (Denny 1842).
(= *Menopon transversum*)
Materiale esaminato: 1 femmina su *Larus ridibundus* (1 ind. pullus), Comacchio(Ferrara), 2.VII.1984 (leg. F. Spina).
Note: la specie è stata segnalata in Eurasia ed America su diversi uccelli larini, fra cui soprattutto *Larus canus, L. marinus, L. ridibundus* e *Rissa tridactyla*. In Italia fu segnalata dapprima (come *Menopon ridibundum*) da Simonetta (1882) con esemplari raccolti sul Gabbiano comune a Villalunga (Pavia) e quindi rinvenuta sia su *L. ridibundus* che su *R. tridactyla* a Santa Gilla (Oristano) nel febbraio 1970 e presso Sassari nel gennaio 1985 (Martin Mateo e Manilla 1988, 1993; Manilla *et al.* 1989).

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6. Carduiceps complexivus (Kellog e Chapman 1899).
(= *Nirmus complexivus*)
Materiale esaminato: 2 femmine su *Calidris alba* (1 ind.), El Bioma, Adale (Somalia), 16.XI.1982 (leg. N. Baccetti).
Note: la specie sembra essere strettamente associata con il Piovanello tridattilo, scolopacide oloartico migratore, e fu inizialmente descritta del continente americano con esemplari rinvenuti sull'ospite abituale (citato come *Calidris arenaria*). In Europa è stata segnalata sullo stesso ospite (come *Crocethia alba*) sia lungo le coste delle Isole Britanniche che lungo quelle del Mar Baltico (Hopkins e Clay 1952; Zlotorzycka 1980). Il reperto in Somalia, primo per il continente africano, così come quelli in Sud America devono attribuirsi ai percorsi migratori propri di *Calidris alba*, che interessano con regolarità anche numerose zone costiere italiane.

7. Carduiceps meinertzhageni Timmermann 1954.
Materiale esaminato: 1 femmina, 2 maschi su *Calidris alpina* (1 ind), Cervia (Ravenna), marzo 1991 (leg. N. Baccetti).
Note: prima segnalazione in Italia della specie, associata soprattutto al Piovanello pancianera, su cui è stata segnalata dalle zone artiche in cui nidifica (Haarlov 1977; Mehl 1981) fino ai suoi quartieri invernali sia in Nord Africa che in America (Zlotorzycka e Modrzejewska 1988). Lungo la costa baltica è stata osservata anche sul Piovanello violetto, *Calidris maritima* (Zlotorzycka 1961).

8. Carduiceps zonarius (Nitzsh 1866).
(= *Nirmus zonarius*)
Materiale esaminato: 4 femmine, 2 maschi su *Calidris minuta* (1 ind., remiganti e addome), Bud Bud (Somalia, 2.XII.1982.(leg. N. Baccetti).
Note: anche questa specie è segnalata per la prima volta nel continente africano nel Gambecchio, che sembra essere il suo ospite abituale e sul quale è stata rinvenuta in più occasioni in Europa occidentale e in Russia (Fedorenko 1968). Su altre specie di *Calidris*, quali *C. ferruginea* (come *C. testacea*) e *C. canutus* è stata osservata rispettivamente sulla costa baltica e in Nuova Zelanda. E' probabile, pertanto, che la specie possa rinvenirsi anche nel nostro Paese, dove tutte queste specie sono di passo regolare.

9. Cummingsiella ovalis (Scopoli 1763).
(= *Pediculus ovalis*)
Materiale esaminato: 1 femmina su *Numenius arquata*, San Rossore (Pisa), 1.III.1991 (leg. N. Baccetti).
Note: sebbene sia stata talora rinvenuta anche su altri Numenini, fra cui il Chiurlo piccolo *Numenius phaeopus* (Martin Mateo et al.,1980; Martin Mateo 1989), la specie risulta associata soprattutto al Chiurlo maggiore *Numenius arquata*, così come hanno potuto verificare Clay e Hopkins (1951) controllando collezioni provenienti da Paesi dell'Europa centrale compresi tra l'Ungheria e le Isole Britanniche. In Italia viene segnalata per la prima volta.

10. Koeniginirmus (Laminonirmus) eugrammicus (Burmeister 1838).
(= *Nirmus eugrammicus, Quadraceps eugrammicus*)
Materiale esaminato: 9 femmine, 5 maschi su *Larus minutus*. Lago di Massaciuccoli (Lucca), 6-14 maggio 1986 (leg. N. Baccetti).
Note: per Zlotorzycka e Modrzejewska (1988) la specie è parassita di diversi gabbiani (*Larus minutus*, *L. sabini*, *Rissa tridactyla*) ed è perciò rinvenibile in diversi areali costieri euroasiatici, africani e nordamericani. Hopkins e Clay (1952) indicano però proprio nel Gabbianello l'ospite-tipo della specie, che viene segnalata per la prima volta in Italia.

11. Koeniginirmus (Laminonirmus) nychthemerus phaenotus (Nitzsch 1866).
(= *Nirmus pahenotus*; *Rallicola phaenota*; *Quadraceps phaenotus*)
Materiale esaminato: 1 femmina (24.IV.1983), 2 femmine (10-17.V..1984: 2 ind.); 2 maschi (23-24.IV.1985: 2 ind.); 1 femmina (23.IV.1987) su *Chlidonias niger*. Lago di Massaciuccoli (Lucca) (leg. N. Baccetti).
Note: la specie è stata spesso osservata sul Mignattino in diverse ragioni paludose dell'Europa settentrionale (Zlotorzycka 1959; Zlotorzycka e Modrzejewska 1988) e in una occasione anche su *Sterna hirundo* in Polonia (Zlotorzycka e Modrzejewska 1988). L'associazione del mallofago ad uccelli della sottofamiglia Sterninae è suffragata anche in Italia dal suo reperimento su *Sterna albifrons* (citata come *Sterna minuta*) a Modena (Picaglia 1885) e su *Chlidonias niger* (citata come *Hydrochelidon nigra*) a Strevi, in provincia di Alessandria (Conci 1940a).

12. Lunaceps holophaeus (Burmeister 1838).
(= *Nirmus holophaeus*)
Materiale esaminato: 2 femmine su *Calidris temminckii* (1 ind.), Bud Bud (Somalia), 30.XI.1982 (leg. N. Baccetti).
Note: la specie è stata segnalata su diversi Caradriformi calidrini, fra cui soprattutto *Calidris minuta*, *C. ferruginea* e *C. temminckii* e *Philomachus pugnax*. Secondo Zlotorzycka e Modrzejewska (1988) essa sarebbe stata osservata anche su rappresentanti di altre tribù di Charadriinae come *Pluvialis squatarola* e *Vanellus vanellus* (v. Discussione) sicchè ha una vasta distribuzione geografica comprendente regioni euroasiatiche e nordamericane. Non risulta che sia stata precedentemente segnalata in Africa. In Italia. invece, essa fu osservata su *Falco vespertinus* a Senago (Milano) da Simonetta (1882), probabilmente a causa di una contaminazione.

13. Quadraceps bicuspis bicuspis (Nitzsch 1874).
(= *Nirmus bicuspis*)
Materiale esaminato: 2 femmine, 3 maschi su *Charadrius dubius curonicus* (1 ind.: remiganti e capo). Lago di Massaciuccoli (Lucca), 15.V.1986 (leg. N. Baccetti).
Note: la specie è stata osservata sempre sul Corriere piccolo in diversi Paesi europei compresi tra Cecoslovacchia Polonia e Spagna (Martin Mateo e Gallego 1977; Zlotorzyca 1978; Literak 1983). In Italia fu segnalata da Picaglia (1885) su *Vanellus vanellus* (come *V. cristatus*).

14. Quadraceps fissus (Burmeister 1838)
(= *Nirmus fissus*)
Materiale esaminato: 6 femmine, 4 maschi su *Charadrius hiaticula* (1 ind.; capo). Lago di

Massaciuccoli (Lucca), 13.V.1986 (leg. N. Baccetti).
Note: il Corriere grosso ospita abitualmente due specie di *Quadraceps* : *Q. fissus* e *Q. hiaticulae* (Clay e Hopkins 1954). La prima, più tozza e robusta, è strettamente associata all'ospite, mentre la seconda, nettamente più esile, è stata rinvenuta anche su altre specie di *Charadrius*, quali *Ch. semipalmatus* e *Ch. vociferus*. *Ch. fissus* risulta diffusa, oltre che in Eurasia, anche in America ed Africa. Per l'Italia questa è la prima segnalazione della specie.

15. Quadraceps furvus (Burmeister 1838).
(=*Nirmus furvus*)
Materiale esaminato: 2 femmine, 1 maschio su *Tringa erythropus* (1 ind.) Lago di Massaciuccoli (Lucca), 24.IV.1985 (leg. N. Baccetti).
Note: la specie è stata spesso rinvenuta sul Totano moro, che è l'ospite-tipo. Forse perchè confusa con altre specie sistematicamente vicine (v. Discussione), è stata segnalata anche su molte altre specie di Caradriformi, quali *Actitis hypoleucos*, *A. macularia*, *Tringa nebularia*, *T. ochropus*, *T. totanus*, *Arenaria interpres*, *Charadrius alexandrinus*, *Ch.dubius*, *Ch. eschenaultii*, *Glareola orientalis*, *Himantopus himantopus*, *Phalaropus tricolor*, *Vanellus cayennensis* e *V. vanellus* sicchè è considerata presente sia in Eurasia che in America. In Italia, Picaglia (1885) segnalò la specie su *Tringa* (=*Totanus*) *ochropus*, *Himantopus himantopus* (citata come *Himantopus candidus*) e su *Vanellus vanellus* mentre Berlese ne osservò esemplari conservati nel Museo Civico di Venezia raccolti su *Tringa totanus* (citata come *Totanus calidris*) e su *A. hypoleucos*. Infine, Conci (1940a) la rinvenne su *Vanellus vanellus* a Mattarello (Trento).

16. Quadraceps hemichrous (Nitzsch 1866).
(=*Nirmus hemichrous*)
Materiale esaminato: 1 maschio su *Himantopus himantopus*. Lago di Massaciuccoli (LU), 21.IV.1981 (leg. N. Baccetti).
Note: la sola segnalazione di specie in Italia risale a Simonetta (1882), che ne rinvenne un esemplare raccolto sullo stesso ospite (citato come *Himantopus rufipes*) nel 1877 a Pavia.

17. Quadraceps similis (Giebel 1866).
(=*Nirmus similis*)
Materiale esaminato: 1 femmina su *Tringa nebularia*. Lago di Massaciuccoli (Lucca), 23.IV.1987 (leg. N. Baccetti).
Note: dalle poche segnalazioni provenienti dai Paesi del Nord-Europa la specie risulta strettamente associata alla Pantana. Per l'Italia si tratta della prima segnalazione.

18. Saemundssonia clayae Hopkins 1949
(=*Docophorus auratus*)
Materiale esaminato: 1 femmina, 2 maschi su *Lymnocryptes minimus* (1 ind.), Cherasco (Cuneo), 8.II.1988 (leg. G. Ferro). Note: la specie è associata alla tribù degli Scolopacini: *Scolopax rusticola*, *Gallinago gallinago*, *G. media* e *Lymnocryptes minimus* ed è stata finora segnalata in Europa, nella penisola araba e in Nord-America (Fedorenko 1968; Zlotorzycka e Modrzejewska 1988). Le segnalazioni di specie in Italia risalgono al secolo scorso e si devono a Simonetta (1882), Picaglia (1885) e Berlese (1894), che ne rinvennero esemplari sulla Beccaccia a Pavia, nel Modenese e nel Veneto, attribuendola a *Saemundssonia aurata*.

19. Saemundssonia conica (Denny 1842)
(=*Docophorus conicus*)
Materiale esaminato: 1 femmina, 1 maschio su *Charadrius alexandrinus* (1 ind., maschio). Lago di Massaciuccoli (Lucca), 9.V.1986 (leg. N. Baccetti).
Note: la specie risulta associata a Caradrini dei generi Charadrius (*Ch. alexandrinus*, *Ch. vociferus*), e *Pluvialis* (*P. apricaria*, *P. dominica dominica*, *P. d. fulva*, *P. squatarola*) ed è, così, ampiamente diffusa in Europa, America ed Asia, fino alla Nuova Zelanda (Fedorenko,1968; Pilgrim e Palma,1982; Zlotorzycka e Modrzejewska 1988). Per l'Italia la sola precedente segnalazione di specie è di Simonetta (1882), che la raccolse su *Pluvialis apricaria* a Pavia nel 1877.

20. Saemundssonia cordiceps (Giebel 1874).
(=*Docophorus cordiceps*)
Materiale esaminato: 1 maschio su *Tringa glareola* (1 ind.; sull'addome). Lago di Massaciuccoli (Lucca), 30.IV.1985 (leg. N. Baccetti).
Note: è specie nota in Italia fin dal secolo scorso. Picaglia (1885) nel riferire di averne trovato esemplari su *Tringa ochropus* in provincia di Modena nell'agosto 1884, riporta l'elenco degli ospiti sui quali era stata in Europa precedentemente osservata: *Philomachus pugnax* (citata come *Machetes pugnax*), *Arenaria interpres* (come *Strepsilas interpres*), *Tringa glareola* (come *Totanus glareola*), *T. ochropus* (come *Totanus ochropus*) e *Tringa hypoleucos* (citata come *Actites hypoleucos*). A sua volta Berlese (1894) raccolse presso Firenze alcuni esemplari su *Tringa glareola* attribuendoli a *Docophorus cephalus* Grube, che egli stesso ritenne sinonimo di *D. cordiceps*. Infine Zavattari (1931) ha segnalato la specie nel Trentino su *Tringa hypoleucos* (come *Tringoides hypoleucos*). Alcune di queste segnalazioni sono certamente da riferire ad altre specie(v. Discussione).

21. Saemundssonia lari (Denny 1842).
(=*Docophorus lari*)
Materiale esaminato: 9 femmine, 7 maschi su *Larus ridibundus* (2 ind) Lago di Massaciuccoli (Lucca), maggio 1986 (leg. N. Baccetti).

Note: la specie è stata ripetutamente segnalata su molte specie di Laridi (*Larus argentatus*, *L. cachinnans*, *L. canus*, *L. fuscus*, *L. marinus*, *L. minutus*, *L. ridibundus*, *Rissa tridactyla*), sicchè essa risulta presente in ogni continente lungo le rotte degli ospiti. Diversi studiosi (Timmermann 1951; Clay e Hopkins 1954; Zlotorzycka 1961, 1978, 1983) ritengono che tutte le specie *Saemundssonia* parassite di uccelli del genere *Larus* debbano essere considerate come sottospecie di *Saemundssonia lari*.

Questa in Italia è stata segnalata da Simonetta (1882) a Pavia su *Larus canus* e *L. ridibundus*; erroneamente (v. Discussione) da Picaglia (1885) a Nonantola (Modena) su *Stercorarius parasiticus* (come *Lestris parasiticus*); da Berlese (1895) con esemplari osservati nei Musei di Firenze e di Venezia e provenienti da *Larus argentatus*, *L. cachinnans*, *L. canus*, *L. fuscus*, *L. minutus*, *L. ridibundus* e *Rissa tridactyla*; da Martin Mateo e Manilla (1988, 1993) su *Larus cachinnans* (citata come *L. argentatus*) a Bellarosa (Cagliari) e su *L. ridibundus* presso Sassari.

22. Saemundssonia scolopacisphaeopodis (Schrank 1803)

(= *Pediculus scolopacis*)

Materiale esaminato: 1 femmina su *Numenius phaeopus*. Lago di Massaciuccoli (Lucca), 5.V.1983 (leg. N. Baccetti).

Note: tuttora poco nota nonostante la dettagliata ridescrizione di Clay ed Hopkins (1960), la specie è stata segnalata sul Chiurlo piccolo in Europa (Islanda, Norvegia, Isole Britanniche, Francia, Polonia, Russia), in America,in Asia e fino alle isole Maldive e in Nuova Zelanda. E' probabile che gli esemplari rinvenuti su *N. phaeopus* da Simonetta (1882) a Pavia e da Berlese (1894) nel Museo di Venezia attribuiti a *Saemundssonia humeralis* (Denny 1842) siano invece da riferire a *S. scolopacisphaeopodis*, essendo noto che popolazioni della prima hanno molti caratteri in comune con la seconda, tanto che per esse fu proposta la sottospecie *S. scolopacisphaeopodis humeralis*.

23. **Saemundssonia sternae melanocephala** (Burmeister,1838)

(= *Docophorus melanocephalus*, *Saemundssonia melanocephala*)

Materiale esaminato: 4 femmine, 2 maschi su *Sterna albifrons* (3 ind.: su capo e collo). Lago di Massaciuccoli (Lucca), 17.V.1984; 6.V.1986; 15.V.1986 (leg. N. Baccetti).

Note: segnalata su diverse Sterninae, la specie risulta essere molto diffusa, fino alla Nuova Zelanda (Pilgrim e Palma 1982) In Italia essa è stata osservata su *Larus canus* e *L. ridibundus* (v. Discussione) da Simonetta (1882) a Pavia e su *Chlidonias niger* (come *Hydrochelidon fissipes*) da Berlese (1895) nel Museo Civico di Storia Naturale di Venezia e da Conci (1940a) a Strevi (Alessandria).

Discussione

Le 23 specie rinvenute ribadiscono la specificità per i loro rispettivi ospiti, concordemente con quanto è possibile rilevare da gran parte della letteratura moderna e soprattutto dai lavori di Zlotorzycka (1990), Zlotorzycka *et al.* (1974). Zlotorzycka e Modrzejewska (1988).

Fra le Amblycera. le specie del genere *Actornithophilus* (*pustulosus*. *totani*, *umbrinus*) e qualcuna del genere *Austromenopon* (*A. durisetosum*) risultano associate a varie tribù (Calidrini, Tringini, Scolopacini) di Scolopacinae mentre solo *A. transversum* è segnalata, anche in letteratura, su specie Larinae (*Larus*, *Rissa*).

Fra le Ischnocera rinvenute, alle Scolopacinae della tribù Calidrini risultano associate specie dei generi *Carduiceps* (*C. complexivus*, *C. meinertzhageni*, *C. zonarius*) e *Lunaceps holophaeus*, con cui nel passato sono state verosimilmente scambiate altre specie dello stesso genere, almeno a giudicare dalle segnalazioni su Charadriinae dei generi *Pluvialis* e *Vanellus*, sulle quali è assai più probabile che siano state invece trovate *Lunaceps incoenis* Kellog e Chapman 1899 e, rispettivamente, *Lunaceps bicolor* Piaget 1880.

Pure fra le Scolopacinae, alla tribù dei Numenini risultano legate *Cummingsiella ovalis* (su *Numenius arquata*) e *Saemundssonia scolopacisphaeopodis* (su *Numenius phaeopus*) mentre a quella degli Scolopacini è associata *Saemundssonia clayae* e a quella dei Tringini *Quadraceps similis*, *Q. furvus* e *Saemundsssonia cordiceps*. Le remote segnalazioni di *Q. furvus* su altri Caradriformi quali *Actitis macularia*, *Arenaria interpres*, *Charadrius alexandrinus*, *Ch. dubius*, *Himantopus himantopus* e *Vanellus vanellus* sono quasi certamente da riferire ad altre specie di *Quadraceps*: rispettivamente *Q. ravus* (Kellog 1899), *Q. strepsilaris* (Denny 1842), *Q. bicuspis* (Nitzsch 1874), *Q. semifissus* (Nitzsch 1866) e *Q. junceus* (Scopoli 1763), mentre quelle di *Saemundssonia cordiceps* precedenti il lavoro di Picaglia (1885), che ne riferiscono la presenza su *Arenaria interpres* e *Philomachus pugnax* sono da attribuire addirittura ad altri generi.

A Caradriformi della sottofamiglia Charadriinae, tutti della tribù Caradrini, risultano associate specie dei generi *Quadraceps* (*Q. bicuspis*, *Q. fissus* e *Saemundssonia conica*) mentre su quelli della sottofamiglia Recurvirostrinae abbiamo trovato solo *Quadraceps hemichrous*.

Fra gli uccelli della sottofamiglia Larinae sono state rinvenute *Koeniginirmus eugrammicus* e *Saemundssonia lari*, la cui segnalazione su *Stercorarius parasiticus* (Picaglia 1885) è certamente da attribuirte a *Saemundssonioa cephala* (Denny 1842).

Infine tra i Caradriformi della sottofamiglia Sterninae abbiamo rinvenuto *Koeniginirmus nychthemerus phaenotus* e *Saemundssonia sternae melanocephala*. Anche per quanto riguarda quest'ultima specie non mancano segnalazioni sicuramente errate, quale quella di Picaglia (1885) che riferì d'averne trovato esemplari su uccelli Larinae. Tali esemplari sono stati confusi con *Saemundssonia lari* o qualcuna delle sue sottospecie, come *S. lari congener* (Giebel 1874) e *S. lari muelleri* (Zloytorzycka 1978).

Conclusioni

I 99 esemplari (15 Amblycera, 84 Ischnocera) facenti parte della collezione esaminata consentono di segnalare 23 specie, di cui almeno 8 nuove per la fauna d'Italia: *Actornithophilus pustulosus* (Piaget 1880), *A. totani* (Schrank 1803), *A. umbrinus* (Burmeister 1838) fra gli Amblycera; *Carduiceps meinertzhageni* Timmermann 1954, *Cummingsiella ovalis* (Scopoli 1763), *Koeniginirmus eugrammicus* (Burmeister 1838), *Quadraceps fissus* (Burmeister 1838) e *Q. similis* (Giebel 1866) fra gli Ischnocera.

Abbiamo escluso fra le prime segnalazioni quelle riguardanti *Carduiceps complexivus* (Kellog e Chapman 1899), *C. zonarius* (Nitzsch 1866) e *Saemundssonia scolopacisphaeopodis* (Schrank 1803): le prime due perchè, pur essendo state rinvenute su uccelli (rispettivamente *Calidris alba* e *C. minuta*) che fanno parte dell'avifauna italiana, sono state raccolte in Somalia e pertanto non figurano neppure nelle Tabelle 1 e 2; la terza per i dubbi sui criteri sistematici adottati nel secolo scorso e di cui s'è detto a proposito della specie.

Tutte le specie risultano essere strettamente associate agli ospiti su cui sono state rinvenute.

Tabella 1. Specie di Mallophaga con i relativi ospiti segnalate in Italia su Uccelli caradriformi (Bac = Baccetti; Ber = Berlese: Cic = Cicolani; Man = Manilla 1986; Man et al. Manilla, Gelsumini e Nissi 1989; M.-M = Martin Mateo; Pic = Picaglia 1885; Sim = Simonetta 1882; Zav = Zavattari 1931). Sono contrassegnati con asterisco * gli ospiti-tipo.

AMBLYCERA

1. Actornithophilus gracilis (Piaget 1880).
* *Vanellus vanellus* (Man. & Cic.).

2. Actornithophilus piceus (Denny 1842).
Sterna hirundo (Conci 1940a).

3. Actornithophilus pustulosus (Piaget 1880).
**Philomachus pugnax* (Man. & Bac.).

4. Actornithophilus totani (Schrank 1803).
**Tringa totanus* (Man. & Bac.).

5. Actornithophilus umbrinus (Piaget 1880).
**Calidris ferruginea* (Man. & Bac.).

5. Austromenopon durisetosum
(Blagoveshtchensky 1948).
**Gallinago gallinago* (Man. & Bac.);
Vanellus vanellus (Man. & Cic.).

6. Austromenopon ridibundus (Denny 1842).
**Larus ridibundus* (Pic.).

7. Austromenopon transversum (Denny 1842).
Larus ridibundus (M.-M & Man..1986; Man.et al;
Man.& Bac);
**Rissa tridactyla* (M.-M. & Man.,1993).

ISCHNOCERA

8. Carduiceps cingulatus (Denny 1842).
Calidris minuta (Sim.);
**Limosa limosa* (Sim.).

9. Carduiceps meinertzhageni Timmermann 1954.
**Calidris alpina* (Man. & Bac.).

10. Cummingsiella aurea Hopkins 1949.
**Scolopax rusticola* (Man.& Cic.; Man.).

11. Cummingsiella ovalis (Scopoli 1763).
**Numenius arquata* (Man. & Bac.).

12. Cummingsiella testudinaria (Denny 1842).
**Numenius arquata* (Ber. 1894);
Numenius tenuirostris (Ber. 1894).

13. Koeniginirmus eugrammicus (Burmeister 1838)
**Larus minutus* (Man.& Bac.).

14. Koeniginirmus nychthemerus phaenotus
(Nitzsch 1866)
**Chlidonias niger* (Conci 1940a; Man. & Bac.);
Sterna albifrons (Pic.).

15. Lunaceps bicolor (Piaget 1880).
Philomachus pugnax (Ber. 1895).

16. Lunaceps phaeopi (Denny 1842).
**Numenius phaeopus* (Ber. 1895);
Numenius tenuirostris (Ber. 1895).

17. Pectinopygus setosus (Piaget 1880);
Sterna albifrons (Pic.)

18. Quadraceps annulatus (Denny 1842).
**Burhinus oedicnemus* (M.-M. & Man. 1988; Man. et al.).

19. Quadraceps bicuspis (Nitzsch 1874).
**Charadrius dubius curonicus* (Man.& Bac.);
Vanellus vanellus (Pic).

20. Quadraceps fissus (Burmeister 1838)
**Charadrius hiaticula* (Man.& Bac.)

21. Quadraceps furvus (Burmeister 1838).
Himantopus himantopus (Pic.);
**Tringa erythropus* (Man. & Bac.);
Actitis hypoleucos (Ber. 1895);
Tringa nebularia (Ber. 1895);
Tringa ochropus (Pic.);
Tringa totanus (Ber. 1895);
Vanellus vanellus (Pic.; Ber. 1895; Conci 1940a).

22. Quadraceps hemichrous (Nitzsch 1866).
**Himantopus himantopus* (Sim.; Man. & Bac.).

23. Quadraceps junceus (Scopoli 1763).
Pluvialis apricaria (Conci 1940a);
**Vanellus vanellus* (Man. & Cic.).

24. Quadraceps lineolatus (Nitzsch 1866).
Larus argentatus (= cachinnans?) (Sim.);
Larus canus (Sim.);
**Rissa tridactyla* (Sim.).

25. Quadraceps normifer (Grube 1851).
Rissa tridactyla (Conci 1940a).

26. Quadraceps ochropygos (Nitzsch 1866).
Himantopus himantopus (Conci 1940a).

27. Quadraceps ornatus (Grube 1851).
Rissa tridactyla (Conci 1940a)..

28. Quadraceps punctatus (Burmeister 1838).
Larus cachinnans (M.-M. & Man. 1993);
**Larus ridibundus* (M.-M. e Man. 1988; Man. et al.)..

29. Quadraceps sellatus (Burmeister 1838).
Larus melanocephalus (Conci 1940a);
**Sterna hirundo* (Conci 1940a).

30. Quadraceps semifissus (Nitzsch 1866).
**Himantopus himantopus* (Pic.).

31. Quadraceps signatus (Piaget 1880).
**Recurvirostra avosetta* (Conci 1940a).

32. Quadraceps similis (Giebel 1866).
**Tringa nebularia* (Man. & Bac.).

33. Quadraceps subcingulatus (Nitzsch 1836).
**Arenaria interpres* (Sim.).

34. Quadraceps testudinarius (Children 1836).
**Recurvirostra avosetta* (Conci 1940a).

35. Rhynonirmus helvolus (Burmeister 1838).
**Scolopax rusticola* (Man. & Cic.).

36. Rhynonirmus scolopacis (Denny 1842).
**Gallinago gallinago* (Man.).

37. Saemundssonia clayae Hopkins 1949.
Scolopax rusticola (Sim., Pic., Ber. 1895):
**Lymnocryptes minimus* (Man.& Bac.).

38. Saemundssonia conica (Denny 1842).
Charadrius alexandrinus (Man. & Bac.);
**Pluvialis apricaria* (Sim.).

39. Saemundssonia cordiceps (Giebel 1874).
**Tringa glareola* (Ber.,1894; Man. & Bac.);
Actitis hypoleucos (Zav.);
Tringa ochropus (Pic.).

40. Saemundssonia gonothorax (Giebel 1874).
Larus fuscus (Conci 1940a);
Rissa tridactyla (Conci 1940a);
Sterna hirundo (Conci 1940a);
Stercorarius parasiticus (Conci 1940b).

41. Saemundssonia humeralis (Denny 1842).
**Numenius arquata* (Ber.? 1894);
Numenius phaeopus (Sim., Ber. 1894);
Numenius tenuirostris (Ber. 1894).

42. Saemundssonia lari (Denny 1842).
**Larus cachinnans* (Sim.; Ber. 1895; M.-M. e Man. 1993);
Larus canus (Sim.; Ber.1895):
Larus fuscus (Ber. 1895);
Larus minutus (Ber. 1895):
**Larus ridibundus* (Sim.; Ber. 1895; M.-M. & Man. 1988, 1993; Man. et al.; Man. & Bac.);
Rissa tridactyla (Ber. 1895);
Stercorarius parasiticus (Pic.).

43. Saemundssonia limosae (Denny 1842).
Calidris alba (Ber. 1895).

44. Saemundssonia pustulosa (Nitzsch 1866).
**Stercorarius parasiticus* (Ber. 1895).

45. Saemundssonia scolopacisphaeopodis (Schrank 1803).
* *Numenius phaeopus* (Man. & Bac.).

46. Saemundssonia semivittata (Giebel 1874).
Charadrius hiaticula (Ber. 1894).

47. Saemundssonia sternae melanocephala (Burmeister 1838).
Chlidonias niger (Ber. 1895; Conci 1940a);
Larus ridibundus (Sim.);
Numenius phaeopus (Sim.);
**Sterna albifrons* (Man. & Bac.).

48. Saemundssonia temporalis (Giebel 1874).
**Vanellus vanellus* (Pic., Ber. 1894).

N.B. Per i lavori precedenti quelli di Conci (1940) valgono le seguenti sinonimie di generi: **Austromenopon** Bedford 1939 (= **Menopon** Nitzsch 1818); **Carduiceps**, **Lunaceps** e **Quadraceps** Clay e Meinertzhagen 1939 (= **Nirmus** Hermann 1804; **Cummingsiella** Ewing 1930 e **Saemundssonia** Timmermann 1935 (= **Docophorus** Nitzsch 1818); **Pectinopygus** Mjoberg 1910 (= **Lipeurus** Nitzsch 1818).

Tabella 2. Specie di uccelli caradriformi trovate in Italia infestate con Mallofagi (A = Amblycera; gli altri appartengono al sottordine Ischnocera).

RECURVIROSTRIDAE

1. Himantopus himantopus
(L. 1758) (= Cavaliere d'Italia)
Quadraceps furvus
Quadraceps hemichrous
Quadraceps ochropygos
Quadraceps semifissus

2. Recurvirostra avosetta (L. 1758) (= Avocetta)
Quadraceps signatus
Quadraceps testudinarius

BURHINIDAE

3. Burhinus oedicnemus (L. 1758) (= Occhione)
Oedicnemiceps (= *Quadraceps*) *annulatus*

CHARADRIIDAE

4. Charadrius dubius (Gmelin) (= Corriere piccolo)
Quadraceps bicuspis

5. Charadrius hiaticula L. 1758 (= Corriere grosso)
Quadraceps fissus
Saemundssonia semivittata

6. Charadrius alexandrinus L. 1758 (= Fratino)
Saemundssonia conica

7. Pluvialis apricaria (L. 1758) (= Piviere dorato)
Quadraceps junceus
Saemundssonia conica

8. Vanellus vanellus (L. 1758) (= Pavoncella)
Actornithophilus gracilis (A)
Austromenopon durisetosum (A)
Quadraceps bicuspis
Quadraceps furvus
Quadraceps junceus
Saemundssonia platygaster temporalis

SCOLOPACIDAE

9. Calidris alba (Pallas 1764) (= Piovanello tridattilo)
Saemundssonia limosae

10. Calidris minuta (Leisler 1812) (= Gambecchio)
Carduiceps cingulatus

11. Calidris ferruginea (Pontoppidan 1763)
(= Piovanello)
Actornithophilus umbrinus (A)

12. Calidris alpina (L. 1758) (= Piovanello pancianera)
Carduiceps meinertzhageni

13. Philomachus pugnax (L. 1758) (= Combattente)
Actornithophilus pustulosus (A)
Lunaceps bicolor

14. Lymnocryptes minimus (Brunnich 1764) (= Frullino)
Saemundssonia clayae

15. Gallinago gallinago (L. 1758) (= Beccaccino)
Austromenopon durisetosum (A)
Rhynonirmus scolopacis

16. Scolopax rusticola (L. 1758) (= Beccaccia)
Cummingsiella aurea
Rhynonirmus helvolus
Saemundssonia clayae

17. Limosa limosa (L. 1758). (= Pittima reale)
Carduiceps cingulatus

18. Numenius phaeopus (L. 1758). (Chiurlo piccolo)
Lunaceps phaeopi
Saemundssonia humeralis
Saemundssonia sternae melanocephala

19. Numenius tenuirostris Vieillot 1817 (= Chiurlottello)
Cummingsiella testudinaria
Lunaceps phaeopi
Saemundssonia humeralis

20. Numenius arquata (L. 1758) (= Chiurlo)
Cummingsiella ovalis
Cummingsiella testudinaria

21. Tringa erythropus (Pallas 1764) (= Totano moro)
Quadraceps furvus

22. Tringa totanus (L. 1758). (= Pettegola)
Actornithophilus totani (A)
Quadraceps furvus

23. Tringa nebularia (Gunnerus 1767) (= Pantana)
Quadraceps furvus
Quadraceps similis

24. Tringa ochropus L. 1758 (= Piro-piro culbianco)
Quadraceps furvus
Saemundssonia cordiceps

25. Tringa glareola L. 1758 (= Piro-piro boschereccio)
Saemundssonia cordiceps

26. Actitis hypoleucos (L. 1758) (= Piro-piro piccolo).
Quadraceps furvus
Saemundssonia cordiceps

27. Arenaria interpres (L. 1758) (= Voltapietre)
Quadraceps subcingulatus

STERCORARIIDAE

28. Stercorarius parasiticus L. 1758 (= Labbo)
Saemundssonia gonothorax
Saemundssonia lari
Saemundssonia pustulosa

LARIDAE

29. Larus melanocephalus Temminck 1820
(= Gabbiano corallino)
Quadraceps sellatus

30. Larus minutus Pallas 1776 (= Gabbianello)
Koeniginirmus (=*Quadraceps*) *eugrammicus*

31. Larus ridibundus L. 1766 (= Gabbiano comune)
Austromenopon ridibundus (A)
Austromenopon transversum (A)
Koeniginirmus (=*Quadraceps*) *punctatus*
Saemundssonia lari
Saemundssonia sternae melanocephala

32. Larus canus L.. 1758 (= Gavina)
Quadraceps lineolatus
Saemundssonia lari
Saemundssonia sternae melanocephala

33. Larus fuscus L. 1758. (= Gabbiano zafferano)
Saemundssonia gonothorax
Saemundssonia lari

34. Larus cachinnans Pallas, (= Gabbiano reale)
Saemundssonia lari

35. Rissa tridactyla (L. 1758) (= Gabbiano tridattilo)
Austromenopon transversum (A)
Quadraceps lineolatus
Quadraceps normifer
Quadraceos ornatus

STERNIDAE

36. Sterna hirundo L. 1758 (= Sterna comune)
Laritophilus (=*Actornitophilus*) *piceus* (A)
Koeniginirmus (= *Quadraceps*) *sellatus*
Saemundssonia gonothorax

37. Sterna albifrons Pallas 1764 (= Fraticello)
Pectinopygus setosus
Koeniginirmus (=*Quadraceps*) *nychthemerus phaenotus*
Saemundssonia sternae melanocephala

38. Chlidonias niger (L. 1758) (= Mignattino)
Koeniginirmus (=*Quadraceps*) *nychthemerus phaenotus*
Saemundssonia sternae melanocephala

Abstract - A total of 99 specimens of Mallophaga collected on 22 species of Charadriiformes were examined. At least 8 of such biting lice are new records to Italy: *Actornithophilus pustulosus* (Piaget 1880), *A. totani* (Schrank 1803), *A. umbrinus* (Burmeister 1838), *Carduiceps meinertzhageni* Timmermann 1954; *Cummingsiella ovalis* (Scopoli 1763), *Koeniginirmus eugrammicus* (Burmeister 1838), *Quadraceps fissus* (Burmeister 1838) and *Q. similis* (Giebel 1866). All the species are closely associated to their hosts.

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Dependence of Yellow-legged Gulls (*Larus cachinnans*) on food from human activity in two Western Mediterranean colonies

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Abstract - The diet of fledging chicks of the Yellow-legged Gull (*Larus cachinnans*) was studied in the Medes Islands and the Ebro Delta, two Northwestern Mediterranean colonies with differing ecological characteristics. The diet of the Medes Islands colony showed a higher biomass percentage of tip food than from the Ebro Delta colony. At the Ebro Delta, chicks consumed a higher biomass percentage of preys from channels, mainly mullets (*Mugil* sp.) and showed a higher foraging niche width. The consumption of garbage from refuse tips seems to affect the growth patterns in both populations.

Introduction

The increase in most gull populations during the last decades in Europe has been associated with the increase in food availability derived from human activity (Blockpoel and Spaans 1990, Furness *et al.* 1992), especially from refuse tips (Mudge and Ferns 1982, Pons 1992). In the Mediterranean region, the Yellow-legged Gull *Larus cachinnans* is the most common seabird (Beaubrun 1993, Bourne 1993) and its population has also grown in recent years, probably due both to its opportunistic feeding habits and its low requirements for suitable nest sites all along the Mediterranean coast (Carrera 1987, Goutner 1992). Sometimes classified as a subspecies of the Herring Gull *Larus argentatus*, *L. cachinnans* is now generally considered to form a separate species (see Yésou 1991, Wink *et al.* 1994).
Although there are many studies on the status of Yellow-legged Gull (De Juana *et al.* 1984, Fasola 1986, Beaubrun 1993), few papers deal with its diet in the Mediterranean, and they are restricted to the analysis of remains and pellets found in the breeding sites (Witt et al. 1981, Carrera and Vilagrasa 1984, Borg and Cachia Zammit 1986-1987, Borgo and Spano 1993) (nevertheless, see Fasola *et al.* 1989). The aim of this paper is to study the diet of Yellow-legged Gull chicks, and to evaluate its influence on the different growth of two western Mediterranean colonies.

Methods

Study sites

Data were collected during 1992 in the Medes Islands and in 1993 in the Ebro River Delta. The two colonies are located in the North Western Mediterranean, 270 km apart (Figure 1).

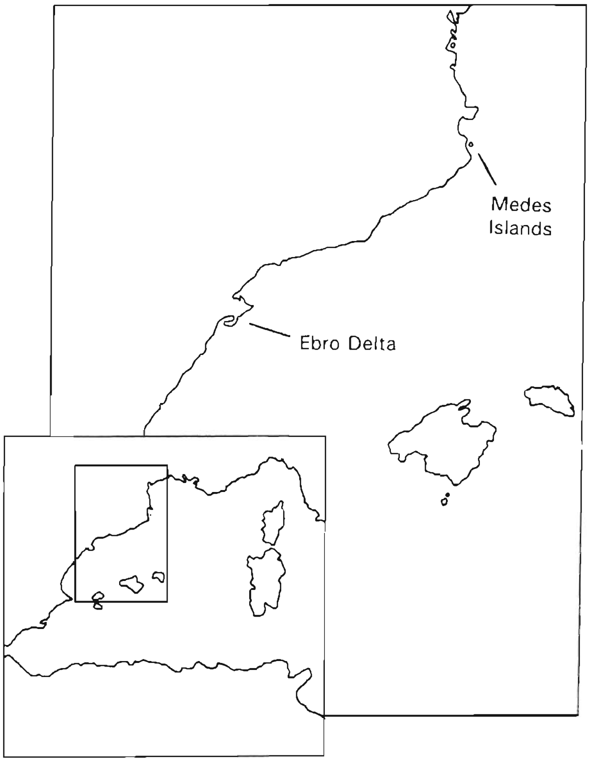

Figure 1. Map of the study areas, indicating colony sites.

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The Medes Islands are calcareous rocks just 0.9 km off the coast, with an area of 20 ha. The vegetation is formed by nitrofilous communities. This site holds one of the largest breeding colonies of Yellow-legged Gulls in the world, with ca. 13500 pairs in 1993, after suffering intensive culling in 1992 (Bosch *et al.* 1994). There are many refuse tips in the surrounding area (Motis 1989), which have been there since the nineteen sixties (Carrera 1987).

The Ebro Delta colony holds a smaller breeding colony, with ca. 1100 pairs. The colony is found on a sandy, flat peninsula of 2000 ha., with small dunes covered by halophilous vegetation. The area has fewer refuse tips than the Medes Islands zone.

Diet

Diet composition was studied during the breeding season from the diet of fledging chicks, which provides a good indication of the food items collected by the adults (Mudge and Ferns 1982).

Data on diets were collected in both colonies using the same method. We assumed that there was low interannual variability in the diet at the two colonies, given that the number of refuse tips and the fishing activity did not change between years. Chicks, when handled for measuring or ringing, regurgitate largely undigested food. These regurgitates were collected and preserved for identification at the laboratory using our reference collections of fish and invertebrates from the same areas. When partially digested, fish were identified with a 10-40x binocular lens using scales and otoliths, but identification was often possible from the entire fish bodies. We did not consider the plant remains found, since we assumed that their ingestion was associated with the consumption of worms and other terrestrial preys (Harris 1965, Fox *et al.* 1990, this study). The quantification procedures always followed the rule of minimum numbers. We calculated the dry weight of each item using an oven and keeping the samples at 60 °C until they reached constant weight. For semidigested preys, dry weight was estimated from reference collection (for fish), and predictive functions (for invertebrates) stated by Rogers *et al.* (1977) and Diaz and Diaz (1990).

Since the categorization procedures might have a decisive influence on the interpretation of diet analyses (Cooper *et al.* 1990), we used two separate criteria to establish prey categories: taxonomy and foraging habitat. Thus, two outcomes were obtained, each one of which was mainly associated with different prey attributes. The taxonomic categories were mainly based on Order level to avoid analytical difficulties coming from an excess of groups with many zero counts (Cooper *et al.* 1990). This also allows comparisons with most other papers on gull feeding ecology, and refers to a universal code.

Foraging habitats were assigned for each prey, to assess where gulls forage. We assumed that fresh marine fish came from fishing vessel discards, since the Yellow-legged Gull is not specialized in active fishing (Witt *et al.* 1981, Carrera 1987, Català *et al.* 1990).

To assess the relevance of the different prey categories in the diet, with either taxonomic or feeding habitat grouping, the following descriptors were used: prey number (N); numeric percentage (% N); percentage of occurrence (percentage of regurgitations containing the prey category, % P); and biomass percentage of each food category (% B). We used the biomass percentage to compare diet composition between the colonies, since this is the descriptor most related to an energy approach to diet.

The width of the trophic niche was measured in relation to foraging habitats by Brillouin's diversity index (Pielou 1975), and a jack-knife procedure was used to estimate diversity at the population level, together with the associated variance (Zahl 1977).

Prey biomass percentages consumed in each regurgitate (both at taxonomic and typological levels) were compared between colonies by the Mann-Whitney U test. Diversities were compared using a modified Student -t statistic (Hutcheson 1970).

Growth of the colonies

We attempted to find the function that best fitted the data on population growth obtained in censuses of both colonies for the last 30 years. We tested the correlation between the real and estimated values (Zahr 1984). We did not consider the Medes Islands census of 1993 since the population had been culled in 1992 (Bosch *et al.* 1994).

Results

Diet composition

We analyzed a total of 85 regurgitates: 51 from the Ebro Delta (99 preys identified) and 34 from the Medes Islands (200 preys identified). The relative importance of the different preys identified and the foraging habitats assigned are shown in Tables 1 and 2. Coleoptera and Diptera included both imago and larvae stages, whereas the remaining categories of arthropods were only formed by imagos; Gastropoda included only slugs.

Diet from the Medes colony shows a higher biomass percentage of garbage than the Ebro Delta colony ($U = 624$, $Z = -1.480$, $P = 0.015$). Moreover, preys from crops found in the Medes Islands colony (earthworms, slugs, arthropods and fruits) were more diverse than in the Ebro Delta colony (only olives). Conversely, the Ebro Delta chicks consumed a higher biomass percen-

Table 1. Diet of Yellow-legged gull chicks from the Medes Islands and Ebro Delta colonies (N = number of preys; %N = numeric percentage; %P = occurrence percentage; %B = biomass percentage).
[1] foraging habitats in brackets: F = Crops; FV = Fishing vessels; RT = Refuse tips; SH = Shore; CH = Channels

		Medes Islands N = 200				Ebro Delta N = 99			
		N	%N	%P	%B	N	%N	%P	%B
Taxonomic[1]									
Amphipoda	(SH)	2	1.0	2.9	0.0	-	-	-	-
Coleoptera	(F)	76	38.0	17.6	2.1	-	-	-	-
Dermaptera	(F)	2	1.0	5.9	0.1	-	-	-	-
Diptera	(F)	2	1.0	5.9	0.0	-	-	-	-
Isopoda	(F)	18	9.0	11.8	1.4	-	-	-	-
Decapoda	(SH)	-	-	-	-	1	1.0	2.0	2.0
Ind. Artropods	(F)	1	0.5	2.9	0.1	-	-	-	-
Oligoquets	(F)	41	20.5	8.8	3.0	-	-	-	-
Hirudinea	(CH)	-	-	-	-	7	7.1	2.0	2.0
Gastropoda	(F)	11	5.5	8.8	1.4	-	-	-	-
Olives	(F)	6	3.0	2.9	2.7	29	29.3	9.9	8.4
Waste meat	(RT)	23	11.5	58.8	52.4	13	13.1	25.5	24.2
Other waste food	(RT)	7	3.5	17.7	7.7	2	2.0	4.0	4.0
Clupeiforms	(FV)	-	-	-	-	23	23.2	25.5	23.3
Perciforms	(FV,CH)	-	-	-	-	18	18.2	33.3	32.2
Ind. Fish	(FV,CH)	11	5.5	32.3	29.0	5	5.1	5.9	4.0
Foraging habitat									
Fishing vessels		11	5.5	32.3	29.0	32	32.3	33.3	33.3
Shore		2	1.0	2.9	0.02	1	1.0	2.0	2.0
Channels		-	-	-	-	20	20.2	27.5	27.5
Crops		157	78.5	26.5	10.8	29	29.3	9.8	8.4
Refuse tips		30	15.0	61.8	60.1	17	17.2	31.4	28.9

tage of preys from channels ($U = 629$, $Z = -2.135$, $P = 0.016$), mainly mullets (*Mugil* sp.). We found no differences between the two colonies in consumption of preys from shore ($U = 1617$, $Z = -0.084$, $P = 0.466$) or vessel discards ($U = 314$, $Z = -1.252$, $P = 0.106$). Foraging habitat diversity at population level was significantly higher in the Ebro Delta colony than in the Medes Islands (2.08 ± 0.07 vs 0.91 ± 0.31; $t = -3.57$, d.f. = 6, $p<0.05$).

Growth of colony populations

Figure 2 shows the population growth of both colonies for the last three decades. Growth of Medes Islands colony was best fitted with a potential curve ($Y = 3.174 * 10^{-3} * X^{3.3509}$; $r = 0.962$, $p < 0.05$), whereas for the Ebro Delta a linear function was the best fitted, although the correlation was not significant ($Y = -1850.92 + 29.938 * X$; $r = 0.724$, $p > 0.05$).

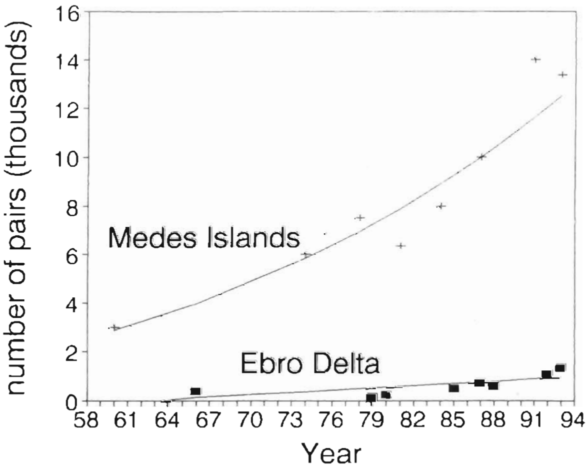

Figure 2. Colony growth of the two study sites in the last three decades. Censuses from Balcells 1964, Westerhagen and Pons 1966, Maluquer 1981, Carrera and Vilagrasa 1984, Carrera 1987, Fortià and Hontangas 1991, Oro and Martínez 1992, Bosch *et al.* 1994.

Discussion

Yellow-legged Gulls showed a generalist and opportunistic diet in the two colonies, suggesting that the species occupies the same ecological niche in Mediterranean habitats as the Herring Gull in northern European areas. Yellow-legged Gulls seem to depend mainly on the preys related to human activities, such as garbage or fishing vessel discards.

Data collected in the Ebro Delta colony show that most of the diet was formed equally by preys from channels, vessel discards and refuse tips, showing a higher foraging niche width. Conversely, in the Medes Islands more than 60% of food ingested was garbage, probably because of the high density of refuse tips in the area (Motis 1989). Several authors have associated the distribution of the species with the presence of refuse tips (Mainardi 1988, Fernandez-Cordeiro 1991, Donazar 1992, Sol *et al.* in press), and a selection for this foraging habitat when available. There is, moreover, a correlation between the size of the refuse tip and the number of gulls concentrated there, since it represents a predictable and abundant source of food (Spaans 1971, Fernandez-Cordeiro 1991). Lower dependence on garbage in the Ebro Delta colony could be due to a lower availability of this resource, rather than a preference for other foraging habitats. Indeed, there are five times as many refuse tips in the Medes Islands area.

Given the suitability of the Ebro Delta as a breeding place for seabirds in Western Mediterranean (Oro and Martinez 1992) and the recent increase in their populations in this area (Fasola *et al.* 1993), it is surprising that the Yellow-legged Gull, generally considered as a dominant species (Bradley 1987), did not increase markedly, especially when there are neither predators nor human disturbance at the colony. It seems that the exploitation of vessels discards by the species in the Ebro Delta is limited when the fleet works near off the coast, and other seabird species probably with higher flight attitudes are able to follow the vessels for greater distances (authors, unp. data). Since refuse tips allow an increase in breeding success and probably in survival (Spaans 1971, Donázar 1992, Pons 1992), lower availability of garbage could therefore affect the different growth patterns in the two colonies.

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Riassunto - La dieta dei pulcini "fledgings" del Gabbiano Reale (*Larus cachinnans*) é stata studiata alle Isole Medes e al Delta dell'Ebro, due colonie del Mediterraneo nord-occidentale con differenti caratteristiche ecologiche. La colonia delle Isole Medes ha mostrato una più accentuata dipendenza trofica dai rifiuti raccolti alle discariche rispetto a quella del Delta dell'Ebro. Al Delta dell'Ebro i pulcini consumavano infatti una maggiore quantità di prede (prevalentemente Mugili *Mugil sp.*) catturate in canali, lagune e campi di riso, e presentavano un'ampiezza di nicchia maggiore. Il consumo di rifiuti di discarica sembra influenzare la crescita della popolazione in entrambe le colonie.

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The breeding biology of Dupont's Lark, *Chersophilus duponti*, in Europe

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Abstract - Very little published information exists concerning the reproductive biology of Dupont's Lark, *Chersophilus duponti*, and what is available largely refers to the North African population. Here we present data from 33 nests found in southeastern (n=15) and central (n=16) Spain between 1989 and 1993.
The reproductive period extended from mid March to early July, a month longer than the North African populations. The laying period in SE Spain started more than a month earlier than in central Spain. Nests were placed on the ground, nearly always partially covered by shrubs (88 %), and oriented to the NW, N or NE (84%) of the closest plant. In SE Spain, this species appears to select nest site positions covered by shrubs 7-12 cm in height. No selection was evident in central Spain, where shrub height may be closer to the optimum required. Mean clutch size (3.6±0.6 sd) was larger than that reported for North Africa, but no differences were found between the two areas in Spain. Indications of asynchronous hatching were found, and appear to depend on clutch size. Mean egg length and width were 0.5 mm greater than those reported previously. The incubation period was 12-13 days. Nestling period was very short (8 days). Nest mortality was extremely high (84%), but egg hatchability was high (95.7%), and no nestlings starved (n=32). Coleopteran and lepidopteran larvae form 50% of nestling diet, but araneids (especially Lycosidae) are particularly important early in the nestling period.

Introduction

The basic aspects of the breeding biology of most European passerines are relatively well known (Cramp 1988). Dupont's Lark *Chersophilus duponti* is one exception in this respect. Due to its secretive behaviour, low population density and difficulty of finding nests, existing information concerning its reproductive biology is extremely limited (e.g. Cramp 1988).

Information on the breeding biology of this species refers largely to the Maghreb, North Africa, and large gaps exist in our knowledge of the species (Cramp 1988, Wunderlich 1987). Cañadas *et al.* (1988) provided data concerning the European population, but from a very small sample size (4 nests). Similarly, Herranz *et al.* (1993) presented information on the diet of nestlings based on a relatively small number of prey items (103) and nests (6).

The objectives of this note are (a) to contribute additional information concerning the reproductive biology of Dupont's Lark and (b) to compare data obtained in this study of the Iberian population with those obtained by Heim de Balsac and Mayaud (1962) in North Africa.

Methods

The major part of this study took place in two localities: Níjar, SE Spain (36°50' N, 2°25' W, 50 m asl) and Layna, in central Spain (41°05' N, 1°50' W, 1100 m). Both possess communities of birds representative of the two principal types of Spanish shrub-steppe habitats: the semi-arid in the first case and the "páramo" in the second (Suárez 1981, Tellería *et al.* 1988).

During an intensive study of reproduction in other lark species in both localities during 1989-93, 15 nests of Dupont's Lark were found in Níjar and 16 in Layna. Also included in the data on phenology and clutch size are records of two additional nests found in the localities of Baza (37°33'N, 2°42'W, 800 m) and Tobarra (38°29'N, 1°37'W, 500 m).

Nests were monitored almost every two days in Níjar (mean = 2.1 ± 1.1 sd days) and daily in Layna. Measurements of eggs (length and width) were made with calipers (accuracy ±0.05 mm). Weights of nestlings were determined using a spring balance (accuracy ±0.1 g). Nestling mortality was calculated using the method of Mayfield (Mayfield 1961, 1975) with modifications by Johnson (1979) and Hensler and Nichols (1981).

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Samples of nestling diet (159 prey items from 19 samples and 4 nests) were obtained using the "ligature" method (Johnson *et al.* 1980) in Layna during 1993. Prey were identified to the level of family whenever possible. Size of prey was considered as length of specimen without appendages; biomass (dry weight) was determined by drying in an oven for 3 hours at 90 °C (Quinney and Ankney 1985) and subsequently weighing with a precision balance (±0.1 mg).

Sample sizes used in the analyses of results varied considerably and are indicated in the text and tables whenever relevant. Furthermore, in determining phenology and clutch size, additional data from Cañadas *et al.* (1988) (n=4) obtained from the same area (Níjar), but in a different year (1986), are also included.

Results and Discussion

Breeding season

The laying period for this species appears to be relatively long, starting in the middle of March with the first egg recorded on 18 March and continuing until the beginning of July with the first egg of the last nest found on 3 July. The laying period is one month longer than in North Africa (Heim de Balsac and Mayaud 1962). Significant differences existed between the laying period in SE and central Spain, with first clutches appearing more than a month earlier in the former (mean dates of all clutches: 18 April and 5 May, n 14 and 15, SE and central Spain, respectively; Mann Whitney U test, U= 4.5; $p<0.05$). This difference is presumably due to the warmer climate in the SE which has a much higher mean temperature in the first months of the breeding season. The last nests found in both localities appeared to be a result of secondary or substitution clutches, as is common for other lark species in Spain (Yanes and Herranz, unpublished).

Nest site selection

Nests (n=28) were situated on the ground and covered either partially by a shrub (89.3%) or a tussock of grass (7.1%); only one completely exposed nest was found (3.6%).

Shrubs covering the nests were generally less than 20 cm in height (mean=6.8±12.3 sd and 13.4±7.5; n=10 and 8 in Níjar and Layna, respectively). Comparison of the height of shrubs in which nests were found with the height of shrubs on a random sample (mean=26.0±14.5 in Níjar and 18.3±13.2 in Layna, n=60 in both cases), suggests that Dupont's Lark tended to select lower shrubs than those available in Níjar (Mann-Whitney U test; U=443, $p<0.05$), while in Layna there was no evidence of selection (U=184.5, $p>0.05$). Although the number of nests used in the analysis is low, the lack of apparent selection in Layna may be explained by the fact that the vegetation height of this shrub-steppe habitat is more similar to the optimum shrub height required for nesting sites by this species.

Positioning of nests in relation to shrub cover is remarkably constant. Most of the nests found (n 27) were oriented towards the NE (33.3%), N (25.9.%) or NW (22.2%). The proportion of nests with other orientations was small (7.4%, 3.7%, 0%, 3.7%, and 3.7% facing E, SE, S, SW and W, respectively). In the areas occupied by this species solar radiation and diurnal temperatures are extremely high (mean maximum temperatures during the breeding season: 25.4, 27.1, 31.1 and 34.2 °C in March, April, May and June, respctively, in Níjar, 27.1, 31.5 and 34.4 °C in May, June and July, in Layna) and nests appear to be orientated to gain shade and thereby avoid excessive heat.

In general, positioning of the nest is apparently similar to that of other larks found in Spanish shrub-steppe habitats (Cañadas *et al.* 1982).

Clutch and egg size

The clutch, as is common among passerines, was laid at a rate of one egg per day. A suggestion of asynchronous hatching was found, which appeared to depend on clutch size (i.e. synchronous hatching in two clutches of three eggs and asynchrony of one day in three clutches of four eggs).

Clutches size varied from three to five eggs (3, 40.0%; 4, 57.1%; 5, 2.9%; n=35). The mean clutch size of 3.6±0.6 sd was significantly larger than that found in North Africa (3.2±0.4, n=75) by Heim de Balsac and Mayaud (1962) ($\chi^2=9.21$, df=1, $p<0.05$). However, no differences were found between the two Spanish sites (3.7±0.6 and 3.6±0.5, n=17 and 16, respectively; $\chi^2=0.02$, df=1, $p>0.05$).

By dividing the data into two groups before and after the mean date of clutches in each locality, mean clutch size in Níjar was 3.7±0.8 for the earlier and 3.6±0.5 for the later period (n=7 and 8 nests). In Layna means for the two periods were 3.7±0.5 and 3.7±0.5 (n=10 and 6). Differences were not statistically significant in either case (Mann-Whitney U test; U=29 and 31, respectively, $p>0.1$). Thus, clutch size appeared to remain constant, or to decrease slightly, during the length of the breeding season.

Mean, standard deviation, maximum and minimum egg dimensions were as follows: length, 24.1±0.9, 25.9 and 22.3 mm; width, 17.7±0.5, 19.0 and 16.8 (n=48 eggs in 14 nests). Mean length and width of eggs was 0.5 mm greater than reported by Cramp (1988) for this subspecies (n= 14 eggs).

Incubation and nestling periods

The incubation period for one nest was 12-13 days, as reported by Cañadas *et al.* (1988). The nestling period was extremely short and the nest was always abandoned some days before the young were capable of flight (8 days, n=3 nests). The brevity of this period is typical among Palearctic ground-nesting species which suffer high mortality rates in the nest (Ricklefs 1969).

Weight increase of nestlings was extremely rapid (Fig. 1), reaching 20-23 g on leaving the nest. This weight increases after leaving the nest to approximately 30 g (n=6), when they were capable of taking their first flight. The young emit a short single syllable to attract the attention of the parents, similar to the last motif of the adult song.

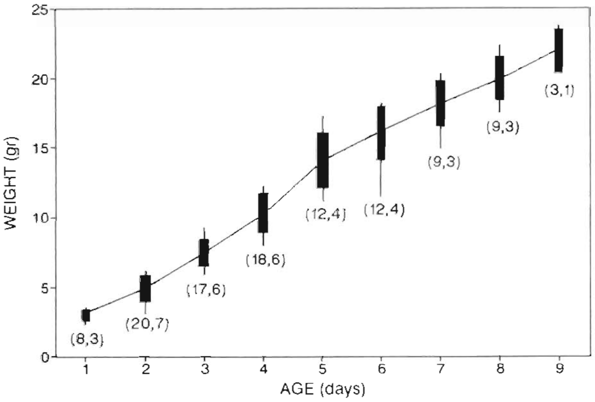

Figure 1. Mean, standard deviation, maximum and minimum values of nestling weight increase of Dupont's Lark (number of nestlings and nest in parentheses). Line shown point mean values.

Nestling mortality

Total nest failure (all eggs or chicks lost) was found to be very high (84%), and similar to that found in other passerines in Spanish steppes (Suárez and Manrique 1992, Suárez *et al.* 1993). Total nest failure during incubation was 51.7% (18 nests, 102 nest-days of observation, nest loss rate=0.059 nests/day). This value rose to 79.5% during the nestling period (18 nests, 79.5 nest-days observation, mortality rate 0.126 nests/day).

Egg hatchability was very high, 95.7% of the total of 69 eggs from 19 nests. No evidence of death by starvation was found in 32 chicks monitored in 9 nests.

Nestling diet

The taxonomic composition of the chick diet was characterised by the high frequency of spiders, especially Lycosidae, together with Orthoptera and larvae of Lepidoptera and tenebrionid Coleoptera, not only in abundance but also in frequency of occurrence in samples (Table 1). In terms of prey biomass, larvae of Lepidoptera and Coleoptera together comprised aproximately50% of the diet, followed by Aranea and Orthoptera.

By including the data of Herranz *et al.* (1993) gathered in Layna in 1992, and grouping the prey items into two periods (before and after 1 July, date of mean hatching period; n=173 and 77 prey items respectively), a significant variation in taxonomic composition of the diet was found ($\chi^2=25.9$, df=11, $p<0.05$). In the later period the importance of araneids decreased, together with that of coleopteran larvae ($\chi^2=10.4$ and 5.77, respectively, df=1, $p<0.05$), while the relative importance of Acrididae increases (Table 1; $\chi^2=15.5$, df=1, $p<0.05$). The numerical importance of lepidopteran larvae remains constant ($\chi^2=0.03$, df=1, $p>0.05$).

The relative importance of araneids in the nestling diet during the first period is particularly interesting. Although other larks also consume this type of prey, the proportion in the diet is notably smaller (e.g. Cramp 1988). Furthermore, most of these prey belonged to the family Lycosidae, suggesting a

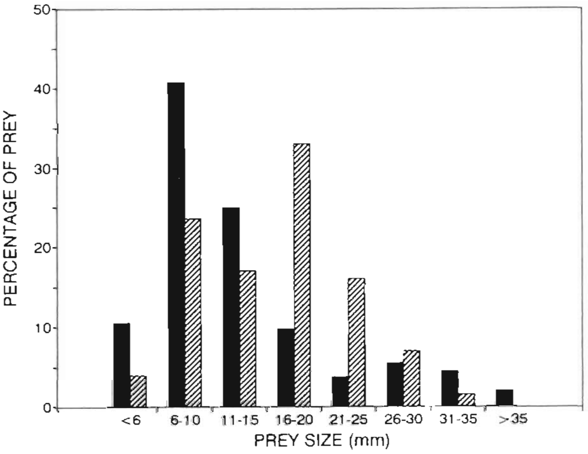

Figure 2. Prey size in the diet of Dupont's Lark nestlings in the locality of Layna, central Spain. Results are divided into two periods; before (filled, n=173) and after 1 July (striped, n= 77). Data of Herranz *et al.* (1993) are included.

Table 1. Taxonomic composition of the diet of Dupont's Lark nestlings. The results are divided into two periods, before and after 1 July, and are expressed as percentages of total prey items (N), total biomass (B) and frequency of appearance of taxa in total samples (F). Data of Herranz *et al.* (1993) are also included.

	Before 1 July			After 1 July		
	N(%)	B(%)	F(%)	N(%)	B(%)	F(%)
Mollusca. Gastropoda	1.2	1.0	10.5	2.6	1.7	15.4
Arthropoda						
Arachnida						
Araneae						
Ctenizidae	1.2	1.6	10.5	-	-	-
Eresidae	1.2	1.7	10.5	-	-	-
Araneidae	0.6	0.6	5.3	1.3	2.3	7.7
Lycosidae	23.1	17.8	78.9	7.8	27.3	38.5
Agelenidae	0.6	0.2	5.3	-	-	-
Salticidae	1.7	0.6	10.5	-	-	-
Drassidae	1.2	0.9	10.5	-	-	-
Thomisidae	4.0	4.6	26.3	-	-	-
Clutch bag	3.5	1.3	31.6	2.6	2.1	7.7
Araneae total	37.0	29.4	-	11.7	31.7	-
Insecta						
Thysanura						
Machilidae	0.6	0.1	5.3			
Hymenoptera						
Formicidae	5.2	0.1	10.5	1.3	0.01	7.7
Andrenidae	0.6	0.7	5.3	-	-	-
Larvae	0.6	0.1	5.3	-	-	-
Hymenoptera total	6.4	0.9	-	1.3	0.01	-
Orthopter						
Acrididae	6.9	3.0	31.6	33.8	31.1	84.6
Tettigonidae	0.6	0.4	5.3	7.8	6.9	46.0
Orthoptera total	7.5	3.4	-	41.6	38.0	-
Dictyoptera						
Mantidae	0.6	0.4	5.3	1.3	1.9	7.7
Phasmida						
Phillidae	-	-	-	1.3	1.2	7.7
Dipter						
Tipulidae	5.2	3.3	10.5	-	-	-
Syrphidae	-	-	-	2.6	0.5	15.4
Bombyliidae	-	-	-	3.9	0.8	7.7
Larvae	-	-	-	1.3	0.1	7.7
Diptera total	5.2	3.3	-	7.8	1.4	-
Hemiptera						
Cicadidae	-	-	-	1.3	2.6	7.7
Lepidopter						
Imagos	1.2	0.4	10.5	1.3	0.1	7.7
Larvas	16.8	17.0	78.9	22.1	14.2	92.3
Crisálidas	0.6	1.3	5.3	1.3	0.4	7.7
Lepidoptera total	18.5	18.8	-	24.7	14.7	-
Coleoptera						
Malachidae	0.6	0.1	5.3	-	-	-

	N(%)	B(%)	F(%)	N(%)	B(%)	F(%)
Apionidae	0.6	0.1	5.3	-	-	-
Carabidae	1.7	1.4	15.8	-	-	-
Scarabacidae	3.5	4.9	21.1	2.6	3.6	15.4
Tenebrionidae	0.6	2.2	5.3	-	-	-
Chrysomelidae	0.6	0.2	5.3	-	-	-
Staphylinidae	-	-	-	1.3	1.8	7.7
Carabidae larvae	-	-	-	1.3	0.6	7.7
Scarabeidae larvae	0.6	0.8	5.3	-	-	-
Tenebrionidae larvae	12.7	26.6	47.4	1.3	0.8	7.7
Cerambycidae larvae	1.7	5.5	15.8	-	-	-
Coleoptera total	22.5	41.9	-	6.5	5.8	-
Vertebrata						
Scincidae (tail)	0.6	0.9	5.3	-	-	-
Prey items, biomass (mg), and samples number	173	3570	19	77	2038	13

positive selection for this taxon, which is not particularly frequent in Layna. During the second period the importance of araneids declined in favour of Orthoptera, a general phenomenon in the provisioning of nestlings in the majority of steppe bird species in Spain (unpublished data).

The length of prey varied from 3 to 40 mm (Figure 2), with almost 50% between 6 and 12 mm, similar to that reported by Herranz *et al.* (1993). Prey size varied between the two time periods, with a significant increase in size of prey items from a mean of 12.9±8.1 mm in the first period to 15.9±6.4 mm in the second ($n=173$ and 77 respectively; $U=4437$, $p<0.05$). This difference is probably a consequence of the mentioned shift in taxonomic composition of prey, but also due to the increase in the available size of grasshoppers, which were the principal prey items.

Concluding remarks

Although the results of this study are based on a relatively small number of nests, they present new information, and provide a better understanding of the breeding biology of Dupont's Lark, a rare and little-known European passerine.

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Resumen - La información publicada sobre la biología de reproducción de la Alondra de Dupont, *Chersophilus duponti*, es muy escasa y se refiere fundamentalmente a las poblaciones norteafricanas. En este artículo se presentan los resultados de 33 nidos encontrados en el sureste (n=15) y centro (n=16) de la Peninsula Iberica, correspondientes a los años 1989-93. El periodo de reproducción se extendió desde mediados de marzo hasta principios de julio, prolongándose un mes más que en las poblaciones del Magreb. El periodo de puesta comoenzó un mes antes en el SE que en el centro de España. Los nidos se situaron en el suelo, casi siempre cubiertos parcialmente por un caméfito (88 %), y orientados preferentemente hacia el NO, N y NE (84%). En el SE de Iberia la especie selecionó para ubicar el nido matorrales de altura comprendida entre 7-12 cm, mientras que en el centro peninsular no se encontró ninguna selección. El tamaño medio de puesta fué superior en la península que en el Norte de Africa, no encontrándose diferencias entre las dos localidades ibéricas. Existen indicios de eclosión asincrónica, que parece dependiente del tamaño de puesta. La longitud y anchura de los huevos fué 0.5 mm mayor que la publicada anteriormente. La duración de la incubación fué 12-13 días. El periodo de estancia de pollos en el nido fué muy corto, 8 días. La mortalidad de nidos fué extremadamente alta (84%), al igual que la fertilidad de los huevos (96%); no se registró ninguna muerte de pollos por inanición (n=32). Las larvas de coleópteros y lepidópteros comprendieron el 50% de la dieta de los pollos. Las arañas (especialmente Lycosidae) fueron también importantes al comienzo del período reproductor.

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Maladaptive adoptions in the Hooded Crow *Corvus corone cornix*

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Abstract - Three cases of post fledging adoption were observed in 13 nests located in a northern Italian study area, where Hooded Crows nest at a high density (6.7 nests per km^2). Adoptions occurred immediately after fledging: any later attempt of young to obtain food from adults other than own parents was unsuccessful. Feeding frequency was not different between adopted young and true offspring. Feeding performance before fledging did not differ between the pairs from which the adopted young originated and those that became foster parents. It is presumed that Hooded crows lack the ability to recognize their offspring and adoptions are a maladaptive phenomenon due to the high nesting density.

Introduction

Adoption, or parental care for unrelated individuals, might be costly in term of fitness. In birds this phenomenon has sometimes been classified as a maladaptive feature of parental behaviour (Graves and Whiten 1980, Holley 1980 and 1984, Bustamante and Hiraldo 1989, Ferrer 1993, Saino et al. 1994). Kin selection, reciprocal altruism and inter-generational conflict are alternative explanations for this relatively rare altruistic behaviour (Pierotti 1980, Waltz 1981, Pierotti and Murphy 1987).

This paper describes three cases of adoption of young which were observed in a population of Hooded Crows *Corvus corone cornix* nesting at high density.

Methods

The study was conducted during 1989 in Northern Italy, near the city of Pavia (45°N, 9°E) in an intensively cultivated 10 km^2 plot, mainly dominated by rice and maize. Natural vegetation was almost absent but suitable nesting sites were provided by poplar plantations and tree rows. The density of nests was 6.7 nests/km^2.

A total of 49 chicks from 22 nests in a core area were individually marked with wing tags and metal rings. Observations on parental behaviour were carried out on 13 nests with chicks aged from 16 days to 36 days, when fledging on average occurred; each nest was observed 4 times, with intervals between observations of 3-5 days; observations were evenly distributed during the day and were carried out only during good weather. Each observation lasted 3 hours during which activity rhythm and adult and young behaviour were recorded. After fledging and until the disappearance of young, the study area was checked almost daily in order to locate fledged young; additional three hours observations were carried out on groups with adopted young. Since adult crows were unmarked, the affirmation that adoption had occurred derived from observation of the same adult simultaneously feeding two fledged young that had hatched in different nests.

Results

Three cases of adoptions were observed (Figure 1); all were first recorded within a few days of fledging. Two adopted young (n.11 and 15) hatched in two contiguous nests and were adopted by a pair (hereafter named pair A) which had nested nearby, and which were caring for two chicks of their own. These two adopted young were observed only within the foster parents home range and were never observed within the home range of their natural parent nest pair, where two adults were caring for the remaining single young. The third adopted young was unmarked and the foster pair (pair B) had one young (n. 47).

During the post-fledging period, two additional intrusions into the home range by strange young were observed that did not result in other permanent adoptions. In one instance an unmarked young approached the adults of pair B and begged many times for food. 28 days after the true offspring (n. 47) had abandoned the nest. The adults ignored this young but the young n. 47 attacked it fiercely. Another case involved pair

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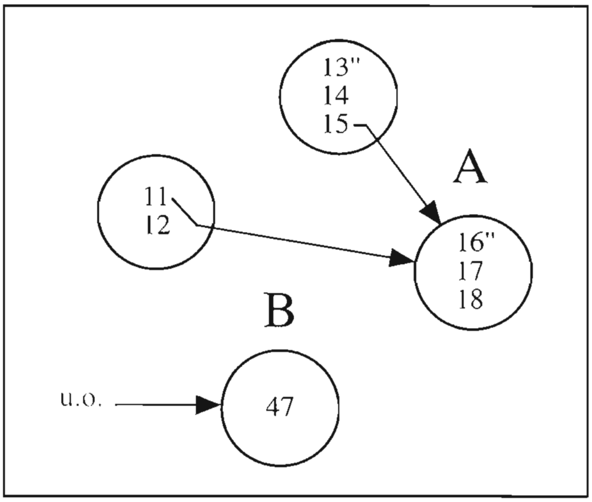

Figure 1 - Schematic view of movements of adopted young. Numbers within circles are tag numbers of young from the same nests; arrows indicate the change of family unit of a young; asterisk shows 2 young which disappeared after fledging; u.o. means unmarked young whose original nest was unknown. A and B are pairs that adopted young.

A; a strange young attempted to be fed by the adults but was only successful once.

Adopted young were fully accepted by foster parents; neither they nor the foster siblings ever showed aggressive behaviour towards the adopted young. Feeding frequency did not differ between adopted and true offspring (data from 10 periods of observations lasting 3 hours, number of feedings per hour; true sons: mean = 1.03, SD = 1.03; adopted young: mean = 1.10, SD = 0.93). Statistical testing cannot be carried out, because data are pseudo-replicas from a limited number of pairs and, therefore, result in an inflated sample size.

The difference in feeding performance, expressed as the rhythm of foraging trips to the nest (see Norris 1990 and Moller 1988) is impossible to test because of the sample size; however, if the 3 hours observation sessions before adoption are used as independent observations, with the same cautions as above, there is no difference between pairs which adopted and genetic parents (genetic parents: mean = 1.43, SD = 0.50, N = 7; pairs which adopted: mean = 1.41, SD = 0.82, N = 6). Mean values of foraging trip frequency of all pairs in the study area was 1.69 (SD = 1.5, N = 56).

All adopted young survived until the abandonment of the foster home range. In this study area there is a strong tendency to disperse, on average at 54 days after fledging (Bogliani *et al.* 1994-a). The two true offspring of pair A disappeared 17 days after fledging and almost certainly died.

Discussion

It is highly improbable that Hooded Crow pairs could gain any advantage by adopting strange young. Poole (1982) and Bustamante and Hiraldo (1989) suggested that kin selection might contribute to adoptions observed in the Osprey *Pandion haliaetus*, the Red Kite *Milvus milvus* and the Black Kite *Milvus migrans* nesting at high density. Some features of the studied Hooded Crow population make this hypothesis unlikely: the lack of philopatry, the strong tendency for early dispersal of young after emancipation (Bogliani *et al.* 1994a), and the lack of breeding opportunities within the study area. Only about 25-43% of the population is involved in nesting activities each year (G. Bogliani and V. Baglione, pers. obs.). These facts make it improbable that neighbouring pairs are related; however one can admit that extra-pair copulations may produce some genetic relationship between young and adults of neighbouring nests. Observations showed that the same home range is used by individuals from different families. Kin selection could play a role in adoption only if kin recognition ability exists (Barnard 1989), but up to now there is no evidence for kin recognition in the Hooded Crow (Yom-Tov 1975). Furthermore reciprocal altruism cannot explain adoptions in this population because, after fledging, young from different nests are not strictly linked to their own nest surroundings; thus foster parents are unable to know the identity of genetic parents and cannot control reciprocation (Waltz 1981).

Pierotti and Murphy (1987) suggested that adoptions could be due to intergenerational conflict. Young with low probability of survival if cared for by their genetic parents, as a result of their low rank within the brood, or the low quality of their genetic parents, are likely candidates to show this strategy. In the study area young changing brood did not suffer high costs, because they were not attacked by strange adults. However, our limited set of data does not suggest any advantage of being adopted. For instance the young n. 15 was the oldest in its brood; n. 11 was the youngest but had only one sibling. Their adoption resulted in a brood of 4 evenly aged young, which is unusual for the study area. In this case one might expect a loss of food intake, especially during the last part of the rearing period, when adults stopped to feed directly but left food items on the ground in front of the young. The closeness of the nests may allow chicks to compare the performance of neighbouring pairs with that of their own parents, and to decide to change family if neighbours were performing better. But this may not be the case as judged from our limited data.

Intensive studies carried out in Europe on this species have not shown any evidence for adoption. However, it is worth noting that nesting density was relatively low: in Scotland 2.2 nests per km^2 (Yom-Tov 1974), in Sweden 1.9-2.5 nests per km^2 (Loman 1985), and in southern France 0.5 nest per km^2 (Salathè and Razumowsky 1986). The density in our study area is among the highest in Europe. Densities can be even higher in Northern Italy, with 14 nests per km^2 in open crops, and 46 and 32 nests per km^2 in poplar plantations (Quadrelli 1985, Bogliani *et al.* 1994b). In Northern Italy there are no historical accounts of density, but most people agree that the population of Hooded Crow has grown dramatically over the last three decades. Thus. Hooded Crows of this area are faced to an unusual social situation. A peculiar feature are spatio-temporal territories, which result in a high overlap of foraging areas (Bogliani *et al.* 1994b). In other areas, the species has sometimes been used as a paradigm of a territorial species whose density is limited by territorial behaviour (Charles 1972, Yom-Tov 1974). At low density, kin recognition is probably location-dependent (Barnard 1989). If nests are spaced out and adults do not tolerate conspecifics, it is highly unlikely that a strange young will be present around the nest. A finely-tuned kin recognition is not necessary and there is no selective pressure for it. Our data show that the parental recognition mechanism of the Hooded Crow does not allow adults to recognize strange young a few days post fledging. Indeed this species proved unable to recognize its own chicks during the nestling period (Yom-Tov 1975). Thereafter, families remain stable and new intrusions by strange young are unsuccessful; this may be due to enhanced parental recognition ability as young grow. This mechanism of parental recognition is suitable at low density, which is, presumably, the original condition of the species, but unsuitable at high density. Adoption could, therefore, be considered maladaptive.

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Riassunto - In un'area dell'Italia settentrionale con una densità di 6.7 nidi di Cornacchia grigia per km^2 sono stati osservati tre casi di adozione di giovani in un campione di 13 nidi. Le adozioni sono avvenute appena dopo l'involo; ogni tentativo successivo di ottenere l'imbeccata di adulti estranei da parte di altri giovani è stata infruttuosa. Le coppie adottive nutrivano i giovani estranei con la stessa frequenza dei figli. Le coppie adottive e quelle che avevano generato i giovani adottati non differivano nell'intensità dei voli di foraggiamento al nido prima dell'involo. Si presume che la Cornacchia grigia non riconosca la propria prole appena dopo l'involo, e che le adozioni siano un fenomeno maladattativo dovuto all'alta densità dei nidi.

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Wasteland bird use. Evidence from the NW Mediterranean coast (Genoa, Italy)

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Abstract - Bird occurrence was recorded from January 1989 to June 1991 in a wasteland area located on a sea embankment within a dammed sea basin close to the city of Genoa. The study area was visited almost weekly, globally recording 173 species whose occurrence ranged from a few to more than one thousand individuals at a time. Regularly detected species showed seasonal occurrence or seasonal fluctuations in numbers of individuals. Bird communities also showed seasonal turnover as testified by the cyclic trend of the herbivores/carnivores ratio. A description of the year succession of bird communities was achieved by correspondence analysis between months and a total of 69 most common species. The first axis (37.6% of inertia) displayed species typical of different seasons, while the second one (22% of inertia) was related to the transient occurrence of migrant species. The most complex bird community was that of wintering species, mainly divided into sea birds and a crowded group of passerine species, whereas the warm season community was less defined, excluding the Ringed Plover and the Short-toed Lark which bred in the area. Additionally, the area was also used as a refuelling ground by many migrant species, especially wetland birds when it was flooded by rain. Based on these data, and considering natural environment depletion, the value of wasteland as wildlife habitat and the opportunity of planning the occurrence of low-disturbance plots within heavily urbanized areas is discussed.

Introduction

The continuous decrease of natural environments has raised the interest towards the potentials of urban areas as wildlife habitats (e.g. Bernadzki 1990). Birds are a recurrent subject in this kind of studies, as their high dispersal capabilities may allow a partial reconstitution of natural communities within anthropic sites (Luniak 1983, Arcamone and Mainardi 1984, Adams *et al.* 1985, Perkins and Lawrence 1985, Martin and Randall 1987, Rosenberg et al. 1987). For the same reason, birds are also used as quality indicators for reclaimed sites and recreational areas (Cicero 1989, Bhat 1990).

Excluding man commensals, human activities are generally adverse for bird species (Keller 1991, Piatt *et al.* 1990). Yet, in some cases the presence of man has been found to produce positive effects on some non-commensal birds (Titus and VanDruff 1981, Woinarski 1990).

Along the Ligurian coast (NE Italy), human population density rates among the highest of Europe and natural coastal environments have been deeply modified (Barberis and Mariotti 1981). This study aims to show that in such heavily urbanized regions, wasteland areas may become important bird refuges, particularly where disturbance is relatively low. These areas can be exploited the year round by different species as wintering, stopover and breeding sites.

Methods

Study area

This investigation concerned a transient wasteland area located on a wide sea embankment aimed at the realization of a new harbour west to the city of Genoa (NW Mediterranean). The embankment neighboured main industrial sites and the city airport. It measured about 1x0.5 Km and was surrounded by a dammed basin of about 2x1.5 km. The region has a relatively wet Mediterranean climate, where the mean temperature of July is 24 °C, that of January is 8 °C, the mean annual precipitation is 1350 mm, and the average for relative humidity is 60%.

The area was visited almost weekly from January 1989 to June 1991, recording all detected birds.

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Working activities produced land changes preventing the use of transect census techniques. However, a complete survey of the land and water portions of the area was achieved by walking along both perimetric and mid crossing paths of the peninsular strip, also making stops at such bird-attractive sites as temporary rainwater ponds or vegetation thickets. Open landscape and low vegetation allowed panoramic views, which minimized the risk of repeated bird records.

Data analysis was based on the numbers of individuals recorded for each species on the whole area. Each month was divided into three periods, referred to as ten-days periods (1st-10th day 11th-20th day and 21th-last day), assigning to each species the highest count recorded within each period. The two and a half years of the study were thus divided into 90 ten-days periods.

Statistics were performed on a desktop computer by using the SAS System, Release 6.04.

Land and sea-water environments

The land portion of the investigated area had the features of wasteland consisting of vegetation alternating with bare ground. A survey of plants led to the identification of more than 200 species showing a sharp dominance of herbs (e.g. *Chenopodium album*, *Kochia scoparia*) and grasses (e.g. *Polypogon monspeliensis*). Most species were typical of ruderals and grassland, about 10% derived from cultures, whereas smaller portions belonged to coastal environments such as wetland, mediterranean scrubland and seashore.

Information about the hard-bottom fauna of the basin derived from the fouling of hauled buoys, showing a typical harbour community.

Results

A total of 173 bird species were recorded during this study. The frequency of records varied consistently from species to species: 49 rare or accidental species were seen only once or twice, 69 most common species occurred in more than 10% of the 90 ten-days periods, while the remaining species showed an intermediate occurrence.

Numbers of individuals were also highly variable among species and through time. The majority of species ranged from a few to tens of individuals occurring at a time, but a few species were more abundant, reaching in some cases hundreds of individuals (e.g. House Sparrow, Starling, Mediterranean Gull), or even more than thousand individuals (e.g. Black-headed Gull, Herring Gull). Many of the 69 most common species followed a marked seasonality, while typical year-round species also showed seasonal numeric fluctuations, e.g. the three most common gull species (Figure 1).

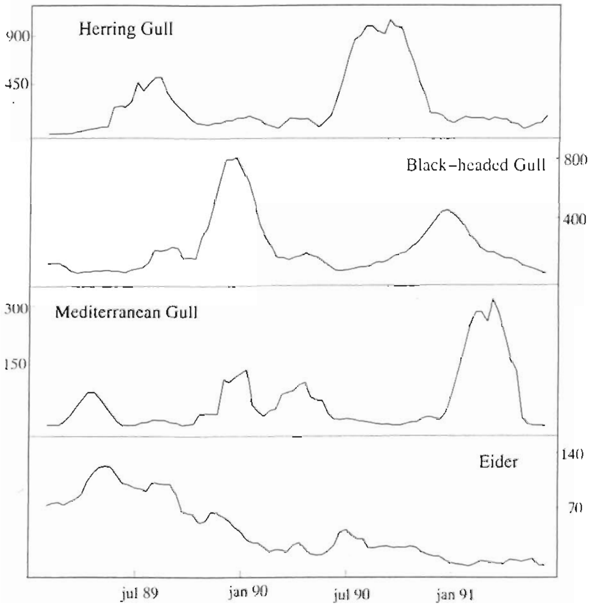

Fig. 1. Running means (n = 5) of the numbers of individuals of some common species recorded each ten-days period along two and a half years.

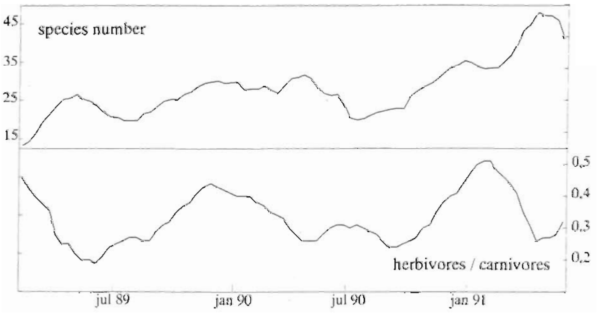

Fig 2. Running means (n = 5) of species richness (above) and of the ratio between herbivores and carnivores (below), derived from data recorded each ten-days period along two and a half year.

A peculiar pattern was shown by the Common Eider, with a resident population at the beginning of the investigation due to an unusual Southward dispersal of immature individuals in the end of 1988 (Borgo et al. 1991a, 1991b). These birds reached maturity in the area, and progressively abandoned it during the investigation period (Figure 1).

Total species diversity showed both seasonal and year-to-year variations. The time plot of the total num-

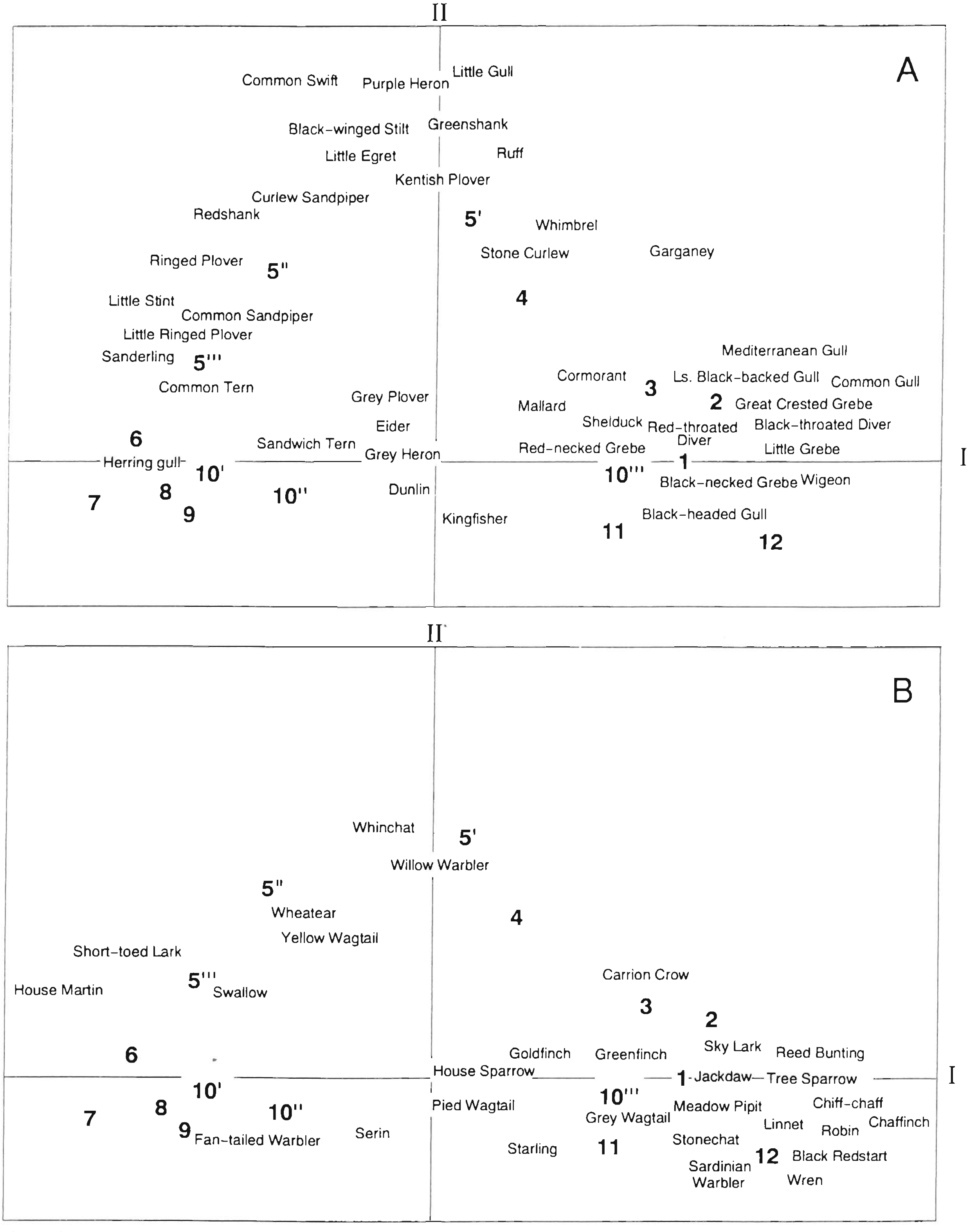

Fig. 3. Correspondence analysis ordination where column points are months (numbers) and row points are species. May and October are represented by distinct ten-days periods (quoted numbers). To allow for readability, separate charts have been drawn for non-passerine (A) and passerine (B) species. First axis (I) yields 37.6% and second axis (II) yields 22% of inertia. See text for further explanation.

ber of species recorded in each ten-days period shows an upward drift, mostly due to the last year of investigation (Figure 2). A periodic pattern is shown by the time plot of the ratio between herbivores and carnivores (guilds are based on the prevailing diet of each species), showing a constant prevalence of carnivorous species with major peaks of herbivores in the cold season and secondary peaks in summer (Figure 2).

An attempt at describing the year succession of bird communities in the area was made by correspondence analysis (Benzécri 1982) using a matrix having 36 ten-days periods as columns, globally covering the twelve months of the year, and the above mentioned 69 most common species as rows. For each species, numbers of individuals recorded throughout the study period were averaged over each of the 36 ten-days periods of the year, and these data were then standardized (mean 0; std 1) to avoid bias due to the great numeric differences among species.

The first axis of the correspondence analysis yields 37.6% of inertia, while the second one yields 22% of inertia, both axes resulting significant according to the Lebart's (1975) tables. Column points (months) are mostly distributed along the first axis, which can be interpreted as the seasonal variation of bird communities in the investigated area. The three ten-days periods of every month except May and October are clustered close to each other and have been comprehensively plotted by a single number coding for the corresponding month. Conversely, the ten-days periods of May and October have been individually plotted on the graph since they are distinctly scattered. Cold-season months cluster to the right side of the origin, warm-season months to the opposite side, while intermediate-season months are interspersed between these two extremities following a chronological order. Column points corresponding to springtime also show a dispersion along the second axis (Figure 3).

The space ordination of the row points (species) suggests that the second axis is indicative of the length of time spent each year by a species in the area. The densest aggregation occurs around late autumn and winter months, which depicts the wintering bird community of the area, including gulls, divers, grebes, ducks and the Cormorant (Figure 3A), together with many passerine species (Figure 3B). Species lying along the first axis towards or just within the cluster of summer column points, e. g. the Herring Gull, are not exclusive of summer but are the only species regularly recorded throughout the warm season.

Excluding the Eider, whose occurrence in the area was unusual, row points falling around the origin represent residents and local migrants recorded along most of the year (e.g. Kingfisher and some passerines), or long-distance migrants visiting the area during both spring and autumn movements, and sometimes also in other periods (e.g. Grey Heron, Grey Plover, Dunlin). Most spring migrants are dispersed along both the first and the second axis, following the pattern of the column points corresponding to April and the three ten-days periods of May. Proceeding from right to left these species can be roughly divided into: (1) early spring migrants, typically the Garganey; (2) most transient migrants regularly recorded in the area between late April and early May, lying on the second axis at topmost distances from the first axis; (3) later migrants and partial summer residents, the latter including the Little Ringed Plover and the Short-toed Lark, which regularly bred in the area.

Discussion

The investigated wasteland area, located in a densely urbanized portion of the city of Genoa, resulted particularly attractive to many bird species, confirming previous data about avian presence in the neighbouring city airport (Spanò and Toschi 1969, Spanò 1974). A number of species showed seasonal fidelity to the investigated area, as shown by the cyclic profile of the ratio between carnivorous and herbivorous birds, and by the sharp correspondence ordination pattern between months and species. Notwithstanding an upward drift of total species diversity, possibly reflecting long-term variations due to climatic events, the year-round predictability of bird presence in the area suggests some community structuring and niche partitioning, particularly in the most complex assemblage of winter visitors.

The winter bird community consisted of two major groupings: (1) sea birds and waterfowl, which prevalently exploited marine resources; (2) passerine birds, generally relying upon land resources. The main attractive factor for water birds was doubtless the occurrence of an artificial basin characterized by a relatively low disturbance. The presence of streams and waste water flowing into the basin contributed to create a highly productive brackish environment and fish nursery area, where developed fouling organisms and fish schools provided foraging sources to water birds. The importance of bivalves, crabs and other crustaceans in the diet of Eiders was ascertained (Borgo *et al.* 1991a), while scattered observations also testified the feeding of cormorants, divers, and terns upon fish occurring within the basin.

The value of the Mediterranean region as a wintering and stopover area for bird species is known (Blondel 1969, Moreau 1972, Lövei 1989). In the investigated plot no true Mediterranean plant community was found, but climate effects allowed abundant seed crop for wintering granivorous species, as well as prey availability for insectivorous ones. Wintering passerines could be roughly divided into scrub species (e.g. finches, warblers, Robin, Wren, etc.) mostly occurring on dried herb remnants and low scrubs, and field species (e.g. larks, wagtails, pipits) occurring prevalently on bare ground and grassland.

The area was also important as a stopover site for migrant birds. From the correspondence analysis it can be inferred that the transition from the winter to the summer bird community, spanning from March to May, was more complex than the opposite shift, occurring rather abruptly by the second half of October. This is clearly related to the higher importance of spring migration, during which maximum species diversity was recorded. About migration time, wide portions of the area were frequently flooded by rain, hence creating refuelling ground particularly for waders and waterfowl. This had a relevant ecological meaning, as wetland birds are mostly affected by coastal urbanization in this region, where their typical stopover sites are naturally rare.

Based on our data, the value of coastal wasteland as a nesting site seems low, but the studied area showed limited extension, landscape uniformity, poor vegetation coat and densely urbanized surroundings. Conversely, data from a wider and more diversified Mediterranean industrial site indicate good nesting opportunities for several species (Delitala and Casu 1991).

The intensive use of wasteland by bird species during non-breeding and perhaps also breeding periods suggests that the occurrence of low-disturbance plots within heavily urbanized areas be planned rather than chancy. This could substantially reduce the effects of natural environment depletion, hence being a potential support even for more ambitious projects of wilderness preservation.

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Riassunto - La presenza di uccelli è stata registrata dal Gennaio 1989 fino al Giugno 1991 in un'area situata su un riempimento a mare realizzato per la costruzione del nuovo porto di Genova. L'area indagata è stata visitata quasi ogni settimana registrando globalmente la presenza di 173 specie, con consistenza variabile da poche unità a più di un migliaio di individui alla volta. Distinte variazioni stagionali sono state riscontrate a livello di tutte le specie presenti con regolarità, come mostrato ad esempio dalle variazioni cicliche stagionali del rapporto tra erbivori e carnivori. Una descrizione della successione annuale delle comunità ornitiche è stata ottenuta tramite analisi delle corrispondenze utilizzando i dati di presenza numerica nei vari mesi dell'anno di 69 tra le specie più comuni. Nell'ordinamento spaziale ottenuto, il primo asse (37.6% dell'inerzia) riguarda la stagionalità delle specie, mentre il secondo (22% dell'inerzia) descrive il grado di persistenza di ciascuna specie nell'area nel corso dell'anno: le specie residenti o stagionali giacciono sul primo asse mentre le migratorie sono disperse sul secondo. La comunità più articolata è risultata quella invernale, divisa essenzialmente in uccelli acquatici e passeriformi, mentre la comunità della stagione calda non era altrettanto ben definita ma comprendeva anche specie nidificanti quali il Corriere piccolo e la Calandrella. L'area era anche usata come zona di sosta e rifornimento da molte specie migratorie. In base ai dati di questa indagine, e considerando l'impoverimento delle aree naturali, viene discusso il valore delle aree dismesse come possibili habitat per specie selvatiche, e quindi l'opportunità di pianificare la presenza di spazi con ridotto disturbo antropico all'interno di aree intensamente urbanizzate.

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Short communication

Prima nidificazione di Lanario *Falco biarmicus* in provincia di Siena e note sulla locale distribuzione storica

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Il Lanario (*Falco biarmicus*), la cui distribuzione e consistenza numerica nella regione Paleartica occidentale sono a tutt'oggi incerte e poco conosciute, è considerato il rapace più minacciato in Europa (Gensbol 1992). In Italia peninsulare la specie risulta essere rara e localizzata (Chiavetta 1981, Mirabelli 1981, Manzi e Perna 1988, Bassi e Brunelli 1989, Giorgini e Truffi 1990, Massa *et al.* 1991, Chiavetta 1992, Meschini e Frugis 1993), mentre solo in Sicilia la popolazione di Lanari è stabile e relativamente numerosa (Massa 1985, Ciaccio *et al.* 1987, Siracusa *et al.* 1989, Massa *et al.* 1991). Ogni nuova nidificazione accertata di Lanario risulta pertanto estremamente importante al fine della conoscenza dello *status* di questo falco nella penisola italiana, considerata anche la quasi totale scomparsa della specie dall' Appennino Tosco-Emiliano, all'estremo nord del suo areale distributivo, avvenuta agli inizi degli anni '90 (Chiavetta e Martelli 1991). Riguardo alla provincia di Siena i dati reperibili in letteratura sono estremamente scarsi: Savi (1827-31) non annovera il Lanario tra le specie toscane nè Giglioli (1890), Dei (1862) e Arrighi Griffoli (1891, 1906) lo citano nelle loro opere storiche sull'avifauna senese. Non esistono inoltre Lanari provenienti dal territorio senese neanche nelle collezioni più importanti della provincia di Siena, quella dell'Accademia dei Fisiocritici di Siena e la collezione Paolucci di San Gimignano (Massi 1990). L'unico dato reperibile in letteratura è quello relativo alla cattura di un esemplare adulto di Lanario, avvenuta nei pressi di Siena, nel 1905 (Martorelli 1911). Inoltre nel 1988 una femmina di Lanario fu illegalmente abbattuta da cacciatori nelle campagne senesi (R. Nardi, *ex verbis*).

Complessivamente per la Toscana sono noti pochissimi casi di nidificazione di Lanario solamente per la provincia di Grosseto (R. Nardi e G. Ceccolini, *ex verbis*). Rimane invece da verificare la segnalazione di Romè e Vanoni (1980) per la zona dell'Orecchiella.

Nell'estate del 1993, in una zona collinare della provincia di Siena a terreni argillosi calanchivi pliocenici (350 m. s.l.m.), sono stati ripetutamente avvistati due esemplari adulti di Lanario in comportamento esplorativo e di caccia. Nella primavera successiva è stata avviata una indagine di campo che ha portato alla individuazione di un sito di nidificazione.

Il nido era costituito da un incavo di erosione (area di circa 1.5 m^2), senza alcuna aggiunta di materiale, posto in una struttura calanchiva argillosa a pareti subverticali, con esposizione a sud sud-ovest. L'incavo di nidificazione era posto a una decina di metri dal suolo e a circa tre metri dalla parte superiore del calanco. Nelle pareti argillose circostanti, a circa 500 m di distanza dal nido dei Lanari, hanno nidificato una coppia di Gheppi (*Falco tinnunculus*) e una piccola colonia di Taccole (*Corvus monedula*). Erano anche presenti nella zona alcuni Colombi (*Columba livia*), che nidificano nelle nicchie delle pareti argillose verticali.

I dati riportati nel presente lavoro sono frutto di 100 ore di osservazioni sul campo in prossimità del sito riproduttivo.

La schiusa del primo uovo è avvenuta il 26 aprile e si calcola che la deposizione sia avvenuta intorno al 21-26 marzo (Tabella 1). Non sono note le cause della mancata schiusa del secondo uovo.

Durante la cova la coppia è risultata molto elusiva. Il maschio generalmente si scambiava con la femmina al mattino, dopo che questa aveva covato per tutta la notte, e covava a sua volta per circa un'ora. Successivamente la femmina rientrava al nido, mentre il maschio si involava per una battuta di caccia, portando la preda alcune ore dopo avere lasciato il sito.

La preda di rado veniva portata direttamente al nido (26.6% delle osservazioni): più frequentemente il maschio richiamava la femmina su un posatoio preferenziale, quasi sempre un albero o qualche volta a terra (73.3% delle osservazioni; Mann-Whitney U Test, $U=60$, $p<0.02$) dove la femmina si alimentava per poi fare ritorno al nido con il resto della preda per nutrire il piccolo. Sono stati frequenti in questa fase richiami di contatto fra i due membri della coppia che, per il resto del tempo, erano generalmente silenziosi.

Le prede (media= 1.5 per giornata, campo di variabilità = 1-4 prede al giorno) sono state portate al nido con una frequenza media di una preda ogni 2.5 ore (range= 2-5 ore), con prevalenza nelle ore centrali della giornata e nel tardo pomeriggio (Figura 1).

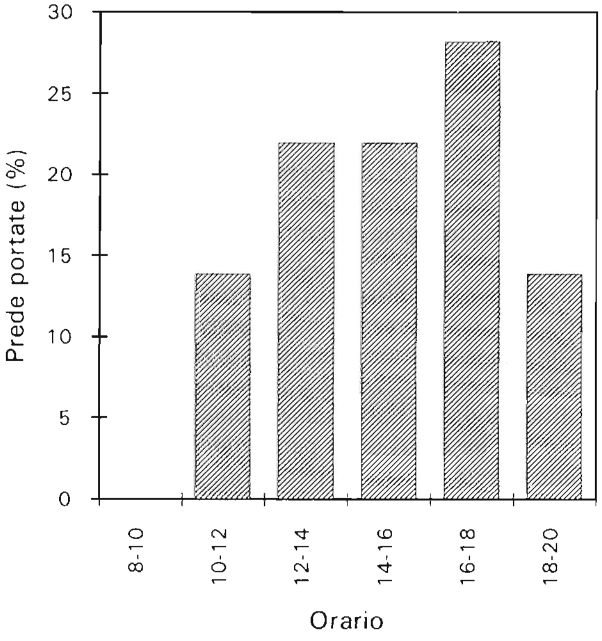

Figura 1. Prede portate al nido durante la giornata (percentuale).

Tabella 1. Parametri riproduttivi della coppia di Lanario (*data desunta dalla schiusa dell'uovo).

data di deposizione*	21-26 marzo 1994
schiusa	26-27 aprile 1994
data di involo juv.	11 giugno 1994
n° uova deposte	2
n° uova schiuse	1
n° juv. involati	1

L'involo del giovane è avvenuto dopo circa 44 giorni dalla schiusa (Tabella 1).

Il Lanario è una specie di falco caratteristica delle zone semi desertiche e steppiche dell'Europa meridionale e di gran parte dell'Africa. Contrariamente al Falco pellegrino *Falco peregrinus* il Lanario tende ad occupare siti di nidificazione posti ad altezze medie o modeste (Massa *et al.* 1991). Questa caratteristica posizione del sito riproduttivo viene confermata dalla nostra osservazione. Inoltre si conferma la forte tendenza di questo falco a occupare ambienti frequentati da taccole e piccioni, che vengono spesso utilizzati come fonte trofica (Leonardi 1989).

In base ai dati storici la presenza del Lanario nella provincia di Siena è un dato nuovo. Il Lanario potrebbe quindi, o essere sfuggito all'attenzione degli ornitologi o avere recentemente colonizzato il territorio senese, a partire dai siti occupati in aree limitrofe. Riteniamo che entrambe le ipotesi siano plausibili; infatti anche se questa specie, ai margini del suo areale distributivo, presenta una certa incostanza e fluttuazione delle nidificazioni, le sue abitudini elusive e la scarsa copertura di quest'area da parte degli ornitologi, non permettono di escludere la presenza in passato del Lanario nella provincia di Siena.

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Ricerca svolta con il parziale contributo finanziario dell'Amministrazione Provinciale di Siena.

Abstract - The first breeding record of the Lanner falcon (*Falco biarmicus*) in Siena county is reported and local historical data on the presence of this species are reviewed. Daily observations at the nest site were carried out during the breeding season of the falcons. Behavioural data were collected together with a description of the nest site.

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Book reviews

Berthold P. 1993. *Bird Migration. A General Survey.* Oxford Ornithology Series. Oxford University Press, Oxford, 239 pp.

Lo studio della migrazione degli uccelli, e più tardi dei meccanismi di navigazione e di orientamento, è stata fin dai tempi di Aristotele una delle discipline zoologiche più seguite per il fascino suscitato in generazioni di osservatori di storie naturali. Ipotesi ed esperimenti spesso controversi e suscettibili di più di una interpretazione occupano un posto di rilievo nella letteratura scientifica dal dopoguerra ad oggi fornendo ora acquisizioni certe ora dubbi.

"Birds are predestined to migrate" (p.2) esordisce l'autore - ricercatori tra i più produttivi del settore - nelle prime pagine di questo libro, ultimo nato della serie ornitologica della Oxford University Press, edizione inglese opportunamente aggiornata della originale versione in tedesco del 1990. Si tratta di un piccolo trattato, una vera e propria "introduzione concentrata", per usare le parole di Berthold, sulla scienza della migrazione degli uccelli voluto appositamente con lo scopo, a nostro parere ottimamente perseguito, di colmare una lacuna: l'ultima rassegna aggiornata ed esaustiva sull'argomento risaliva addirittura al 1984 (Baker). Non che la letteratura scientifica dell'ultimo decennio sia poco fornita tutt'altro, ma si tratta di libri, pubblicazioni o reviews che mettono a fuoco argomenti particolari e per specialisti; e la esaustiva bibliografia (oltre 350 voci) cui l'autore rimanda di continuo nel testo sta lì ad indicarcelo. In questo libro Berthold è riuscito ad amalgamare produttivamente la formidabile messe di dati e acquisizioni degli ultimi decenni in dodici capitoli comprendenti informazioni su: attuali metodologie utilizzate (cap. 4); definizioni e tipi di strategie migratorie (cap. 5); substrati e adattamenti fisiologici e comportamentali (cap. 6); meccanismi di orientamento e navigazione (cap. 7); problemi di conservazione delle specie migratrici (cap. 9); non sono tralasciati gli aspetti evoluzionistici e del futuro sviluppo del comportamento migratorio (ben noto il caso tuttora in corso d'indagine delle capinere mitteleuropee che hanno iniziato a svernare in Gran Bretagna) in un interessante quanto speculativo scenario di aumento della temperatura media con presumibili effetti di diminuzione delle abitudini di migrazione a lunga distanza e cambi marcati nei modelli attuali di migrazione (cap. 10). La trattazione ha il pregio di descrivere e discutere il vasto scibile a disposizione in un testo particolarmente conciso con rigore e obiettività ammirevoli nel discutere risultati e ipotesi tuttora argomento di infuocati dibattiti e controversie: Berthold li riporta ed evita il più possibile commenti e discussioni personali anche se tra le righe spesso appare l'opinione dell'autore.

La lettura non è mai stancante grazie alla brevità dei paragrafi (quasi mai oltre le due pagine), alle classiche foto in bianco e nero, ai numerosi grafici e cartine con rotte di migrazione che aiutano il lettore nella comprensione della materia trattata. Inoltre il trovarsi alla fine della trattazione di ciascun argomento di fronte a frasi del tipo "non è stato del tutto chiarificato" (inizio della migrazione in specie nomadiche o irruttive), "è necessario indagare ancora molto su..." (adattamenti nutrizionali), "c'è bisogno di ulteriori indagini" (controlli genetici e ambientali sul comportamento migratorio) o "non ci sono evidenze che supportino..." (ipotesi della navigazione tramite segnali celesti), suggerisce che la ricerca è viva e in continua evoluzione, mai statica o colma di certezze. Un problema particolarmente enfatizzato è quello della prima migrazione nei piccoli passeriformi. Risulta chiara la notevole ridondanza di meccanismi di orientamento e navigazione adottabili (bussola solare, bussola magnetica, bussola stellare, olfatto sono ormai suffragati da dati sperimentali inequivocabili) sulla base, evidente ormai in circa 20 specie, di direzioni migratorie innate e geneticamente determinate (decisivi al riguardo i recenti esperimenti di cross-breeding nelle capinere effettuati dai teams di Berthold e Wiltschko); a tal proposito è da notare l'accuratezza e la semplicità con cui l'autore presenta un tema tanto difficile e controverso come i meccanismi di orientamento e navigazione. La trattazione è quasi da manuale tanto da rendere accessibili anche al profano gli affascinanti problemi di questa materia.

Non mancano piacevoli arricchimenti culturali come l'etimo linneiano di *Fringilla coelebs* (p. 51) ad indicare la caratteristica di migrazione parziale e sex biased delle popolazioni svedesi di questa specie (*coelebs* = celibe) o la predisposizione autunnale all'"ingrassamento" ereditata dai progenitori selvatici nelle oche domestiche e sapientemente sfruttata dagli allevatori (p. 93).

Assai arduo e ambizioso appare il tentativo di schematizzare e catalogare tutte le ipotesi di movimenti migratori (cap. 5).

Particolarmente originale il capitolo 8 (sinossi) in cui l'autore, sulla base di tutte le informazioni fin lì esposte e discusse, quasi si "tramuta" in un silvide descrivendone cambiamenti endocrinologici e comportamentali, dubbi di rotta e programmi spazio-temporali innati che s'intersecano con l'esperienza accumulata dal primo involo all'arrivo nelle aree di svernamento africane.

Traspare di continuo l'interdisciplina della materia trattata: non è più sufficiente applicare un anello e sperare in un'improbabile ricattura (tasso sotto l'1% in molti passeriformi!); acquistano sempre più importanza i metodi di laboratorio come lo studio dei ruoli di differenti ormoni nel controllo dei fenomeni migratori o degli aspetti neurofisiologici e dei substrati neurali (ad es. l'ippocampo) coinvolti. È necessario, inoltre,che allo studio in natura si affianchino tecniche sofisticate di telemetria: un esempio è il satellite tracking a cui Berthold sembra affidare a ragione, molte speranze nello studio delle migrazioni.

Assai approfondito il trattamento di un argomento delicato come la conservazione e Berthold dimostra una notevole padronanza e sensibilità in questo campo di recente sviluppo portando esempi concreti (i casi della cicogna bianca e della sterpazzola), proposte e prospettive pur accompagnate da un pessimismo velato; interessante e personale la presa di posizione sulla caccia in Italia (p. 189), a suo parere non il solo fattore responsabile del declino su scala europea di molte specie migratrici.

In conclusione il libro offre all'ornitologo, all'etologo, al fisiologo, ma anche al bird-watcher e al profano desiderosi di approfondimenti, un'eccellente rassegna dei recenti progressi compiuti nel campo della migrazione degli uccelli mai dimenticando, anzi evidenziando, le numerose lacune di conoscenza che rendono i fenomeni migratori ancor più stimolanti all'occhio del giovane ricercatore.

Francesco Bonadonna e Claudio Carere

Realini G. 1994. *Gli uccelli nidificanti in Lombardia (Pianura e collina)*. Edizioni RGF, Ispra (VA), 384 pp.

Con un'elegante veste tipografica il volume di Gianfranco Realini "Gli uccelli nidificanti in Lombardia (pianura e collina)" completa dopo i precedenti riguardanti le zone umide e i monti, il lavoro sulle specie nidificanti in Lombardia.

L'opera si propone ad un vasto pubblico, dai semplici appassionati di natura agli specialisti di ornitologia. Per questo ad una parte divulgativa, che riporta anche i nomi dialettali, e in cui vengono descritti i caratteri distintivi di ogni singola specie, illustrata con un dettagliato disegno a colori di Guerino Morselli, segue una ben più corposa parte scientifico-documentativa frutto sia dell'attuale ricerca sul campo, effettuata da rilevatori di provata esperienza, sia della confluenza di dati raccolti in passato da diversi esperti e finora inediti. Così vengono riportate le caratteristiche morfologiche e biometriche di nido, uova e piccoli. La presenza riproduttiva attuale delle singole specie è stata rilevata in zone campione, e quella passata ricostruita non solo con un attenta analisi della bibliografia esistente, ma anche stimolando la "memoria storica" di molti appassionati anziani, che assai frequentemente divennero esperti per necessità di vita, e che diversamente sarebbe andata completamente persa.

La conoscenza qualitativa e quantitativa delle specie nidificanti viene opportunamente integrata con lo studio della biologia riproduttiva di singola specie, con l'analisi dell'incidenza dei fattori ambientali e delle caratteristiche intrinseche delle coppie nidificanti. Ad integrazione del testo sono comprese numerosissime foto a colori dei nidi con uova e piccoli, pregevoli per dettaglio e leggibilità.

La notevole mole di dati raccolti, frutto di anni di ricerca effettuata in natura, ha consentito l'elaborazione di istogrammi concernenti la distribuzione altimetrica delle presenze e all'inizio della deposizione delle uova per ogni singola specie.

In riferimento al passato, pianura e collina sono risultati generalmente gli ambienti meno recettivi per la nidificazione, avendo subito un grado di trasformazione e sconvolgimento senza confronti, anche se talune specie sono aumentate o addirittura si sono insidiate recentemente. Il bilancio diventa ancor più negativo se si considera un fattore che viene generalmente trascurato dagli altri Autori, o comunque trattato non propriamente a proposito, ossia il prelievo effettuato dall'uomo: attualmente painificato ed in passato effettuato con ogni mezzo ed in ogni periodo dell'anno.

Ad integrazione dei volumi precedenti, vengono anche riportati, in un'apposita appendice, gli istogrammi degli inizi delle deposizioni e le misure dei nidi di alcune specie, che sono elencate in ordine alfabetico per facilitare la consultazione.

Ettore Ruberti

Avocetta N° 18: 163 (1994)

Newsletter

A CURA DI PAOLO GALEOTTI

Dipartimento di Biologia Animale, Piazza Botta 9, 27110 Pavia
Tel. 0382/386301; Fax 0382/386290

CONVEGNI, SIMPOSI & SEMINARI

ISAE International Congress 1995

Ventinovesimo Congresso della Società Internazionale per l'Etologia Applicata.

Luogo: Università di Exeter, UK. Data 3-5 Agosto 1995.

Sessioni: Cognitive Aspects of Welfare (somiglianze e differenze individuo/specie, implicazioni per la gestione); Measuring Behaviour (tecniche quali-quantitative, disegni sperimentali, statistica); Companion Animal Behaviour (interazioni uomo-animali, allevamento e gestione).

Per informazioni: Dr John Eddison, Department of Agriculture and Food Studies, Seale-Hayne Faculty, University of Plymouth, Newton Abbot, Devon, TQ12 6NQ, UK; e-mail: j. eddison@plymouth.ac.uk.

7th International Conference on Human-Animal Interactions

La Conferenza organizzata da IEMT (Svizzera) e AFIRAC (Francia) sarà intitolata "Animals, Health and Quality of Life".

Luogo: International Conference Centre di Ginevra (Svizzera). Date: 6-9 Settembre 1995. Lingua: Inglese. Gli argomenti trattati sono: Salute e qualità della vita; Animali e qualità della vita umana; Uomini e qualità della vita animale. Durante la Conferenza si terrà un Simposio su "The Ethology of Domesticated Species and its consequences for the human-animal bond". Gli abstract vanno spediti su modulo standardizzato fornito dall'AFIRAC entro l'1 Marzo 1995.

Per ulteriori informazioni contattare AFIRAC, Rue de Pasteur Wagner, 75011 Parigi, Francia; tel. 33 1 4929 1200; fax: 33 1 4806 5566.

Seabird Group Conference

Conferenza sugli aspetti di conservazioni degli uccelli marini. Luogo: Kelvin Conference Centre, Glasgow. UK. Date: 25-26 Marzo 1995. Per informazioni: Dr R.W. Furness, Zoology Building, Glasgow University, Glasgow G12 8QQ, UK.

Tel: 0141 339 8855, Fax: 0141 330 5971.

10th International Wader Study Group WSL/IWRB

Simposio sull'ecologia dell'avifauna acquatica. Luogo: Aveiro University, Portogallo. Date: 15-17 Settembre 1995. Per informazioni: IWRB, Slimbridge, Gloucester GL2 7BX. Tel: 01453 890624.

Bird Numbers 1995. EBCC Conference

Si tratta del 13° meeting dell'European Bird Census Council. Luogo: Parnu, Estonia. Date: 25-29 Settembre 1995. Per informazioni: Estonian Ornithological Society, PO Box 227, EE-2400 Tartu, Estonia.

Fax: +372 34 32 433.

International Conference on Wetlands and Development

Questa conferenza su gestione e conservazione delle zone umide è organizzata congiuntamente dall'AWB e IWRB. Luogo: Malacca, Malaysia. Date: 8-14 Ottobre 1995. Per informazioni: Sig. Muralee Menon, Asian Wetland Bureau, Institute of Advanced Studies (IPT), University of Malaya, Lembah Pantai, 59100 Kuala Lumpur, Malaysia.

Tel: +60 3 7566624, Fax: +60 3 7571225.

Southern Hemisphere Ornithological Congress

Uccelli e loro habitat in Australasia, Africa, Sud-America, Antartide e Isole vicine. Luogo: Perth, Western Australia. Date: 5-9 Ottobre 1996.

Per informazioni: Prof. Brian Collins, School of Environmental Biology, Curtin University of Technology, GPO Box U 1987, Perth, Western Australia 6001.

Tel: 619 351 7041, Fax: 619 351 2495.

9th Pan African Ornithological Congress

Luogo: Accra, Ghana. Date: 1-8 Dicembre 1996. Per informazioni: Dr Yaa Ntiamoa-Baidu, Ghana Wildlife Society, PO Box 13252, Accra, Ghana.

Fax: +233 21 665197.

22nd International Ornithological Congress

Luogo: Durban, South Africa.

Date: 23-29 Agosto 1998.

Avocetta N° 18: 165 (1994)

Errata Corrige

Corrections to Volume 17, Number 2, December 1993:

In: Parkes K.C. 1993. Taxonomic notes on the White-collared Swift (*Streptoprocne zonaris*).

ERRATA	CORRIGE
page 95, top line	
Avocetta N° 17: 95-100 (1994)	*Avocetta N° 17: 95-100 (1993)*

In: Collins C.T. and Murphy R. 1993. Echolocation acuity of the Palawan Swiftlet (*Aerodramus palawalensis*).

ERRATA	CORRIGE
page 157, top line	
Avocetta N° 17: 157-162 (1994)	*Avocetta N° 17: 157-162 (1993)*

In: Tarburton M.K. 1993. Determinants of clutch size in the tropics; with reference to the White-rumped Swiftlet.

ERRATA	CORRIGE
page 163, top line	
Avocetta N° 17: 163-175 (1994)	*Avocetta N° 17: 163-175 (1993)*

In: Boano G., Cucco M., Malacarne G. and Orecchia G. 1993. Survival rate and mate fidelity in the Pallid Swift *Apus pallidus*.

ERRATA	CORRIGE
page 191, Table 1 line 4	
reduced-parameter model with constant capture;	*reduced-parameter model with constant capture and survival probabilities;*

Sorry for these inconveniences

Norme per gli autori

AVOCETTA pubblica articoli originali, brevi note, sintesi di aggiornamento, commenti, corrispondenze e recensioni, 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 regiona 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: 471-571.

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 pubblicato 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 x 214 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 e grafici in china nera devono essere fatti su carta bianca o da lucido. Assieme all'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 articolo sono inviati gratis. Ulteriori copie possono essere acquistate con buono d'ordine allegato alle bozze di stampa.

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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.

Photographs should be submitted in quadruplicate. The legend of both figures and photographs should be typed separately from the rest of the manuscript.

Fifty (50) offprints of each paper are supplied free of charge. Additional offprints can be purchased, provided the order is received with the corrected proofs.

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AVOCETTA

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