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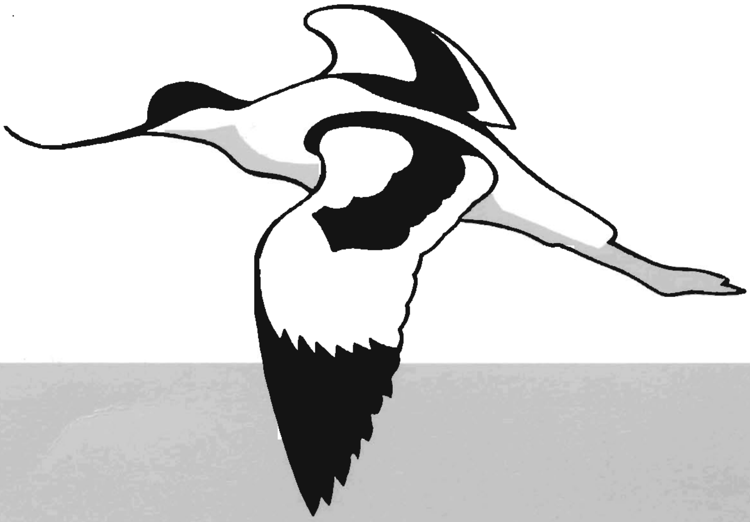

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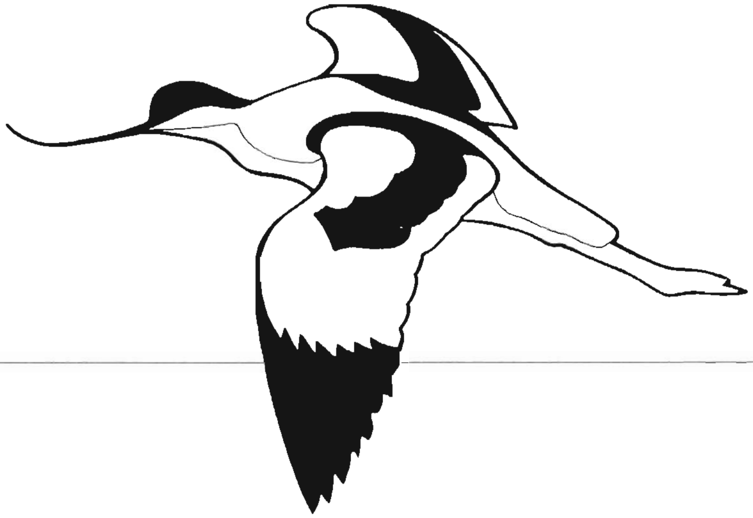

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Clutch size of the Great Tit *Parus major* and the Blue Tit *Parus caeruleus* in some areas of Central Italy

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Abstract - Small values of clutch size were observed for both species in all the study stations, as compared with other European areas located at higher latitude; these results could be related to the lower seasonality of food resources in Mediterranean area. In some sites preliminary data show a high presence of youngsters among the breeders; considering also the small effect of competitive factors and predation on clutch size, a trade-off between reproduction and survival does not appear to be important. As far as clutch size variations among the study areas are concerned, habitat features, density of breeders and laying date seem to play a decisive role. Clutch size does not decrease with altitude. Food availability might produce the observed differences in breeder density.

Introduction

The significance of avian clutch size has occupied much space in the literature on evolution and ecology (Cody 1966, Klomp 1970, Ricklefs 1983, Murphy and Haukioja 1986). Although the correct estimate of heritability of this breeding parameter is no clear (Perrins and Jones 1974, van Noordwijk *et al.* 1981, Emlen 1984), clutch size is definitely an important component of individual fitness.

Among the factors affecting clutch size, Lack (1947, 1948, 1954) stressed the direct role of food availability and proposed that clutch size corresponds to the largest number of offspring that parent birds can raise. On the other hand, Ashmole (in Ricklefs 1980) stated that clutch size should increase with seasonality of food supply. Another hypothesis explained the variations of this breeding parameter with a trade-off between reproduction and survival (Cody 1971, Nur 1988) and with the unpredictable year-to-year fluctuations in selection pressures (Boyce and Perrins 1987). Finally for some authors, clutch size could be inversely related to the probability of predation (Slagsvold 1982) and to the increasing risk of brood hyperthermia (van Balen and Cavè 1970), an hypothesis with little favour. It is, however, difficult explain the geographical variation of clutch size since many factors influence Blue Tit *Parus caeruleus* and Great Tit *Parus major* clutch size, e.g. female age, nest box size, laying date, breeder density and altitude (Bellavita and Sorace 1991). However, some authors (Zang 1982, Krementz and Handford 1984, Hamann *et al.* 1989, Delgado *et al.* 1992), did not find altitude effects on clutch size. A decrease in clutch size as a consequence of population density increase (Kluyver 1951, Lack 1966, Dhondt and Eyckerman 1980) may represent an effect of density on food supply or an adaptation to the poorer prospects for successful rearing of young (van Balen 1973, Ashmole in Ricklefs 1980, Ekmann and Askenmo 1986). Note, however, that in deciduous oak woods, Tits present the largest clutches (Perrins 1965, Orell and Ojanen 1983, Blondel et al. 1987) as well as the highest density (Snow 1954, Lack 1966, van Balen 1973, Perrins 1979).

The present study investigated the role of laying date, breeder density, habitat and predatory pressure on Great and Blue Tit clutch size at some sites in Central Italy. The correlation with some environmental factors may indeed help us to understand the mechanisms producing variations in demographic parameters (Ricklefs 1983). The choice of nearby sites reduces some useful information (e.g. latitude effect); on the other hand the comparison among very distant areas could raise other kinds of problems in the interpretation of the observed results (e.g. different importance of some environmental factors, Ricklefs 1985; different time and energy budget of the study populations, Cody 1966, Walsberg 1983, Bryant

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and Westerterp 1983, Hussel 1985: subspecific differences, Blondel et al. 1992 b).

Study Area, Materials and Methods

This investigation was carried out in seven areas in Central Italy (Tab.1). Nest boxes (14 x 14 x 22 cm, entrance hole 3.5 cm) were placed about 3 m above the ground and about 50 m apart.

During the breeding season, the boxes were checked weekly. Laying dates were calculated assuming that females lay one egg per day (Kluijver 1951, Lack 1955). For each site, hatching success was defined as the ratio between the observed number of chicks and eggs laid.

Taking into account the effect of laying date on clutch size and the fact that after April 30 many second clutches are usually present (Bellavita et al. 1990, Bellavita and Sorace 1991), the analysis of clutch size variations in the study area was carried out only for the first clutches laid before this date. In some cases, the observed results were validated by carrying out comparisons among different environments or sites over shorter periods when laying dates overlapped (unpublished data). For each environment of a study area, data of different years were sometimes summed:

Tab.1. Geographical coordinates, altitude, habitat features and nest-box numbers for each studied sites.

Study areas	geographical coordinates	altitude	environment (prevailing species)	nest-box number
Monte Rufeno:	42° 47' N 11° 93' E	500	deciduous wood 25-30 years old (Quercus cerris)	30*
			pine wood 20-25 years old (Pinus halepensis)	20
			Mediterranean scrub in secondary stage (Quercus ilex)	20
Orbetello:	42° 27' N 11° 13' E	0	pine wood 30-40 years old (Pinus pinea)	30
Burano:	42° 24' N 11° 22' E	0	Mediterranean low scrub with sparse plants (Quercus ilex)	20
Lago di Vico:	42° 20' N 12° 11' E			
S. Rocco (locality)		800	deciduous wood 40-70 years old (Quercus cerris)	30
M. Venere (locality)		700	beech wood 70 years old (Fagus sylvatica)	30
Palo:	41° 56' N 12° 05' E	0	deciduous wood 40-50 years old (Quercus cerris)	50°
Macchia Grande:	41° 50' N 12° 13' E	0	Mediterranean scrub in primary stage (Quercus ilex)	38
Castelporziano:	41° 44' N 12° 24' E	0	deciduous wood 50-60 years old (Quercus robur)	31
			pine wood 30 years old (Pinus pinea)	20

* second year 40 nest boxes ° in 1990 20 nest boxes

generally, in these cases the observed results did not differ from those of single years (unpublished data). During the spring of 1991, information on breeder density was collected in each site using the Line Transect Method (Järvinen and Väisänen 1973). In the Palo woods, data were collected in the spring of 1989 (Bellavita et al. 1990), and in the L.Vico woods in the spring of 1988 (Ruvolo *et al* 1991).

Results

Clutch size and laying date

For all the sites in all the study years, the average clutch size varies between 6.2 and 8.2 in the Great Tit (except for the data of Orbetello, which refer to four clutches only) and between 7.0 and 8.4 in the Blue Tit (Fig.1-2). In some cases, clutch size differences among the various sites show statistical significance (Tab.2). For clutches laid up to April 30, nesting occurs between April 16 and May 20; in Rome (41°53'N, 12°27'E), over this period, the actual evapotranspiration, AE, varies between 60 and 90 mm and in autumn it is at the same level as in April (Pinna 1977).

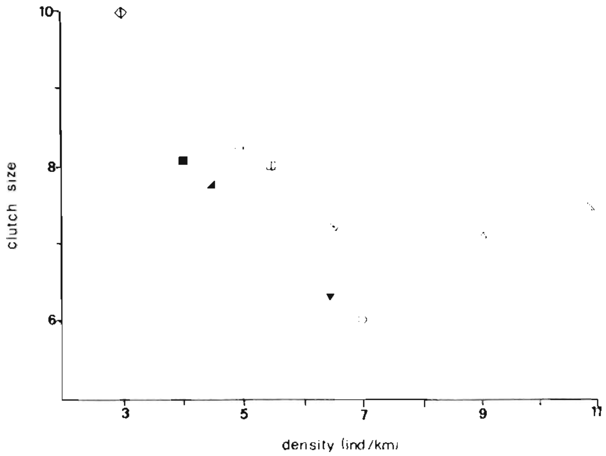

Fig.1. Great Tit density (ind/km) and clutch size in each environment of the following study areas (in brackets, study years and number of clutches for each environment): Monte Rufeno= □ (1989-91, deciduous wood n=16; pine wood n=13; Mediterranean scrub n=10); Orbetello= ◇ (1990-1991, n=4); Burano = ◿ (1990-1991, n=6); Lago di Vico = ◺ (1988-89, deciduous wood n=11; beech wood n=4); Palo = (1983-84 and 1990, n=39); Macchia Grande= ▽ (1990-91, n=21); Castelporziano = △ (1991, deciduous wood n=6). For each study area: empty symbol = deciduous wood; filled symbol = mediterranean scrub; barred symbol = pine wood; dotted symbol = beechwood.

For clutches laid before April 30, laying date comparisons between the same environment at two different sites were not significant (Mann-Whitney test). For the Great Tit, however, the mean laying date in each study area (i.e. summing data of different environments) and the relative mean clutch size are positively correlated (Spearman Rank Correlation, 1-tailed, r=0.89, n=7, p<0.01, Fig.3), while in some areas Blue Tit data are most likely too scarce (Fig.2) to reveal possible correlations. 92.7% of Blue Tit and

Tab.2. Significance of comparisons among clutch sizes at different sites (Anova and Student t test).

Environment	species	compared areas*	year(s)	Test	significance
deciduous wood	GT	1-3-4-6	all	$F_{3\text{-}67} = 7.1$	$p<0.01$
deciduous wood	GT	1-4	all	$t_{53} = 2.5$	$p<0.02$
deciduous wood	GT	3-4	all	$t_{48} = 3.0$	$p<0.01$
deciduous wood	GT	1-3	1989	$t_{9} = 3.3$	$p<0.01$
deciduous wood	BT	1-3	all	$t_{56} = 2.1$	$p<0.05$
deciduous wood+ pine wood	GT	1-6	1991	$t_{14} = 2.2$	$p<0.05$
deciduous wood+ pine wood	BT	1-6	1991	$t_{22} = 2.4$	$p<0.05$
mediterranean scrub	GT	1-2-5	1991	$F_{2\text{-}23} = 6.9$	$p<0.01$
mediterranean scrub	GT	1-5	1991	$t_{20} = 3.6$	$p<0.01$
mediterranean scrub	GT	2-5	1991	$t_{17} = 2.8$	$p<0.05$
mediterranean scrub	GT	1-5	1989-91	$t_{29} = 4.4$	$p<0.01$
mediterranean scrub	GT	2-5	1990-91	$t_{25} = 3.0$	$p<0.01$

* 1=Monte Rufeno. 2=Burano. 3=Lago di Vico. 4=Palo. 5=Macchia Grande. 6=Castelporziano.

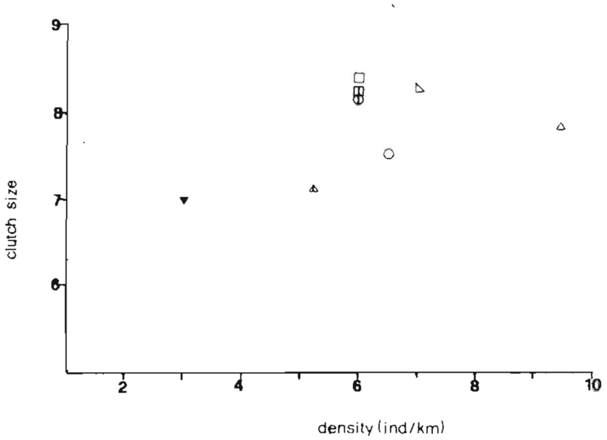

Fig.2. Blue Tit density and clutch size in each environment of the following study areas (in brackets, number of clutch for each environment): Monte Rufeno (deciduous wood n=43; pine wood n=12); Lago di Vico (deciduous wood n=15; beech wood n=13); Palo (n=3); Macchia Grande (n=2); Castelporziano (deciduous wood n=8; pinewood n=3). Symbols and study years as in Fig.1.

86.0% of Great Tit females started laying their first clutches before April 30.

Density

The density of Tits is higher in deciduous woods than in Mediterranean scrubs and, for the same environment, when density increases clutch size often decreases (Fig.1-2). The mean breeder density of Great Tits in each site and the relative mean clutch size are inversely correlated (Tab.3). Great Tit breeder density in Macchia Grande was lower in the first of the two study years (5 ind/km vs. 6.5 ind/km); clutch size decreased in the second year, but the difference was not significant (F_{1-19}=0.4). This result provides some useful information about the effect of breeder density on clutch size in the Mediterranean scrub.

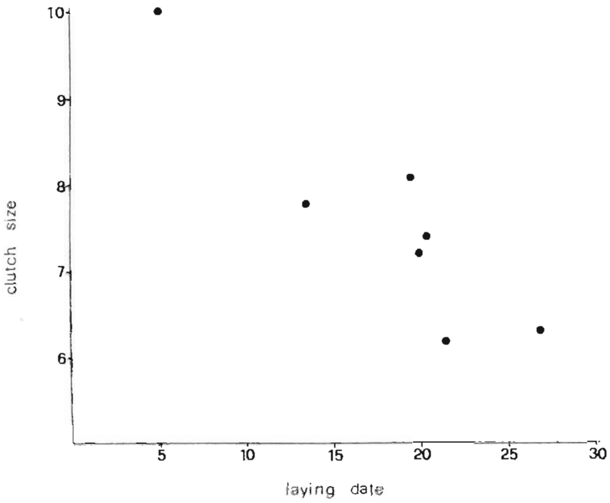

Fig.3. Relationship between clutch-size and laying date (1=march25) for the Great Tit in each study area.

Competitive factors between the two species of Tits, however, do not seem to be important enough to produce the observed values of clutch size (Tab.3) and they are possibly only important for the more crowded stations. Some information on the avian community of the study areas shows that the lower values of clutch size (Fig.1-2) are often observed in less saturated environments. The density of all the species, as well as that of insectivores, is clearly lower in Macchia Grande (Guerrieri *et al.* in press) than in Palo (Fraticelli and Sarrocco 1984) and Castelporziano (Bernoni *et al.* 1989); in Castelporziano it is lower in pine wood than in deciduous wood (unpublished data) and in M.Rufeno is lower in mediterranean scrub than in deciduous and pine woods (Calvario *et al.* 1992). In 1991, four Great Tit and four Blue Tit females caught during the night

Tab.3. Significance of the correlation between breeder density and relative clutch size for each study area (average of the values of all the environments for that area; Spearman Rank Correlation, one-tailed).

Clutch	size*	density	r.	n	significance
Great	Tit	Great Tit	-0.71	7	p<0.05
Great	Tit	Blue Tit	-0.41	7	N.S.
Great	Tit	Great Tit + Blue Tit	-0.42	7	N.S.
Blue	Tit	Blue Tit	0.10	5	N.S.
Blue	Tit	Great Tit	-0.10	5	N.S.
Blue	Tit	Great Tit - Blue Tit	0.30	5	N.S.

* 1991 data; L. Vico: 1988 data; Palo: Great Tit. 1990 data; Blue Tit. 1983 data.

Tab.4. Number and percentage of unsuccessful clutches and number of preyed-upon clutches in each study area; Blue and Great Titdata summed.

	A	B	C	D	E	F	G	H	I	J
clutches unsuccessful	7	12	0	0	6	10	4	0	4	4
(%)	(11)	(40)	-		(35)	(38)	(10)	—	(25)	(23)
clutches preyed-upon	0	1	-		3	2	1	—	1	0

A: M. Rufero 1989-90; B: M. Rufero 1991; C: Orbetello; D: Burano; E: L. Vico beech wood; F: L. Vico deciduous wood; G: Palo; H: Macchia Grande 1990; I: Macchia Grande 1991; J: Castelporziano.

in nest-boxes in the Castelporziano area, as well as four of six females caught in the night at Macchia Grande, displayed characteristics typical of young individual (Svensson 1984).

Environmental factors

With the exception of the L.Vico data, at all sites clutch size is larger in deciduous wood than in the other environments (Fig.1-2), but the differences are not statistically significant. In 1991, for the whole breeding season, Great Tit clutch size was significantly larger in the Castelporziano deciduous woods than in the Mediterranean scrub of Macchia Grande ($F_{1-33}=6.8$, $p<0.05$). This comparison was possible because clutch size in these two stations, located at similar latitude, does not seem to decrease with laying date (breeding season total: Castelporziano $\bar{X}=7.2$ +/- 1.0 n=8; Macchia Grande $\bar{X}=6.0$ +/- 1.2 n=27; see Fig.1-2 for comparison).

Altitude could have caused the low clutch size of the L.Vico deciduous wood, but beech wood in the same area did not display this effect (Fig.1-2). Likewise, the Monte Rufeno data (Fig.1-2) seem to indicate that altitude does not produce a decrease in clutch size.

Unsuccessful clutches

In the study area, the number of preyed-upon and, in general, unsuccessfull clutches was generally low (Tab.4). Only in the first part of 1991, when climatic conditions in Central Italy were the worst in the last 30 years, bad weather caused low breeding success (Bellavita and Sorace in press).

The small clutch size of the L.Vico deciduous wood (Fig.1-2) could be related to the higher number of unsuccessful clutches in this environment as compared with other sites, but the same effect is not observed (Fig.1-2) in the beech woods, which exhibit a similar number of nest failures (Tab.4). Moreover, low hatching success has generally been observed in the deciduous wood of L.Vico (Blue Tit, 1988, beech wood: 77.8%, deciduous wood: 26.2%; 1989, beech wood: 77.0%, deciduous wood 37.6%; Great Tit, 1988, beech wood: 79.7%, deciduous wood: 44.0%; 1989, beech wood: 100%, deciduous wood: 87.6%); this was not at all related to bad weather nor to other natural events (the only two cases of possible egg predation were not accounted for in these percentages). It is useful to observe that, in spite of the bad weather in the first part of the 1991 breeding season, hatching success in the M.Rufeno Reserve was 87,0% for the Great Tit and 52,6% for the Blue Tit (Bellavita and Sorace, in press).

Discussion

Clutch size in the Mediterranean area

Great and Blue Tit clutch size in the Central Italian study areas is generally lower than in other European regions at higher latitudes (Bellavita and Sorace 1991, Blondel et al. 1992 a), in spite of an earlier laying date (Bellavita and Sorace 1991) and irrespective of the study year, of the environment and of the densities. In disagreement with Lack (1966), some authors (for the Great Tit, see Orell and Ojannen 1983; for the Blue Tit, see Isenman 1987) have not found a latitudinal gradient of clutch size in Central and Northern Europe; likewise, their results do not agree with the correlation between the decrease of Tit clutch size and the length of the day in Mediterranean areas. Moreover, in this area during the nestling period, the values of AE, a parameter related to primary productivity in plants and probably with resource production (Ricklefs 1980), are equal to or higher than those reported by that author for the temperate zone. Considering that in mediterranean area the yearly primary productivity is high (Reichle 1970), that plant growth partially occurs in autumn and that winter is generally mild (Polunin and Walters 1987), the sharp drop in Tit clutch size toward Southern Europe could be related to a reduced seasonality of food resources (Ricklefs 1980, Isenmann 1987, but see Hussel 1985).

In the study period, the effect of predation, as well as that of nest failures (Slagsvold 1984), does not appear to be decisive, although negative years such as 1991 might result in a clutch size decrease in the following year (Boyce and Perrins 1987). The low clutch size in the L.Vico deciduous wood could be partially related to a higher number of nest failures as compared with other sites, but the values of hatching success and the comparison between the two study environments of this area seem to indicate that clutch size in the L.Vico deciduous wood might be due to environmental stress (Ruvolo et al. 1992); in some species of Passeriformes, hatching success and clutch size were observed to decrease on account of pollutants (Kallander and Smith 1989).

In the Palo wood, Fraticelli (in press) has observed, in spring. a higher percentage of youngsters than in other regions of North Europe and these results seem to be confirmed by preliminary data on breeding females in the other study sites. Furthermore some observations seem to rule out effects of competitive factors on clutch size. According to the data from other Mediterranean areas (Blondel 1985, 1992 b), these results are in disagreement with the reproduction-survival trade-off hypothesis. On the other hand, the trade-off between fecundity and adult survival involves other factors, namely post-fledging survival and percentage of birds breeding as yearlings: the values of these life-history traits could both be higher in the Mediterranean area (Blondel *et al* 1992 b). Moreover, for all the hypotheses concerning clutch size, the role of second clutches in the Mediterranean area has to be carefully examined (Bellavita and Sorace 1991).

Variations of clutch size in the Mediterranean area

Remarkable differences in habitat quality cause higher clutch size variations in the Mediterranean area than in other European regions (Blondel et al. 1992 a). For this area, among other factors, it has been found that clutch size in Mediterranean scrub is lower than in deciduous wood and that this breeding parameter varies among different sites according to the laying date (Blondel *et al.* 1987, Isenmann 1987, Delgado *et al* 1992). Our results, however, suggest that breeder density may also play a central role in clutch size variations in the Mediterranean area (see also Perrins and McCleery 1989, Perrins 1990). Considering that young woods and mountain habitats (i.e. M.Rufeno, Burano) should provide Tits with smaller food supplies than older woods on the plains (i.e. Palo, Castelporziano, Macchiagrande) (Kluijver 1951, Leclerq 1976, 1977, Perrins 1979, Krementz and Handford 1984), breeder density, in turn, seems to be related to food availability (e.g. Lack 1966, van Balen 1973, Leclerq 1976, Perrins 1979, Blondel 1985). On the other hand, deciduous woods (as compared with Mediterranean scrubs), mountain habitats and open environments (i.e. Burano low scrub with sparse vegetation as compared with Macchia Grande mature scrub) show higher food resources seasonality (Lack and Moreau 1965, Klomp 1970, Cody 1971, Boyce 1979, Isenmann 1987; but see for mountain habitat Krementz and Handford 1984); consequently they might exhibit larger clutch size and, due to a greater winter mortality (Ashmole in Ricklefs 1980), lower breeders density. Furthermore, in the Mediterranean area, no evident relationships between latitude and clutch size seem to exist (Blondel *et al.* 1987); in the Mediterranean scrub, Southern and Northern populations of Blue Tit lay clutches of similar size (Isenmann *et al* 1990, Delgado *et al* 1992). Likewise, the clutch size of this species in the L.Vico beech woods is well within the limits reported for this breeding parameter in a similar environment at same altitude in Southern France (Isenmann 1987). On the other hand, clutch size in Mediterranean scrub for the Great Tit and in deciduous wood for both species is the same as that observed in Spanish populations at similar latitude (Potti et al. 1988, Barba *et al* 1988) but is lower than in areas in Southern France (Cramm1982, Blondel et al. 1987, Isenmann 1987). Due to environmental factors, laying date and breeder density should be ruled out when studying this relation.

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Riassunto - In sette località del centro Italia sono stati correlati parametri ambientali con la dimensione della covata. In tutte le aree di studio la dimensione della covata appare inferiore rispetto ad aree centro e nord europee. Ciò potrebbe imputarsi alla minore fluttazione stagionale di risorse presente nelle aree mediterranee.

La densità dei riproduttori, la data di deposizione e l'eterogeneità ambientale sembrano fattori importanti nel determinare la variabilità, tra le località, di questo parametro riproduttivo.

Non si osservano clini altitudinali mentre la disponibilità di cibo può influenzare la densità di coppie in riproduzione. In generale, le dimensioni di covata di cinciarelle e cinciallegre in centro Italia sono inferiori di quelle della Francia del Sud mentre sono simili a quelle spagnole di latitudine corrispondente.

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Prey selection by parents and chicks of the Little Tern *Sterna albifrons*.

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Abstract - The diet of Little Tern chicks was studied in order to analyze the prey choice of a species that carries single, unbroken prey to its nest. Chicks less than 5 days old were fed with thinner fish than chicks older than 10 days. The average prey size was smaller for younger chicks. Prey left uneaten by chicks included larger, bulkier fish, shrimps and potentially poisonous fish. The parents select prey according to the chicks' ability to swallow, and a further selection is accomplished by the chicks themselves.

Introduction

Most studies on diet and prey choice of central place foragers deal mainly with multiple prey loaders and, to a lesser extent, with single prey loaders which are able to break-up large prey items in order to feed themselves or their chicks (Houston and McNamara 1985). Other species are single prey loaders which do not break the prey; their chicks swallow the prey whole. This constraint is particularly important, because the ability of the chicks to swallow items of increasing size continues throughout their growth, and the adults' optimal prey choice changes accordingly.

In this paper we analyze the feeding behaviour of the Little Tern *Sterna albifrons*, as a model for studying diet and prey choice of single prey loaders that do not break food items. Previous studies described the diet of the Little Tern (Glutz Von Blotzheim and Bauer 1982, Cramp 1985, Bogliani *et al.* 1992, Dementev *et al.* 1966), its foraging niche (Isenmann 1979, Dubois 1982, Fasola *et al.* 1989), and chick behaviour (Davies 1981). However no attention has been paid to optimal prey selection performed by the adults in relation to the age of chicks.

Methods

Data were collected in the Comacchio lagoon (North Adriatic coast), a very old 100 km^2 lagoon, presently banked up at the edges and managed as fish pond. The Little Terns breed on islets in the middle of the lagoon and search for food mainly within 4 km of the colony (Fasola and Bogliani 1990). Nests are placed mainly on bare ground and beaches covered by empty *Cardium* shells and with patches of halophytic vegetation.

Observations were made from a hide close to 40 nests from 22 June to 5 July 1983. Prey items carried by adults were identified to the lowest possible taxon, and the total length was estimated using bill length as a reference. No adjustment was made for possible systematic bias in the length estimate (Goss-Custard *et al.* 1987). One set of observations was limited to two age classes: chicks younger than five days (179 prey items) and chicks older than 10 days (107 items). Both age groups were observed simultaneously within the same colony, therefore any effect due to the uneven availability of the different prey can be excluded. It was impossible to know the sample size of chicks, because they were usually hidden among vegetation and were observed only when adults arrived with food. For the same reason it was difficult to have an accurate measurement of the handling time; only in few instances it was possible to observe chicks while disgorging food items.

In order to compare abandoned with offered prey,on 2 July 1983 we removed all prey items abandoned near the nests; from 2 July-5 July we carefully searched for recently abandoned prey items twice a day.

Results

Around the nests, 164 abandoned prey were collected; over the same four days, 784 feedings were observed.

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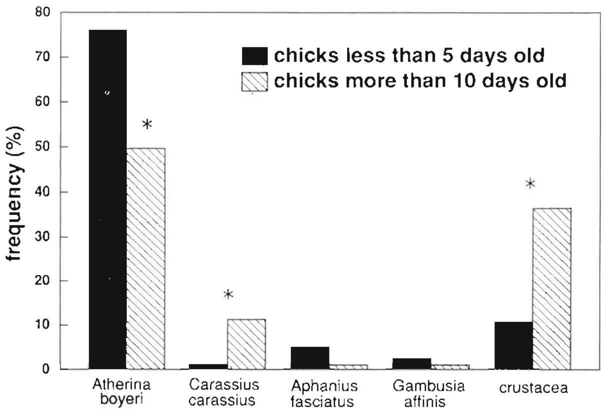

Figure 1 - Relative frequency of different prey fed to chicks aged less than 5 days (n=179) and more than 10 days (n=107). The asterisks indicate a significant difference (X^2 test, d.f.=1, p<0,01).

Table 1 - Length of the main prey delivered to chicks of differrent ages (mm).

	age of chicks							
	less than 5 days			more than 10 days			t	p
	mean	sd	n	mean	sd	n		
Atherina boyeri	34.6	6.9	136	47.7	9.5	53	9.3	<0.001
crustacea	40.1	5.7	19	51.4	2.7	39	10.3	<0.001

The frequency of occurrence of different prey items varied with the age of chicks (Figure 1). Young chicks received more Sand Smelts *Atherina boyeri* than older ones (X^2=19.7, d.f.=1, P<0.01), while the opposite occurred for the Crucian Carp *Carassius carassius* (X^2 =12.6, d.f.=1, P<0.01). Chicks over 10 days were fed with more crustaceans than were chicks less than five days old (X^2=26.1, d.f.=1, P<0.01). Young chicks received 27% smaller Sand Smelts and 22% smaller Crustacea on average (Table 1).

Overall, chicks less than 5 days old received prey items which being short and narrow were easy to swallow.

Crustaceans are probably difficult for small chicks to swallow as a consequence of the numerous appendages protruding from their bodies.

Abandoned prey was not a random sample of the offered prey. Relatively few thin fish such as Sand Smelt and Mosquito fish *Gambusia affinis* were abandoned; more bulky fish such as the Crucian Carp and Gobiidae and crustacea were overrepresented (Figure 2). Abandoned fish items were larger, on average, than offered ones (Table 2). Very few attempts at prey disgorging were observed, since chicks often took shelter immediately after receiving prey from the adult and went out of view.

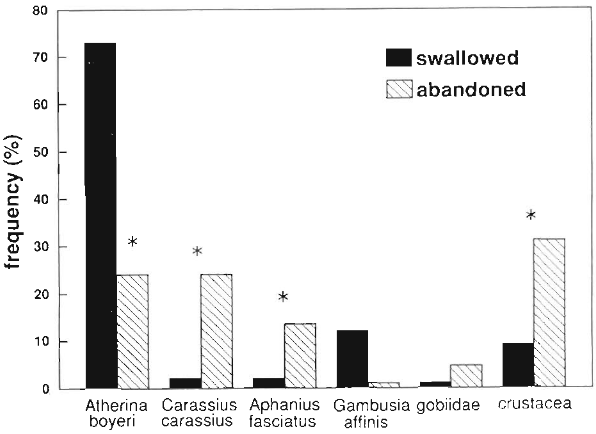

Figure 2 - Relative frequency of different prey swallowed by chicks (n=784) and abandoned uneaten near the nest (n=164). The asterisks indicate a significant difference (X^2 test, d.f.=1, p<0,001).

Table 2 - Length of the main prey observed and abandoned near the nests (mm).

	offered items			abandoned items				
	mean	sd	n	mean	sd	n	t	p
Atherina boyeri	34.7	20	574	39.9	10.4	40	3.1	<0.01
C.carassius	32.1	4.0	21	43.8	10.4	40	10.3	<0.001
Aphanius fasciatus	26.6	8.5	16	39.5	7.5	21	4.8	<0.001

Discussion

Adults selected prey of various length in relation to their chick's ability to swallow them, older chicks receiving larger prey. Obviously, a large chick is able to swallow a small prey, but this prey would not be an optimal choice for the parents. They may be qualitative differences between the pairs with young and old chicks at the same time, the latter being early layers and probably therefore older, more experienced birds. A change in the length of prey delivered to chicks of varying age has been observed in some other species, such as the Kingfisher *Alcedo atthis* (Bogliani and Massara 1990), the Sandwich Tern *Sterna sandvicensis* (Veen 1977) and the male Common Tern *Sterna hirundo* (Wiggins and Morris 1987). In the latter species the female did not increase the length of prey as chicks got older. In the Grey Heron *Ardea cinerea*, the maximum size of fish swallowed by chicks increases with chick age (Moser 1986). Furthermore, heron chicks less than 20 days old were fed more frequently with small prey and less frequently with bulky fish than were older chicks, as was also observed with the Little Tern of varying ages in the Comacchio Lagoon. However it is not clear if the Little Tern selects for prey size and prey type according to the age of chicks, or if it simply selects for prey size; the difference in prey species could be due to the fact that small prey include species which are different from larger prey. Few items were not eaten by chicks and these tended to be those which were either more difficult to swallow than average ones, because of their shape. (e.g. fat fish), sometimes with numerous appendages causing handling problems, (e.g. shrimps), or possibly because of their bitter taste, (e.g. *Aphanius fasciatus*), which is poisonous to small mammals (Cavicchioli 1962).

There is no evidence that selection against bulky prey was due to factors other than bulk, but in the crustaceans the proportion of indigestible material they contain may reduce their palatability. This non-optimal foraging by adults would probably warrant investigation. However it seems that the amount of abandoned prey is a small fraction of prey loads brought to the nest by parents.

The difference between abandoned and swallowed prey cautions against the analysis of abandoned prey to estimate the diet of terns, as attempted by some authors (Boldreghini *et al.* 1988, Atwood and Kelly 1984). Abandoned prey are likely to be unwanted by chicks.

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Riassunto - I pulcini di Fraticello delle Valli di Comacchio vengono imbeccati dai genitori con pesci piccoli e di forma affusolata quando hanno meno di 5 giorni; in seguito ricevono in maggior misura prede piu grandi, piu tozze o con appendici. Una parte delle prede portate dagli adulti resta abbandonata a terra. Questa frazione comprende pesci più grandi e di forma più tozza della media, crostacei con lunghe appendici e pesci potenzialmente velenosi. Gli adulti selezionano le prede in relazione all'abilita dei pulcini di ingoiarle; una ulteriore selezione viene operata probabilmente dai pulcini stessi, che scartano quelle meno idonee.

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Radio-tracking small aerial foraging birds: a preliminary study of the Sand martin *Riparia riparia*

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Abstract - A method is described for attaching radio-tags to small aerial feeding birds, illustrated with data from three Sand martins (*Riparia riparia*). The radio transmitters had no measurable effects on the subjects. Foraging range, and roost sites were recorded for a pair rearing chicks, which had a similar nest visit rate as a control pair in a neighbouring nest. The birds often foraged close to water, and the male used a larger area than the female. The pair roosted in agricultural crops several Kilometres from their nest, while the third bird (a mate guarding male) was found roosting in the burrow that it defended during the day. Some future applications of radio-tracking to small aerial foraging birds are discussed.

Introduction

Space use by breeding birds can be divided into two categories. Some birds exploit and defend relatively small exclusive territories, contaning the nest site and sufficient food supplies. Others forage over much larger areas, often tracking ephemeral food patches, which are not defended. The latter often benefit from nesting and feeding in groups. Examples of the second category include seabirds, swifts and hirundines.

Despite extensive work on breeding birds at colonies, relatively little is known about where such individuals roost, forage or go when away from the colony. Radio-tracking facilitates studies where direct observation is made difficult by cover, distance or darkness, but it has seldom been applied to small birds(East and Hoffer 1986, Greig-Smith 1985, Hanski and Haila 1988, Jonstone 1992, Nygard and Einavik 1992, O'Connor *et al.* 1987). Although radio-tags have been used on hirundines (Brigham 1989), and on bats weighing less weighing less than 10 g(Lunney et al.1985), the Sand martin is the smallest bird to be radio-tagged to date.

The Sand martin is the smallest hirundine species breeding in Britain (Cramp 1988).Sand martins nest in dense colonies with up to several hundred pairs (Hjeartaas et al. 1988, Jones 1986a, Petersen 1955, Stoner 1936) and are an example of social 'central place foragers' (Bryant and Turner 1982).

The aims of this study were to 1) assess the feasibility of radio-tagging Sand martins and 2) to illustrate the type of novel information radio-tracking can provide for aerial feeding birds on foraging ranges and roost site selection.

Methods

The study site.

The study site was Barbush Sand Quarry (56° 12' N, 3°59' W), central Scotland in June 1992. The Sand martin colony contained 516 occupied nests, occuring in subcolonies within 200-800 m of the River Allan. Criteria for assessing burrow occupancy followed Jones (1986a).

Radio-tags and radio-tracking.

Birds were caught using a hand net as they left their burrows, weighed, radio-tagged, marked with coloured dye and released within 5 minutes. A trial was carried out in which a radio-tag was glued (cyanoacrylate) between the shoulders of a Sand martin directly above the centre of gravity, following O'Connor *et al.* (1987) and Brigham (1989). The radio-tag fell off, or was removed by the bird within 24h so this technique was abandoned in favour of tail-clips.

Radio-tags were attached using miniature tail-clips (East and Hoffer 1986, Greig-Smith 1985, Johnstone 1992) such that they were hidden by the undertail coverts. Tail-clips weighed 0.3 g and consisted of two perspex plates clamped together using a pair of nylon bolts. The single stage SS-2 radio-tags (Biotrack,

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Dorset, UK) weighed 1.0 g, resulting in a total package mass of 1.3 g. The 15 cm long external whip antenna projected from the tip of the tail. Only the central four tail feathers were contained within the clip so that the eight outer feathers could be spread as required. In Sand martins, the post-nuptial moult includes the tail (Turner and Rose 1989) so tags would soon be lost. However such an additional load on the tail may change the centre of gravity of the bird, potentialy increasing flight costs or compromising manouverability (Evans and Thomas 1992).

Information on nest attendance was collected for two hours during late morning (10-12 h) while birds were being radio-tracked. A neighbour's nest at the same stage was used as a control.

Three Sand martins were caught in the same subcolony (Table 1). Only the pair provisioning nestlings was radio-tracked during daytime. All birds were also searched for at night throughout the lifetime of the radio-tags locate roost sites.

All radio-tracking was done using hand-held three element Yagi antennas and RX-81 receivers. The $\theta_{.95}$ error arc (Springer 1979) of the antennas was ± 1.5°. During daylight, birds were monitored by an observer at each of two fixed vantage points near the nesting subcolony. The compass bearings of radio-signals were simultaneously recorded from the vantage points every five minutes during each bout of tracking. These were then converted to locations on a 1:10,000 scale map of the study area. Four bouts of tracking were undertaken each day, each lasting 2 h and distributed over the day (early morning, late morning, afternoon and late evening). The pair provisioning nestlings were radio-tracked regularly during daytime for a period of 48 hour, over which the weather was warm, calm and sunny.

Analysis of radio-tracking data.

The degree of statistical independence between radio locations was evaluated by comparing colony attendance estimated from radio-tracking data with the nest attendance measured by direct observation over the same period. Both individuals attended the nest burrow between consecutive locations placing them some distance away. Therefore using a sample interval of 5 min, locations were considered independent following the 'rule of thumb' that the time taken to cross the home-range is equal to the time to independence (White and Garrot, 1990). Space use was quantified by using the grid-cell technique since this non-statistical range estimator makes few assumptions about the utilization distribution (White and Garrot 1990).

Table 1 - Capture and recapture details of Sand martins that were equipped with radio-tags.

Sex	Date tagged	Breeding stage	Initial mass (g)	Duration (Days)	Mass change on recapture (g)	No. burrow visits$	Subsequent behaviour
Female	8thJune	provisioning nestlings (1st brood)	12.5	3*	0	34 (21)	1st brood fledged 2nd brood attempted 39 days after being radio-tagged.
Male	9thJune	Mate nestlings (1st brood)	13.0	14#	+0.25	28 (23)	1st and 2nd broods fledged.
Male	24thJune	Mate guarding (2 brood)	12.5	5#	-0.5		Mate deserted while attempting 2nd brood.
Mean (±SD)			12.7 (0.29)	7.3 (5.9)	-0.1 (0.4)		

* Radio-tag not subsequently recovered.
# Radio-tag removed on recapture.
$ Number of burrow visits recorded in two of hours observation during late morning (control birds in brackets).

Two variables are required to describe the use of space by an animal relative to a central place: direction and distance. The direction of the location estimates from the nest burrow were measured to the nearest 10° on the map of the study area. Locations that were less than 100 m from the burrow were considered to be at the burrow and had no bearing from it. Distances of locations from colony and river were measured to the centre of grid cells and rounded down to the nearest 100 m.

Since both members of the pair were tracked concurrently and the successive locations were independent, it was possible to measure the degree of interaction between the birds. A measure of static interaction can provide information on the degree to which two utilization distributions overlap, and also whether the shared area contains the least or most utilized parts of each range. The degree of static interaction was calculated using the 'Static' computer program of Doncaster (1990).

Simultaneous pairs of locations can also provide an estimate of dynamic interaction between a pair of animals. Positive dynamic interaction indicates two individuals occur close together more often than would be expected at random (mutual attraction), negative dynamic interaction indicates mutual avoidance (Doncaster 1990). A critical separation distance between pairs of locations of 150 m was used to include the eight cells surrounding the occupied cell. Dynamic interaction was calculated using the 'Dynamic' program (Doncaster 1990).

All statistical treatments follow Zar (1984).

Results

Radio-tag performance and accuracy of locations.

The radio transmitters had a maximum range of 1.2 km and cell life of approximately 7 days.

During daytime tracking, bearings could not be obtained on 5% of occasions for the male and 1% of occasions for the female. Sudden changes in signal strength suggested that this was due to birds being close to the ground where local topography blocked the signals, rather than to the birds being out of range.

All locations were assigned to one hectare grid-cells. Measurement of error polygons indicated that 95% of the locations conformed to this level of accuracy, following the criteria of Kenward (1987). The remaining 5% percent were less accurate, but as outlying locations, contributed little to the utilization distribution. Since Sand martins are highly mobile, movement error may be an inevitable source of inaccuracy in the radio-locations. However, since pairs of bearings from each individual were always recorded within a few seconds of each other, this was thought to be of little importance.

Effects of radio tags

Tagged birds behaved apparently normally. They flew with a mixed flapping and gliding gait typical of the species and could not be distinguished from other birds in flocks. When perching at the entrance of the burrows they were never seen to peck at the tags. Only small changes in body mass were shown between radio-tagging and recapture (Table 1), and no apparent damage to rectrices was observed.

The pair rearing chicks exhibited normal attendance behaviour just after tagging. They fed chicks at a broadly similar rate to a pair in a neighbouring nest used as a control (Table 1). The subsequent behaviour of the birds that were tagged is shown in Table 1.

Examples of what radio-tracking can reveal

1) Space use and habitat selection

The radio-locations obtained from the pair provisioning chicks, along with the locations of the subcolonies and the nearby river, are shown in Figure 1. The male and the female visited 69 and 39 one hectare grid-cells respectively.

On average the male showed little directional preference, while the female showed a strong preference for locations to the west of the subcolony (Figure 2).

For both male and female, over 70% of the locations occurred within 300 m of the burrow. There was no significant difference in the distance from the subcolony between the two birds (Mann-Whitney $W=22164$, $p=0.11$, male $n=154$ and female $n=148$). Distances from the subcolony at different times of the day (early morning, late morning, afternoon and evening) differed for the male (Kruskal-Wallis, $H=8.63$, $p<0.04$), but not for the female (Kruskal-Wallis, $H=5.74$, $p<0.13$). The male, was located further from the subcolony in late morning than in early morning (non-parametric Tukey comparisons, $Q = 2.912$, $p<0.05$).

The birds were located near the River Allan and over grassland and agricultural crops, when away from the colony. Birds were considered to be foraging most of the time when away from their nest burrow during daytime. Locations which placed the birds at their own subcolony were excluded from the sample, since such space use could be the result of the need to feed young rather than selection of habitat for foraging. Over the whole period that the birds were tracked, the male occurred significantly further from the river than

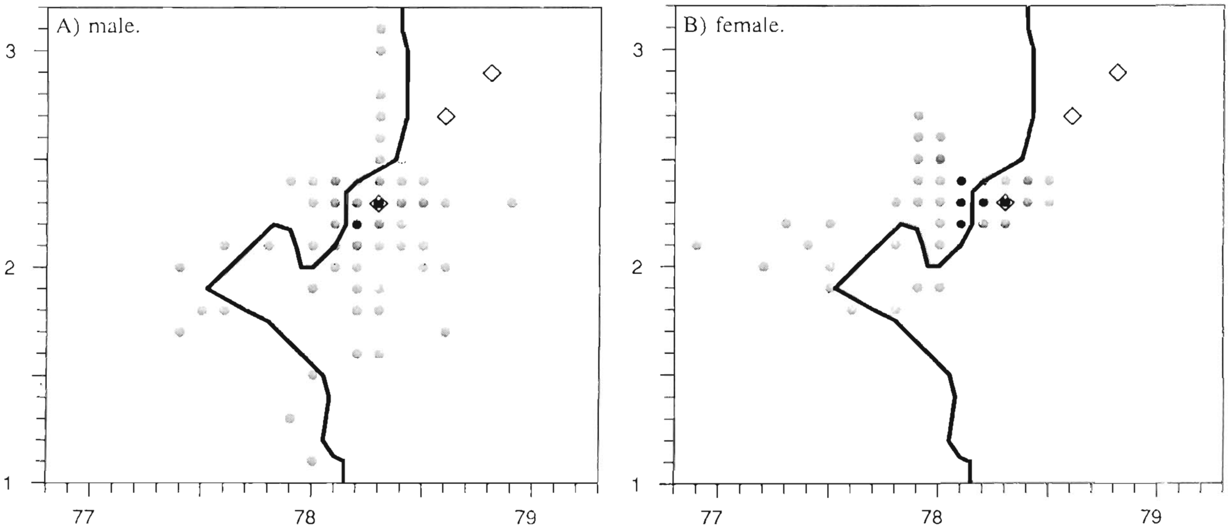

Fig. 1. Locations at which a pair of radio-tagged Sand martins were recorded, A) male n=148, B) female n=154. Black symbols represent >5% of the total number of locations. The diamond symbols represent subcolonies and the solid line the River Allan. Axes refer to km intervals within the 100 km grid square NN of the British national grid, north is the top of the figure. In both cases, the locations were concentrated around the subcolony containing the pair's nest burrow.

the female (Mann-Whitney W=11676.0, p<0.001, male n=118, female n=114). Both birds showed a significant tendency to be further from the river when they were at large distances from their nest burrow (male r_S=0.27, p<0.01, n=118; female r_S=0.52, p<0.01, n=114). Locations which placed the birds at their burrow were again excluded.

In contrast to its mate, the male visited other subcolonies; a behaviour which could be interpreted as seeking extra-pair copulations (EPCs). Of the occasions that the male was recorded closer to other subcolonies than to its own subcolony, 90% occurred in the afternoon and evening (n=11).

2) Interaction between the individuals

Of the 77 grid cells used by at least one member of the pair, only 29% were visited by both. Spearman's coefficient was used to test for a correlation between the utilization distributions of the pair, following Doncaster (1990). For the pair of Sand martins ranges, r_S was +0.43 (p<0.05). For ranges that overlap by the observed value of about 30%, a positive value for r_s indicates that the shared area contains the most utilized parts of each range (Doncaster 1990). Although male and female shared the most utilized parts of their home range, an analysis of dynamic interaction showed no tendency for the male and

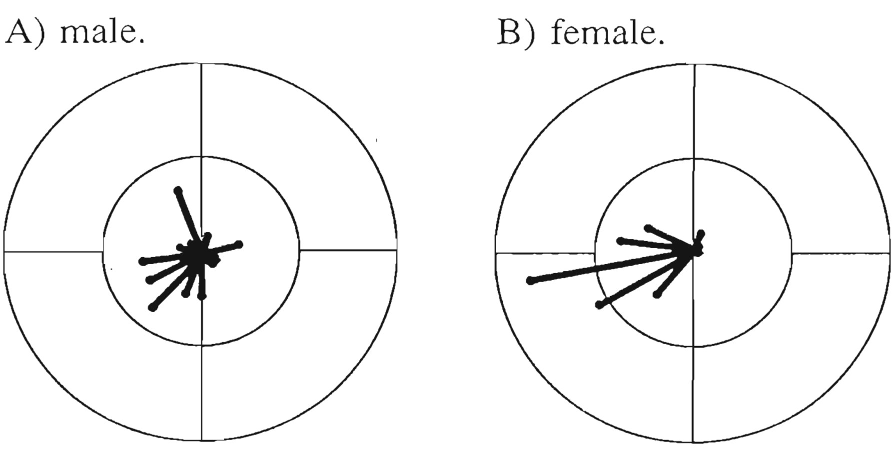

Fig. 2. Percentage of occasions which birds were recorded in different directions from the nest burrow, bearings rounded to the nearest 10°. A) male (n=118), B) female (n=114). The radius of the inner circles represents 20 % of the total. North is towards the top of the figure. Locations placing the birds at the burrow were excluded.

female to be separated by less than 150 m more often than would be expected at random (X^2=0.008, df=1, p>0.20).

3) Roost selection during the rearing period

The locations of roost sites chosen by the Sand martin pair with chicks are shown in Figure 3. On the nights of the 9th and 10th June, immediately after tagging, the female was located roosting in its burrow, while the male was not found within a 1 km radius. Both birds were located on the 12th June away from the colony, the first night that a search of the area surrounding the colony was carried out. The pair was found roosting together in a field of oilseed rape, (*Brassica napus*), 4.7 km from their nest burrow. On the following night they were located together in the same field, 50 m from the previous roost site. At dusk a few swallows (*Hirundo rustica*) foraged in the area, but there were no Sand martins visible and there was no contact calling or social interaction to suggest the presence of a large communal roost. Both birds were again located roosting together on the 14th and 15th June. On these occasions the sites were in a field of wheat, (*Triticum aestivum*), 3 km from the subcolony, and in slightly different locations on each night. Again there was no suggestion as to the existence of a large communal roost. On the 16th June the birds were located together just before dusk. Fluctuating signals indicated that the birds were still active 2.7 km from the subcolony and heading in the same direction as the roost sites of previous nights. However they were not located after dusk despite an extensive search covering approximately 30 km^2, suggesting that the birds could have crossed the River Teith and the roost site was more than 6 km from the colony. On the night of 17th June, the last time the birds were searched for, neither was located. By then the chicks were 17 days old and only the male was feeding the brood.

The second male was radio-tagged during mate guarding, and was recorded roosting at night in the same burrow that it defended during the daytime.

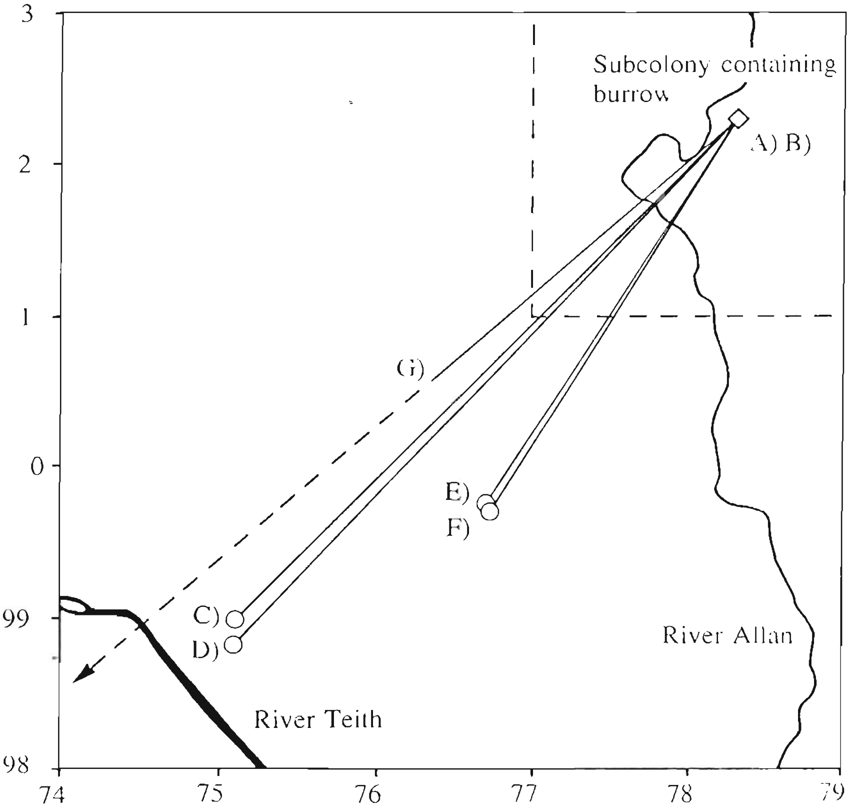

Fig. 3. Selection of roost sites by a pair of Sand martins during brood provisioning. A) and B) 9th and 10th June, nest burrow, female only, male not found. C) 12th June, oilseed rape (*Brassica napus*), male and female together. D) 13th June, oilseed rape (*B. napus*), male and female together. E) 14th June, wheat (*Triticum aetivum*), male and female together. F) 15th June, wheat (*T. aetivum*), male and female together. G) 16 June, still active just before dusk, male and female together, not found after dusk and probably crossed the River Teith. The square bounded by hatched line represents the area covered by Fig. 2. Axes refer to km intervals within the 100 km grid squares NS and NN of the British national grid, north is towards the top of the figure.

Discussion

1) Effects of tags

Radio-tags represented 10% of the mean body mass of the Sand martin (13 g), twice the widely recommended limit of 5 % (Cochran 1980). Accordingly, the minimum power required for level flight with and without radio-tags was derived using the programs of Pennycuick (1989). This indicated that a Sand martin of mean mass carrying a 1.3 g tail-mounted radio tag will incur a 15% increase in the power required for level flight. Since laying Sand martins (15 g) routinely incur a 27 % increase in minimum power, the additional load represented by the radio-tags fell well within that which Sand martins naturally experience. It is likely, however, that laying birds anticipate increases in flight cost associated with mass change and may adjust their physiology accordingly.

Only a few studies of small birds present quantitative results about the effects of radio tags (Brigham 1989, East and Hoffer 1985, Johnstone 1992). Studies on birds with high aspect ratio wings are also rare (Brigham 1989, Nygard and Einavik 1993). The effect of packages on the flight of such birds is of great importance since they are aerodynamically efficient, leaving relatively little scope for carrying additional loads, and also spend much of their time flying to collect food.

The present study suggests that the tail clips and associated change in centre of gravity caused no obvious problems to Sand martins. However, Wright and Cuthill (1990) have shown that subtle changes in provisioning rate may occur as a result of adding tail weights. Larger samples of birds and periods of observation would be necessary to test such changes in provisioning between tagged birds and controls.

Over the period that the birds carried radio-tags they showed on average only a slight decrease in body mass; consistent with the general decline in mass of the population during the breeding season (Jones 1986b). The pair provisioning chicks showed a slightly higher rate of nest attendance, in comparison with a neighbouring control nest. If the increase in wing loading due to the radio-tags caused a reduction in the mass of the prey bolus that birds could economically carry, burrow visits could became more frequent to maintain a constant rate of delivery to the chicks. The observed rates were, however, both within normal limits (Turner 1980) and the difference could be due to different demands of the broods or individual variations. Furthermore, the female successfully began a second clutch while tagged, indicating that radio-tags did not impair egg laying. The results are consistent with tail mounted radio-tags having no major effects on Sand martins.

2) Space use and habitat selection

The use of radio-tracking techniques to determine foraging range and feeding locations by shags (*Phalacrocorax aristotelis*), a similarly highly mobile social 'central place forager', during chick rearing showed no significant sex difference (Wanless *et al.* 1991). But the radio-tagged male and female Sand martins commonly took different directions when foraging during the chick rearing period. They visited only 11% and 6% respectively of the area accessible within the maximum flight distance they used, which suggests a high degree of site selectivity. The bearings of the locations from the burrow suggested that the female concentrated foraging in the direction of the river, while the male showed much more variation. A previous study of predation strategies in aerial foraging birds recorded 75% of the feeding patches used by Sand martins to be over land and only 25% to be over or near water (Waugh 1978). Although the male showed a significant tendency to be further from the river than the female, the results from the present study recorded over 70% of the locations to be within 100 m from the river. A possible reason was that the local topography caused concentrations of insects along the river valley at the height favoured by foraging Sand martins (Waugh 1978). The birds being located further from the river at greater distances from the burrow, was almost certainly due to them taking a beeline flight paths to and from prey concentrations at different places along the meandering course of the river. This increased their probability of being located while overflying the intervening farmland.

The independent tracking data collected in this study provides no information on the search paths of individuals. The collection of highly interdependent locations, for example by using Doppler radio direction finders (Angerbjorn and Becker 1992) would allow such detailed space use to be monitored. This would provide a more accurate picture of the economics of aerial foraging, as birds locate, exploit and subsequently abandon ephemeral prey patches.

3) Information centres

Nestling feeding by both parents provides an opportunity to investigate ideas generated by information-centre hypothesis. That is, roosting and other assemblies (including breeding colonies) could serve as information-centres, where individuals benefit by following successful ones to profitable feeding areas, particularly for unevenly distributed resources (Ward and Zahavi 1973, Bayer 1982, Brown 1986). Radio tracking can provide a way to answer the question: do pairs co-operating to rear nestlings exchange information about the location of profitable prey patches?

As would be expected for a 'central place forager', the cells that were most utilized by each bird, were visited by both of them and were concentrated at and close to their burrow. Both birds must repeatedly have flown through these cells to deliver food to the chicks. The absence of any degree of dynamic interaction suggests that the birds were not using cues from each other or a third party to locate food.

4) Mixed reproductive strategy

The tendency for the male to visit more grid cells, and to be located on average further from the river than its mate, was possibly due to the male looking for potential extra-pair copulations (Riley 1992, Alves pers. obs.). Sand martin chasing behaviour shows its highest peak early in the morning, decreasing in the middle of the day and increasing again in the afternoon to reach another peak by evening (Jones 1986b). Fertile Sand martins could be located by males in a flock of foraging birds by a distinctive gait during flight (Jones 1986b). Radio-tracking Sand martins during the pre-laying and laying stages (when the males guard their mates) would give useful information about mate guarding and opportunities for extra-pair copulations when the birds are away from their nest burrows. This information is otherwise difficult to obtain.

5) Roost selection

Published information about roosting when away from the nest burrow during breeding is scarce in hirundines. In Sand martins, the females and sometimes the males roost in the nest burrow until the nestlings are 10 days old (Petersen 1955), after which there is no information. Huxley (1949) records House martins (*Delichon urbica*), Barn swallows (*Hirundo rustica*) and Chimney swifts (*Chaetura pelagica*) returning to ground level from a great height at dawn, suggesting the possibility of aerial roosting. However, Smart (1990) recorded House martins roosting in oak trees (*Quercus* sp) in June before a night of wet and windy weather. Common swifts (*Apus apus*) (Holmgren 1993) have been observed going into trees at dusk, and radio-tracked White-throated needletails (*Hirundapus caudacutus*) were also shown to be roosting in trees (Tarburton 1993). Records of massive communal roosts of hirundines in Autumn during migration are widespread (Cramp 1988), sites usually being located in reed beds. Ford and Elphick (1993) observed the progressive formation of such a roost by swallows in maize (*Zea mays*) during August and September.

The use of roost sites in this study suggests an explanation for the absence of previous records of roosts away from the burrow during breeding. It is possible that single birds or pairs scatter into countryside surrounding a colony at dusk, and select separate locations in the highly abundant suitable sites represented by agricultural crops. Birds roosting in these situations would be impossible to detect without radio-tracking. These sites become increasingly rare during the late summer and autumn due to the harvesting of crops. This might account for the progressive formation of communal roosts after breeding when the birds became concentrated into remaining sites such as reed beds. The ability to locate roost sites many kilometres from the colony demonstrated by this study could open the possibility of monitoring the post breeding movements of individuals.

This pilot study suggests that there were no measurable effects on the behaviour, body mass and short term survival of Sand martins equipped with tail-mounted radio-tags. Thus the application of radio-tracking to such a small aerial foraging bird can provide useful information on foraging range, habitat selection and behaviour.

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La popolazione di *Larus cachinnans michahellis* nidificante nella città di Trieste.

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Abstract - Urban nesting by Yellow-Legged Herring Gulls in the city of Trieste was first observed in 1987. The number of nests on the top of buildings increased by 49.9% on average each year since 1988, this increase may dictate management measures in the future. A specific research was carried out in 1992 in order to investigate the relations between environmental factors and distribution, and the breeding succes. A total population of 70-90 breeding pairs was estimated both by direct nest counts (66 breeding pairs) and by contemporary counts on the calling adults. A colony (24 nests) was located in the industrial harbour area, while the nests in the urban area (37) can be described as a loose colony. Breeding site features such as exposure and roof covering, distance from sea and from nearest nest were surveyed and their distribution and effect on breeding were analyzed. Hatching and survival ratio and breeding success were significantly higher in the urban area than in the industrial area colony.

Introduzione

Negli ultimi decenni il Gabbiano reale mediterraneo *Larus cachinnans* ha subito un notevole incremento numerico in tutto il suo areale, analogamente a quanto accaduto all'affine Gabbiano reale nordico *Larus argentatus*. I motivi vanno ricercati principalmente nella spiccata adattabilità della specie, nella cessata raccolta delle uova per scopi alimentari e nella capacità di sfruttare nuove fonti trofiche negli ambienti antropizzati (Cramp & Simmons 1983).

Nell' Europa settentrionale, da più di un ventennio, sono note nidificazioni di Laridi su costruzioni in ambienti urbani (Cramp 1971, Sharrock 1976, Monaghan 1982), mentre nel bacino del Mediterraneo solo agli inizi degli anni '80 il Gabbiano reale mediterraneo a iniziato localmente a nidificare in città della Francia e Spagna come, ad esempio, Barcellona (Garcia-Petit *et al.* 1986).

Anche in Italia sono state accertate nidificazioni per lo più isolate della specie in Liguria a Sanremo (Balletto & Spanò 1982) e a Genova (Spanò 1986), in Toscana a Livorno (M. Lambertini *com. pers.*), nel Lazio a Roma (Cignini & Zapparoli 1985, Sommani 1986) e nella Campania a Napoli (M. Fraissinet *com. pers.*). Nel Friuli Venezia-Giulia la specie nidifica nelle lagune di Grado e di Marano, 1010 coppie censite nel 1984 (Perco *et al.* in Fasola 1986), e presso le foci del fiume Timavo.

Nel 1987 é stata documentata la prima nidificazione in ambito urbano con una coppia individuata su un tetto della città di Trieste (AA.VV. 1989, Benussi & Dolce 1990), ed in seguito si é rilevato un costante incremento numerico. Nel 1988 é stato osservato l'inizio di una riproduzione in forma coloniale da parte di 14 coppie.

Nel 1992, vista l'evoluzione e la rilevanza del fenomeno, unico a livello nazionale, é stato condotto uno studio approfondito delle coppie nidificanti (Benussi *et al.* 1993) al fine di programmare, se necessario, il futuro controllo della popolazione.

Metodi

Dal 1988 le coppie nidificanti sono state individuate da zone sopraelevate della città e molte informazioni sono state raccolte utilizzando stampa e televisione locali con esiti soddisfacenti. Il mappaggio dei siti riproduttivi é stato effettuato utilizzando la Carta Tecnica Regionale (scala 1:5.000).

Le coppie sono state censite in base al conteggio diretto dei nidi e la stima complessiva della popolazione é stata fatta anche contando gli adulti in allarme durante rilievi contemporanei su diversi nidi.

Nel 1992 é stata operata una distinzione tra i siti esattamente coincidenti con quelli già utilizzati nel 1991, i nidi costruiti sullo stesso tetto già occupato nel

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1991 ma ubicati ad una certa distanza dal sito utilizzato in precedenza, e quelli nuovi su tetti mai utilizzati per la nidificazione.

In base alla pendenza e al tipo di copertura sono state individuate diverse tipologie di tetti: tetto piatto con ciottoli e con più o meno abbondante copertura vegetale (tetti indicati come "ciottoli ed erba", "ciottoli", "erba"), tipologia riscontrata negli edifici d'inizio secolo; tetto liscio, catramato o di cemento, privo o con scarsa ed irregolare presenza di vegetazione erbacea, tipico di capannoni industriali e costruzioni recenti; tetto con copertura in tegole. L'esposizione dei nidi é stata rilevata, anche su tetti piatti. in base alla presenza di strutture emergenti costituenti riparo, anche parziale, in prossimità del nido.

Nei nidi accessibili é stato contato il numero di uova deposte, di pulli nati e di giovani involati, e sono stati calcolati: successo di schiusa (no. pulli nati / no. uova deposte), successo riproduttivo (no. juv. involati / no. uova deposte), sopravvivenza (no. juv. involati / no.pulli nati).

Foto 1 - Trieste, 29 aprile 1991. Nido con uova costruito su un tetto piatto in ciottoli ed erba del centro storico, tipico di palazzi d'inizio secolo. Foto: E. Benussi

Risultati

Popolazione e distribuzione

La popolazione nidificante (Fig.1) é aumentata dal 1988 al 1992 con un incremento medio annuo del 49.9%.

Nel 1992 sono stati censiti 66 nidi di cui 37 nell'area urbana in senso stretto e 29 nella zona del porto industriale, dove 24 coppie si sono riprodotte in forma spiccatamente coloniale con 13 nidi posti assai vicini tra loro (Fig.2).

Nell'area urbana i siti di nidificazione sono distribuiti tra 250 m ed i 1400 m di distanza dal mare. La distanza minima tra i nidi varia tra i 15 m (relativa all'unica presenza accertata di 2 nidi sul medesimo tetto) e di 700 m in ambito urbano e tra i 2 m ed i 20 m sul capannone industriale (Fig.3).

Data la difficoltà oggettiva di censire tutti i nidi, si ritiene che la popolazione nidificante possa essere di 70-90 coppie, stima ottenuta anche in base al conteggio degli adulti in allarme.

Per i nidi dell'area industriale non é stato possibile riconfermare l'occupazione dei siti utilizzati l'anno precedente. Dei siti censiti in ambito urbano, oltre la metà (51.4%) coincidono con siti già utilizzati nel 1991, mentre nel 21.6% dei casi il nido é stato costruito sullo stesso tetto a breve distanza (da 1 m a 29 m) dal sito dell'anno precedente. Non si evidenzia alcun legame significativo tra riconferma, spostamento o novità del sito e distanze dal mare o distanze minime tra un nido e l'altro.

Siti di nidificazione

In ambito urbano il Gabbiano reale mediterraneo ha nidificato su tetti di diverse dimensioni, comprese tra i 16 mq ed i 3500 mq di superficie, ad un' altezza tra i 6 m ed i 35 m dal suolo (media 22 m, DS=5.08, N=31). Nel 64.5% dei casi non esistono edifici più elevati entro 30 m dal nido.

Il sito della colonia nella zona industriale é costituito da un complesso di tetti convessi in cemento, interrotto in qualche punto da chiazze di piccole piante succulente, la cui superficie complessiva é di 8372 mq e l'altezza é di 6-15 m dal suolo.

La distribuzione di frequenza delle diverse esposizioni dei nidi nell'area urbana e nell'area industriale é rappresentata in Fig.4A-B e risulta significativamente diversa tra le due popolazioni (χ^2= 12.847, GL=4, $P<0.05$). In ambito urbano non si é evidenziato alcun legame significativo tra esposizione e riconferma, spostamento e novità del sito.

Il 75% dei nidi dell'area urbana si trova su tetti piatti

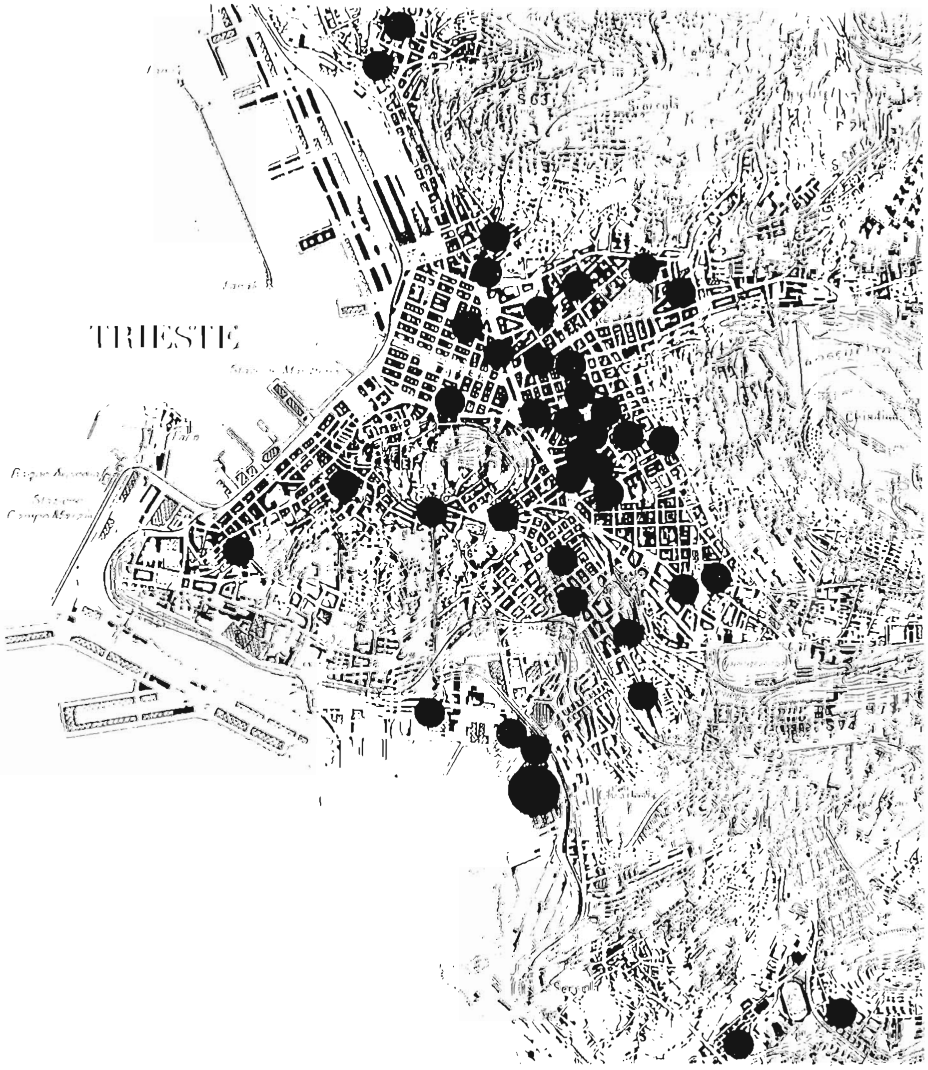

Figura 1 - Distribuzione dei nidi in ambito urbano nel 1992. Con tondo piccolo nidificazioni singole (Solo in un caso di due nidi sullo stesso tetto), con tondo grande nidificazione di più coppie vicine in forma strettamente coloniale (area portuale).

ricoperti da ciottoli ed erba, il 12% su tegole e solo il 3% per ciascuno dei tipi a ciottoli, sintetico ed erba. Distinguendo tra siti riconfermati, spostati e nuovi, risulta significativa la tendenza ad utilizzare tetti in tegole o altri materiali solo nel caso di siti riutilizzati: la maggioranza di questi ultimi é la totalità dei siti spostati e nuovi si trovano comunque su substrati tipo ciottoli ed erba (χ^2=6.359, GL=2, P<0.05). Su tetti di questo tipo, la copertura vegetale intorno al nido varia tra il 10% ed il 95% e l'altezza media della vegetazione tra i 4.8 cm ed i 26 cm.

Nell'area urbana si trova, nella maggior parte dei casi, almeno una struttura emergente dalla superficie del tetto entro 3 m dal nido.

Nidi

Le dimensioni dei nidi sono riportate in Tab.I. I nidi nell'area urbana e quelli dell'area industriale risultano significativamente diversi per il diametro esterno massimo (t=3.271, N=21 e 23, P<0.01), inoltre i primi presentano un maggior numero di correlazioni significative tra le diverse dimensioni rispetto ai secondi che sono di forma meno regolare.

L'esposizione sembra avere una certa influenza sul diametro esterno massimo dei nidi (F=2.757, GL=3 e 17, P=0.074), che aumenta dai siti esposti ad E-NE, a quelli senza esposizione precisa, a quelli esposti a S-SE e N-NW ed è massimo nei nidi al riparo della bora, vento freddo che soffia da E-NE.

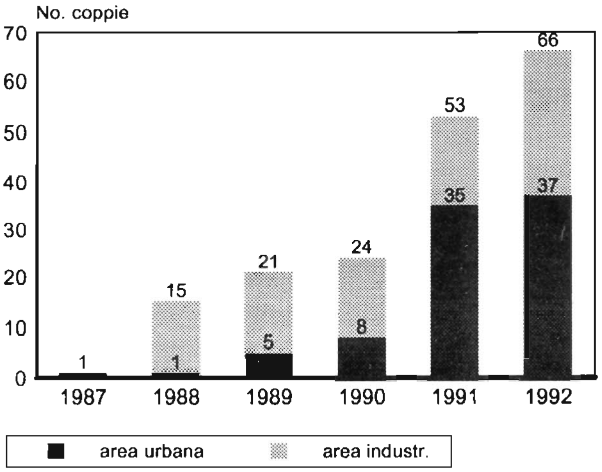

Figura 2 - Andamento della popolazione nidificante nella città di Trieste. L'incremento maggiore è stato riscontrato nell'area urbana nelle stagioni riproduttive 1991 e 1992.

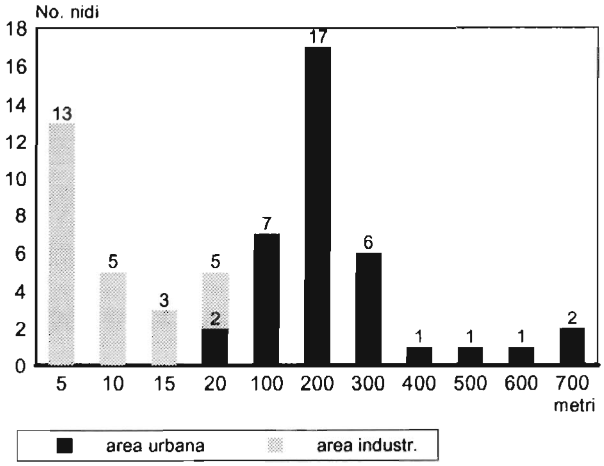

Figura 3 - Distribuzione delle distanze minime trai nidi nel 1992: area urbana: X= 226.2, DS=155.7, area industriale: X=7.6, DS=5.5. Nell'area industriale la minore distanza tra i nidi evidenzia una nidificazione in forma tipicamente coloniale.

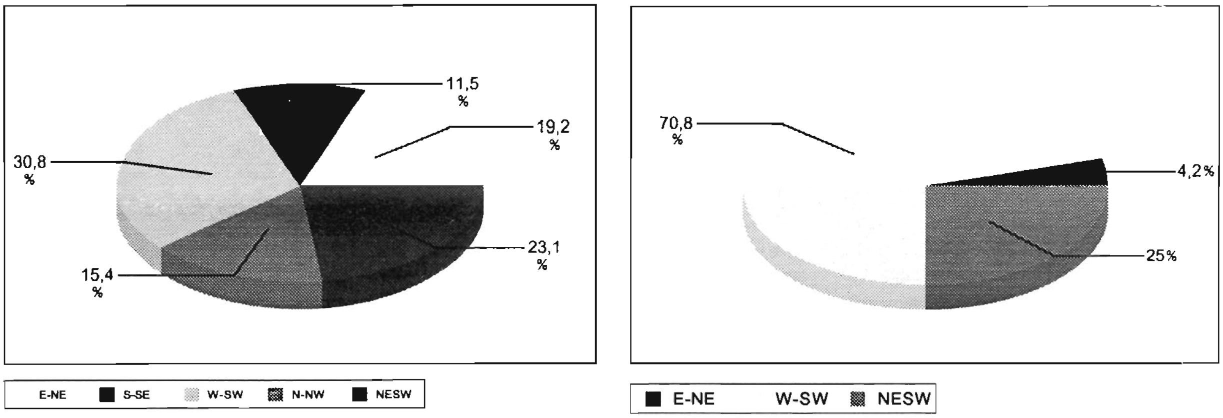

Figura 4A,B - Esposizione dei nidi nell'area urbana (A) e nell'area industriale (B) nel 1992; i nidi senza una precisa esposizione sono indicati con NESW. Mentre l'esposizione dei nidi nell'area urbana appare casuale, nell'area industriale sembra essere condizionata dalla conformazione del tetto sito della colonia.

Tab. I - Misure nidi (cm) (N=44)

	Diametro esterno minimo	Diametro esterno massimo	Diametro interno minimo	Diametro interno massimo	Profondità coppa
media	32.6	38.4	16.0	17.0	6.2
D.S.	4.5	7.8	2.1	2.6	2.8
intervallo	25 - 43	25 - 67	10 - 22	11 - 25	2 - 22

Nella colonia dell'area industriale i nidi esposti a S-SW sono più larghi e più profondi rispetto a quelli senza esposizione precisa (F=13.650, GL=1 e 20, P<0.01 ed F=7.695, GL=1 e 20, P< 0.05).La composizione media dei nidi (n=44) è data da rami (8.6%, DS 18.1), erba (62.4%, DS 33.5), penne e piume (3.6%, DS 6.5) ed altri materiali (25.4%, DS 33.4). L'esposizione tende ad influenzare la percentuale di rami (F=4.319, GL=1 e 20, P=0.0508) che risulta maggiore nei nidi esposti a 360°.

Riproduzione

La popolazione dell'area industriale differisce significativamente da quella urbana (Tab.2) per il numero di pulli nati per nido (t=3.526, N=30 e 23, P<0.001 e t=2.181, N=30 e 16, P<0.05) e per il numero di giovani involati per nido (t=4.523, N=30 e 23, P<0.001 e t=3.256, N=30 e 16, P<0.01).

Considerando la popolazione nidificante in ambito urbano (N=30) ed i 16 nidi della colonia dell'area industriale che non sono stati distrutti nel corso di lavori di manutenzione del tetto, le differenze di frequenza sono significative per la percentuale di schiusa (χ^2=14.421, GL=1, P<0.001), per il successo riproduttivo (χ^2=21.712, GL=1, P<0.001) e per la percentuale di sopravvivenza dei pulli (χ^2=6.665, GL=1, P<0.01).

Nell'area urbana il successo riproduttivo aumenta significativamente (r=0.443, N=21, P<0.05) ed il numero di giovani involati e la percentuale di sopravvivenza tendono ad aumentare (r=0.305, N=21, P=0.076 e r=0.407, N=21, P=0.067) dove maggiore é la copertura vegetale intorno al nido. Dall'analisi della varianza risulta significativa l'influenza del numero di adulti in allarme sul numero di giovani involati per nido (F=4.499, GL=1 e 19, P<0.05) che risulta maggiore laddove ci sono più adulti in allarme.

Nei 16 nidi della colonia non distrutti durante il periodo riproduttivo, il numero di giovani involati ed il successo riproduttivo sono significativamente correlati alla distanza dal nido più vicino (Tab. III).

Tab. II - Riproduzione

		n. uova/ nido	% schiusa	n. pulli nati	% sopravvivenza	n. juv. involati	successo riproduttivo
TOTALE	media	2.40	54.7	1.38	52.2	1.15	46.5
NIDI	D.S.	0.59	47.0	1.26	47.7	1.17	44.7
(N=53)	popolaz.	127	57.5	73	83.6	61	48.0
AREA	media	2.37	75.6	1.87	73.3	1.70	68.9
URBANA	D.S.	0.60	40.1	1.12	40.5	1.10	39.8
(N=30)	popolaz.	71	78.9	56	91.1	51	71.8
AREA	media	2.43	27.5	0.74	24.6	0.43	17.4
INDUST.	D.S.	0.58	41.0	1.15	42.0	0.82	32.0
(N=23)	popolaz.	56	30.4	17	58.8	10	17.9
AREA	media	2.56	39.6	1.06	35.4	0.63	25.0
INDUST.	D.S.	0.50	44.0	1.25	46.4	0.93	35.8
(N=16)*	popolaz.	41	41.5	17	58.8	10	24.4

* esclusi i nidi distrutti per cause antropiche.

Tab. III - Correlazioni siti in area industriale
* = p<0.05, ** = p<0.01, ns=p<0.05

	SITO	
	% Cop. veget.	Dist. min. nidi
n. uova deposte	ns	ns
n. pulli nati	ns	ns
n. pulli involati	*	**
% di schiusa	*	ns
successo riproduttivo	*	**
% di sopravvivenza	*	ns

Anche la percentuale dischiusa tende ad aumentare dove maggiore é la distanza minima tra i nidi (r=0.488, N=16, P=0.055). In Tab. III sono evidenziate anche le correlazioni significative con la copertura vegetale presente intorno al nido.

Discussione

Dal confronto delle popolazioni di Gabbiano reale mediterraneo nidificanti più prossime (Valle Cavanata, Grado, P. Utmar *com.pers.*, e Isola Lunga in Istria, E.Benussi *ined.*) (Fig.5), appare evidente come l'incremento numerico delle coppie nidificanti, seppur con valori diversi, coincida con quello della popolazione della città di Trieste. In Valle Cavanata, in un quinquennio la popolazione nidificante è raddoppiata passando dalle 300 coppie del 1987 alle 600 del 1992 (incremento medio annuo 16.6%), mentre minore è stato l'incremento nell'Isola Lunga in Istria 3.5% annuo), passata dalle 320 coppie del 1987 alle 380 del 1992.

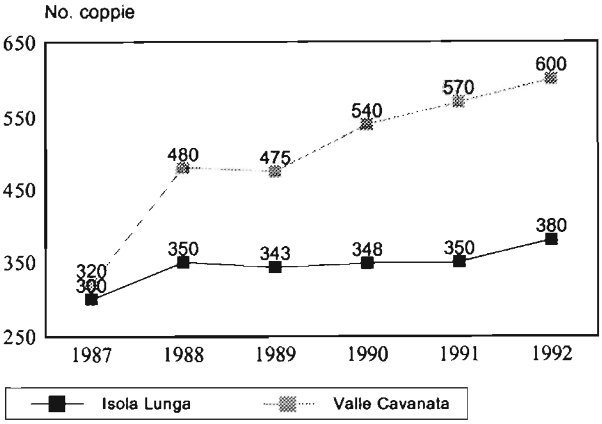

Figura 5 - Andamento delle popolazioni nidificanti dell'isola Lunga (Istria, HR) e Valle Cavanata (Grado), maggiori colonie più vicine alla città di Trieste.

La scelta del sito di nidificazione in ambiente urbano, sembra essere condizionata principalmente dal tipo di substrato e nonostante manchino dati precisi sull'effettiva disponibilità e distribuzione delle diverse tipologie dei tetti della città, si manifesta una spiccata preferenza per le coperture in ciottoli e/o erba (83.8%). La distribuzione dei nidi descritta in Fig. 1 è da interpretare alla luce di questa preferenza.

La distanza minima tra i nidi legittima la distinzione operata tra la popolazione urbana e quella dell' area industriale. Mentre per quest'ultima si può parlare di colonia ben definita, nel senso di gruppo di individui che nidificano ravvicinati manifestando interazioni sociali che favoriscono l'aggregazione delle coppie, l'intera popolazione della città di Trieste potrebbe essere considerata come una colonia lassa in fase di insediamento ed espansione sussistendo, seppure su altra scala, le stesse caratteristiche.

A questa conclusione porta anche la constatazione che gli individui i cui nidi sono posti a distanze elevate, appaiano comunque in grado di cooperare efficacemente alla difesa di altri siti di nidificazione. Alcune situazioni, quali la riproduzione di alcune coppie lontane dai nuclei principali, sembrano potersi attribuire a questa prima fase di colonizzazione in cui la struttura della popolazione non è ancora ben definita nell'area urbana.

Nella colonia dell'area industriale il successo della riproduzione risente evidentemente della forte aggressività intraspecifica, ben nota per il Gabbiano reale mediterraneo, senza che ad essa si accompagni il vantaggio di una maggiore difesa dalla predazione riscontrato per le colonie in ambienti naturali. Nella città infatti sono stati riscontrati solo alcuni casi di predazione di uova e pulli da parte di Cornacchia grigia *Corvus corone* che risulta essere, fino ad ora, l'unica specie in grado di incidere, a nostro avviso marginalmente, sul successo riproduttivo del Gabbiano reale mediterraneo. La riproduzione risulta quindi avvantaggiata nell'area strettamente urbana in conseguenza della minore competizione intraspecifica relativa alla maggiore distanza tra i nidi.

Dall'andamento della popolazione studiata, che dal 1988 ad oggi ha subito un incremento medio annuo del 49.9%, è prevedibile un'ulteriore espansione della specie nei prossimi anni anche se non quantificabile, in mancanza di una precisa valutazione della capacità portante dell'ecosistema urbano e dei suoi fattori limitanti.

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Avocetta N° 18: 29-35 (1994)

Acari plumicoli nuovi per la Fauna d'Italia (*Acari: Sarcoptiformes*).

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Riassunto - L'esame di una collezione di Acari plumicoli occasionalmente raccolti in 7 regioni italiane (Veneto, Toscana, Lazio, Abruzzo, Molise, Campania, Sardegna) su 31 specie di uccelli in gran parte passeriformi (*Alauda arvensis, Anthus campestris, Calandrella cinerea brachydactyla, Cettia cettii, Corvus corone cornix, Delichon urbica, Emberiza calandra, Erithacus rubecula,Fringilla coelebs, Garrulus glandarius, Hippolais icterina, Lanius senator, Lullula arborea, Monticola solitarius, Parus caeruleus, Passer domesticus italiae, Phoenicurus phoenicurus, Pica pica galliae, Prunella modularis, Sturnus vulgaris, Sylvia atricapilla, S. melanocephala, S. sarda, Turdus merula*) ma anche piciformi (*Dendrocopos medius*), caradriformi (*Haematopus ostralegus*),gruiformi (*Porphyrio porphyrio, Rallus aquaticus*) e galliformi (*Perdix perdix, Phasianus colchicus*), ha consentito di individuare 41 specie di Sarcoptiformes. Di esse, una, rinvenuta sull'Usignolo di fiume (*Cettia c.cettii*) in Sardegna ed appartenente al genere *Proctophyllodes* risulta nuova in letteratura. Altre dieci (*Analges bidentatus, A. spiniger, Megniniella obesa, Bychovskiata subcharadriii, Pteronyssoides truncatus, Brephosceles haematopi, Proctophyllodes arcticus, P. troncatus, Temnalges mesalgoides, Hirstia chelidonis*) vengono segnalate per la prima volta in Italia. E' probabile che possano essere considerate prime segnalazioni per il Paese anche quelle relative a *Montesauria rosickji* , di cui sono stati osservati esemplari parzialmente mutilati, e a *Sokoloviana rehebergi*, descritta da Canestrini e Berlese (1881) con materiale proveniente dalla Bolivia.

Introduzione

Una collezione di Acari plumicoli raccolti nel corso delle ricerche sull'ixodofauna parassita di uccelli e giacente presso il Dipartimento di Scienze Ambientali dell'Università di L'Aquila ci ha dato la possibilità di proseguire ricerche sulle specie Sarcoptiformes presenti in Italia.

Sebbene fra i fondatori dell'Acarologia moderna figurino due illustri italiani come Antonio Berlese e Giovanni Canestrini, l'acarofauna plumicola nel nostro Paese è rimasta senza cultori per quasi un secolo.

Il lungo silenzio è stato interrotto solo recentemente con la pubblicazione dei risultati ottenuti nell'isola di Montecristo in seguito all'esame parassitologico su 1707 uccelli migratori appartenenti a 72 specie passeriformi durante gli anni 1989-90 (Mani e Zullo, 1991).

L'abbondante materiale presente nella nostra collezione ci ha fatto supporre che il suo esame avrebbe potuto rappresentare una continuazione dell'anzidetto lavoro e ci ha spinti a proseguire le indagini, per le quali, come nella precedente occasione, s'e rivelata insostituibile e preziosa la collaborazione del Prof.Jean Gaud, dell'Università di Nizza.

Materiali e Metodi

Gli Acari sono stati raccolti fra piume e penne di Uccelli in occasione del loro inanellamento presso alcune Stazioni ornitologiche oppure durante le cure ad essi prestate presso Centri di recupero; in diverse circostanze sono stati prelevati anche da esemplari rinvenuti morti sul terreno.

Piume e penne sono state esaminate dapprima con una lente di ingrandimento e quindi allo stereomicroscopio; quelle su cui sono stati osservati Acari, sono state immerse in alcool a 70° e poi trattate con pennello con setole a punte smusse per distaccarne i parassiti.

La preparazione dei vetrini è stata effettuata secondo le metodiche descritte da Krantz (1986).

Risultati

Nell'elenco che segue si riferisce sulle specie di Acari plumicoli rinvenute, suddivise anzitutto per superfamiglie: Analgoidea (con le famiglie Analgidae, Avenzoariidae Proctophyllodidae, Psoroptoididae, Pyroglyphidae, Trouessartiidae) e Pterolichoidea (con

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le famiglie Falculiferidae, Gabuciniidae, Ptiloxenidae); quindi in rapporto ai generi per ordine alfabetico.

Per ciascuna specie vengono indicati gli ospiti-tipo e quelli su cui sono state trovate nel corso della ricerca nonchè le località di rinvenimento degli ospiti, indicate con le denominazioni dei rispettivi Comuni e, in parentesi, con le targhe automobilistiche delle corrispondenti province, con brevi note di commento. I riferimenti all' opera di Berlese (1885-1897) sono contrassegnati con la sigla "A.M.S. it.", seguita dall'indicazione del fascicolo (con cifre romane) e del numero (cifre arabe) mentre quelli riguardanti i preparati dell'Acaroteca Berlese, desunti dal catalogo di Castagnoli e Pegazzano (1985), sono indicati con due cifre romane separate da sbarra: la prima indica il numero del contenitore, la seconda quella del vetrino.

Tali risultati hanno confermato l'ipotesi che lo studio del materiale occasionalmente raccolto potesse arricchire le conoscenze sull'acarofauna plumicola ; essi, infatti, consentono di segnalare una specie nuova in letteratura e almeno dieci specie nuove per l'Italia nonchè di aggiornare i dati, sistematici e geografici, su alcune di quelle già note per il Paese.

Analgidae

Analges Nitzsch, 1818.

1) **bidentatus** Giebel, 1871.
Ospite-tipo: *Prunella modularis*. Ex: *Prunella modularis* (L.) : isola S.Pietro (CA), 4.XI. 1970 (leg.Mocci Demartis). Note: prima segnalazione della specie per l'Italia.

2) **chelopus** (Hermann, 1804).
Ospite-tipo: *Luscinia svecica cyanecula* . Ex: *Passer domesticus italiae* (Vieillot) : Fagnano (AQ), 22.V.1978; Ururi (CB), 15.X.1978 (leg.Manilla). Note:in Berlese (1884: A.M.S. it. XV, 3,4) come *Analges claviceps* Berl. su "passerucci" a Padova e come *A.incertus* Berl. su *Sylvia atricapilla* a Firenze (Coll.vitr.: 44/19, 90/34); in Canestrini (1886, p.290) come *Analges nitzschii* Hall. su *Emberiza citrinella* nel Veneto.

3) **corvinus** Mégnin, 1877.
Ospite-tipo: *Corvus corone*. Ex: *Corvus corone cornix* L. : S.Demetrio(AQ), 26.XI.1983; Rocca di Mezzo (AQ), 19.X.1984 (leg.Manilla). Note: in Canestrini (1886, p.285) e in Berlese (1886: A.M.S. it. XXIV,4) come *Analges corvinus* Mégn. su *Corvus* sp. a Firenze e *Corvus monedula* " in Toscana".(Coll.vitr.: 44/ 18, 146/27).

4) **passerinus** (L.,1758).
Ospite-tipo: *Fringilla coelebs*. Ex: *Fringilla c.coelebs* L.: Fagnano(AQ), 1.XI.1977 (leg. Manilla). Note:in Berlese (1884: A.M.S.it. XV,1) su *Fringilla coelebs* a Portici (NA) e a Firenze (Coll.vitr.: 86/42, 146/22-25). Canestrini (1886, p.283) ne indica come ospiti "molte specie di passeracei". Su *Fringilla coelebs* è stata rinvenuta anche a Montecristo (Mani e Zullo, 1991).

5) **spiniger** Giebel, 1871.
Ospite-tipo: *Hippolais icterina*. Ex: *Sylvia a.atricapilla* (L.):Santa Giusta (OR), 23.I.1987; ex: *Sylvia s.sarda* Temminck: Isola rossa (SS),7.V.1985; ex *Cettia c.cettii* (Temminck): Santa Gilla (CA), 8.V.1988 (leg. Mocci Demartis). Note:prima segnalazione di specie per l'Italia.

6) **tridentulatus** Haller, 1878.
Ospite-tipo: *Alauda arvensis*. Ex: *Perdix p.italica* Hartert: Montereale (AQ), 24.IX.1978 (leg. Manilla). Note: in Canestrini (1886,p.288) e in Berlese (1886: A.M.S. it. XXIV,3) su *Alauda arvensis* a Firenze (Coll.vitr.:44/15)
Il reperto di specie sulla starna è verosimilmente attribuibile ad una contaminazione accidentale, forse derivante dalla nidificazione a terra, che caratterizza anche l'allodola.

Megninia Berlese, 1881.

7) **ginglymura** (Mégnin, 1877).
Ospite-tipo: *galliformi domestici*. Ex: *Perdix p.italica* Hartert: Montereale(AQ), 24.XI.1978; ex: *Phasianus colchicus* L., Rocca di Cambio (AQ), 9.X.1990 (leg.Manilla). Note: in Berlese (1897: A.M.S.it.,Cryptostigmata I:70) su *Phasianus* sp.a Firenze (Coll.in alcool: 6/297). Mégnin segnalò come ospite-tipo della specie (*Analges ginglymurus*) la cornacchia (*Corvus corone*), sulla quale,in realtà, essa non è stata mai più rinvenuta.Ospiti comuni risultano essere, invece,molti galliformi,soprattutto domestici;sia in Italia che in Olanda,India e Brasile la specie è stata trovata anche su *Meleagris gallopavo* (Gaud *et al.* ,1988), sicchè è probabile che essa sia stata importata mediante il tacchino dall'America all'Europa, dove s'è adattata agli ospiti sui quali attualmente si rinviene più frequentemente (Gaud, 1992).

Megniniella Gaud, 1958.

8) **obesa** Gaud,1968.
Ospite-tipo: *Porphyrio porphyrio*. Ex: *Porphyrio p.porphyrio* (L.): Cabras (OR),20.III.1981 (leg.Mocci Demartis). Note: prima segnalazione di specie in Italia.

Metanalges Trouessart, 1919.

9) **rallorum** (Trouessart, 1885).
Ospite-tipo: Rallus aquaticus. Ex: *Rallus a.aquaticus* L.: S.Omero(TE), 29.XII.1977 (leg. Manilla). Note:in Berlese(1887:A.M.S. it.XXXVII,4) su *Gallinula chloropus* a Firenze (Coll.vitr.44/33 sub *Megninia grossa var. rallorum*).

Avenzoariidae

Bychovskiata Dubinin, 1951.

10) **subcharadrii** Dubinin, 1951.
Ospite-tipo: *Himantopus himantopus.* Ex: *Haematopus o.ostralegus* L. : Isola S.Pietro (CA), 7.V. 1982 (leg. Mocci Demartis). Note: prima segnalazione di specie in Italia.

Parapteronyssus Faccini & Atyeo, 1981.

11) **brevipes** (Berlese, 1855).
Ospite-tipo: *Picus viridis.* Ex: *Dendrocopos m.medius* (L.): Rocca di Cambio (AQ) ,13.XII. 1983 (leg.Manilla). Note:Berlese (1885: A.S.M.it.XVIII,4) fondò la specie (*Pteronyssus brevipes*) con un esemplare maschio trovato su *"Picus" medius* a Firenze (Coll.vitr.: 82/17).

Pteronyssoides Hull, 1931.

12) **striatus** (Robin, 1877).
Ospite-tipo: *Fringilla coelebs.* Ex: *Fringilla c.coelebs* L.: Capri(NA), 23.III.1989 (leg. Montemaggiori). Note: in Canestrini (1886,p.271) e in Berlese (1886: A.M.S. it. XXIV,2) come *Pteronyssus striatus* Rob. su *Fringilla coelebs* a Portici(NA) (Coll.vitr.:5/29,5/37-38,44/27).

13) **truncatus** (Trouessart, 1885).
Ospite-tipo: *Sturnus vulgaris.* Ex: *Sturnus v.vulgaris* L.: Ocre (AQ), 22.X.1978(leg.Manilla). Note:prima segnalazione in Italia. Come *Pteronissus quadratus* Hall. la specie era stata segnalata anche da Canestrini (1886, p.272) e da Berlese (1886: A.M.S.it. XXVI, 3; coll. vitr.55/39) su *Sturnus vulgaris* in Francia.

Proctophyllodidae

Brephosceles Hull, 1934.

14) **haematopi** Peterson, 1971.
Ospite-tipo: *Haematopus ostralegus.* Ex: *Haematopus o.ostralegus* L.: isola S.Pietro (CA), 7.V. 1982 (leg.Mocci Demartis).Note: prima segnalazione in Italia della specie , descritta in Australia con esemplari raccolti su *Haematopus ostralegus longirostris* (Peterson,1971).

Joubertophyllodes Atyeo e Gaud,1983.

15) **modularis** Berlese, 1894.
Ospite-tipo: *Prunella modularis.* Ex: *Prunella m.modularis* (L.): isola S.Pietro (CA), 4.XI. 1970 (leg.Mocci Demartis). Note:Berlese (1894: A.S.M.it. LXXV,9) fondo la specie (come *Alloptes modularis*) con esemplari rinvenuti a Portici (NA) su *Prunella (=Accentor) modularis* (Coll.vitr.: 5/30,47/42, 51/50).Mani e Zullo (1991) a Montecristo(LI) hanno rinvenuto la specie su *Acrocephalus a.arundinaceus* (L.), *Sylvia b.borin* (Boddaert) e su *Prunella modularis.*

Monojoubertia Radford, 1950.

16) **microphylla** (Robin, 1877).
Ospite-tipo: *Fringilla coelebs.* Ex: *Fringilla c.coelebs* L.: Isola Sant'Antioco (CA),7.III. 1982 (leg.Mocci Demartis). Note: in Berlese (1884: A.M.S.it.XVI,7) come *Alloptes palmatus* Can.su *Fringilla coelebs* a Portici (NA) e " in Toscana" (Coll.vitr.: 5/28-29, 5/31-37, 42/18, 42/21-26). Pure da Portici l'A. ne segnalò esemplari anche su *Emberiza* sp. e *Prunella(=Accentor) modularis* (Coll.vitr.:5/32, 5/35). Canestrini (1886,p.290) ne riferì come *Alloptes microphyllus* su *Fringilla coelebs* nel Veneto e nel Trentino. A Montecristo (LI), la specie è stata rilevata su *Fringilla coelebs* (Mani e Zullo, 1991).

Montesauria Oudemans, 1905.

17) **bilobata** (Robin, 1868).
Ospite-tipo: *Alauda arvensis.* Ex: *Alauda a.arvensis* L.: Quartu S.Elena (CA), 25.XII.1980; ex: *Calandrella cinerea brachydactyla* (Leisler): Cabras (OR) 4.VIII.1988; ex: *Lullula a.arborea* (L.): isola S.Pietro (CA), 3.XI.1980 (leg.Mocci Demartis). Note: in Berlese (1886: A.S.M.it. XXVII,10) come *Pterodectes bilobatus* Rob. su *Alauda arvensis* a Firenze (Coll. vitr.: 42/46, 50/50, 156/35-36). Canestrini (1886,p. 306) aggiunge come ospiti *Anthus "arboreus"* e "rondini".

18) **cylindrica** (Robin, 1868) Ospite-tipo: *Pica Pica.* Ex: *Pica p.galliae* Kleinschmidt: Raiano (AQ),7.X.1983 (leg. Manilla). Note: in Canestrini (1886,p.304) e in Berlese (1886: A.S.M. it. XXVII, 9) come *Pterodectes cylindricus* Rob. su *Pica pica* nel Veneto e in Toscana (Coll.vitr.: 208/28).

19) **rosickji** (?) (Cerny, 1963)
Ospite-tipo: *Oenanthe hispanica.* Ex: *Monticola s. solitarius*(L.) : Sarroch(CA), 5.III.1970 (leg. Mocci Demartis). Note:sull'ospite sono stati

rinvenuti due esemplari maschi, molto vicini alla specie descritta da Cerny ma parzialmente mutilati, sicché della specie può solo sospettarsi la presenza anche in Italia.

Proctophyllodes Robin, 1877

20) **arcticus** Dubinin,1952.
Ospite-tipo: *Anthus cervinus* (Pallas). Ex: *Anthus c.campestris* (L.): Santa Giusta (OR), 30.VIII. 1970 (leg.Mocci Demartis). Note: prima segnalazione della specie in Italia e fra le prime del continente. Fu fondata con esemplari raccolti sull'ospite-tipo in Islanda nel 1938.

21) **doleophyes** Gaud, 1957.
Ospite-tipo: *Muscicapa striata*. Ex: *Hippolais poliglotta* Vieillot: S.Zenone degli Ezzelini (TV), 25.VIII.1978 (leg.Mocci Demartis). Note: la segnalazione segue in Italia solo quella di Mani e Zullo (1991),che a Montecristo hanno segnalato la specie su *Ficedula h.hypoleuca* (Temminck), *Luscinia m.megarhynchos* Brehm, *Phylloscopus c.collybita* (Vieillot), *Ph.sibilatrix* (Bechstein) e *Ph.t.trochilus* (L.). Anche in Marocco , dove furono osservati i primi esemplari,la specie era stata rinvenuta su diversi muscicapidi. silvidi e turdidi.

22) **glandarinus** (Koch,1841).
Ospite-tipo: *Garrulus glandarius*. Ex: *Garrulus g.glandarius* (L.): Fontecchio (AQ), 22.XII. 1983 (leg.Manilla) Note: la specie è stata certamente confusa nel passato con altre ad essa sistematicamente vicine oggi riunite in gruppo ("glandarinus group"). Canestrini (1879) nel Veneto e nel Trentino cita fra i suoi ospiti *Carduelis carduelis*, *C.chloris*, *Emberiza citrinella* e anche turdidi, che oggi sono riconosciuti come ospiti tipo di altre specie del gruppo (*Proctophyllodes caulifer*, *P.cotyledon*, *P.rubeculinus*) (Atyeo e Braasch,1966). Nell'acaroteca Berlese risultano attribuiti alla specie esemplari rinvenuti su *Acrocephalus arundinaceus* "in Italia" e su *Passer domesticus* a Firenze (Coll.vitr.: 42/41, 156/34). Mani e Zullo(1991) a Montecristo(LI) hanno segnalato la specie su *Coccothraustes c.coccothraustes* (L.).

23) **hipposideros** Gaud, 19 5 3
Ospite-tipo: *Saxicola rubetra*. Ex: *Phoenicurus phoenicurus* (L.): S.Zenone degli Ezzelini (TV), 25.VIII.1968; ex: *Monticola s.solitarius*(L.) : Sarroch (CA), S.III.1970 (leg. Mocci Demartis) Note: anche questa segnalazione è stata preceduta solo da quella di Mani e Zullo (1991), che hanno osservato la specie a Montecristo (LI) su *Saxicola rubetra* (L.). Sia in Europa che in Africa è stata segnalata su Turdidae di generi diversi: *Oenanthe* (*O.hispanica* L., *O.rufa* Brisson), *Phoenicurus* (*Ph.moussieri* Olph-Galliard, *Ph.phoenicurus* L.), *Saxicola* (*S.rubetra* L.) e *Cercotrichas* (*C. galactotes* Temminck) (Gaud, 1953,1957; Gaud e Till,1961; Atyeo e Braasch, 1966).

24) **leptocaulus** Gaud, 19 5 7 .
Ospite-tipo: *Lanius senator*. Ex: *Lanius s.senator* L.:Sindia (NU),4.VIII.1988; Uras (OR) 9.VIII.1989 (leg. Mocci Demartis). Note: insieme con quella di Mani e Zullo (1991) (sullo stesso ospite, a Montecristo),questa è fra le primissime segnalazioni in Italia della specie, rinvenuta su varie Laniidae in Europa (*Lanius collurio* L., *L.minor* Gmelin) , Marocco (*L. senator* L.) e Giappone (*L.bucephalus* Temminck e Schlegel) (Gaud, 1957; Fritzsch, 1961; Atyeo e Braasch, 1966).

25) **miliariae** Gaud, 1957.
Ospite-tipo: *Emberiza calandra*. Ex: *Emberiza c.calandra* L.: Santa Giusta (OR), 1.IV.1982 (leg.Mocci Demartis). Note:anche questa segnalazione segue solo quella fatta sullo stesso ospite da Mani e Zullo (1991) a Montecristo. La specie è stata ovunque (Marocco,Bulgaria, Cecoslovacchia) osservata su fringillidi del genere *Emberiza* (*E.calandra* L., *E.circlus* L., *E.citrinella* L., *E.hortulana* L. (Gaud, 19S7; Atyeo e Braasch, 1966).

26) **musicus** Vitzhum, 1922.
Ospite-tipo: *Turdus musicus*. Ex: *Turdus m.merula* L.:Ocre (AQ), 22.X.1978; Rocca di Cambio (AQ), 13.XII.1983 (leg.Manilla). *Note*: seconda segnalazione della specie per l'Italia dopo quella di Mani e Zullo (1991) su *Turdus ph.philomelos* Brehm a Montecristo. *Ph.musicus* è stata finora rinvenuta su diverse specie di *Turdus* (*T.iliacus L.*, *T.merula L.*, *T.migratorius L* , *T.naumanni* Temminck, *T.olivaceus, T philomelos Brehm, T pilaris L., T torquatus L., T.viscivorus* L.) in Europa Asia, Africa e Nord-America(Vitzhum, 1922,1929; Gaud,19S7; Vassilev, 1960,1962; Fritzsch, 1961; Lichard, 1962;Atyeo e Braasch, 1966; Wheeler e Threlfall,1986).

27) **parinus** (Koch,1841).
Ospite-tipo: *Parus caeruleus*. Ex: *Parus c.caeruleus* L.: Santu Lussurgiu (OR), 16.I.1979 (leg. Mocci Demartis). Note: in Berlese (1883: A.S.M.it.IV,6) come *Pteronyssus parinus* Koch su *Parus caeruleus* in Toscana (Coll.vitr.: 44/28, 82/14-1S). Sullo stesso ospite è citata anche da Canestrini (1886,p. 275).

28)**picae** (Koch,1840).

Ospite-tipo: *Pica pica.* Ex: *Pica p.galliae* Kleinschmidt : Rocca di Mezzo (AQ), 19.I 1984 (leg.Manilla). Note: Canestrini (1886, p.302) cita la specie nel Veneto su "parecchi uccelli, come ad esempio, *l'Emberiza citrinella, Corvus pica, Anthus pratensis*". In realtà essa è associata a Corvidi dei generi *Corvus* (*C.corone sardonius* Klein.), *Nucifraga* (*N.caryocatactes* L.) e *Pica* (*P.pica* L.), sui quali è stata segnalata in diversi Paesi d'Europa e in Marocco (Koch, 1840; Oudemans, 1897; Vitzhum, 1922,1929; Gaud, 1957; Fritsch, 1961; Atyeo e Braasch, 1966).

29)**rubeculinus** (Koch, 1841).

Ospite-tipo: *Erithacus rubecula.* Ex: *Erithacus r.rubecula* (L.): Capri (NA), 23.III.1989 (leg. Montemaggiori). Note:precedentemente in Italia la specie è stata segnalata solo da Mani e Zullo (1991) sullo stesso ospite. E' nota in Bulgaria, Germania, Inghilterra, Francia, Marocco, Camerun e Madagascar (Koch,1841;Haller,1878; Poppe, 1888; Vitzhum, 1922; Gaud, 1952, 1957; Gaud e Mouchet, 1957; Fritzsch, 1961; Atyeo e Braasch, 1966).

30)**silviae** Gaud, 1957.

Ospite-tipo: *Sylvia atricapilla.* Ex: *Sylvia a.atricapilla* (L.): Capri (NA), 23.III.1990 (leg. Montemaggiori). Note: anche questa specie è stata precedentemente segnalata in Italia solo da Mani e Zullo (1991) a Montecristo oltre che sull'ospite-tipo su *Sylvia u.undata* (Boddaert), *Phylloscopus c.collybita* Vieillot) e su *Erithacus r. rubecula* (L.). La specie è stata osservata anche in Bulgaria e Marocco sull'ospite-tipo e su *Sylvia melanocephala* Gmelin) (Gaud 1957; Atyeo e Braasch 1966).

31)**stylifer** (Buchholz, 1869).

Ospite-tipo: *Parus caeruleus.* Ex: *Parus c.caeruleus* L.: Santu Lussurgiu (OR), 16.I. 1979 (leg.Mocci Demartis). Note:in Berlese (1886: A.S.M.it. XXV,8) su *Parus caeruleus* in Toscana (Coll.vitr.: 202/20-21) e su *Turdus merula* a Portici (NA) (Coll.vitr.:42/43-44). Canestrini (1886, p.303) sottolineò che si rinviene soprattutto su uccelli del genere *Parus*, sui quali è stata effettivamente osservata sia in altri Paesi d'Europa che nell'Africa` nord-occidentale (Buchholz, 1869; Vitzhum, 1922,1929; Bonnet e Timon-David, 1934; Gaud, 1957; Radford, 1958; Fritsch, 1961; Lichard, 1962; Atyeo e Braasch, 1966).

32)**troncatus** Robin, 1877.

Ospite-tipo: *Passer domesticus.* Ex: *Passer domesticus italiae* Vieillot :Fagnano (AQ), 26. VIII.1978 (leg.Manilla). Note: prima segnalazione della specie in Italia. E'stata finora segnalata in Europa,nord-Africa e in nord-America prevalentemente su *Passer domesticus*; talora anche su *P hispaniolensis* (Temminck) e *P.montanus* (L.) (Robin,1877; Vitzhum,1922; Gaud,1957; Fritzsch,1961; Lichard,1962; Atyeo e Braasch, 1966).

33)**n. sp.** Gaud.

Ex: *Cettia c.cettii* (Temminck) :Santa Gilla (CA), 8.V. 1988 (leg.Mocci Demartis). Note:gli esemplari raccolti sull'usignolo di fiume(3 ♂♂, 3 ♀♀) sono simili a *Proctophyllodes silviae* ma con caratteri che li differenziano nettamente da essa (Gaud,*in litteris*).

Psoroptoididae

Temnalges Gaud & Atyeo, 1967

34)**mesalgoides** Gaud & Atyeo,1967.

Ospite-tipo: *Porphyrio porphyrio.* Ex: *Porphyrio p.porphyrio* (L.): Cabras (OR), 20.III.1981 (leg.Mocci Demartis). Note: prima segnalazione della specie in Italia.

Pyroglyphidae

Hirstia Hull,1931.

35)**chelidonis** Hull,1931.

Ospite-tipo: *Delichon urbica* Ex: *Delichon u.urbica* (L.): Onna (AQ),19.VIII.1978 (leg. Manilla). Note: prima segnalazione della specie in Italia.

Trouessartiidae

Trouessartia Canestrini, 1899.

36)**inexpectata** Gaud, 1957.

Ospite-tipo: *Svlvia melanocephala.* Ex: *Sylvia m.melanocephala* (Gmelin) : Cabras (OR), 19.IV. 1979 (leg.Mocci Demartis). Note:in Italia era stata segnalata solo a Montecristo (LI) da Mani e Zullo (1991) su *Sylvia m.melanocephala* (Gmelin), *S.c.cantillans* (Pallas) e *Phylloscopus c.collybita* (Vieillot).

37)**rosterii** (Berlese, 1886).

Ospite-tipo: *Sturnus vulgaris.* Ex: *Sturnus v.vulgaris* L.: Ururi (CB), 15.X.1978 (leg. Manilla). Note: la specie fu fondata da Berlese con esemplari rinvenuti su *Sturnus vulgaris.* Sullo stesso ospite è stata rinvenuta anche a Montecristo (LI) da Mani e Zullo (1991).

38) **rubecula** Jablonska, 1968.
Ospite-tipo: *Erithacus rubecula*. Ex: *Erithacus r.rubecula* (L.) : Palo (Roma), 28.III.1989 (leg. Montemaggiori). Note: la specie e stata precedentemente segnalata in Italia solo da Mani e Zullo (1991) sullo stesso ospite a Montecristo (LI).

Falculiferidae

Falculifer Raiiliet,1896.

39) **rostratus** (Buchholz, 1869).
Ospite-tipo: *Columba livia domestica*. Ex: *Columba l.livia Gmelin*: Corvaro (RI), 15.VIII.1986 (leg. Manilla); Viareggio (LU),17.X.1991 (leg.Baldaccini). Note: come *Falciger rostratus* (Buchh) in Canestrini (1886, p.249) su *Columba livia* e *C.palumbus* nel Veneto e in Berlese (1886: A.S.M.it. XXVII,6) su "piccioni" a Firenze e su "colombi di passo" a S.Vincenzo (PI) (Coll.vitr.: 146/40-41, 151/8-9, 213/6-7).

Gabuciniidae

Gabucinia Oudemans, 1905.

40) **delibata** (Robin, 1877).
Ospite-tipo: *Corvus corone*. Ex: *Corvus corone cornis* L.: Rocca di Cambio (AQ), 19.XI.1983 (leg. Manilla). Note: in Canestrini (1886,p. 256) e in Berlese (1886: A.M.S. it. XXVII,8) come *Pterolichus delibatus* (Rob) su *Corvus* sp. a Firenze (Coll.vitr.: 49/20).

Ptiloxenidae

Sokoloviana Dubinin, 1951.

41) **rehebergi** (Can.e Berl.,1881)
Ospite-tipo: *Haematopus ostralegus*. Ex: *Haematopus o.ostralegus* L.: isola di S.Pietro (CA), 7.V. 1982 (leg. Mocci Demartis). Note: la specie fu fondata dagli Acarologi italiani (come *Pterolichus rehebergi*) con rari esemplari rinvenuti su *Pluvialis dominica* (Muller) della Bolivia. Canestrini (1884) aggiunse che essa "vive sull' *Haematopus ostralegus*",senza precisare se ne avesse osservato altri esemplari anche in Italia, sicchè e probabile che questa segnalazione sia la prima per il Paese. Nell'acaroteca Berlese è conservato un maschio della specie rinvenuta sul piviere americano (Coll.vitr.: 52/5).

Discussione

I risultati delle indagini sull'acarofauna plumicola, riprese in Italia dopo un secolare disinteresse, se non consentono ancora di colmare molte lacune, si prestano ad alcune considerazioni, fra le quali ci sembra particolarmente rilevante, oltre la eccezionale attualità che ancora conservano gli studi di Berlese e Canestrini, quella riguardante la specificità parassitaria.

Per una migliore conoscenza delle relazioni filogenetiche e della distribuzione geografica degli Uccelli, Hopkins (1951) propose come specie indicatrici i Mallofagi, dopo che le ricerche ' fino ad allora condotte sembravano aver dimostrato che ad ogni specie di tali Insetti ne corrispondesse una d'ospiti.

Gli studi successivi hanno dimostrato, invece, che tale specificità va spesso intesa in senso lato, poichè in più occasioni una stessa specie di Mallofagi é risultata associata a numerose specie di uno stesso ordine di Uccelli, rendendo così difficoltosa e talora impossibile una corretta interpretazione della coevoluzione parassita-ospite. Peraltro la diagnostica delle specie Mallophaga si avvale tuttora della biometria, che notoriamente e fra le metodiche meno adatte a standardizzare l'errore, sicchè la proposta di Hopkins è basata su presupposti difficilmente attuabili, almeno fino a quando la sistematica dei Mallofagi non si avvarra di piu sofisticati mezzi di indagine (Manilla e Gelsumini, 1988).

Gli Acari plumicoli, invece, anche dal nostro lavoro risultano più strettamente associati agli ospiti, nei cui confronti l'associazione solo raramente si spinge fino ai limiti delle famiglie e la cui diagnosi e classicamente fondata su caratteri somatici spesso ai limiti dell'evidenza ma certamente piu discriminanti e, perciò, piu scevri da errori. L'Ornitologia, perciò, potrà avvalersi di essi, più degli stessi Mallofagi, per lo studio delle diverse problematiche che fra gli Uccelli sono ancora aperte alla discussione.

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Summary - Feather mites occasionally collected in 7 italian Regions (Veneto , Toscana, Lazio, Abruzzo , Molise, Campania, Sardegna) on 31 species of birds for the most part Passeriformes (*Alauda arvensis, Anthus campestris, Calandrella cinerea brachydactyla, Cettia cettii, Corvus corone cornix, Delichon urbica, Emberiza calandra, Erithacus rubecula, Fringilla coelebs, Garrulus glandarius, Hippolais icterina, H.polyglotta, Lanius senator, Lullula arborea, Monticola solitarius, Parus caeruleus, Passer domesticus* *italiae, Phoenicurus phoenicurus, Pica pica galliae, Prunella modularis, Sturnus vulgaris, Sylvia atricapilla, S. melanocephala, S.sarda, Turdus merula*) but Piciformes (*Dendrocopos medius*), Caradriiformes (*Haematopus ostralegus*) , Gruiformes (*Porphyrio porphyrio, Rallus aquaticus*) and Galliformes (*Perdix p. italica, Phasianus colchicus*) also, are studied.

41 species of Sarcoptiformes are isolated: a *Proctophillodes* on river nightingale (*Cettia c. Cettii*) of Sardinia is new species. Certainly 10 (*Analges bidentatus, A. spiniger, Megniniellla obesa, Bychovskiata subcharadrii, Pteronyssoides truncatus, Brephosceles haematopi, Proctophyllodes arcticus, P. troncatus, Temnalges mesalgoides, Hirstia chelidonis*) and probably 2 (*Montesauria rosickii, Sokoloviana rehebergi*) other species are new records for Italy.

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The Dipper *Cinclus cinclus* in Sicily

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Abstract -. The distribution and density of the Dipper (*Cinclus cinclus*) in Sicily has been studied from existing records over the main island's catchments. The species has been decreasing in number over the past 40 years and it is now restricted to a few , isolated and residual montane areas and can be considered on the verge of extinction. Mean density in these areas (6.3 pairs/10 kms) matches the mean values reported for continental Europe, but the decrease in range and the isolation of the populations follow the progressive drying and transformation undergone by the Sicilian basins as a result of anthropogenic and metereological factors. The Dipper's presence is strongly tied to permanent streams, but its density, assessed by multiple regression analysis, is related to stream bed morphology: gradient, substrate granulometry, water temperature and depth. The species breeds along stretches of high quality water where, according to the E.B.I. method, the fauna is richer in macroinvertebrate than elsewhere.

Introduction

In the past few decades, owing to progressive human intervention, the natural environment of Sicily has undergone large changes in its characteristics and appearance. In this regard, some stenotropic (i.e. organisms exhibiting a limited response of adaptation to changing environmental conditions; Lincoln et al. 1990) riverine species sensitive to the altered environment, act as ecological indicators.

Lotic ecosystems represent one of the Sicilian environments recently affected by heavy anthropogenic pressure. River embankment works, canalisation building of artificial dams and basins, groundwater capture and collection, are all responsible for the drying up or radical transformation of the majority of Sicilian streams. The prolonged drought of the past few years (1987-1990) has on one hand caused the natural drying up of several torrents, while on the other increased the consumption of water. In this context, the Dipper (*Cinclus cinclus*) can play a crucial role both as an ecological indicator of the quality of the lotic ecosystems still in existence, and as a species in great danger of extinction along with the aquatic community it represents. With this view in mind, we present the preliminary results of research, started in 1987, on the Dipper's distribution and ecology across the island.

Material and Methods

Data and information on the captures and habits of the Dipper in Sicily since the second half of the last century, were obtained from library and museum records. Some historical texts reported breeding in some areas, whereas breeding from the museum records was judged by the date of capture. The historical research checked all the main texts and sicilian collections and the resulting past Dipper distribution can be considered quite exhaustive even if some information has been lost (i.e. specimens in Italian and foreign museums and few specimens without data in Sicilian collections).

Thirty field excursions in some of the main Sicilian catchment basins, where the species was formerly recorded, were carried out to check for the presence and breeding of the species, in line with the European Ornithological Atlas Committee code (A=possible; B=probable; C=certain breeding), and thus update the Regional Atlas (UTM grid; 10kms per side) distribution data for the 1979-1983 period (Priolo in Massa 1985). With the aim of determining the population density of the species in some sample areas, 41 additional field trips were repeated in different months (from April to July and October-November) of the years 1988-90 in 7 streams, in the Nebrodi mountains of North-Eastern Sicily (Rosmarino, Scavioli, San Barbaro, San Fratello, Milè, San Pietro) and the Sicani mountains in MidWestern Sicily (Sosio river).

The duration of each trip was timed, excluding pauses; this enabled us to estimate the relative contact frequency (n of contacts/trip duration in min) and the number of individuals. The number of nest-building pairs was estimated along some of the torrents by searching for nests and "doubling back" method

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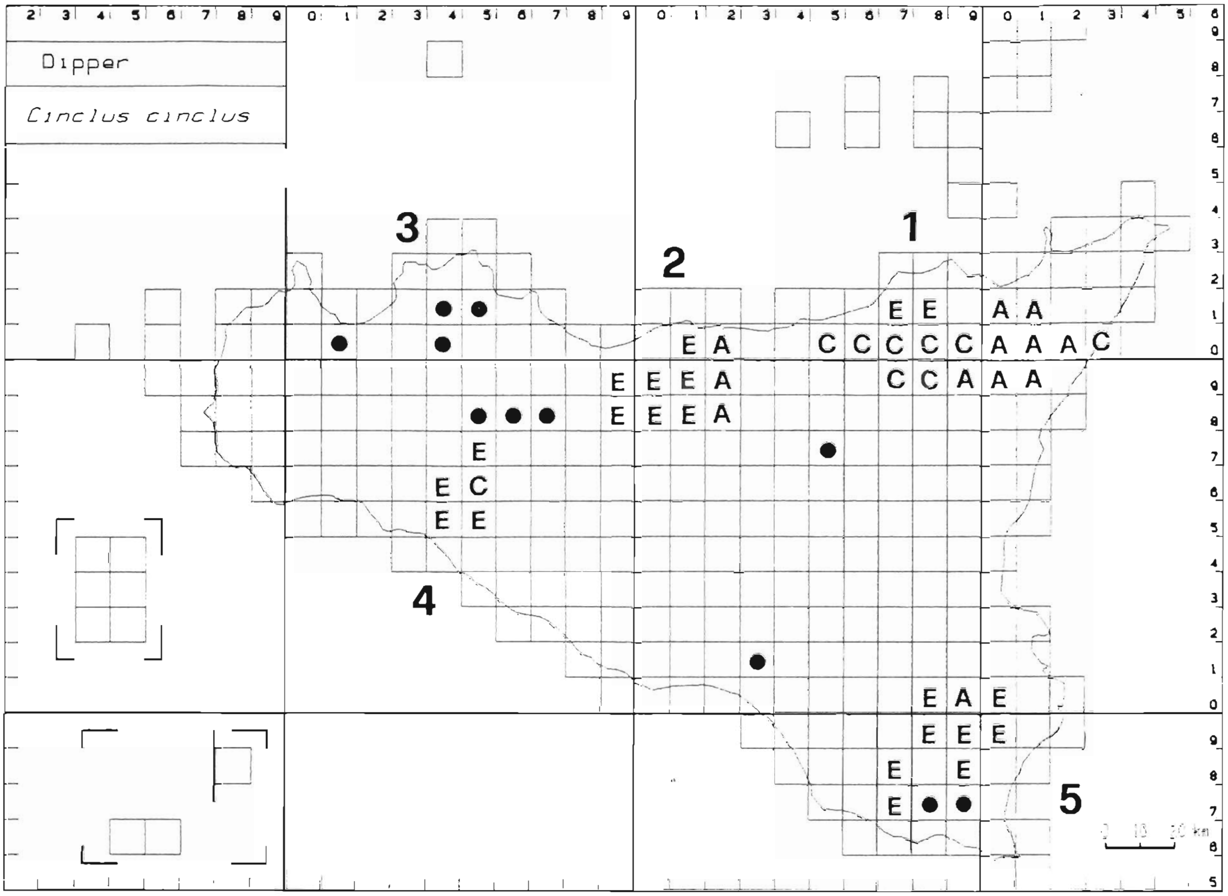

Figure 1 - Distribution of Dipper (*Cinclus cinclus*) in Sicily on an U.T.M. grid (10 kms per square). C = certain breeding, A = possible breeding; E = extinct within the period 1950-90, black dots = past records of presence and/or breeding before 1950. Dipper absence was checked and confirmed in the squares marked with E and black dots during the research. 1-5 regions cited in text; 1 = Caronie and Peloritani; 2 = Madonie; 3 = Conca d'Oro; 4 = Sicani; 5= Iblei.

(Balat, 1962); in that individuals occupy linear territories and at their borders change flight direction so as to remain within their own home range.

The physical features of each stream were monitored and recorded at the same stations in different months. Water temperature, pH and dissolved O_2 were measured with portable instruments; a mean of 7,6 ± 4,9 samples of temperature, pH and O_2 were recorded per excursion. Samples of aquatic macroinvertebrates, taken by one of us (Gi.Sa.) at two fixed stations (up and downstream) in 5 streams, according to the standard E.B).I. methods (Woodwiss 1978, Ghetti 1986), have enabled us to assess the water quality of stretches of these streams. By the use of multiple regression analysis (MULVA software, Wildi and Orloci 1990), in which the Dipper density (pairs/kms) is considered the dependent variable and the torrent characteristics the independent ones, we worked out the importance of the torrent features as correlates with the Dipper density .

Results

Distribution

The Dipper is now scarce in Sicily, with small populations becoming increasingly isolated; the distribution map for the 1979-1990 decade, together with some historical records, is shown in Fig. 1.

Breeding is certain (C) only in 9 UTM squares, corresponding to 3% of the whole grid representing Sicily in the Atlas Faunae Siciliae-Aves (Massa 1985); in 12 more squares breeding is possible (A). In 21 more squares the letter E (extinct) was used to indicate the areas where Dippers were recorded, as breeders, during the years 1950-79, and were checked but not found in 1979-90.This past distribution was worked out both from historical records and monitoring of the remnants of suitable habitats (dry and/or cemented river beds) located within the hydrografic basins in which this species was encountered in the 1979-90 period. (•) indicates other historical encounters (1800-1950) both of breeding birds and wanderers.

The following is the summarized status relative to the main regions:

Conca d'Oro mountains (Palermo): the former presence of the bird in this area is presumed from reports from Doderlein (1869-1874) and from 3 stuffed individuals found along the upper Oreto valley in 1902 and 1907 (Whitaker and Orlando collections). Recent records (2 shooted individuals after 1960 and a third on 3 .12.1990) indicate its sporadic presence in winter, along the Oreto catchment, whose branches carry water only during the winter period.

Caronie and Peloritani mountains: until the past century, the Dipper was a common species (Giglioli, 1890); 27 individuals were stuffed between 1940 and 1960 (Priolo and Trischitta collections). Today this area is the only suitable environment for the species, which is present with probably the last viable population. The ongoing constructions in concrete could endanger the integrity of the last Sicilian stronghold for this species.

Madonie mountains: here the species was sedentary and common, in the opinion of Minà Palumbo (1857), Doderlein (1869-1874) and Giglioli (1890); 11 specimens were stuffed between 1932 and 1987 (Baglieri, Sorci, Orlando, Cannata collections). The Dipper is to be considered as virtually extinct here, for the drying up of most of the perennial torrents due to water collection and concrete construction carried out in the past 3 years, together with the prolonged drought. Occasionally, individuals may be encountered in the winter.

Sicani mountains: one encounter is reported by Krampitz (1958) along the Sosio river; later (1970) two more individuals were captured in the same basin. Three specimens (1902-32) from the Corleone area (Orlando and Whitaker collections) indicate the occurrence of breeding in a region included among the Sicani, Madonie and Palermo mountains. The research has confirmed the occurrence of breeding along the Sosio river; however, the recorded pairs were only 4 and the water level of the remains (12 kms) of this unique environment is quite unstable due to an upstream lock.

Iblei mountains: the species, considered as sedentary yet scarce in the Modica district, could still be found in suitable areas along the Anapo river and its tributaries . Its presence was reported in 1958 (2

Table 1 - Mean ± standard deviation features of five sicilian streams, where the Dipper (*C. cinclus*) population has been studied. Systematic Units refer to the number of macroinvertebrate taxa according to the EBI procedure; na=not available. All the characteristics, except downflow, pH and O_2, were used as indepedent variables to regress Dipper density in the same torrents.

	Scavioli	S. Fratello	S. Barbaro	Sosio	Rosmarino
Downflow	continuous	continuous	continuous	continuous	continuous
Turbulence (cm/sec)	4.5	4.5	3.5	3.5	3.0
Width of wet river bed (m)	4.5±1.1 (2.5-6.5; n12)	8.6±0.9 (7-10; n8)	3.2 (n3)	5.2±1.3 (4-7; n6)	10.4±2.7 (7-15; n10)
Width of dry river bed (m)	17.7±8.8 (12-40; n10)	19.6±3.4 (14-25; n8)	13.7 (n3)	15±5.3 (8-22; n8)	70.5±21.5 (45-100; n10)
Course depth (cm)	24.6±9.8 (10-50; n24)	80.6±43.1 (20-160; n16)	30.8±21.5 (5-50; n6)	59.2±33.1 (20-150; n12)	20±8.2 (10-30; n10)
Pool depth (cm)	61.7±17.4 (20-100; n24)	112±47.8 (40-200; n16)	73.3±23.4 (50-100; n6)	150±77.3 (70-300; n10)	43.3±15.3 (30-60; n10)
Gradient (m/km)	12.5%	8.5%	4.7%	3%	5%
Dominant substratum (diameter of stone)	mass of stones (>265 mm)	mass of stones (>265 mm)	gravel. pebbles (2-265 mm)	gravel. pebbles (2-265 mm)	gravel. pebbles (2-265 mm)
Water temperature C°	17.9±4.28 (5-27; n41)	17.3±1.3 (15-19; n10)	23.7±3.29 (20-29; n14)	19.6±1.5 (18-21.5; n9)	24.7±4.5 (19-29; n10)
pH	8.34±0.15 (7.85-8.48; n40)	8.36±0.07 (8.27-8.44; n20)	na	na	8.52±1.5 (6.3-11; n10)
% saturation of water O_2	105.9±8.1 (88.8-114.7; n36)	121.1±6.8 (114.3-132.2; n9)	96.4±6.0 (88.5-98.8; n8)	na	108.9±0.9 (107-109.9; n10)
Systematic Units	12.5	11	8	14.5	6.5

specimens in the Trischitta collection), and later between 1979 and 1983, by Priolo (1985) along the Anapo and Cassibile rivers. However, recent research (1990-92) has failed to confirm its presence in stretches of the same rivers. In all cases, the individuals recorded ten years ago belong to another relict small population not yet localized.

Habitat characteristics

The results of the habitat surveys on five rivers are presented in Table 1, whereas the results of the Dipper census are reported in Table 2. In the natural reaches of these torrents the average density is 0.63 pairs/km (± 0.29; 0.1-1; n=7); whereas in the canalized reaches, the species was always absent (0 pairs over 8 kms), with the observed disappearance of some breeding pairs due to the concrete construction of banks carried out from 1988 to 1990 on the Scavioli and S. Pietro torrents. Table 3 shows the results of the multiple regression test: the multiple squared correlation coefficient R is equal to 1 (F test for analysis of variance on R = 16.96 > $F_{9,5}$ = 13,8; P<0.005). R measures the fit of the independent variables to the dependent one; the high value obtained, means that the variation in density can be fully explained by the simultaneous variation of the 9 variables characterizing the torrents. The variables which highly correlate (> 0.90) with the Dipper density have proven to be the substratum granulometry, turbulence and temperature; the last correlation being negative (i.e. the warmer the water the lower the Dipper density). The remaining variables, also show quite a high correlation (from 0.51 to 0.68); among these the course depth is liable to correlate positively with Dipper abundance only over a limited range (i.e. 0-10 m.; Ormerod in litt.). Only two variables, the pool depth and the width of wet river bed, does not seem to affect the Dipper density.

The better habitats are thus the larger branches of the mountain torrents which are highly hydrodynamic, with low temperature waters and the substratum made of big stones and large pebbles, such as the San Fratello or the Scavioli streams. The final reaches of these torrents with a slighter slope, wider bed, lower hydrodynamism and warmer waters, as well as the

Table 2 - The Dipper (*C.cinclus*) relative breeding density in some streams in Sicily. The linear home range is from 1000 to 2500 m. for a pair; in Wales it ranges from 300 to 2000 meters.The minimun length of a stream in which a breeding population exists is 10 km (Sosio, Mid-Western Sicily). (*) This high frequency results from excursions during the post-breeding season. n = n of excursions per stream in April-July and October-November 1988-90. One pair of Dippers disappeared from the Scavioli stream due to damming work from 1988 to 1989. Linear densities from Scavioli 1989, S.Fratello, Sosio, S.Barbaro and Rosmarino were used as dependent variable to compute multiple regression analysis with the torrents characteristics as indipendents (Table 1).

	Stretch censussed (km)	Linear Density (pair/km)	Frequency (n 'contacts /t excursion)
Natural Stretches			
Scavioli 1988	9	0.78	0.044±0.02 (0.02-0.07: n9)
Scavioli 1989	8	0.75	0.038±0.02 (0.02-0.07; n5)
S.Fratello	4	1	0.082±0.05 (0.01-0.16; n6)
Sosio	10	0.4	0.031±0.03 (0-0.5; n5)
S.Pietro	1.5	0.71	0.01 (n3)
Milè	1.5	0.67	0.19 (*) (n2)
S.Barbaro	1.5	0.1	0.01±0.01 (0-0.2; n4)
Canalized Stretches			
Scavioli 1989	1	0	0 (n1)
S.Pietro and Milè	3	0	0 (n3)
Rosmarino	4	0	0 (n3)

Table 3 - Multiple regression analysis of Dipper density (Y = dependent variable) over 9 stream characteristics (X_1-X_9= indipendent variables). B' coefficients are the standard partial regression coefficients and give the rate of change in standard deviation unit of Y per one standard deviation unit of Xi (all other X variables kept constant). B are the conventional partial regression coefficients necessary to compute the regression equation; each B yields the rate of change of Dipper density as a function of a given X variable with the other kept constant at their means. Rs are the univariate correlations among the density and each indipendent variable. The intercept of the regression equation = 1.391.

Independent Variables	B'	B	R
Width of wet river bed (m)	-0.421	-0.059	0.004
Width of dry river bed (m)	0.111	0.002	-0.514
Course depth	0.230	0.376	0.664
Pool depth	0.187	0.185	0.382
Gradient	-1.050	-0.117	0.681
Substratum	2.638	0.015	0.914
Temperature	-0.182	-0.23	-0.961
Turbulence	-1.063	-0.672	0.944
Systematic Units	0.001	0.000	0.606

Table 4 - Results of the Extended Biotic Index procedure to assess water quality by macroinvertebrate sampling in some Sicilian stream. Number of Systematic Units (S.U.) per each taxonomic group used in the E.B.I. method arranged accorging the quality class at each station. The Dipper was absent (abs) from stretches of lower water quality (classes III-IV) whereas breeding (br) occured in higher water quality stretches.

	Scavioli1	S.Fratello1	Sosio1	Sosio2	Scavioli2	Rosmarino2	Rosmarino1	S.Fratello2
Trichoptera	7	0	1	2	2	2	1	1
Plecoptera	1	1	1	1	0	0	0	0
Ephemeroptera	2	4	2	3	4	3	4	2
Diptera	2	1	1	2	2	0	1	2
Eteroptera	1	2	0	1	1	0	0	3
Triclades	1	0	0	0	0	0	0	0
Oligochetae	1	0	0	0	0	0	0	0
Cleoptera	0	3	4	4	1	1	1	1
Odonata	0	1	3	2	0	0	0	0
Urudinea	0	0	1	0	0	0	0	0
Crustacea	0	0	0	1	0	0	0	0
Total S.U.	15	12	13	16	10	6	7	9
E.B.I. value	8	8	8	9	6	6	7	5
Quality class	II	II	II	II	III	III	IV	IV
Dipper	br	br	br	br	br	abs	abs	abs

tributary streams of the mountain torrents with shallow waters, narrow bed and absent flow during the summer months, can be then considered as secondary habitats. However, these streams play a crucial role in the spreading of the young birds and during the altitude migrations of the autumn-winter period, by allowing dispersal inside and among the basins (Price and Bock 1983). The density in these streams (e.g. San Barbaro) is very low and individuals are especially found during the post-reproductive period. In Wales, the abundance of nest-building pairs (Ormerod et al. 1986, Ormerod and Tyler 1987) is closely linked to slope and water hardness, as well as to the abundance of Plecopteran, Trichopteran and Ephemeropteran larvae, the main feeding source for the adults and youngsters. It is worth remarking that the same macroinvertebrate taxa represent key-groups for high quality water determination, according to the EBI methods.

Damiani (1988), by comparing EBI stations respectively located in a natural and a canalized bed of the Aterno river (Abruzzo - Central Italy), has found that the natural stream, with its 22 Systematic Units (n of taxa arranged according the EBI procedure), falls within quality class I, whereas the canalized reach, with only 4 Systematic Units, belongs to class IV and the Trichoptera, Ephemeroptera (except *Ecdyonurus* spp.) and Plecoptera are absent. It can then be hypothesised that the species should be present along streams with a higher EBI value. This is in agreement with the results gained from some EBI sampling along 5 of the 7 considered streams.

The species, in fact, breeds along the reaches with water of class II quality (8-9 EBI value) and is absent or occasionally present where the class becomes III-IV (5-6 EBI value) (Table 4). Abundance and quality of food is therefore important; the number of Systematic Units proved, in fact, to be positively correlated by multiple regression analysis, with Dipper density. Finally, it is worth remarking the higher taxonomic richness and relative abundance of Plecoptera, Trichoptera and Coleoptera found in the stretches where the Dipper breeds (Table 5). As cited by Ormerod et al. (1986) and Ormerod and Tyler (1987), all the chemical and physical parameters affecting the abundance and composition of the benthic fauna are also likely to influence the population density.

Table 5 - Mean number of S.U. (left) and numerical percentage (right) found in stretches where the Dipper is breeding or absent.

	Dipper breeding Mean S.U.	Dipper absent Mean S.U.	Dipper breeding % N	Dipper absent % N
Trichoptera	2.4	1.33	11.09	4.55
Plecoptera	0.8	0	3.12	0.00
Ephemeroptera	3	3	38.99	81.17
Diptera	1.6	1	16.64	7.14
Eteroptera	1	1	1.73	4.22
Triclades	0.2	0	0.35	0.00
Oligochetae	0.2	0	4.33	0.00
Coleoptera	2.4	1	17.68	2.92
Odonata	1.2	0	1.39	0.00
Irudinea	0.2	0	0.35	0.00
Crustacea	0.2	0	4.33	0.00
Mean S.U.	13.2	7.33		
Mean E.B.I. value	7.8	6		

Discussion

The location of Sicily on the edge of the European living range for the Dipper, makes the island, with its hot and dry Mediterranean climate, few and small rivers and torrents, an extreme habitat for the species. The Sicilian average density of 6.3 pairs/l0 km matches the mean values reported by Roche (1988) for France (1.5-10.7 pairs/10 km) or by Ormerod et al. (1985) for Wales (2-8 pairs/10 km). The first limiting factor, as already recorded in Morocco (Tyler and Ormerod 1991), for the species distribution in Sicily is the presence and extension of a network of permanent streams. All the remaining factors (both anthropogenic and metereological), which alter the downflow and water quality within the island's suitable areas, were responsible for its decrease since the 1950. Ormerod and Tyler (1993) showed, how other pollutants than acidity, such as organic enrichment, can also affect Dippers by reducing food abundance. Since the montane streams and stretches house the nucleus of the reproductive population, every alteration of these will directly affect density. On the other hand, any alteration of the secondary habitats will cause the progressive isolation of the populations, as shown in the distribution map.

Adaptations to extreme Mediterranean conditions could be interesting to investigate. The Sosio Dippers, for example, suffered in 1991 a prolonged (at least July-October) water shortage from the upstream lock, that reduced the river to a sequence of pools and small basins without a continuous downflow; but this small nucleus (4 pairs so far recorded, that should be below the minimum viable population) was still breeding there in 1992.

Until the first few decades of the 20th century, the Dipper must have had a continuous distribution along the North-Western Ridge which includes the Peloritani, Caronie, Madonie and Palermo province mountains. The Eastern Sicani populations were probably connected to this area through the upper Belice basin, whereas the Southern Iblei populations were probably already isolated at that time. By adding the 21 squares marked with E and the other 21 in which the species results as a certain (C) or possible (A) breeder we should obtain an idea about the Dipper coverage in the 50s and 60s (14.1%). Therefore, the suitable area for the species has undergone a 57% decrease (in number of squares) in the last 30-40 years and it seems doomed to diminish even further, on the basis of the census carried out in 1991-92 in the Madonie and Ibleian mountains. Anyway, some records outside the breeding season, within the Conca D'oro and Madonie catchments (such as the bird shooted in December 1990 along the Oreto river or a second shooted in August-February 1991 along the Northern Imera river) can evidence either a certain dispersion from the known breeding areas or the presence of small nuclei not yet localized.

The decrease of the distribution area and the isolation of the populations seems to follow the progressive drying undergone by the Sicilian basins in response to the synergic effects of anthropogenic and metereological factors. This process can be seen in the framework of a more general "anthropogenic desertification" in progress in Sicily and in the Mediterranean range of Dippers. Water resource development, catchment perturbation and water pollution is widespread in Southern Italy and generally in the Mediterranean region, and should be properly monitored also by using Dippers as indicators of water quality.

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Riassunto - Si riportano i dati di distribuzione e densità in Sicilia del Merlo acquaiolo (*Cinclus cinclus*), desunti da ricerche museografiche, bibliografiche e sul campo. La specie mostra una distribuzione molto localizzata in residue aree montane e la sua copertura è in diminuzione dagli ultimi 40 anni. La densità media in 7 torrenti presi come campione è di 6.3 coppie/l0km, ed è comparabile a quella di altre aree europee, ma la specie è sulla soglia dell'estinzione a causa delle trasformazioni del suo habitat determinate dall'intervento umano e da fattori meteorologici. La presenza del Merlo acquaiolo è infatti fortemente legata a corsi d'acqua a deflusso ininterrotto, mentre la sua densità è correlata alle caratteristiche morfologiche dei torrenti (pendenza, substrato roccioso, altezza e temperatura dell'acqua, ecc.). La specie inoltre sembra nidificare esclusivamente lungo torrenti o tratti di questi dove è stata determinata, per mezzo del metodo E.B.I, un'alta qualità delle acque.

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The foraging behaviour of the Chough *Pyrrhocorax pyrrhocorax* in two contrasting habitats

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Abstract - The foraging behaviour of the Chough *Pyrrhocorax pyrrhocorax* was compared between Alpine and coastal environment at the same time of the year (summer).

Choughs in both study areas (Aosta valley in northwestern Italy and the isle of Islay in western Scotland) took a wide range of arthropods but the diet appeared more diverse in the Alpine area. The Aosta Choughs had more variable feeding methods than the Islay ones. Such differences might merely reflect the prey species diversity of the two sites, perhaps in turn depending on the environmental diversity. The length of stay at any one patch was considerably shorter at Aosta, and this might be related to the lower cost of moving in the Alps, by being able to glide along steep slopes. Pecking rates were similar in the two areas, although slightly faster at Aosta. Observations carried out on Islay on colour-ringed individuals suggested that foraging techniques were age-dependent.

Introduction

The Chough *Pyrrhocorax pyrrhocorax* is a corvid whose populations all over Europe are declining considerably (Bignal and Curtis 1988). This species feeds mainly on soil and soil-surface invertebrates, changing its diet according to the availability of prey species (Cowdy 1973, Roberts 1982 and 1983, Garcia-Dory 1983, Warnes and Stroud 1988, McCracken *et al.* 1992, Soler and Soler 1993). In Scotland birds show seasonal variation in the use of vegetation patch types (Warnes and Stroud 1988) and display different activities in different patches (Curtis *et al.* 1988).

However, the Chough occurs in two dramatically different environments, high Alpine continental areas and low coastal maritime ones. Since the food items available to the Chough will differ widely between the two habitats, it seemed likely that the birds' foraging behaviour might also be very different as they coped with divergent conditions. The aim of the present study was to compare the foraging behaviour of the Chough in both Alpine and coastal environments at the same time of year (summer).

Study areas and Methods

The Alpine study area was near Aosta, Italy, in the upper (southern) part of the Val di Rhêmes, an area of cliffs and Alpine pastures at an altitude of 1,950-2,500 m (Fig. 1), which was visited from 11 June to 12 July 1991, following preliminary observations in July 1990. The coastal area was the island of Islay, Argyll, UK, on the west coast of Scotland. Two study sites were established on Islay, one on a sandy peninsula at Ardnave at the north end of the island and the other at Kilchoman, a bay on the west coast (Fig. 2). Both were areas mainly of short grazed grassland with fields of improved grassland (some cut for hay and silage) and sand dunes. Field observations on Islay were carried out from 26 June to 17 July 1991.

Observations on the Choughs in both areas were made using binoculars and 15X-45X telescopes from vantage points. Flock size was determined whenever the whole group could be seen clearly and detailed observations of foraging behaviour and feeding rates were made opportunistically whenever flocks were close enough to the observers. The tameness of the Choughs on Islay allowed observation from 50-100 m while the birds at Aosta were observed from 100-300 m. On Islay we could determine the age of many individuals since the population was colour-ringed (Bignal *et al.* 1987)

The duration of the Choughs' stay in each patch of pasture was measured by selecting one bird in the middle of a landing group and recording the time for which it foraged before flying up and moving to a new patch (over 50 m away). In similar observations

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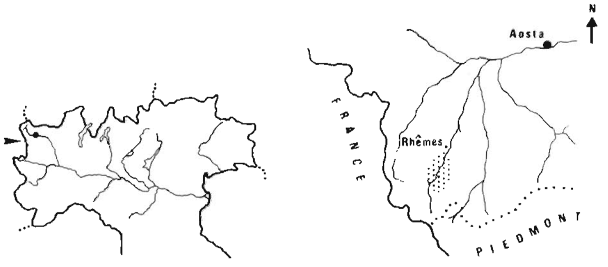

Fig. 1. Location of the Val di Rhêmes in northern Italy and that of the study area in the southern part of the Val di Rhêmes (in the Aosta Valley).

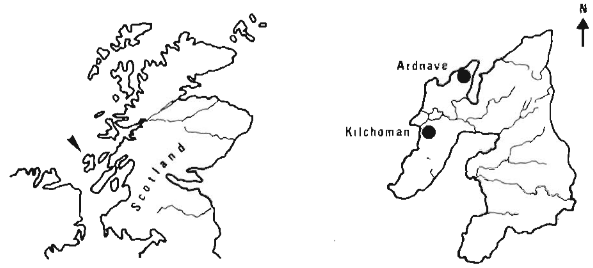

Fig. 2. Location of the isle of Islay in Scotland and that of the two study sites (Ardnave and Kilchoman) in the western part of Islay.

Table 1. Prey species found in faeces at Aosta and on Islay and the percentages of samples in which each was found. When not specified, individuals were adults.

Prey item			Percentage of faeces		
			Aosta	Islay	
			Rhêmes	Ardnave	Kilchoman
Orthoptera			15.2	1.1	—
Coleoptera	Scarabaeidae	adults	33.3	100.0	38.0
		larvae	21.2	89.0	64.0
	Geotrupidae		3.0	—	—
	Curculionidae		24.2	57.1	68.0
	Elateridae	adults	36.4		4.0
		larvae	9.1		—
	Carabidae	adults	27.3	17.6	24.0
		larvae	6.1	—	—
	Cerambycidae		6.1	—	—
	Birridae		12.1	1.1	16.0
	Lathridiidae		3.0	3.3	—
	Staphylinidae	adults	9.1	—	9.3
		larvae	3.0	—	4.0
	Coccinellidae		3.0	—	—
	Chrysomelidae		3.0	1.1	2.0
	Silphidae		—	1.1	2.0
Dermaptera	Forficulidae		15.2	17.6	14.0
Heteroptera			24.2	1.1	—
Lepidoptera		eggs	3.0	—	—
		larvae	72.7	86.8	36.0
		pupae	3.0	—	—
Diptera	Tipulidae	adults	—	6.6	8.0
		larvae and pupae	9.1	57.1	64.0
	Other Nematocera	adults	—	1.1	—
		larvae and pupae	—	5.5	56.0
	Brachicera	adults	—	—	8.0
		larvae and pupae	3.0	20.9	26.0
Hymenoptera	Formicidae		36.4	2.2	2.0
	Others		18.2	3.3	—
Diplopoda			12.1	28.6	24.0
Isopoda			—	—	16.0
Arachnidae			39.4	4.4	16.0
Gagea fistulosa			33.3	—	—
N. samples			33	91	50

on the Alpine Chough *Pyrrhocorax graculus*, there was no significant difference between stay times which ended in the whole flock moving and those when the "focal bird" moved with only some of the flock, nor between measurements made by two different observers (Rolando and Patterson unpublished).

Individual birds were selected at random and watched for at least three minutes to determine the foraging techniques being used. The peck rate was measured by timing a bird while it pecked and apparently swallowed 25 items (if possible; minimum 10 items), although, even using a telescope at close range it was not always easy to see if a prey item had been obtained. Faeces were collected from areas where the Choughs had been seen feeding or resting and at Aosta were taken only if a Chough (rather than an Alpine Chough) had been seen defecating. The birds were observed in different feeding habitats as opportunities occurred; there was no attempt to observe all habitats equally (or proportionally to their relative areas) and no measurements of the areas of different habitats could be made in the time available.

Results

a) Diet

The mean dry weight of faecal deposits on Islay (0.198 ± 0.016 g, n=30) was significantly higher than that at Aosta (0.083 ± 0.018g, n=22; t=4.72, P<0.005). The Choughs in both areas took a wide

Table 2. Feeding techniques used on grass by Choughs of different age on Islay in different areas and time periods

	Percentage using			
	Probing	Surf. Pecking	Both	N
Adults (Ardnave)				
1 - 5 July	97.2	0.0	2.8	71
6 - 10 July	90.9	1.8	7.3	55
11 - 17 July	81.3	3.1	15.6	64
All date	90.0	2.6	7.4	190
Seasonal variation: $\chi^2=9.7$, $P<0.05$				
Adults (Kilchoman)				
26 - 30 July	100.0	0.0	0.0	15
1 - 5 July	100.0	0.0	0.0	10
6 - 10 July	75.0	15.6	9.4	32
11 - 17 July	76.9	15.4	7.7	13
All dates	84.3	10.0	5.7	70
Seasonal variation: $\chi^2=7.3$, $P>0.05$				
First-year (Kilchoman)				
26 - 30 June	100.0	0.0	0.0	21
1 - 5 July	100.0	0.0	0.0	7
6 - 10 July	9.1	81.8	9.1	11
11 - 17 July	40.0	60.0	0.0	5
All dates	70.5	27.3	2.3	44
Seasonal variation: $\chi^2=34.6$, $P<0.001$				
Juveniles (Ardnave)	0.0	100.0	0.0	35

Adults: Ardnave vs Kilchoman; $\chi^2=6.4$, $P<0.05$
Kilchoman: Adults vs First Year (1st & 2nd periods); $\chi^2=6.2$, $P<0.05$
Arndave: Adults vs Juveniles (1st & 2nd periods); $\chi^2=191.6$, $P<0.001$.

Table 3. Length of time spent at one place by Chough flocks at Aosta on four categories of pastures: A) wet pastures with a slope minor than 13° comprised between 2200 and 2300 m a.s.l., B) rather dry pastures with a slope major than 26°, C) pastures with a slope minor than 19° and an altitude comprised between 2400 and 2500 m, often covered with snow in June-July and D) pastures with a slope minor than 18° and lower than 2100 m. The four type of pastures were also characterized by different vegetation.

Meadow Category	Mean Stay (min)	SE	N
A	6.98	0.91	60
B	6.57	0.74	135
C	2.12	0.44	10
D	6.68	0.57	154
Overall	6.56	0.40	359

$F_{3,355} = 1.21$, $P = 0.306$

Category C vs A, B and D combined; $t = 7.61$, $P<0.001$

range of arthropod groups but the number of taxa was higher in the alpine area, where birds were also observed feeding on bulbs of *Gagea fistulosa*. Among Scarabaeidae, *Aphodius* adults were commonly observed in faeces of Choughs both at Aosta (21.2%) and at Islay (Ardnave 97.8%, Kilchoman 36.0%), *Onthophagus* (6.1%) occurred only at Aosta whereas *Serica brunnea* (Ardnave 25.3%, Kilchoman 2.0%) only at Islay. Some seasonal variations were observed: Curculionidae and Diptera, for instance, were most frequent at Kilchoman in early July, and a shift to *Aphodius* was recorded later. (Table 1).

b) Feeding habitats and feeding techniques.

At Aosta almost all of the groups observed feeding were on pastures. On Islay most birds were seen foraging on grazed grassland, many of them feeding by probing in cow pats. Some also fed in the sand dunes, occasionally probing in the soil above the buried carcasses of sheep. When grass cutting began, many birds were seen on cut fields at Kilchoman but few at Ardnave, although cutting also occurred commonly there.

Table 4. Time (min) spent at one site by feeding flocks of Choughs on Islay

Flock	Ardnave			Kilchoman		
Size	Mean	SE	N	Mean	SE	N
1 - 5	8.41	1.14	25	11.12	1.22	77
6 - 10	18.37	3.60	16	16.56	2.83	16
Over 10	22.84	9.65	5	9.36	2.14	34
All sizes	13.44	1.87	46	11.33	1.01	127

All sizes, Ardnave vs Kilchoman; $t = 0.99$, $P>0.05$

Table 5. Mean feeding rate (items ingested per min) of Choughs at Aosta. Pasture categories as in Table 3.

Meadow Category	Mean Rate	SE	N
A	2.14	0.26	39
B	1.97	0.14	43
C	2.61	0.49	8
D	2.39	0.15	75
Overall	2.23	0.10	165

$F_{3,161} = 1.20$, $P = 0.310$

At Aosta most birds (84%) used a continuous mixture of surface searching, digging and stone-turning, with a minority using only one technique during a period of observation. No bird was seen to use stone-turning as a sole technique. In contrast, on Islay most birds used only one feeding method during an observation period. At the start of the study period, almost all of the birds fed by probing but they changed later (significantly for adults at Ardnave and first-year birds at Kilchoman) towards more surface pecking or a mixture of both methods (Table 2). Overall, adults at Kilchoman used significantly more surface pecking than those at Ardnave and first-year birds (at Kilchoman, up to 5 July) used significantly more than adults at the same site and period. Juveniles used only surface-pecking.

c) Stay times

The Aosta Choughs' stay times averaged 6.56 ± 0.40 min, with no significant variation among habitat categories (Table 3). However, stay times in high areas with snow patches (category C) were significantly shorter than those in the other categories. There was no significant difference in stay time between morning and afternoon, or between different flock sizes.

The Islay birds' stay times averaged 13.44 ± 1.87 min at Ardnave and 11.33 ± 1.01 min at Kilchoman, with no significant or consistent variation over the study period (Table 4).

d) Peck rate

At Aosta, the peck rate averaged 2.23 ± 0.10 pecks per min with no significant variation between habitat categories (Table 5), or between morning and

Table 6. Mean feeding rates (items ingested per min) of Choughs on Islay in different areas and time periods

	Habitat								
Age group;	Grass (probing)			Cut Grass			Dung		
Area; Dates	Mean	SE	N	Mean	SE	N	Mean	SE	N
– Adults, Ardnave									
1 - 5 July	2.16	0.12	69						
6 - 10 July	1.40	0.10	50						
1 - 17 July	1.55	0.88	52						
All dates	1.75	0.07	171				13.20	1.40	18
– Adults, Kilchoman									
26 - 30 June	1.36	0.16	15						
1 - 5 July	1.12	0.25	10	1.30	0.26	7			
6 - 10 July	0.61	0.07	24	1.38	0.10	47			
11 - 17 July	0.83	0.15	10	1.83	0.22	22			
All dates	0.92	0.08	59	1.50	0.10	76	24.34	4.32	12
· First Year, Kilchoman									
26 - 30 June	1.64	0.21	21						
1 - 5 July	1.44	0.23	7	1.56	0.82	3			
6 - 10 July	0.41	–	1	1.45	0.70	32			
11 - 17 July	0.47	0.31	2	1.04	0.12	7			
All dates	1.48	0.16	31	1.39	0.11	42	22.99	1.83	32
· Juveniles, Ardnave									
All dates							5.61	0.80	35

Seasonal variation (grass):	Cut grass vs Grass:	Dung vs Grass:
Adults, Ardnave; $F_{2,168} = 12.54$, $P<0.001$	Adults, Kilchoman; $t = 4.53$, $P<0.001$	Adults, Ardnave; $t = 8.17$, $P<0.001$
Adults, Kilchoman; $F_{3,55} = 6.48$, $P<0.001$	First Year, Kilchoman; $t = 0.46$, $P>0.05$	Adults, Kilchoman; $t = 5.42$, $P<0.001$
1st Year, Kilchoman; $F_{3,27}= 2.52$, $P>0.05$		1st Year Kilchoman; $t = 11.71$, $P<0.001$

afternoon. On Islay the peck rate varied between 0.92 ± 0.08 and 1.75 ± 0.07 pecks per min on grass and cut grass; there was no significant difference between the rates on these two habitat categories in adults, but first-year birds had significantly higher peck rates on cut grass than on grazed grass (Table 6). There was a tendency for peck rates to decrease during July, significantly so for adult birds on grass. Peck rates on dung pats were significantly higher than those on grass for both first-year and adult birds (Table 6). Juveniles were an exception to this having a very low peck rate on dung pats (Table 6). There was a slight but significant tendency for peck rate to be faster in larger flocks ($r=0.202$, $P<0.05$, $n=166$).

Discussion

The Choughs in both areas fed on similar types of invertebrates, those living on or near the soil surface, although of course the species were different in the two places. In summer the diet of the Choughs at Aosta seems to be more diverse than that on Islay. This might depend on a greater prey species diversity in the Alps, perhaps due to the greater environmental diversity (for instance the four categories of meadows of Table 3). However analysis of the diet on Islay demonstrated that, throughout the year, the Chough there also feeds on a great variety of items (McCracken *et al.* 1992). Both populations took Lepidopteran larvae but apparently very few grasshoppers, which were a main food of Alpine Choughs at Aosta (Rolando and Patterson 1993) and in the Pyrenees (Dendaletche and Saint-Lebe 1987). Invertebrate larvae found in cow dung were an important component of the Islay birds' diet, in keeping with the findings of Warnes and Stroud (1988) and McCracken *et al.* (1992). Only old dry dung (after the winter period) with no remaining fauna was available at Aosta in June but nevertheless proportions of Scarabeidae were about 30% (adults) and 20% (larvae).

Choughs showed to take advantage of the local availability of food items. Birds at Aosta, for instance, fed on bulbs of *Gagea fistulosa* which is a typical Alpine flower, whereas at Islay they fed on Nematocera (especially at Kilchoman) since carcasses of sheep and cows buried in the sandy soil produced a lot of these insects.

The lower mean weight of Chough faeces at Aosta may indicate that the diet there was less bulky, with a lower proportion of undigestable matter.

Both populations fed mainly on short-grass meadows, but exploited other feeding sites available in their areas, especially at Islay (cut grass, dung pats and buried carcasses).

The Aosta Choughs had more variable feeding methods, with most birds switching frequently between digging, surface-searching and stone-turning, whereas the Islay birds tended to use one method at one time (chiefly digging at the start of the study period with more surface-searching later). The greater diversity of feeding methods at Aosta might be correlated with the prey species diversity, which might be greater at Aosta than on Islay. Lovari (1976) described Choughs in Abruzzo catching insects in flight near the ground, but we never saw this either at Aosta or at Islay. Digging activity at Islay was greatly facilitated by the sandy soil and by the apparent facility with which birds caught *Tipula* larvae. It is worth noting that even though the peck rates in cow dung were significantly higher than those in meadows, birds continued to dig in meadows until mid July when presumably *Tipula* were scarcer or more difficult to catch (deeper in the soil because of the lack of rain). In the same period birds readily shifted (only at Kilchoman) to cut grass where peck rates on *Tipula* were significantly higher for 1st year birds. It was not possible to estimate the size of the items taken by the birds, so the rate of food intake could not be compared between the different feeding situations. The length of stay at any one patch was considerably shorter at Aosta than on Islay (about half the duration). This may be related to the lower costs of moving at Aosta, by being able to glide along steep slopes. Choughs of both population had stay times longer than those observed in the Alpine Chough (Rolando and Patterson 1993).

Pecking rates were similar in the two areas, although slightly faster at Aosta. The estimated intake per stay at a feeding patch (adults on grass) was 14.63 items at Aosta, 23.52 at Ardnave and 10.42 at Kilchoman. Observations carried out at Islay on colour-ringed individuals (Bignal *et al.* 1987) suggested that foraging techniques were age-dependent. In particular juveniles (2-3 months old) had to learn a lot and did not dig at all; moreover their peck rates were very low. They were observed many times to beg from adults, with fights between adults and juveniles in some occasions.

There was some evidence of a possible social influence on peck rates (faster in larger flocks). These data are in keeping with those from other corvids. It was suggested, for instance, that magpies in flocks have a higher average feeding rate than birds alone or in pairs (Vines 1981).

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Riassunto In Europa il Gracchio corallino (*Pyrrhocorax pyrrhocorax*) si rinviene in ambienti anche nettamente diversi tra loro, quali le coste atlantiche e le aree montuose alpine. Lo scopo del presente lavoro è stato quello di paragonare, nello stesso periodo dell'anno (estate), il comportamento trofico di questo corvide nei due habitat. Lo studio è stato quindi condotto contemporaneamente in alta Val di Rhêmes, Val d'Aosta, e sull'isola scozzese di Islay. Lo spettro alimentare, desunto dall'analisi delle deiezioni, è risultato ampio in entrambe le zone con una maggior diversificazione nell'area alpina, dove la specie si alimenta frequentemente di larve di Lepidotteri, Formicidi e Coleotteri Elateridi mentre ad Islay utilizza perlopiù Coleotteri Scarabeidi e larve di Ditteri (principalmente Tipulidi). Le tecniche di ricerca del cibo riflettono il differente grado di diversificazione della dieta nei due siti: sulle Alpi è di solito utilizzata una tecnica mista che prevede l'alternarsi di sonde, scavi, catture in superficie e rimozione di sassi mentre ad Islay si osserva con maggior frequenza l'uso di una sola tecnica alimentare. I tempi di stazionamento sono risultati inferiori in ambiente alpino, probabilmente in relazione al minor costo degli spostamenti, prevalentemente effettuati sfruttando le correnti ascensionali che risalgono le pareti rocciose. Le osservazioni condotte ad Islay su animali marcati hanno permesso di appurare che il comportamento trofico cambia significativamente a seconda dell'età dell'individuo.

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Some aspects of the feeding habits of the Cormorant (*Phalacrocorax carbo sinensis*) wintering in the Maremma Natural Park (Grosseto, Central Italy).

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Abstract - The feeding habits of the Cormorant wintering in the Maremma Natural Park have been assessed through the analysis of pellets collected in the winter of 1991-92 and 1992-93. In both years the quantitative-qualitative analysis of the pellets showed the presence of a much greater percentage of Mullets (Mugilidae) than of other fishes: 60% in number and 90% by weight; the mean size of the fish was 21.5 cm. The mean fish weight ingested daily, estimated from the pellet contents, was 278 g in 1991-92 and 377 g in 1992-93.

Introduction

In the last 10-15 years, there has been a remarkable increase in the number of Cormorants *Phalacrocorax carbo sinensis* wintering in Italy, estimated at around 13,000 birds in 1987-88 (Baccetti 1989).

However little research has been carried out on food selection and the feeding strategies of the species outside of the breeding season.

Studies on the diet in the wintering season have been carried out in France (Im and Hafner 1984), in the Netherlands (Marteijn and Dirksen 1991), in Switzerland (Suter 1991) and only recently in Central Italy by Martucci and Consiglio (1991) and Sarà and Baccetti (1993).

In view of the necessity and urgency to evaluate the impact of these birds on commercial fishing we have established the diet of the Cormorants wintering in the Maremma Natural Park, by evaluating the daily food intake of each bird.

Methods

The Maremma Natural Park (42°38' Lat. N, 11°00 Long. E), situated near Grosseto with the Ombrone River running through it, has a large concentration of Cormorants which have been observed diving for food.

Since the winter of 1990, after the temporary closure of the angling season, the birds have started to use trees along the Ombrone River as night roosts (Giovacchini in press). The habitual fishing grounds and the night roosts are shown in Figure 1.

A census of the night roosts was taken every fifteen days, from October to April in 1991-92 and 1992-93. The maximum number of birds was recorded on 18 January 1992 with 151 individuals and, in the following season, on 16 February 1993 with 143 specimens.

During the two winters we collected weekly the pellets (fragments of undigested material wrapped in mucus) dropped during the night every 24 hours (Duffy and Laurenson 1983, Johnstone *et al.* 1990).

Pellet analysis is usually indicated as the most effective method for studying the food choice of these birds without disturbing them unduly (Marteijn and Dirksen 1991).

The remains of fish ingested by the birds, useful for the determination of species or genus (otoliths, pharyngeal bones), have been identified by using the tables described in Libois and Hallet-Libois (1988) and in Härkönen (1986). Fish size has been estimated by using the regression formulae that enable calculation of the length and weight of fish by measuring otoliths and pharyngeal bone length (Härkönen 1986, Martucci *et al.* 1993).

Results

In the winter of 1991-92, 21 of the 80 pellets collected (26%) contained only mucus or unidentified remains,

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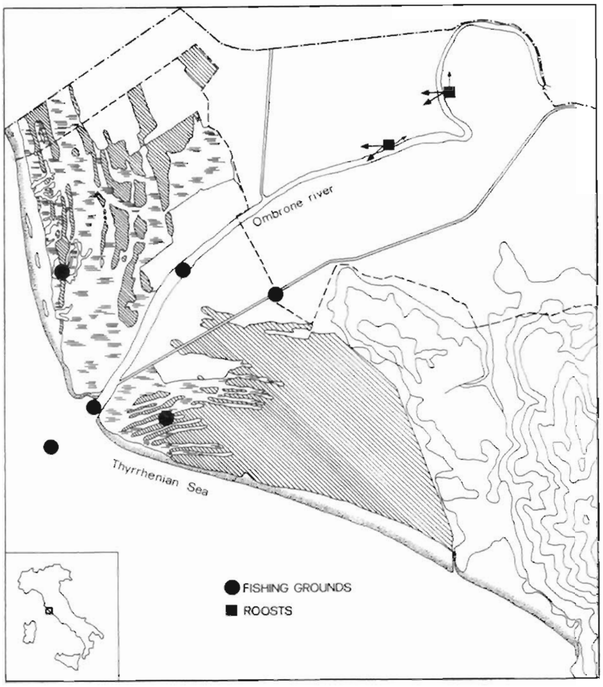

Figure 1. In the map of the Maremma Natural Park are localized the night roosts, the main fishing grounds and the flight directions.

whereas 194 kinds of fish were identified in the remaining pellets. In the winter of 1992-93, 15 of the 80 pellets collected (19%) yielded only unidentified remains while 236 prey items were identified in the other pellets.

The results are shown in Table 1. The largest proportion was represented, in both years, by Mullets (Mugilidae): 63.6% and 64.4% in number.

Ciprinidae (*Scardinius erythrophthalmus, Carassius carassius, Chondrostoma soetta, Alburnus alburnus alborella, Leuciscus cephalus cabeda*) were 9.5% and 10.1% in number respectively in 1991-92 and the following year.

In both seasons there was only a small percentage of Eels (1.5% and 2.1%); the unimportance of this species in the diet has been noticed elsewhere (Im and Hafner 1984, Martucci and Consiglio 1991, Sarà and Baccetti 1993).

Mullets represented, in both years, 90% of the weight of the Cormorant food (Figure 2), while the other species constitued a very small part of the diet.

The mean size of Mullets caught by Cormorants was 21.5 cm (SD = 7.8, min = 5.8 cm, max = 39.6 cm, N = 243), which corresponds to a weight of 110 g.

The mean daily weight of all fish ingested by each bird (calculated from the contents of the pellets, which enabled the recalculation of the weight of the ingested fish, and considering that each bird produces one pellet per day) was 278 g in 1991-92 (SD = 231, min = 16 g, max = 864 g, N = 46). The mean number of fish per pellet was 3.5 (SD = 5.1, range 1-30). In the following winter the mean daily food intake was remarkably higher at 377 g (SD = 318, min = 10 g, max = 1,370 g, N = 49), and the mean number of fish per pellet was 3.7 (SD = 3.3, range 1-21).

The difference in weight of fish ingested was highly significant (chi-square test: $X^2 = 35$, d.f. = 1, $p<0.001$).

The Cormorant catches Mullets of varying size and the mean size is quite large (Figure 3).

Table 1. Results of the pellet analysis.

Prey Species	Number		Frequency (%)		Occurrence in pellets (%)	
	91-92	92-93	91-92	92-93	91-92	92-93
Anguilla anguilla, Eel	3	5	1.5	2.1	3.1	7.5
Atherina boyeri, Sandsmelt	31	20	15.7	8.5	4.6	3.0
Ciprinidae	19	24	9.6	10.2	25.0	15.1
Ictalurus melas, Catfish	3	—	1.5	—	4.6	—
Mugilidae	126	152	63.6	64.4	65.6	68.1
Dicentrarchus labrax, Sea Bass	11	29	5.6	12.3	4.6	19.6
Sparidae	—	1	—	0.4	—	1.5
Umbrina cirrosa, Umbrine	1	-	0.5	—	1.5	—
Lepomis gibbosus, Sunfish	—	1	X	0.4	X	1.5
Not identified	4	4	2.0	1.7	6.2	6.0
Total	198	236	100	100		

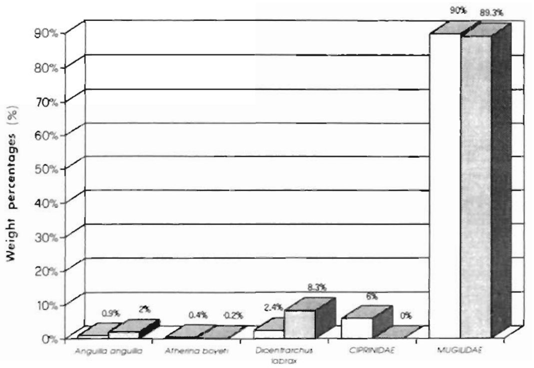

Figure 2. Composition of the food of the Cormorants on the base of the weight, referred to the fish for which it was possible to calculate the weight, in 1991-92 (N=163), and 1992-93 (N=206).

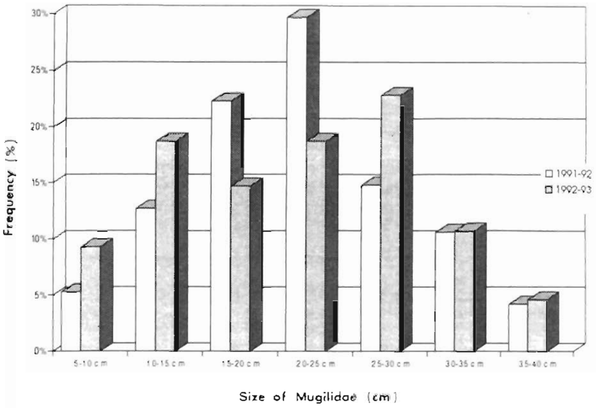

Figure 3. Size-frequency distribution of Mugilidae. The mean size of these fish preyed upon by the Cormorants is 21.5 cm.

Discussion

We have no information regarding fish population of the Ombrone River, and it is not possible to establish wheter the Cormorant selects food while fishing.

Almost all the fish caught were Mugilidae, which is probably the most abundant and largest fish at the mouth of the Ombrone River, being the most resistant to pollution of organic origin.

In other European countries the mean size of the prey does not exceed 10-15 cm (Marteijn and Dirksen 1991, Suter 1991, Van Dobben 1952).

The scarsity of Eels in the diet is remarkable and could be due to mistakes in the pellet analysis, because the otolith of the Eel is small (2-3 mm) and might be completely dissolved by gastric secretions (Martucci *et al.* 1993).

The mean daily weight of the fish ingested agrees with the results obtained by Marteijn and Dirksen (1991) and by Suter (1991), and corresponds to the theoretical energy requirements (330 g) calculated by Voslamber (1988).

The difference between the weight of 1991-92 and that of the following winter could be due to effective differences in the availability of the fish, or to the random selection of the samples tested, because many pellets were lost.

The economic impact of the wintering population of Cormorants is evident considering that the total weight of fish consumed in a season is about 3.3 tons. One can appreciate the necessity to increase our knowledge about feeding strategies, in order to devise remedies and deterrents to reduce fish depredation and economic losses where conflicts arise with commercial fishing.

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Riassunto - Nel corso dell'inverno 1991-92 e del successivo 1992-93 si è provveduto a raccogliere e analizzare le borre prodotte dai Cormorani *Phalacrocorax carbo sinensis* svernanti nel Parco Naturale della Maremma (GR). L'analisi è stata effettuata utilizzando le chiavi diagnostiche e le formule di regressione reperibili in bibliografia. Nelle due stagioni esaminate il 90% della dieta è rappresentato dai Muggini (Mugilidae), la cui taglia media è di 21.5 cm; le altre specie segnalate alla foce dell'Ombrone non compaiono che con percentuali molto scarse. Il pasto medio giornaliero è risultato essere di 278 grammi nel corso del 1991-92 e di ben 377 grammi durante l'inverno seguente.

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Fledging rate in the Cormorant *Phalacrocorax carbo* at the colony of Val Campotto (Po Delta, N-E Italy)

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Abstract – Cormorants *Phalacrocorax carbo* nesting at the Val Campotto colony occupied 270 nests in 1993. In 1992 and 1993, the number of fledglings from 190 successful broods was recorded. Each brood was assigned to one of 3 laying periods defined within the breeding season (February-March, April-early May, late May-July). The mean number of fledglings per nest was 2.81 ± 0.08 (SE) in 1992 and 2.80 ± 0.06 (SE) in 1993. In 1993 the fledgling production in late broods was lower than in early ones; no difference was found between nests at the centre and those at the edge of the colony, nor among clusters of trees of different density. No cases of predation were observed. Data indicate a further growth of the colony. Some second brood attempts are also reported.

Introduction

Val Campotto is presently the largest Cormorant colony in Italy. Its establishment in 1985 (Spina et al. 1986) is linked with a strong increase in the number of breeding pairs in Central and Northern Europe as well as in the wintering population in the Mediterranean area in the last 15 years (Cramp and Simmons 1977, van Eerden and Zijlstra 1991, Baccetti e Brichetti 1992). The colony has grown from 12 nests in 1986 to 270 nests in 1993.

At Val Campotto breeding occurs from February until September, with the main peak in spring and a secondary one in summer. Most birds breeding in summer use nests built by other pairs in spring. It is possible that some of the late broods are really second broods; thus the exact number of breeding pairs is still unknown (Grieco *et al.*, in press).

In this paper the fledging rate of the Cormorant in 1992 and in 1993 is analysed. Some attempts to breed twice are also reported. The second brood was supposed since very late broods (July) have occurred for the North-Atlantic subspecies *P. c. carbo* and eggs have been recorded over a period of seven months for the continental subspecies *P. c. sinensis*. Several late broods may refer to replacement broods (Haverschmidt 1933, Witherby et al. 1940, Cramp & Simmons 1977).

Study area and methods

Since 1986 Cormorants have nested on dead trees 10-20 m high (poplars *Populus sp.* and willows *Salix alba*) surrounded by water in a 130 hectare basin called "Bassarone" contiguous to the 1600 hectare semi-natural marshes of Valle Campotto and Vallesanta; nests are 1-15 m above the water level. The breeding trees are mainly located at the centre of the basin but several birds nest on trees close to its banks. Many trees are in rows and form groups of different density. Peripheral trees are often isolated.

In 1992 and 1993 I recorded the number of chicks at fledging in 190 successful broods. Unsuccessful broods (37 in both years, approximately 10% of the total number of broods: see Grieco *et al.* in press) were not considered since the nest position, laying period and stage that they had reached were unknown. Out of the unsuccessful nests, 32 were lost because the respective trees fell down and thus the stage of those broods is unknown. Nests were checked a few days before the young started to leave the nest temporarily, about 35-40 days after hatching. Surveys of the colony were made about every three weeks between February and July, at various times of the day. Nests were monitored from the banks of Bassarone with a zoom 20-60x telescope, the distance of the observer from nests ranging from 80 to 350 m. The shortest distance refers to peripheral trees, for which the problem of investigator influence might have occurred.

Each brood was assigned to one of the three laying periods fixed within the breeding season; samples refer only to the total number of broods started in each period (Figure 4):

Period 1 (P1) - February and March; the number of nests strongly increasing. Sample: 42 (18.6% of the nesting population) in 1992 and 59 (26.5%) in 1993.

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Period 2 (P2) - April-early May; nesting population slowly growing to a peak. Sample: 20 (87% of new nests) in 1992 and 37 (78.7%) in 1993.

Period 3 (P3) - late May-July; the number of nests decreasing. Many sites are taken again after fledging by the young. Sample: 13 (18.1%) in 1992 and 19 (23.0%) in 1993.

The position of nests was classified according to two criteria. In relation to the density of trees, I defined isolated trees, thin rows (trees with branches not touching each other) and thick rows (trees with branches in closer contact). With regard to the simple location of trees, the colony was divided into the centre (almost all trees in rows, over 70% of the total sites) and the periphery (trees closer to the banks).

Chick loss was only verified for broods regularly monitored for the entire rearing period, beginning from the stage when the presence of chicks could be checked (about 8-10 days after hatching).

Data were entered on a Statgraphics worksheet. The mean fledging rate is given in the text with the standard error (S.E).

Results

As depicted in Figure 1, the nesting population of Val Campotto has strongly grown since 1985 when nesting by a founder pair is assumed. Figure 2 shows the phenology of 240 nests in the 1993 breeding season. A massive occupation of sites occurred between February and April, but in early May some nestings were already finished. As indicated in Figure 3, the proportion of nests with chicks had two peaks, hence Cormorants laid eggs in summer as well. Many nests were used twice within the same season.

First data collected in 1991 revealed a mean rate of 2.78 ± 0.15 (n= 9) fledglings per nest. The fledging rate for the three laying periods in 1992 and 1993 is shown in Table 1. The number of fledglings was recorded in 75 successful broods in 1992 and 115 in 1993 (22.9% and 31.9% of the total successful broods, respectively: Grieco et al. in press).

No differences were found between the two years, nor between corresponding periods of the two years. The mean was similar among the periods of 1992, but not in 1993 (Table 2). In both years, the proportion of pairs rearing 3 or 4 chicks decreased as the season progressed (Figure 5). Most of the summer broods (laying period 3) were in previously used nests: 11 out of 13 broods in 1992 and 13 out of 19 in 1993; the others, in new nests, did not differ substantially from their own sample: 3 or 4 chicks per nest (n= 2) in 1992 and 2.33 ± 0.33 (n= 6) in 1993.

Data from laying periods 1 and 2, 1993 (n= 96) were assigned to one of three groups of trees differing in density and to one of the two areas defined in the colony. No significant differences were found among fledging rates in thick rows (2.84 ±0.08, n= 57), thin rows (3.14 ± 0.17, n= 21) and isolated trees (2.72 ± 0.11, n= 18) (Kruskal-Wallis one-way analysis, p>

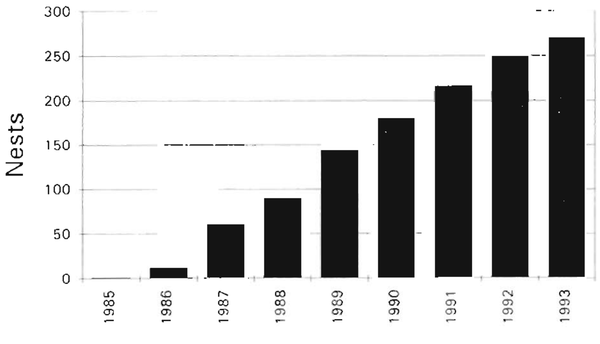

Figure 1. Maximum counts of nests at the colony of Val Campotto, 1985-1993. (From Spina et al. 1986 (1985 and 1986) and Baccetti & Brichetti 1992 (1987-1989).

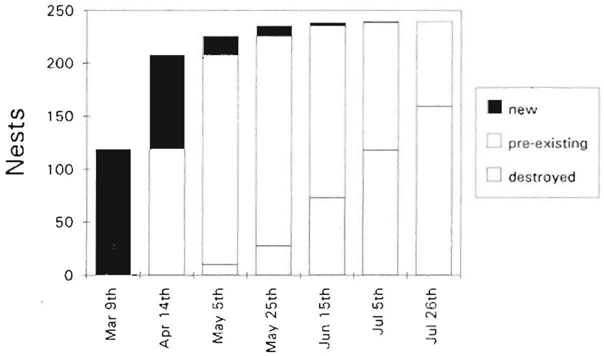

Figure 2. Phenology of nests in part of the colony (n= 240, 80% of total sites) in 1993.

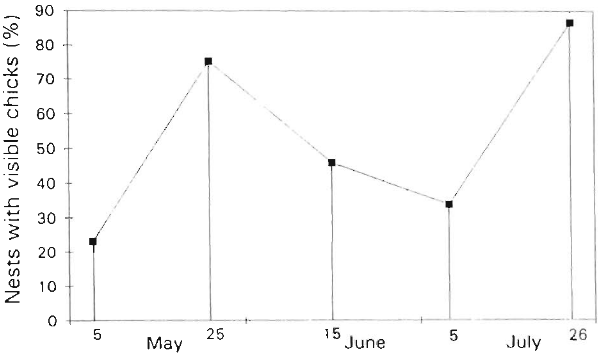

Figure 3. Percentage of nests with visible chicks in 1993. 6 May, n=224; 25 May, n= 158; 15 June, n=181; 5 July, n= 118; 26 July, n= 83.

Table 1. Mean fledgling production of 190 pairs of Cormorant, in relation to the laying periods, 1992-1993.

Year	Period	Number of nests	Mean	SE
1992	P1	42	2.86	0.12
	P2	20	2.85	0.15
	P3	13	2.62	0.21
	total	75	2.81	0.08
1993	P1	59	3.00	0.08
	P2	37	2.72	0.11
	P3	19	2.32	0.15
	total	115	2.80	0.06

Table 2. Comparison bet-ween fledgling production in broods of the different laying periods. *= p< 0.05; **= p< 0.001, Wilcoxon test.

Year	Period	p	Year	Period	p
1992-93	P1	NS	1992-93		NS
	P2-P2	NS			
	P3-P3	NS			
1992	P1-P2	NS	1993	P1-P2	*
	P2-P3	NS		P2-P3	*
	P1-P3	NS		P1-P3	**

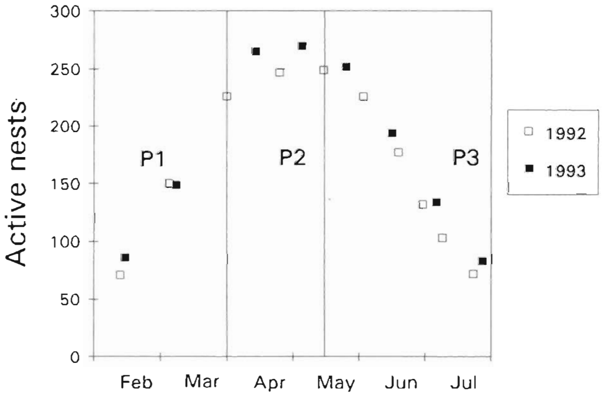

Figure 4. Active nests in 1992-93 and laying periods as defined in the text.

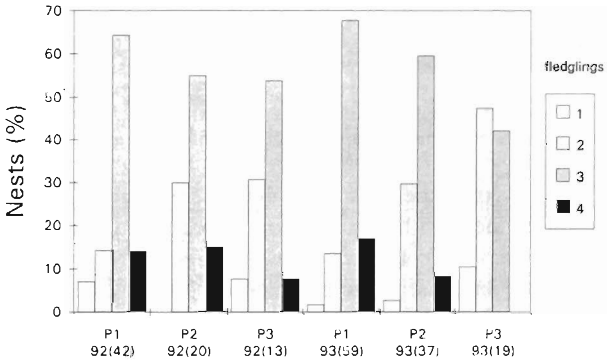

Figure 5. Fledgling production (percentage of each sample) in relation to the laying periods within the breeding seasons 1992 and 1993 (in brackets: sample size).

0.05). Similarly, no difference was found between the periphery (2.72 ± 0.11, n=18) and the centre of the colony (2.92 ± 0.08, n=78) (z= -1.33, p> 0.1, Wilcoxon test).

Loss of chicks. Predation pressure.

As most successful broods were not monitored for the whole rearing period, data on chick mortality are incomplete. However, in 1992, 17 nests belonging to laying period 1 were observed from hatching to fledging: two pairs lost one of 4 chicks observed after hatching, but the cause of loss is unknown.

During observations in the breeding seasons 1991, 1992 and 1993, no cases of egg or chick loss by predation were recorded (36 broods monitored from laying to fledging in the period February-July for a total of 1626 hours, mean 45h 10' per nest, SD= 15h 45'). Defensive behaviours against potential flying or resting predators, Hooded Crows *Corvus corone cornix* and Herring Gulls *Larus cachinnans*, were not observed.

Further breeding attempts after successful breeding.

During surveys in 1992 and 1993, I observed adults holding the nest, as in a normal occupation of a site, while full-feathered chicks were not yet definitively fledged. Adults held sites without reacting against young in the nest and sometimes fed them. These observations suggested that some birds, having successfully bred, occupied their site and bred again. In 1992 this situation was recorded in 4 nests and in one of them the second brood was successful: three young left the nest in August. Nesting birds were not individually recognizable, as they were not ringed, so one could not verify whether the pair, or at least one of the birds, had really bred twice. In May 1992 a pair occupied its nest again when one of the chicks had not yet reached the fledging stage (eggs were probably laid in February). As both adults were sitting in the nest for a few minutes, the occupying stage was not so advanced as for other breeding pairs. One of the birds claimed the site by Wing-waving more than once. Moreover, the parents fed the young regularly and fetched a lot of nest-material. On 4 June a copulation was observed; ten days later the pair left the nest. None of the adults re-occupying nests after rearing chicks had white patches on the thighs or white elongated feathers on the crown and neck.

Discussion

The 2.8 young per nest recorded in this study is very close to the 2.95 reported from Val Campotto in 1989 (Nicosia 1991): these values suggest a rather high hatching success, as the mean clutch size is thought to be about 3-4 (Cramp and Simmons 1977, Røv 1984). Such a result is much more evident if compared with the proportion of successful broods: 328 out of 365 started in 1992, 360 out of 397 started in 1993 (Grieco et al. in press). As the survival rate of young Cormorants is unknown, it is not possible to say whether local population growth is self-sustaining. For comparison, we can consider data collected in a newly-established population of the related Double-crested Cormorant *Phalacrocorax auritus* in South Carolina. The breeding colony is inland and the number of nesting pairs and the population growth are similar to those of Val Campotto. The average of 2.2 fledglings per nest is thought to be sufficient to allow local self-sustaining population growth (Post & Seals 1991). At Val Campotto the fledging rate in 1992 was as high as in 1993, but in the latter year it decreased through the breeding season, as recorded previously for this and other species (Kortlandt 1942, Nelson 1978, Ryder 1980, Debout 1988). As most late clutches were in previously used, successful nests (initiated in late winter-early spring), lower success should not be due to nest-site quality. Moreover, the fledging rate in late nests in sites not previously used was about the same as in the others in that period. Further, no differences were found in nest success among clusters of different density, nor between central and peripheral nests. In several nesting colonies of certain Phalacrocoracidae and of other species, late nesting was thought to be by young inexperienced birds that have lower success and use the periphery of the colony (Kortlandt 1942, Nelson 1978, Potts et al. 1980, McNeil and Léger 1987, Sæther 1990). The Val Campotto colony shows a wave of summer broods as soon as the winter and spring nests are left by the young, thus summer broods are in re-occupied sites. It is possible that late nesting by inexperienced birds really occurs in this colony, as suggested by immature birds occupying sites (Baccetti & Brichetti 1992): in 1992 and 1993, 8 pairs with at least one immature mate bred successfully and many others made attempts. All these broods refer to laying periods 2 and 3 (immature birds occupied sites and formed pairs as from the middle of April). Nevertheless, the number of summer broods (71 pairs in 1992 and 85 in the following year: Grieco et al. in press) and some recorded breeding attempts after successful nesting by the same pair induce one to think that a significant proportion of the summer nestings are by experienced breeders. The very few records of summer broods with 4 chicks in the early development stage suggest that the lower fledging rate, if it really exists, might simply be due to a smaller clutch size rather than a higher mortality rate of chicks.

High fledging rates obtained in this and previous studies are also probably due to a low predation rate. Moreover, the type of predator is limited to other birds as nests are on trees over water.

The loss of chicks, also recorded in 1989 (Nicosia 1991), is not sufficient to indicate a frequent offspring-reduction strategy, as identified in the related species *Phalacrocorax aristotelis* (Snow 1960), *P. atriceps* (Williams and Burger 1979), and *P. coronatus* (Williams and Cooper 1983), which is an adjustment of breeding to food availability.

The increase of the number of breeders, verified since the establishment of the colony (Baccetti and Brichetti

1992), and the breeding success are even more significant because of the progressive falling of dead trees and the consequent lack of nesting sites: this has determined the dispersion of nests and the use of isolated trees near the banks. However, the ability of Cormorants in utilizing sites not previously used, even those made with broken trunks, has been described (Grieco et al. in press). Data from Val Campotto show the potential capability of expansion of a species whose continental European population has grown strongly in recent years.

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Riassunto – La colonia di Cormorani *Phalacrocorax carbo* di Val Campotto (Ferrara) ha raggiunto le 270 coppie nel 1993. Nel 1992 e 1993, si è rivelato il numero di pulli involati da 190 covate. Ogni coppia è stata associata ad uno dei 3 periodi di deposizione definiti (febbraio-marzo; aprile-inizio maggio; fine maggio-luglio). Il numero medio di pulli involati per nido è stato di 2,81±0,08 (ES) nel 1992, 2,80±0,06 (ES) nel 1993. Nel 1993 il successo fu più basso per le covate tardive rispetto a quelle primaverili, ma fu simile in nidi a diversa collocazione spaziale. Nessun caso di predazione è stato osservato. I dati indicano un'ulteriore crescita della colonia. Vengono inoltre descritti alcuni tentativi di seconda covata.

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Does prey size affect predatory behaviour of Kestrel ?

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Abstract – A sample of 10 rehabilitated kestrels *Falco tinnunculus* was tested immediately prior to release to ascertain whether their predatory behaviour was modified according to the type of prey the kestrel faced. The tests were carried out individually in captivity conditions, using either one laboratory agouti mouse weighing 12-15 g or one laboratory agouti rat weighing 48-60 g. The size ratio between the prey was then constantly of 1:4.

The behavior displayed by the kestrels before either prey was clearly different, both prior to and after its catching. The rat elicited more conflict patterns, such as preening and movements on the perch, while this was hardly ever recorded during the mouse-tests. There were instead no differences in the latency of predation and the technique used for grasping the prey. In contrast, the rat received more biting than the mouse, and the latency of ingestion, interpreted as the time span necessary to induce the death of the prey, was much longer when the rat was captured. The adaptive implication of such behaviour differences are discussed.

Introduction

The predatory behaviour of raptors is known to be affected by the prey itself. The American kestrel *Falco sparverius* is very stimulated by prey movement (Sparrowe, 1972), pelage colour, and morphology (Ruggiero *et al.*, 1979). The same is likely to occur in the Eurasian counterpart, the kestrel *Falco tinnunculus,* that is also able to catch dead prey in captivity (Csermely, 1993) and so without any stimulation by movement. Learning is another important aspect for prey recognition and selection (Ruggiero *et al.*, 1979; Mueller, 1987), that, in turn, allow the development of the Specific Searching Image (SSI) (von Uexküll, 1934; Tinbergen, 1960) that is widely displayed in birds of prey (Curio, 1976). Size is another important parameter that potentially affect prey catching. Large size prey animals are more conspicuous, more easily detected, they offer higher energy income as compared with smaller prey. On the other hand, a large prey is also stronger, with efficient defensive weapons, potentially hurting the predator itself, and is less easily subdued, which corresponds to higher energy expenditure till its ingestion (Curio, 1976; Griffith, 1980; Korpimäki, 1985).

Both *Falco tinnunculus* and *F. sparverius* are well adapted to feed on a wide range of prey sizes (Cramp and Simmons, 1980; Johnsgard, 1990), catching opportunistically many taxa, from small arthropods to young rats and hares (Village, 1990). Bryan (1984) reported a bias in prey selection by male and female American kestrels during the reproductive period. Females caught large mice more often, while males and juveniles chose small ones. Prey size is reported to be an important choice parameter in other raptor species as well. The barn owl *Tyto alba* showed a trend to choose large rodent prey in direct relation to its own body size (Ille, 1991). Nevertheless, the increase of prey body size correlated with the frequency of conflict behaviour patterns, indicating that the barn owl is progressively less confident about the attempt at success and aware of the possibility of being hurt by the rodent.

This study aims to describe in detail the predatory behaviour of the Eurasian kestrel when facing alternatively prey of rather different size and to ascertain whether the predatory behaviour is modified in its performance by such a variable. The kestrel was chosen because of easy management in captivity and its adaptation to prey on a wide range of taxa. It is then possible that, although the predatory behaviour of birds of prey is rather stereotyped (Meyer-Holzapfel and Räber, 1976; Csermely *et al.*, 1989, 1991), the kestrel is adapted to modify its behaviour according to the prey to be caught. A less generalist species is in fact expexted to have a much more rigid

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behaviour sequence, and less drive to catch prey differing from the usual ones.

Methods

The kestrels *Falco tinnunculus* studied were all wild individuals recovered after several kinds of injuries and kept in the Raptor Rehabilitation Centre (RRC) managed in Parma by the Italian Society for the Protection of Birds (LIPU). The birds were housed in a large maintenance pen and were all experiencing captivity for the first time. They were fed once daily with chicken carcasses throughout the period of their stay at the RRC. At testing they were all in perfect physical condition and the plumage was fully developed.

The kestrels were tested individually shortly before release in an experimental pen 4.30 x 2.60 m located in the same building as the maintenance pen. The pen was empty save for a perch placed at a height of 1.80 m across the shorter side of the pen, and a square wooden platform (60 x 60 cm) with 60 cm wire legs located in the middle of the pen at a distance of 2.60 m from the perch. The reader is referred elsewhere for further details regarding the pen (Csermely *et al.*, 1989).

At testing the prey was inserted manually into a pipe, running from outside the experimental pen to the platform edge and at the same height of it (Fig. 1). Once at the end of the pipe, the prey became then completely visible to the kestrel. The behaviour of the birds was recorded continuously through a one-way window located just above the insertion of the pipe in the side wall. The number of tests was kept as low as possible, but compatible with procuring a significant sample, whilst at the same time sacrificing as few prey as necessary, as recommended by Still (1982), Huntingford (1984), and A.S.A.B. and A.B.S. (1991).

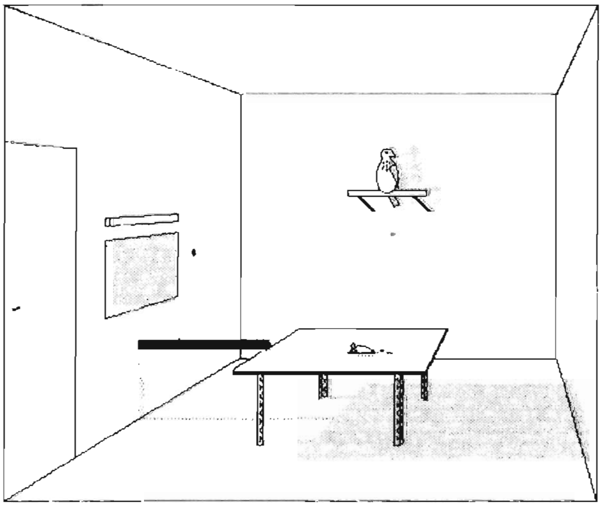
Fig. 1. A prospectic view of the predation pen.

Each bird was tested only twice, on 2 consecutive days. One of two kinds of prey was offered at each test: a live adult laboratory mouse *Mus domesticus* with agouti phenotype, C3H strain, or a live adult laboratory rat *Rattus norvegicus* with the same phenotype, Brown-Norway strain. The order of prey presentation was random. The size ratio between prey was constantly 1:4; in fact, the mice weighed 12 to 15 g, while rats weighed 48 to 60 g. Although wild individuals have been proved to prey adult rats easily (Southern, 1974; Shrubb, 1993), heavier rats were not used because previous preliminary tests revealed that kestrels facing rats greater than 60-70 g either had difficulty in catching them or refused to prey at all.

The tests were carried out between 10.00 am and 2.00 pm. They started when the rodent emerged on the platform and lasted till its ingestion by the kestrel, or for 60 min if no predation occured. The birds were tested after 2 days of fasting in order to enhance and equalize the predatory motivation for all birds. In any case it has already been demostrated that hunger is correlated with prey killing in captive raptors, such as the Broad-winged Hawk (*Buteo platypterus*), the American kestrel (*Falco sparverius*) (Mueller, 1973), and the Screech-owl (*Otus asio*) (Marti & Hogue, 1979).

All the kestrels were chosen randomly among the sample present at the RRC and ready for release. The birds' sex and age, i.e. adult or sub-adult, were not taken into account, since another study (Csermely *et al.*, 1989) did not reveal any difference in the predatory behaviour.

The time latencies and durations of the behaviour patterns recorded were analyzed with the Mann-Whitney *U*-test, while the frequencies were analyzed with the Permutation test (Siegel, 1956). Means are given ± SE, and the probability is always given as one-tailed.

Results

Ten kestrels were used in this study and most of the them (n=8) preyed on both the mouse and rat. The remaining two caught the mouse only. The prey appearance on the platform elicited invariably the kestrel's attention. Nevertheless some activities were performed. A couple of these, movements on the perch and preening, were recorded much more often with the rat present (Table 1) (Movements on the

Table 1. The mean (± SE) latency (in seconds) and frequency for three patterns considered prior to the predation attempt, during each mouse- and rat-tests (n = 10 for both). Figures bearing the same suffix letter are significantly different ($p < 0.05$).

	Mouse-Tests		Rat-Tests	
Pattern	Frequency	Latency	Frequency	Latency
Movem. on perch	5.5±3.5^{a}	262.50±74.5	7.0±2.4^{a}	581.40±156.6
Preening	2.0±0.0^{b}	114.00± 0.0	3.4±1.1^{b}	601.60±163.4
Flights	5.3±4.3	73.67±71.7^{c}	6.0±2.2	680.33±145.0^{c}

perch: Permutation test, $p < 0.05$; Preening: Permutation test, $p < 0.05$).

The kestrel did sometimes perform one or more flights too: it started from the perch, flew over the platform and then returned to the perch itself. Even this pattern was elicited more often but not significantly ($\alpha = 0.05$) when the kestrel was facing the rat (Table 1). While the latency of the first movement on the perch and the first preening action after prey appearance in both tests were not statistically different, the first flight was, on the other hand, recorded earlier during the mouse tests (Table1) ($Z= 1.936$, $n = 9$, $p < 0.05$). A clear association between flights and movements on the perch during the rat-tests was also noted. In fact, in all but one test the birds either performed both flights and movements at least once or did not display them at all (Fisher's test, $p = 0.02$). Such an association did not occur during the mouse-tests.

In addition to eliciting more conflict patterns, the rat induced a trend for a greater latency to predation (494.60±84.65 sec for the mouse vs 776.88±273.71 sec for the rat). However, such values did not differ significantly ($\alpha = 0.05$), maybe due to the small sample of data. Two types of attack to the prey were recorded: *direct*, i.e. the kestrel flew from the perch and landed directly on the prey's body, and *indirect*, i.e. the kestrel landed on the platform and blocked the prey after a few steps. While the mouse was always caught on the platform, irrespectively of the attack type, the rat sometimes jumped down during the indirect attack and was consequently captured on the floor of the pen. The types of attack in the mouse-tests were recorded almost equally (6 vs 4), while the rat-tests scored more indirect attack (6 vs 2).

The prey was always caught with only one foot in both direct and indirect attacks, without preference for either foot in both rat (4 left vs 4 right) or mouse-tests (5 left vs 5 right). No predation with both feet was observed. Six kestrels out of the 8 preying both prey used the same leg (left or right) to catch both the mouse and the rat, while the remaining 2 birds used different feet. The prey was invariably caught on the trunk and almost always with the same orientation as the bird, i.e. the rodent had the head facing away from the kestrel. When this did not occur the kestrel turned the prey soon after blocking and took it in the "correct" position.

After capture the kestrel stood in the same posture for some time, holding firmly the prey with the foot, squeezing its trunk. There was no indication of talon use during this phase or at catching. Such a posture lasted till ingestion started, determining the so-called "latency of ingestion". It was much longer during the rat-tests (350.63±54.53 sec) than in the mouse-tests (148.40±55.58 sec) ($Z = 2.443$, $n = 18$, $p < 0.01$). Some bill strikes were carried out on the prey with opened mandibles, and were much more similar to real bites than to peckings. The strength of these bites to the rats was subjectively judged similar to the mice. The bites were directed invariably to head (occipital and ocular regions) and every kestrel performed them much more frequently to the rat (46.0±6.5 mean bites/rat vs 6.9±0.6 mean bites/mouse; Permutation test, $n = 8$, $p < 0.01$). Even subtracting tentatively a frequency of 25 bites from each rat, the 2 samples still remained significantly different (Permutation test, $n=8$, $p < 0.02$).

Discussion

The size of the prey used in this study was found to affect the predatory behaviour greatly. Such an effect was found not only for the attack itself, but also for the preceding activities. The rat elicited more conflict patterns as well as exploratory flights. These are likely to be caused patterns as well as exploratory flights. These are likely to be caused by the conflict between the motivation to catch the rat after its recognition as a prey and the evaluation of the possible damage from retaliation. In fact, retaliation of the rat while struggling to escape from the kestrel's grip can result in very painful bites and dangerous wounds. This suggestion is in full accord to what Ille (1991) found in the barn owl preying small or large rodent prey. In fact, when catching rats of more than 80 g (large prey) the birds displayed many more conflict patterns. Besides, the greater the body size of the rodent the higher its speed is.

Probably, the kestrel also evaluated the probability the rat had of escaping safely when perceiving the bird approach. The higher frequency of flights performed during the rat-tests are likely to indicate such an evaluation. The lack of confidence is indicated also by the trend to increase the latency of predation. The more frequent use of indirect attack when preying the rat supports the awe it may feel. Nevertheless, the motivation to grasp the prey was always greater than the possible costs of its retaliation and damage. In contrast to Village (1990), the kestrel's bites of the prey inhibit the quarry's movements and escape attempts by damaging the central nervous system and are not a tool for killing. The bites recorded in this study are performed exactly in the same way as observed previously against mice only (Csermely *et al.*, 1989; Csermely, 1993), confirming the same hypothesis raised there about their meaning. Assuming a similarity in bite strength, as shown above, the rat received many more bites just because of its greater skull thickness. The kestrel then requires repeated peckings to damage severely its central nervous system, while the same results is obtained with a smaller number of strikes to the thinner skull of the mouse.

In case the kestrel used the talons as a weapon to kill the prey one must assume that both the rodents die by those wounds and then within similar amount of time. It is then expected to record a few bites and, moreover, a similar frequency between the two prey. However, this did not occur at all.

The longer latency of ingestion during the rat-tests is a direct consequence of the repeated biting carried out to the rat itself. Such a latency is likely to represent the time span necessary to fully subdue the rodent prey and to induce death. In fact, the kestrel continued to remain in the same posture and never stopped squeezing the prey during that phase. Such behaviour is indirect evidence of a lack of talons too, since we would expect a much quicker death and a shorter latency of ingestion if they were inserted in the quarry's body.

In conclusion, this study shows how prey size can greatly modify the several patterns of the kestrel's predatory sequence, but only quantitatively. Given a certain level of motivation to prey, the kestrel is readily able to catch a small-medium size rat although it induces more conflict behaviour patterns and a trend to increase the latency of predation.

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Riassunto - È stato studiato un gruppo di 10 gheppi *Falco tinnunculus* riabilitati e pronti per la liberazione in natura, al fine di valutare se il comportamento predatorio in generale o qualche aspetto dell'intera sequenza predatoria variavano in rapporto al tipo di preda. I tests sono stati condotti in cattività sottoponendo i gheppi individualmente a 2 prove di predazione, in 2 giorni consecutivi, nei confronti di un topo di laboratorio di manto agouti e di peso compreso tra 12-15 g, o di un ratto di laboratorio di 48-60 g, anch'esso di manto agouti. Il rapporto mole tra i due tipi di preda è, quindi, rimasto costantemente di 1:4.

Le risposte date dai gheppi nei confronti delle prede sono state nettamente diversificate, sia prima che dopo la cattura. In presenza del ratto si sono osservate molte attività conflittuali, quali preening e spostamenti sul posatoio, mentre esse non sono state quasi mai effettuate durante i tests con il topo. Non sono emerse differenze per quel che riguarda la latenza di predazione o la tecnica di cattura della preda. Al contrario, il ratto ha ricevuto un maggior numero di morsi rispetto al topo e la latenza di ingestione, interpretata come il tempo occorente per causare la morte della preda, è stata nettamente maggiore quando era catturato il ratto. Le implicazioni adattive di tali differenze comportamentali sono discusse in dettaglio.

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Egg size variability between clutches of Choughs (*Pyrrhocorax pyrrhocorax*)

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Abstract - The main sources of egg-size variability at interclutch level (clutch size and female) have been analyzed for 57 pairs of Choughs breeding at the Ebro Valley (Monegros) area in 1992. Egg-size variability is not affected by clutch size variation (4,5 and 6 eggs), whereas it is influenced by female characteristics. These results are discussed in relation to the findings in other birds, particularly Corvidae, and a final hypothesis, taking into account the existence of sexual dimorphism and courtship feeding behaviour in these birds, is emitted to explain them.

Introduction

The Chough (*Pyrrhocorax pyrrhocorax*) is a widely distributed bird, ranging from European Atlantic coasts to the Himalayas (Coombs 1978). Although accurate data on changes in breeding pair densities are only available from the British Isles (Rolfe 1966, Bullock et al. 1983, Warnes 1983, Bignal and Curtis 1988). there is general agreement about its population decline in Europe during the last two centuries (Guillou 1981, Owen 1988). At present, reduced populations are scattered throughout its range and, because of this, the Chough has been included among the species of wild birds requiring maximum protection (Easterbee and Bignal 1988). Therefore, data on their breeding biology and ecology are relevant to ensure suitable conservation policies. Data on breeding parameters of Choughs are very scarce, mainly due to low breeding densities and the difficulties in reaching their nesting sites, though some studies are available for the British Isles (Bignal et al. 1987).

In the Iberian Peninsula, there are still some areas with large populations of Choughs (Soler 1988; Blanco et al. 1991) and, in some cases, with easily accessible nests (Tella and Torre 1993), but their breeding biology still remains poorly known.

Among reproductive parameters, egg size has been recognized as a relevant factor in determining hatchling size (Rofstad and Sandvik 1987) and chick growth and survival in quite different bird groups (Parsons 1970; Schifferli 1973; Ricklefs et al. 1978; Slagsvold *et al.* 1984). So, even though it has not yet been investigated in Choughs, we assume that egg-size differences have potential relevancy to analyze breeding success variability among pairs also in this species. Furthermore, it will be of great interest for conservation strategies, to know whether such potentially influential reproductive parameters depend mainly on pair or territory characteristics.

Material and Methods

Data were collected during the breeding season of 1992 from Choughs nesting in abandoned buildings from the Ebro Valley (Northeast Spain), where there is a large population of such birds (Tella and Torre 1993).

Fiftyseven pairs of Choughs were monitored during this study. Nest visits were distributed during the breeding season to determine clutch size and breeding success (number of hatched eggs, number of fledged chicks). All nests containing eggs were visited at least twice since egg laying had started. There was an interval of 10 days between such visits and when final clutch size was recorded. No more than 15 min. was spent in each visit, and possible undesirable effects were monitored by recording the time elapsed before the female returned to the nest. This was generally short (range 7-34 min.).

In a total of 2910 egg-days of exposure the loss of only one egg was recorded, so it was assumed that

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egg loss was very low during this season; and that clutch sizes reported would closely correspond to the eggs actually laid.

All the eggs were marked with a felt-tip pen and their length and breadth were measured with a digital caliper (± 0.1 mm). Since Chough eggs have a typical ellipsoid shape, their external volume was estimated using Hoyt's (1979) volume constant Kv.= 0.509 to egg length x breadth^2. Since our methodological approach did not allow the obtention of freshly laid eggs, egg weight was not measured because of its variation along the incubation period (Rahn and Ar 1974).

To test for egg size differences among females (i.e. breeding pairs) and clutch sizes, a hierarchical analysis of variance on egg size parameters, with clutch size as a fixed effect and including breeding pairs as nested random effect, was undertaken using those clutch sizes with sufficient sample size, namely 9 clutches of four, 28 of five and 17 of six eggs (n=54). Normality of distributions was assessed through inspection of normal plots and departures from homoscedasticity using Box-M test.

Results

In Table 1 descriptive statistics corresponding to a case egg (n=291) approach are given. These 291 eggs were distributed in five different clutch sizes (2 of three eggs, 9 of four, 28 of five, 17 of six and 1 of seven eggs). The modal clutch size was five eggs and the mean clutch size 5.10 (s.d. 0.82). In Table 2 we give statistics corresponding to the case-nest approach (n=54).

Results obtained from the nested analysis of variance performed on these clutches indicate that, while a relevant nest effect was detected for egg size variability (Vol.: $F_{51,224} = 18.03$, $p < 0.001$), no significant egg-size effect was found linked to clutch size (Vol.:$F_{2,51} = 0.32$, p= 0.731). Nest differences in egg-size estimated through volume were the result of significant nest differences arising both from egg length ($F_{51,224} = 16.01$, $p < 0.001$) and breadth ($F_{51,224} = 10.56$, $p< 0.001$). Neither egg length nor breadth showed clutch-size related significant effects.

Discussion

Interclutch variability in egg size is an outcome of various interactions between parental quality and ecological conditions (Birkhead 1991), but there is general agreement that female phenotype might explain a large amount of this interclutch variability (see Jover *et al.* 1993 and references therein).

There is evidence that clutch size and egg size are inversely related when comparisons are performed at the across species level (Blackburn 1991); at within species level, however, the existence of such a trade-off between these variables is not so clear.

Some authors have found positive relationships between clutch size and egg size (Coulson 1963, Ojanen *et al.* 1978) while in other cases the relationship found was the opposite (Myrberget 1977, Ojanen *et al.* 1978) or did not appear at all (Pikula 1971, Bryant 1975, Ojanen *et al.* 1978). Especially relevant is the case reported by Järvinen and Väisänen (1983) working with three different populations of Pied Flycatchers (*Ficedula hypoleuca*) in Finland, where they found all three trends, attributing differences to female quality and habitat conditions. Potti (1993), working with Pied Flycatchers has found that egg size tends to increase from clutches of four- to five-eggs and to diminish from those of five- to six- and seven-eggs, suggesting the existence of a trade-off between clutch-size and egg-size, but only detectable under stringent ecological conditions (Lindén and Möller 1989). In any case, at within species level it is clear that female condition and other ecological and life history constraints might produce significant deviations from this pattern (Blackburn 1991, Potti 1993).

Working with Magpies in Sweden, Högsted (1980, 1981) attributes the variation in clutch size observed in his studies, mainly to differences in food supply (i.e. territory quality). However, these results do not agree with those reported by Goodburn (1991) for Magpies in England, who found that female quality is the main factor explaining both clutch and egg size variation. Discrepancies between such studies are attributed by Goodburn (1991) to a greater degree of variability in territory quality, enhanced by the

Table 1 - Measures in mm and volume in ml for n=291 Chough eggs from the Ebro Valley in 1992.

	Mean	Std.dev	Min	Max
Lenght	40.71	1.66	35.98	45.37
Breadth	27.77	0.69	25.62	29.66
Volume	15.99	1.11	12.49	19.46

Table 2 - Measures (mm) and volume (ml) of Chough eggs grouped by nest and accounting for the Global values and the three main clutch sizes (4,5 and 6) at the Ebro Valley area in 1992. A total of 54 clutches are included (9 of four eggs, 28 of five and 17 of six).

	C-S	Mean	Std.dev	Min	Max
Lenght					
	G	40.71	1.45	37.03	44.81
	4	40.36	1.12	38.45	41.73
	5	40.91	1.24	38.57	43.14
	6	40.57	1.90	37.03	44.81
Breadth					
	G	27.74	0.58	26.29	28.90
	4	27.63	0.57	26.99	28.35
	5	27.74	0.65	26.29	28.90
	6	27.80	0.49	27.15	28.85
Volume					
	G	15.96	0.97	13.78	18.98
	4	15.69	0.80	14.91	17.09
	5	16.03	0.87	13.78	17.90
	6	15.98	1.21	14.09	18.98

existence of more frequent territory vacancies, in Högsted's studies.

This would suggest that female effects on clutch size could be overcome only when differences among territories are large enough. If this is so, our results might indicate that, in our study area and in this breeding season, Choughs occupy rather similar quality territories and, then, differences in clutch size stated should come, mainly, from differences in the breeding pair quality.

Since, as occurs in Magpies, in Choughs the larger male parent (Tella and Torre 1993) provides food for the female during the laying and incubation periods and for both the female and their brood during the early stages of brooding period (Easterbee and Bignal 1988), differences in the breeding parameters, other than those which are primarily linked to female phenotype, as occurs with egg size (Van Noordwijk *et al.* 1981; Birkhead 1991; Jover *et al.* 1993) or shape (Bignal, pers.com.), could be better explained by male characteristics and their interaction with the female ones. This would suggest that the different cluth sizes reported are due to differential abilities of males to provision their females, chiefly during the rapid follicular growth period of egg formation (Walsberg 1983).

Further long term studies including repeatibility among pairs and territories are needed to evaluate properly their influency in egg-size and the relationship of this trait to lifetime breeding success of Choughs.

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Riassunto - Per 57 coppie di Gracchi corallini nidificanti nella valle dell'Ebro (Spagna) nel 1992, è stata analizzata la variabilità dimensionale delle uova deposte, ponendola in relazione alla dimensione della covata. Le dimensioni delle uova non sono risultate essere significativamente influenzate dal numero di uova deposte per coppia (4-5-6 uova). Le caratteristiche della femmina sono probabilmente il fattore che maggiormente influenza la variabilita nella dimensione delle uova in questi corvidi.

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Short communications

Flight strategies of Honey Buzzards during spring migration across the Central Mediterranean

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During pre- and post-reproductive migration, the route across the Central Mediterranean is important for Honey Buzzards (*Pernis apivorus*).

During spring migration a large number of individuals have been observed at Cap Bon, Tunisia, and over the Straits of Messina (Thiollay 1975, Dejonghe 1980, Dimarca and Japichino 1984, Agostini 1992, Agostini et al. 1993, 1994) while few individuals were observed in Malta (Sultana and Gauci 1982).

Unlike the other two pathways used by these raptors when crossing the Mediterranean basin, the Straits of Gibraltar and the Bosphorus (Cramp and Simmons 1980, Porter and Beaman 1985), crossing the central Mediterranean entails flying over the Sicilian Channel and the Straits of Messina. Sicilian Channel is 150 km wide, implying a long, powered flight over the sea, with a considerable expenditure of energy. Since thermals are almost absent over water, migrants cannot use soaring alternating with gliding during the crossing. as they do over land (Kerlinger 1989). This study provides information on the spring migration of Honey Buzzards across the Central Mediterranean, through observations at Cap Bon (Tunisia) and the Straits of Messina (Italy), and concentrating on the flight behaviour of migrating individuals.

The Cap Bon peninsula in north-eastern Tunisia is a 25 km-wide plain dominated in the north by a promontory that reaches a height of 392 m, before dropping steeply to the sea opposite Sicily, which is not visible. According to Thiollay (1975), gliding raptors converge along a 2 km-front of this promontory during spring migration, taking advantage of thermals before their long flight across the sea. Thus this area would be extremely important to monitor the passage of birds across the Central Mediterranean.

The Straits of Messina separates Calabria and Sicily, in southern Italy. In its narrowest part, this stretch of sea is approximately three km wide. Two mountain systems are present: the Aspromonte in Calabria and the Peloritani Mountains in Sicily.

Observations were made 4-16 May 1990 in the Straits of Messina (119 hr) and 3-15 May 1990 at Cap Bon (105.3 hr).

A single observation post was used at Cap Bon (Fig.1) on the promontory at the extreme northern part of the Tunisian peninsula at its highest point.

Two observation posts along the Calabrian side of the Straits between Reggio Calabria and Scilla were used at the Straits of Messina (Fig.1). Though the migratory front appears to be very broad, migration is concentrated along the 15 km of coast around the narrowest part of the Straits (Dimarca and Japichino 1984, Agostini 1992).

Observers were equipped with 10x50 binoculars. telescope, compass, anemometer, IGM map 1:25000 and, at the Straits of Messina, receiving-transmitting radio to avoid recounting the same individuals.

The Tunisian National Institute of Meteorology supplied weather bulletins for Cap Bon, which were recorded at hourly intervals by the station in Kelibia.

At Cap Bon 2124 Honey Buzzards were observed. This number is an approximation. Once raptors reached the coast near the promontory, they rarely started the crossing towards NE and most of them flew back and forth along the coast or even inland, then disappeared towards the south.

Individuals were also observed leaving the coast in a SE direction. Only in a limited number of cases was it

Fig. 1: The study area.

possible to identify individuals, thanks to particular features of their plumage (broken or missing remiges and/or rectrices) or entire flocks, through particular interspecific associations. transit again over our observation posts after an hour or, in the case of the former, repeatedly over several days and thereby avoid recounting the birds. Individuals were seen returning to the coast after disappearing over the sea.

Finally flocks with numerous individuals were seen leaving the coast in a NE direction much farther south than our observation post, but because of the distance it was impossible to identify the species or count the individuals.

Only 743 birds undertook the crossing in a NE direction. As compared to other species frequently observed - the Black Kite (*Milvus migrans*), the Marsh Harrier (*Circus aeruginosus*), the Egyptian Vulture (*Neophron percnopterus*) - this species was the most likely to undertake flight in a NE direction (percentages of individuals crossing respectively 10.4, 6.9, 5.9 and 32.3). The behaviours observed along the coastline near the Tunisian promontory are similar to those reported by Kerlinger (1984, 1985) in his study of numerous species of raptors across Lake Superior and Delaware Bay at Cap May, New Jersey. He also recorded a significant difference in the percentage of individuals of other species undertaking the crossing: the percentage was much higher for species with higher aspect ratio (longer) wings. His hypothesis was that raptors with relatively long wings are more suited to undertake crossings of large bodies of water as this feature decreases the induced drag, and thus the energy needed for powered flight.

Indeed, the Honey Buzzard has a rather streamlined shape, but this feature is undoubtedly evident also in the other two species we observed, the Black Kite and the Marsh Harrier, which had lower percentages of individuals undertaking the crossing. This result may be distorted by the period in which the observations were carried out. In fact, the Black Kite and the Marsh Harrier migrate earlier in spring than the Honey Buzzard and from 3 to 15 May 1990 there was a much higher percentage of young of the former, which we were unfortunately unable to identify given the difficulties we encountered. As regards the Marsh Harrier, only two adult males were observed. Perhaps results also reflected the fact that the young are not motivated by reproduction to undertake migration. Moreover, the unsignificant influence of lateral winds on the Black Kites and Marsh Harriers crossing at Cap Bon (Agostini and Duchi 1994) suggests that these species are suited to undertake crossings of large bodies of water.

Differently the Honey Buzzard, like the Sharp Shinned Hawk (*Accipiter striatus*) above Lake Superior and Cap May (Kerlinger 1984), tends to cross the Sicilian Channel more frequently with weak lateral winds (from ESE) probably to minimize "drifting" (Agostini et al. in press).

It is also interesting that the 20 individuals that left the coast in a NE direction with strong winds blowing from SSW allowed themselves to be transported by the wind, by beating their wings and keeping the longitudinal axis of their body perpendicular to the direction of flight.

In the Straits of Messina, 4223 Honey Buzzards were observed, 48% on one day - 9 May - and 96% over five days. By comparing daily variations in migratory flow with those of Cap Bon, considering the number of individuals that undertook the crossing in the NE direction hourly during the observation period, we note

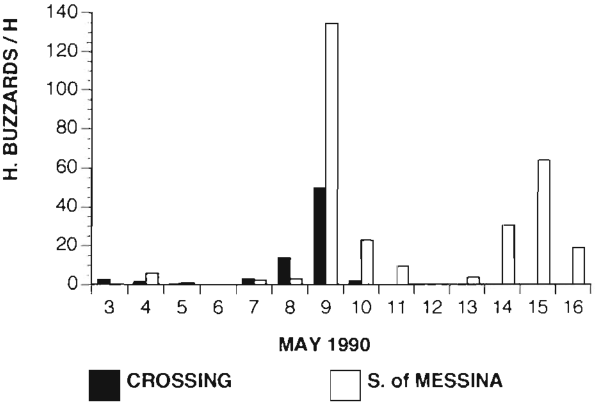

Fig. 2: Variations in migratory flow of Honey Buzzards from 3 to 16 May 1990 at Cap Bon (individuals crossing in a NE direction) and at the Straits of Messina.

a cosiderable correspondence, with the exception of 14 and 15 May (Fig. 2). This was the only period in which winds on the Tunisian peninsula were from NW.

If we compare the percentages of the various species observed, there is a correspondence between raptors observed in the Straits of Messina and those crossing in a NE direction from Tunisia. The percentages are different if we take into account all birds observed at Cap Bon (Table I).

Our observations at Cap Bon and at the Straits of Messina, do not seem to confirm results reported from Cap Bon by Thiollay (1975, 1977). The migratory front was not concentrated in the two kilometres of coast around the promontory of the Tunisian peninsula and was probably more diffuse. Our study also seems to underline the impossibility of accurately counting migrants because the site is quite unsuitable even for partial surveying of raptors migrating across the Central Mediterranean.

In the sample of 743 buzzards crossing at Cap Bon, flock size was 18.3(±3.1). In 46% of cases, once the raptors reached the promontory, they continued migration without moving along the coast or soaring. On four occasions individuals in the flock started soaring before continuing migration. On three occasions certain individuals left the flock and returned inland.

Of the individuals that did not undertake the crossing in a NE direction, flock size was 8.1(±0.7) birds; the difference between the mean size of the flock was significant for the two sample groups ($t=4.77$; $p<0.001$).

The Honey Buzzards, in a similar manner to Black Kites (Agostini and Duchi 1994), showed a strong tendency to remain in flock in front to a water barrier since the first individuals taking a decision (crossing or not) are followed by the others.

The importance of flocking behaviour during raptor migration is related to the location of the thermals (Kerlinger 1989). Studying the autumn Honey Buzzard migration above Malta, Thake (1980) hypothesized that flocking behaviour can also be utilized to diminish orientation errors by way of information transmission.

Such a hypothesis would imply a contemporaneous migration of adults (expert individuals) and young (inexpert individuals). This, however, does not occur among long distance migrating raptors because the adults precede the young during the spring migration (Kerlinger 1989).

The strong tendency of Honey Buzzards to remain in flock at Cap Bon and the low percentage of individuals crossing, suggests that flocking behaviour is important for water crossings, because an increase in flock size increases the probability that the flock will contain one or more individuals with a pronounced tendency to continue migrating.

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We also wish to thank the Tunisian National Institute of Meteorology for their precious collaboration.

Riassunto - Questo studio fornisce dettagliate informazioni sul comportamento in volo del Falco pecchiaiolo (*Pernis apivorus*) sul promontorio di Cap Bon, in Tunisia, e sullo Stretto di Messina, durante la migrazione primaverile.

Le osservazioni sono state effettuate tra il 3 ed il 16 maggio 1990.

2124 Falchi pecchiaioli sono stati osservati a Cap Bon; 743 hanno intrapreso la traversata del Canale di Sicilia in direzione NE. Sullo Stretto di Messina sono stati osservati 4223 individui, il 48% dei quali il 9 maggio ed il 96% in 5 giorni.

Le nostre osservazioni non confermano i risultati di un precedente studio effettuato a Cap Bon. Durante la migrazione primaverile questo promontorio non sembra essere adatto per effettuare una realistica quantificazione del flusso migratorio dei rapaci sul Mediterraneo centrale.

Table I. Percentages of different species observed at Cap Bon (individuals observed and individuals crossing) and in the Straits of Messina from 3 to 16 May 1990.

	Honey Buzzard	Black Kite	Marsh Harrier	Egyptian Vulture	other sp.
Cap Bon (**)	66.8	14.7	6.9	4.8	6.8
Cap Bon (*)	85.7	6.1	2.0	1.1	5.1
S. of Messina	92.6	2.2	1.9	0.1	3.2

(**) Individuals observed. (*) Individuals crossing.

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Inter-annual constancy in the laying period of Cory's Shearwater *Calonectris diomedea diomedea* on Lavezzi Island (Corsica)

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Some migrant species of petrels have a laying period that is short, constant and with little inter-colony variation (*e.g. Puffinus tenuirostris*: Serventy 1963). But this is not a general rule, other migrant species showing some variation between both years and colonies (Warham 1990). In Cory's Shearwater (*Calonectris d. diomedea*), the laying period lasts less than three weeks throughout its distribution area (Massa and Lo Valvo 1986), even though the Mediterranean populations breed one week earlier than the Atlantic population (Selvagem Is.: Zino *et al.* 1987, Berlinga I.: Granadeiro 1991). Moreover, the Mediterranean population is mainly migrant, leaving in October via Gibraltar (Telleria 1980) to winter in the South Atlantic (Mougin *et al.* 1988), while Atlantic populations are totally migrant (Mougin *et al.* 1988).

Previous studies on the laying period of Cory's Shearwater in the Mediterranean did not compare data among several breeding seasons (Aegean Is.: Wink *et al.* 1982, Corsica: Thibault 1985, Linosa I.: Massa and Lo Valvo 1986, Malta I.: Cachia Zammit and Borg 1986-87, Zembra I.: Gaultier 1981). The aim of this note is to study the inter-annual constancy in the laying date of the Cory's shearwater at a single colony in the Mediterranean.

The study was carried out on a monospecific colony of 255-400 pairs of Cory's Shearwater on Lavezzi Island (41°20'N, 09°15'E), a 66-ha nature reserve situated between Corsica and Sardinia in the Western Mediterranean. The island is mainly flat, but there are several discrete blocks of granite rocks, isolated from each other, which rise to a height of 40 m above sea level. Shearwaters occupy different blocks, forming distinct subcolonies.

In order to know the laying dates, samples of respectively 67, 57 and 51 occupied breeding sites were selected in 1982, 1992 and 1993 before the pre-laying exodus. Breeding sites were selected on the basis of good visibility of the birds in their nests. Laying occurs in the hours following the return of the female, after an exodus of several days (Gaultier 1981, pers. obs.); before laying, nest-sites are generally empty during the day: males visit them regularly, but mainly at night (pers. obs.). To obtain laying dates, breeding sites were monitored every morning in May and June in 1982 (from 20 May to 2 June) and 1992 (from 16 May to 12 June); in 1993, burrows were checked at the beginning and at the end of the laying period (22-23 May, 28-30 May and 6 th June). For the three years, dates were transformed into days of the civil year because of leap year 1992. We assumed that we always observed birds on the first day when they laid. Differences between the tempored distribution of egg laying during the different breeding seasons and among subcolonies were tested with a non-parametric test (Kolmogorov-Smirnov) and differences between the three years in the proportion of eggs laid at different times during the period with a contingency table.

Length of the laying period

In 1992, the first egg was laid on the 139th day (May 18), and the last on the 152th day (May 31). Moreover, most eggs (80.6%) were laid in seven days (Table 1). No differences appeared in the proportions of eggs laid at different times during the overall period for the three years (X^2=1.43, 2 d.f. n.s.). Mean laying dates corresponded to the 147th day in 1982 and to the 146th day in 1992.

Annual variation in the laying period

Data for the three years are presented in Table 2. No differences appear between distribution of egg-laying periods expressed in accumulated clutches for the years 1982 and 1992 (Kolmogorov-Smirnov test, D=0.07, n.s.), nor when comparing the beginning and the end of the 1992 and 1993 egg-laying periods (Kolmogorov-Smirnov test, D=0.10, n.s).

Table 1 - Comparison between the three years in the proportion of eggs laid between the 143th and the 149th day.

Years	Number of eggs laid during the 143th and the 149th day	%	Number of eggs laid before the 143th and after the 149th day
1982	57	85.1	10
1992	44	77.2	13
1993	40	78.4	11

Variation in laying period between subcolonies

Data obtained in 1982 and 1992 are presented on Table 3. No difference was detected in the laying period among the two main subcolonies for 1982 (Kolmogorov-Smirnov test, D=0.10, n.s.) and 1992 (Kolmogorov-Smirnov test, D=0.04, n.s.).

These results show that there were no differences in the range of laying dates within and between subcolonies. They also confirm the high synchrony among breeding localities in the western Mediterranean, with a mean laying date corresponding to 26-28 May (Massa and Lo Valvo 1986). The two other petrels breeding in the Mediterranean, the Storm Petrel (*Hydrobates pelagicus*) and the Mediterranean Shearwater (*Puffinus yelkouan*), show a very different pattern. The Storm Petrel's laying period occurs from the end of April to mid June on Corsica (Guyot and Thibault 1985, Bretagnolle and Thibault 1990), and from the end of April up to mid -July on Malta (Sultana and Gauci 1982) and Sicily (Massa and Catalisano 1986). The mean laying-period of the Mediterranean Shearwater occurs from mid-March to the beginning of April on Hyéres Is., France (Vidal 1985), mainly in mid-March in the Balearics (Aguilar 1991) and from the first half of March on Malta (Galea 1990-91). So, at least in the Western Mediterranean, the Storm Petrel has a laying-period spread over more than two months, whereas the Mediterranean Shearwater shows variations according to breeding locality. In contrast, Cory's Shearwater has a short and regular laying-period with no difference between breeding localities. We suggest that these different patterns represent different strategies in the exploitation of feeding resources. The Storm Petrel and the Mediterranean Shearwater are coastal and their breeding time depends notably on feeding resources available in the

Table 2 - Number of eggs laid during the three years. First column given the number of eggs laid daily and second column give the cumulated total of eggs; — = no check.

Day/Year	1982		1992		1993	
≤141	4	4	5	5	—	—
142	0	4	1	6	—	5
143	3	7	8	9	5	10
144	4	11	8	17	—	—
145	8	19	8	25	—	—
146	14	33	5	30	—	—
147	13	46	8	38	—	—
148	10	56	9	47	—	42
149	5	61	3	50	3	45
≥150	6	67	7	57	6	51

Table 3 - Number of eggs laid in 1982 and 1992 in the two main subcolonies.

Day/Year	1982		1992	
	subcolony A	subcolony B	subcolony A	subcolony B
≤141	1	3	1	2
<142	0	0	1	0
<143	2	0	3	0
<144	3	1	6	1
<145	2	5	2	3
<146	2	10	1	1
<147	2	8	3	2
<148	1	6	6	2
<149	2	2	1	1
≥150	2	3	2	4

strict vicinity of the colony where periods of abundance are known to vary annually (Zotier *et al.* 1993). In contrast, Cory's Shearwater seems to be unhindered by the inter-annual variability of feeding resources, as birds are able to fly long distances in search of food. Its short laying-period and high inter-colony and inter-annual synchronism may result from migratory habits (with the main part of the population leaving the Mediterranean in autumn for a trans-equatorial trip) and more predictable food supply.

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Résumé - Une étude sur la période de ponte du Puffin cendré l'île Lavezzi (Corse) montre qu'il n'existe pas de différences inter-annuelles. Elle confirme également la grande synchronie, entre les différents sites de reproduction en Méditerranée, relevée par de précédents auteurs.

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Status and habitat use of a population of Great Bustard in southern Spain.

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The European populations of the Great Bustard (*Otis tarda*) have greatly decreased during this century due to the destruction of their natural habitats (Goriup 1987). Nowadays the Spanish population is the most important in Europe, estimated to be about 10.000-11.000 birds (Hidalgo and Carranza 1990). The original habitat of Great Bustards was natural grassy steppes (Cramp and Simmons 1980) although they eventually adapted to some artificial environments such as agricultural lands in West Germany or Hungary where Great Bustards now use extensive agricultural or pasture areas (Dornbusch 1983). The Spanish population is very fragmented and the main areas are located in extensive pastures and herbaceous crops in the mid-west of Spain. At present in Southern Spain there are only a few groups totalling less than 100-120 birds (Hidalgo and Carranza 1990). One of the largest groups in Andalucia is located in the Campiña, in the province of Cordoba. In 1987 this group of Great Bustards was composed of less than 30 birds which use the herbaceous cultivation fields and the border of the olive groves in winter (Redondo 1990). This is unusual because the Bustards' habitats are open areas as seen above and not tree-covered ground. Field work was carried out from October 1990 to June 1993 in an area of 177 km^2 in the Campiña of the province of Cordoba (Southern Spain) (Figure 1). We considered the following classes of land use: herbaceous crops, arable and stubble plots and olive groves which have a density of 100 trees/ha. We also defined an olive grove border as an arbitrary 50 m wide band, including 25 m outside and 25 m inside the first line of olive trees. We made two monthly visits early in the morning by car at a constant speed of 20 km/h. For each bird or flock sighted we recorded the date, flock size, location on a 1:50.000 scale map, type of land used and distance to the nearest olive grove. Because of the importance to the Great Bustards of visibility in their use of each plot, we calculated the lowest visibility as the minimum distance to the nearest horizon or object which restricts visibility (Martinez 1991). We calculated four levels of core area by the harmonic mean method (Dixon and Chapman 1980), using the Space Ecological Analysis System (SEAS 1989) personal computer software package. The core areas were defined by contour lines (isopleths) enclosing areas in which Bustards were observed in 30, 50, 75 and 90 % of all records.

Table 1 shows the number of Great Bustards located in the study area in each month. The highest number was sighted in December 1990 (24 birds), a similar number to that detected by Redondo (1990) in 1987, which suggests that this population has not increased despite their protection after 1985. Nevertheless, and taking into account the vast area of the Campiña, we cannot be sure we have detected all the birds. Great Bustards probably disperse into small groups in the Campiña between May and October, as occurs in other regions (Lucio and Purroy 1987, Hidalgo and Carranza 1990). Bustards were sighted more frequently from October to April. In April 1991 and 1992, we watched some groups performing a lek-like behaviour. In addition, we located in June 1992 a female with two chicks, thus confirming that Great Bustards breed in this area.

Figure 1 shows the core area in which Great Bustards could be found with a probability of 30 % (129.4 ha), 50 % (340.6 ha), 75 % (872.5 ha) and 90 % (4, 445.1 ha). These results imply that Bustards have a high preference for an area near the olive groves. Nevertheless birds were only sighted in the border band and never completely within the olive groves. As summarized in figure 2, this preference for the border of the olive groves was stronger in winter, when there many olives on the ground. The distance from the olive grove border increased after April and decreased again when the olives were ripe at

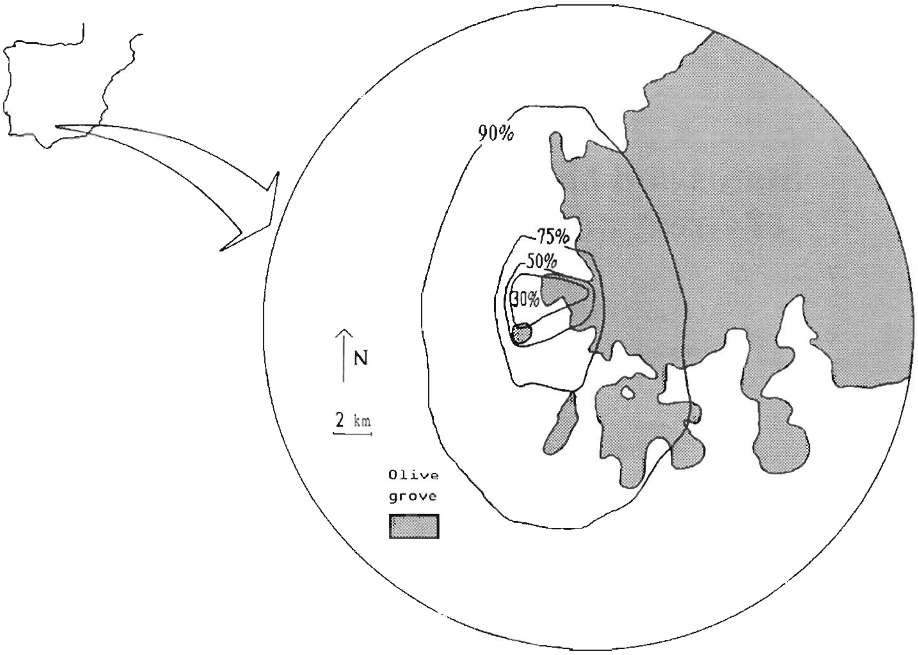

Figure 1 -Study area and core areas at 30 %, 50 %, 75% and 90 % of probability.

the end of autumn (one way ANOVA. F=37.2, d.f.=64, p<0.001) (figure 3). The analysis of excrement collected in winter (December to March) shows that 70.3 % of sample had olive pits (range 0-22 rips, mean=3.7, SD=5.21, N=47) which suggests that olives were an important part of the winter diet of Great Bustards. We also found beetle and plant remains.

The lowest visibility of plots used by Great Bustards changed during the year in a manner similar to the distance to the olive groves (figure 3). The visibility was lower in winter when Bustards moved close to the olive grove. On the contrary, in spring and summer, birds used high visibility patches (one way ANOVA, F=17.7, d.f.=65, p<0.001). When Bustards were near the border of the olive grove the flock size tended to be higher than in those groups sighted far away (partial correlation between flock size and distance to the olive trees, after controlling for the date, r=-0.32, N=65, p<0.05).

Table I - Monthy maximun number of Great Bustards, mean flock size, standard error (S.E.) and sample size (N). July and August are not included because no bird was sighted during these months.

	Maximun Sighted				Flock Size		
Month	1990	1991	1992	1993	Mean	S.E.	N.
I	-	18	9	6	12.2	2.7	6
II	-	14	13	12	7.9	0.8	15
III	-	5	12	5	7.3	1.2	11
IV	-	8	20	5	10.7	2.3	7
V	-	0	12	0	7	0.5	2
VI	-	0	3	0	3	0	1
IX	-	1	0	-	1	0	1
X	7	5	8	-	7.5	1.7	4
XI	12	7	7	-	8.3	2.5	4
XII	24	7	8	-	9.2	1	15

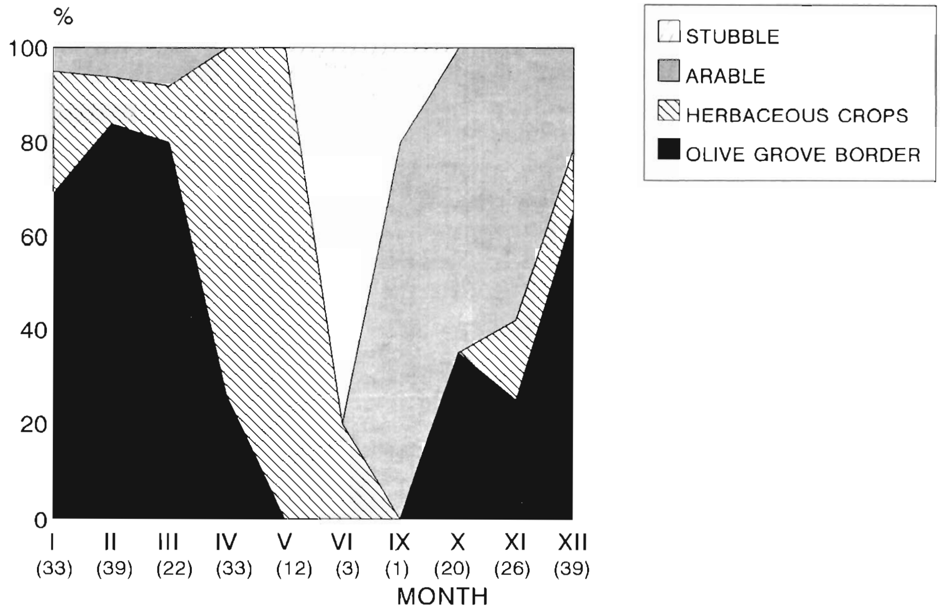

Figure 2 - Monthly habitat use of Great Bustards in the study area. The percentages are calculated from the number of birds sighted in every patch. Months VII and VIII are not included because no bird was sighted (Sample size in brackets).

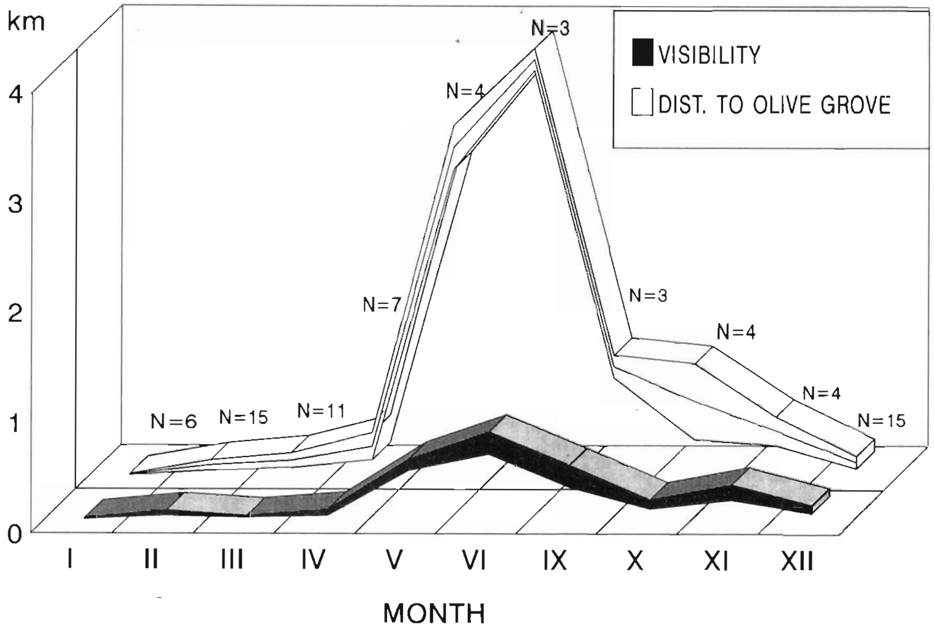

Figure 3 - Monthly distance to the nearest olive grove and the lowest visibility of each bird or flock sighted.

Results of core areas which show a high preference for an area near the olive groves are unexpected since the original habitats of Great Bustards are open fields and grassy steppes, or some open agricultural environments because of their adaptability in colonizing these new habitats (Cramp and Simmons 1980). To our knowledge, this is the only study in which Great Bustards have been detected with regularity in the surroundings of a tree-covered area. The abundant food supply in the olive grove, due to the many olives on the ground in winter (Munoz-Cobo 1987), could explain the use of this habitat, as suggested also by the high frequency of olive pits found in the excrement. In addition, food in olive groves is seasonally predictable as a consequence of human management. According to Schluter (1982), in predictable conditions birds will use patches with high food supply whereas habitat structure or predation risk will not be so important. As a matter of fact, Bustards use the olive grove border in winter when is possible a high food intake despite the predation risk due to the lower visibility. In contrast, when olives were not available, birds used high visibility patches in the herbaceous crops, arable or stubble fields, far from the olive grove. Increasing flock size when Great Bustards came close to the olive grove may be explained as a response to the higher predation risk because of the negative relationship between vigilance time and flock size (Pulliam 1973, Elcavage and Caraco 1983, Sullivan 1984).

Riassunto - Sono presentati i risultati di censimenti di Otarda effettuati tra l'ottobre 1990 e il giugno 1993 nella Campiña, provincia di Cordoba. Un massimo di 24 individui fu rilevato nel dicembre 1990. I dati fanno ritenere che la locale popolazione di Otarda non si sia incrementata dopo la protezione accordata nel 1985. La maggior parte dei soggetti è stata avvistata tra ottobre ed aprile, in un'area inferiore ai 900 ha. Nonostante la minor visibilità e l'aumentato rischio di predazione, le Otarde frequentano in inverno i margini di uliveti, in relazione all'abbondante disponibilità alimentare. I gruppi tendono ad essere più consistenti proprio in vicinanza degli uliveti.

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Avocetta N° 18: 85-89 (1994)

Book reviews

Del Hoyo J., Elliott A. e Sargatal J. (eds.) 1992. Handbook of the Birds of the World. Volume 1. Lynx Edicions, Barcelona, 696 pp.

Ogni ornitologo ha prima o poi sentito la necessità di un testo che elencasse ed illustrasse tutte le specie di uccelli del mondo. Tuttavia, incredibilmente, nonostante le innumerevoli guide ornitologiche presenti sul mercato internazionale, tale opera non era sino ad oggi disponibile. Dobbiamo quindi essere riconoscenti a Del Hoyo, Elliott e Sargatal per essere riusciti, dopo una prima fase di pianificazione dell'Handbook of the Birds of the World (HBW), a passare alla fase operativa, che ha visto il coinvolgimento dell'International Council for Bird Preservation (ICBP), ed è culminata nella pubblicazione del primo volume dell'opera nell'autunno del 1992 e del secondo nell' inverno del 1994.

L' ICBP ha valutato che a tutt'oggi delle più di 9000 specie di uccelli esistenti, 5000 siano in declino e 1000 risultino minacciate di estinzione. Queste nude cifre, da sole, sono più che sufficienti ad illustrare la drammaticità della situazione dell'avifauna del pianeta, situazione che è tanto più grave quando si consideri che il numero di specie in pericolo di estinzione è andato inesorabilmente aumentando a partire dal 1958, quando quelle considerate a rischio erano meno di 100. Sebbene l'HBW non sia stato stilato da personale dell'ICBP, uno degli obiettivi perseguiti fin dalle fasi iniziali della pianificazione dell'opera è stato quello di produrre una pubblicazione utile alla politica di protezione e conservazione dell'avifauna. E' stato così deciso che per ogni famiglia e ogni specie venissero analizzati sia lo status globale che le prospettive di conservazione.

L'intento prioritario dell'opera, comunque, era e rimane quello di descrivere ed illustrare la sorprendente diversità biologica riscontrabile all'interno della classe Aves. La classificazione adottata è stata sostanzialmente quella di Morony, Bock e Farrand (1975), considerata la più elaborata e ben bilanciata fra tutte le più recenti classificazioni. Gli autori dell'HBW hanno compiuto una scelta dettata dalla prudenza, evitando la nuova classificazione proposta da Sibley e Ahlquist (1990), tanto innovativa e rivoluzionaria da aver già attirato in più occasioni pesanti critiche.

Un'opera di questo genere presentava un rischio concreto, e cioè quello di risultare come un doppione (sebbene a scala mondiale) dei trattati regionali già esistenti (The Birds of the Western Palearctic, Handbuch der Vögel Mitteleuropas ecc.). Questo pericolo è stato scongiurato scegliendo di trattare in modo esteso le diverse famiglie di uccelli, e in modo assai stringato le singole specie. L'HBW è stato così suddiviso in capitoli, ciascuno dedicato ad una famiglia diversa ed articolato in una prima parte in cui vengono tratteggiate le principali caratteristiche del taxon considerato ed in una seconda parte in cui vengono illustrate le singole specie. Il testo relativo ad ogni famiglia si articola in diversi paragrafi che affrontano nell'ordine i seguenti argomenti: Sistematica, Morfologia, Habitat, Abitudini, Voce, Cibo, Riproduzione, Movimenti, Rapporti con l'uomo e, in ultimo, Status e Conservazione.

La sezione relativa alla Sistematica discute le principali teorie relative all'origine ed evoluzione della famiglia ed evidenzia l'organizzazione interna del taxon in termini di sottofamiglie e tribù. Gli aspetti morfologici vengono esaminati cercando di interpretare il significato di certi adattamenti ed il loro possibile ruolo nell'evoluzione delle specie. L'analisi degli habitat usati si concentra prevalentemente su quelli riproduttivi, anche se non vengono tralasciati gli ambienti di sosta o di alimentazione. Il paragrafo relativo alle abitudini è un contenitore impiegato per analizzare aspetti peculiari della biologia della famiglia considerata; le tematiche trattate sono pertanto assai diverse e si va dalla socialità alla termoregolazione, dall'aggressione intraspecifica alla pulizia individuale. Le vocalizzazioni sono state analizzate enfatizzandone la funzione, sia essa legata alla difesa territoriale, alla formazione della coppia o all'allevamento della prole. L'uso dei sonogrammi è stato escluso per non appesantire troppo la trattazione e perché gli autori hanno ritenuto che questa forma di rappresentazione risulti essere troppo tecnica e quindi interpretabile correttamente solo da un lettore specializzato. L'esame della dieta è solitamente integrato dall' illustrazione delle più comuni tecniche di alimentazione impiegate nella famiglia. La biologia riproduttiva viene trattata a più livelli considerando i diversi stadi della nidificazione e le molteplici attività di corteggiamento. Il paragrafo relativo ai movimenti si riferisce principalmente alle migrazioni, ma anche gli spostamenti ridotti, tipici delle specie stanziali, vengono presi in considerazione ed illustrati. Le relazioni con l'uomo sono esaminate ricordando tradizioni e leggende popolari o, più pragmaticamente, analizzando il livello di sfruttamento commerciale subito dalle varie specie. Lo status generale della famiglia, infine, viene esaminato con cura evidenziando i pericoli e le minacce che riguardano il taxon nel suo complesso. Le singole specie di ogni famiglia vengono trattate con testi brevi e concisi (a caratteri di stampa ridotti) che presentano informazioni relative alla Tassonomia, Distribuzione, Morfologia, Habitat, Dieta, Riproduzione, Movimenti, Status e Conservazione. Ad ogni testo è affiancata una mappa distributiva che distingue, tramite l'impiego di tre colori diversi, le aree di riproduzione da quelle in cui la specie non si riproduce. La descrizione delle varie specie è integrata da tavole a colori a tutta pagina dove è di norma illustrato solo l'habitus dell'individuo adulto (maschio, nella maggior parte dei casi).

L'organizzazione bibliografica dell'HBW è complessa. Riferimenti bibliografici sono riportati per ogni specie e per ogni famiglia al termine della relativa trattazione. A fine volume viene proposta una Bibliografia Generale che riporta tutte le citazioni bibliografiche precedenti e una Bibliografia delle Descrizioni Scientifiche che riporta gli articoli con le descrizioni originali di ogni genere, specie o sottospecie accettata nell' HBW.

Le 27 famiglie trattate nel 1° Volume appartengono ai seguenti ordini: Struthioniformes, Tinamiformes, Sphenisciformes, Gaviiformes, Podicipediformes, Procellariiformes, Pelecaniformes, Ciconiiformes, Phoenicotteriformes e Anseriformes. La trattazione delle famiglie monospecifiche, o comunque composte da poche specie (Rheidae, Casuariidae, Struthionidae ecc.) risulta senza dubbio più chiara ed omogenea rispetto a quella di taxa che annoverano molte specie (Anatidae, Procellariidae). Questi ultimi infatti presentano spesso irrisolti problemi sistematici e un ventaglio di straordinarie diversità morfologiche ed ecoetologiche. Nell'ambito della famiglia Anatidae, che annovera almeno 147 specie, il rango tassonomico di non poche entità è ancora da chiarire. Fischione europeo (*Anas penelope*) e Fischione americano (*A. americana*) potrebbero essere considerate unitamente come superspecie, così come il Codone (*A. acuta*) e l'Anatra georgiana (*A. georgica*); d'altra parte l'Anatra zamperosse *A. rubripes*, sarebbe una sottospecie del Germano reale *A. platyrhynchos* ecc. La confusione sitematica viene accresciuta dal fatto che molte specie si ibridano con diverse altre. Il Germano reale, ad esempio, si incrocia con almeno 23 altre specie di anatidi, non di rado producendo ibridi fecondi. In questa famiglia le caratteristiche morfologiche e riproduttive sono assai diversificate. Quanto a dimensioni e colorazione, ad esempio, si va da specie che possono raggiungere quasi i due metri di lunghezza (il Cigno trombettiere *Cygnus buccinator*) a specie lunghe 30 centimetri (l'Oca pigmea africana *Nettapus auritus*), da specie a dimorfismo sessuale "classico", con maschi brillantemente colorati, a specie con dimorfismo sessuale invertito con femmine più vistose dei maschi (la Casarca del Paradiso *Tadorna variegata*). Altrettanto diversificate le modalità riproduttive, con la maggior parte degli Anitini che si accoppiano ogni anno con un nuovo partner e gli Anserini, che, al contrario, presentano la tendenza a formare coppie stabili nel tempo. In genere il nido è una struttura semplice posta sul terreno, ma alcune specie nidificano sugli alberi, a volte utilizzando nidi altrui (come nel caso dell'Oca egiziana *Alopochen aegyptiacus* che utilizza i giganteschi nidi dell'Uccello martello *Scopus ombretta*). In breve, la trattazione delle famiglie ad elevata ricchezza specifica evidenzia quasi sempre lo stato di difficoltà in cui si dibatte tuttora la Sistematica e, quindi, la Filogenesi della Classe. D'altra parte, l'enorme diversificazione morfologica ed eco-etologica che viene spesso evidenziata suggerisce che l'adattamento all'ambiente non può non aver giocato un ruolo fondamentale nella storia evolutiva di questi taxa.

Un discorso a sé meritano i paragrafi relativi allo status e alla conservazione delle specie. L'HBW affronta la tematica in termini globali, considerando gli effettivi delle singole specie nella loro consistenza e distribuzione mondiale. Non deve pertanto stupire che alcune specie incluse nelle liste rosse nazionali (ad esempio l'Uccello delle tempeste *Hydrobates pelagicus*, il Mignattaio *Plegadis falcinellus* e il Tarabuso *Botaurus stellaris* per l'Italia) non siano ancora considerate in questa sede in pericolo di estinzione. E' quindi tanto più preoccupante constatare che ad altre specie (il Gobbo rugginoso *Oxyura leucocephala* per l'Italia) venga invece accordato lo status di specie vulnerabile, nonostante gli eventuali sforzi di reintroduzione in atto. Sebbene le cause del declino riscontrabile in molte specie appartenenti alle 27 famiglie trattate siano numerose e diverse tra loro, è indubbio che i dati riportati dall'HBW suggeriscono che nella maggior parte dei casi la salvaguardia delle specie si raggiungerà attraverso la preservazione degli ecosistemi frequentati, a partire dal loro livello di diversità vegetale ed animale.

Le fotografie che corredano il volume sono di ottima qualità. Certe inquadrature che illustrano in sequenza un determinato comportamento integrano il testo scritto in modo impareggiabile (si veda, a titolo d'esempio, la sequenza di caccia dell'Airone azzurro maggiore *Ardea herodias* a pagina 391).

Da quanto sopra succintamente esposto è facile evincere che l' HBW è un'opera veramente importante. Il costo del primo volume è elevato (235.000 lire) ma, a mio avviso, la mole di informazioni ottenibili vale abbondantemente la spesa.

Antonio Rolando

Lo Valvo M., Massa B. e Sarà M. 1993. Uccelli e paesaggio in Sicilia alle soglie del terzo millennio. Il Naturalista Siciliano, vol. XVII (Suppl.), 371 pp.

A distanza di otto anni dalla comparsa dei primo atlante siciliano (Massa 1985), quest' opera si configura non solo come un aggiornamento delle conoscenze relative all'avifauna nidificante in Sicilia, ma anche come un'analisi complessiva del patrimonio ornitico insulare. In essa vengono infatti trattate tematiche che spaziano dalla fenomenologia annuale delle specie alle relazioni tra avifauna e le diverse tipologie ambientali, cercando nel contempo di evidenziare i cambiamenti faunistico-ecologici legati alle modificazioni subite dal paesaggio in tempi storici. Un'opera complessa, quindi, articolata in un corpus centrale, in cui vengono presentati i dati relativi all'avifauna nidificante e svernante, e in una serie di allegati (nove), che sono in realtà articoli che affrontano e approfondiscono aspetti diversi dell'ornitofauna siciliana.

Le cartine distributive delle specie nidificanti differenziano i rilevamenti del periodo 1979-83 da quelli del periodo 1984-92. Si constata così che nel secondo periodo di osservazione il numero di specie nidificanti è aumentato di tredici unità e ben 120 hanno mostrano un incremento della copertura. Tali risultati sono stati senza dubbio ottenuti in seguito al maggior sforzo esplorativo prodotto ma anche, in misura ridotta, grazie al processo di colonizzazione che ha interessato nuove specie (Cicogna, Svasso maggiore, diverse specie di ardeidi). Accanto alle cartine di distribuzione, gli istogrammi relativi alle frequenze di rinvenimento mettono a confronto la selezione di habitat osservata nella stagione riproduttiva con quella rilevata in inverno. ed evidenziano così con immediatezza il diverso uso stagionale dell'ambiente.

Tra gli allegati, degni di nota sono gli articoli relativi alla conservazione e protezione dell'avifauna (utilissima, in particolare, la raccolta delle normative locali, nazionali ed europee in materia di protezione ambientale) e quelli che analizzano i rapporti della fauna ornitica con le cenosi boschive o con l'ambiente agricolo. Interessanti sono anche alcuni articoli relativi ad aree particolari della Sicilia illustranti metodologie di rilevamento ornitico (rapaci diurni) o casi di colonizzazione di ambienti umidi artificiali, e che, pur nella loro diversità, sono comunque di interesse ecologico generale. L'opera, corredata da una ricca bibliografia, si impone nel panorama degli atlanti regionali italiani come il primo riuscito tentativo di lettura dei dati distributivi e fenologici dell'ornitofauna in chiave di dinamica ecologico-evolutiva. Essa evidenzia la preoccupante regressione di alcune specie (Nibbio reale, Capovaccaio, Occhione, Coturnice, Merlo acquaiolo) accanto all'incremento delle specie più eurivalenti (Gabbiano reale, Colombaccio, Merlo, Gazza), confermando nel contempo la buona salute popolazionale di altre specie per le quali la Sicilia vanta ancora un primato a livello nazionale o internazionale (Uccello delle tempeste, Berta maggiore, Grillaio, Lanario). Se qualche rilievo critico deve essere fatto possiamo solo rammaricarci che lo sforzo di rilevamento effettuato in inverno non abbia consentito di stilare un Atlante distributivo delle specie svernanti, o che alcune tematiche degne di nota come quelle del pastoralismo o dell'ecologia del paesaggio (che pure era presente nei titolo) non siano state trattate con l'approfondimento riservato ad altri argomenti. Gli spunti forniti dagli amici siciliani sono comunque così numerosi e stimolanti che questi rilievi nulla tolgono alla validità complessiva dell'opera.

Antonio Rolando

Bordignon L. 1993. Gli uccelli della Valsesia. CAI Varallo, 189 pp.

L'arco alpino è senza dubbio uno dei comprensori ambientali di maggior interesse naturalistico del nostro paese. L'avifauna delle Alpi occidentali, in particolare, a tutt'oggi era stata oggetto di un saggio di Bocca e Maffei relativo alla Valle d'Aosta (1984) o era stata trattata nell'ambito degli atlanti degli uccelli nidificanti in Piemonte e Valle d'Aosta (1988) e in Liguria (1989).

La conoscenza avifaunistica delle Alpi occidentali, comunque, non poteva e non può considerarsi sufficientemente approfondita con tali opere. Mancano ancora informazioni precise relative all'avifauna svernante e di passo mentre la distribuzione delle singole specie potrebbe essere analizzata con un maggior dettaglio cartografico.

L'opera di Bordignon tende a colmare tali lacune relativamente al comprensorio alpino della Valsesia. La maglia di riferimento per la distribuzione delle specie nidificanti è infatti basata su quadrati di soli 2km di lato e ciò, come è facilmente comprensibile, ha richiesto un notevole impegno di ricerca sul campo. I dati relativi all'avifauna invernale e migratrice sono risultati assai utili per descrivere in dettaglio la fenomenologia annuale delle diverse specie, ed ottenere nel contempo un quadro generale dello svernamento e del movimento migratorio in Valsesia. L'approfondita conoscenza diretta dell'autore traspare dai testi e dalle mappe relative ad ogni singola specie; l'analisi bibliografica è accurata, e di un certo interesse e anche il tentativo di fornire dei punteggi di qualità ambientale ad ogni singolo quadrato di rilevamento. L'opera di Bordignon, arricchita da un impeccabile corredo fotografico, è senza dubbio pregevole, anche se l'uso della terminologia scientifica specialistica è a volte incerto, come traspare dall'analisi del glossario, che pure dovrebbe spiegare con chiarezza il significato dei termini impiegati. Il Volume è richiedibile al C.A.I. Varallo, via Durio 14,13049 Varallo Sesia (Vc) al prezzo di lire 28.000.

Antonio Rolando

Mezzavilla F. e Stival E. (red.) 1993. Atti 1° Convegno Faunisti Veneti. *Centro Ornitologico Veneto Orientale*, Montebelluna (TV) , 229 pp.

Questo volume raccoglie i contributi presentati in occasione di un Convegno sulla fauna dei Vertebrati del Veneto tenutosi a Montebelluna (Treviso) nell'aprile del 1993. Tra i circa quaranta lavori pubblicati metà sono a carattere ornitologico mentre gli altri riguardano pesci, mammiferi e, in minor misura, rettili e anfibi. La maggior parte dei contributi relativi all'avifauna è di interesse prettamente locale ma alcuni, pur relativi al solo ambito territoriale veneto, rivestono un interesse nazionale. Voglio ricordare, tra gli altri, l'articolo di Garavelli relativo al progetto di reintroduzione dell'Ibis eremita e quello di Basso e De Faveri riguardante la migrazione del Piviere tortolino. L'obiettivo principale del Convegno era quello di promuovere e stimolare le ricerche faunistiche a livello regionale e, considerato l'alto numero dei partecipanti (150) ed il buon numero di contributi presentati, sembrerebbe essere stato felicemente raggiunto.

Iniziative di questo tipo possono anche avere la funzione di stimolare l'impegno delle Istituzioni locali nei settori della salvaguardia e della gestione del patrimonio naturale. Ci auguriamo perciò che questa pubblicazione, che ospita anche alcuni articoli relativi alla gestione faunistica nelle aree protette, possa contribuire a rafforzare l'impegno delle amministrazioni pubbliche del Veneto in materia di protezione ambientale. Il volume è richiedibile al CORVO (Centro Ornitologico Veneto Orientale, Museo di Storia Naturale, via Piave 51, 31044 Montebelluna-TV), al prezzo di lire trentamila.

Antonio Rolando

Meininger P.L. & Atta G.A.M. (eds.), 1994- Ornithological studies in Egyptian wetlands 1989/90. FORE-repor 94-01, WIWO-report 40, Vlissingen/Zeist, 402 pp.

Le zone umide egiziane sono tra le più rilevanti dell'Africa ed assumono una importanza fondamentale nel bacino del Mediterraneo. Tuttavia le informazioni sul ruolo di queste zone per l'avifauna acquatica, quali aree di svernamento e di sosta durante le migrazioni, erano molto scarse e frammentarie. Questo volume riporta i risultati di un ampio progetto di ricerca organizzato dalla Foundation for Ornithological Research in Egypt (FORE) e dalla Foundation Working Group International Waterbird and Wetland Research (WIWO), allo scopo di cercare di colmare questa lacuna. La spedizione, formata da 22 membri, è riuscita a coprire un ampio periodo di studio (dal 17.12.1989 al 2.2.1990 e dal 1.3.1990 al 30.6.1990), raccogliendo informazioni sufficientemente complete sull'entità delle popolazioni di uccelli acquatici svernanti e sulla fenologia della migrazione primaverile di limicoli e rapaci. Vengono anche presentati i risultati di alcune ricerche mirate, condotte negli stessi periodi, su biometria ed alimentazione dei limicoli, fauna bentonica di alcune zone umide costiere, biologia riproduttiva del Fratino, status delle popolazioni nidificanti di Airone guardabuoi, Gabbiano roseo, Gabbiano reale, Sterna comune e Fraticello. Compaiono anche interessanti notizie sulla presenza in Egitto di specie rare come Nibbio bianco, Alzavola asiatica, Piro piro pettorale, Gabbiano di Armenia e Topino africano. Le 16 schede sui principali complessi di zone umide dell'Egitto, che aprono il volume, sono molto dettagliate e corredate da cartine: esse possono offfrire motivi di interesse per studiosi e viaggiatori e costituire utili strumenti a fini conservazionistici e gestionali. Unidici dei ventuno contributi presentati, soprattutto le note più brevi, sono stati pubblicati in precedenza su riviste scientifiche (Courser, WSG Bull., Avocetta, Sandgrouse, Dutch Birding, British Birds). Rispetto ai precedenti rapporti del WIWO, infine, questo risulta essere molto più curato sia dal punto di vista grafico sia per quanto riguarda l'esposizione dei risultati. L'importanza delle zone umide oggetto di studio, l'ampiezza ed il livello di approfondimento delle indagini effettuate fanno inserire a pieno titolo questo volume tra gli elementi fondamentali della libreria di ogni studioso e appassionato di fauna mediterranea. Il report si può richiedere inviando 35 fiorini olandesi (più 15 per ogni ordine per spese postali) a WIWO, Lindengracht 9, 3633 AS Vreeland, The Netherlands.

Giuseppe Cherubini

Avocetta N° 18: 91-92 (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

VIII Convegno Italiano Ornitologia

Il prossimo Convegno Italiano di Ornitologia sarà organizzato da Mauro Fasola (Università di Pavia, Dipartimento di Biologia Animale) e da Nicola Saino (Università di Milano, Dipartimento di Biologia), per conto del Centro Italiano Studi Ornitologici, con la collaborazione della Regione Lombardia, Settore Agricoltura e Foreste.

Il Convegno si terrà a Pavia, presso l'Università, da giovedì 7 a domenica 10 settembre 1995, e comprenderà le seguenti sessioni:

- Biologia degli uccelli coloniali
- Eco-etologia dei rapaci
- Fisiologia-morfologia-comportamento
- Ornitologia applicata alla conservazione e alla gestione
- Migrazione, svernamento e homing
- Comunicazione e territorialismo

Contributi su tutti gli altri temi ornotologici saranno presentati come Poster. Sarà possibile concordare la programmazione di Gruppi di lavoro e Tavole Rotonde. Segreteria organizzativa: VIII CIO PRAGMA, Piazza Berengario 5, 27100 Pavia, tel. 0382-28060/302859, Fax 0382-27697

III Convegno dei Biologi della Selvaggina

Il terzo Convegno nazionale dei Biologi della Selvaggina, organizzato dall'Istituto per la Fauna Selvatica in collaborazione con il Dipartimento di Biologia dell'Università degli Studi di Milano, sarà articolato in due seminari, dedicati ad argomenti specifici e per i quali sono previste solo relazioni ad invito, ed in una sessione di poster a tema libero. Il primo seminario tratterà delle immissioni faunistiche mentre il secondo verterà sulla biologia e la conservazione della Beccaccia.

Luogo: Bologna, Palazzo della Cultura e dei Congressi. Date: 9-11 Febbraio 1995. Per informazioni: Segreteria del Convegno, Istituto Nazionale per la Fauna Selvatica, via Ca' Fornacetta 9, 40064 Ozzano dell'Emilia (BO), tel. 051/798746

International Conference on Holarctic Birds of prey

Conferenza Internazionale organizzata dal World Working Group on Birds of Prey (W.W.G.B.P.).
Argomenti: tutti gli aspetti di ricerca e conservazione sui rapaci diurni e notturni dell'emisfero boreale.
Luogo: Badajoz (Spagna). Date: 14-16 Aprile 1995.
Lingue: Inglese e Spagnolo.
Possono essere presentate comunicazioni orali o poster. Il termine per la presentazione non è stato ancora definito. Per informazioni: Dr. Bernd-U. Meyburg, Wangenheimstrasse 32, 1419 Berlino, Germany, fax: +49 30 8928067.

XXIV International Ethological Conference

Conferenza internazionale di Etologia organizzata dall'Università delle Hawaii. Saranno affrontati i temi più diversi, dall'apprendimento nei pesci corallini, dalla conservazione degli endemismi all'etologia umana.
Luogo: Honolulu, Hawaii (USA).
Date: 10-17 Agosto 1995; sono previsti 5 gg di lavori (sessioni plenarie, comunicazioni orali, poster, video e film) e 1 giorno di escursioni.
Il termine per le presentazioni di contributi è gia scaduto, ma date le scarse adesioni finora pervenute è stato prorogato. Per informazioni: Conference Secretariat c/o Travel Planners Inc., Suite 150, GPM Building, San Antonio, Texas 78216-5674, fax: 210 341-5252. tel. 210 341-8131.

GIORNALI & RIVISTE

Sta per uscire (giugno-luglio 1994) il primo numero di una nuova rivista in inglese edita dalla Jagiellonian University di Cracovia, Polonia: **The Journal of Wildlife Research**. L'editore è Boguslaw Bobek. La rivista pubblica in tempi rapidi (6 mesi dal ricevimento!) contributi originali su specie di

Vertebrati selvatici privilegiando i seguenti temi: ecologia, comportamento, fisiologia, anatomia, sistematica, conservazione e gestione. La rivista apparirà quattro volte l'anno e potrà talvolta essere accompagnata da speciali monografie sull'ecologia delle varie specie. Ogni numero si articolerà in due parti di cui la prima ospiterà ricerche originali, mentre la seconda, denominata "Wildlife Forum" darà spazio a review, commenti, notizie brevi e opinioni su argomenti "caldi" di conservazione e gestione. Il costo annuo dell'abbonamento è di 78 US $.

I manoscritti vanno inviati a: Editor in Chief, c/o Department of Wildlife Research, Jagiellonian University, Ingardena 6 30-060 Kraków, Poland.

Avocetta N° 18: 93-94 (1994)

Notices

Costituito il gruppo di ricerca sui Cormorani

Il Gruppo di ricerca sui Cormorani (Cormorant Research Group), recentemente costituito, ha ufficializzato il suo status nell'ottobre 1993, allorché è stato riconosciuto come gruppo di ricerca dell'International Waterfowl and Wetlands Research Bureau (IWRB). Al momento il Gruppo riunisce essenzialmente persone interessate ad aspetti di ricerca, conservazione e gestione del Cormorano europeo *Phalacrocorax carbo*. Tuttavia il gruppo al suo terzo incontro europeo a Danzica (Polonia) nell'aprile 1993, che faceva seguito a precedenti incontri a Falsterbo (Svezia) nel 1985 e a Lelystad (Paesi Bassi) nel 1989, ha deciso di ampliare i suoi fini e le sue attivita.

Poichè il numero dei cormorani dell'Europa continentale *P. c. sinensis* cresce drammaticamente, vi e un grande interesse, da parte di organizzazioni governative e non governative, legato alla convinzione che i cormorani provochino in alcune zone perdite sostanziali alla pesca umana.

Un approccio integrato, per quanto riguarda la ricerca, la conservazione e la gestione del Cormorano, è perciò considerato urgente e necessario. Il Gruppo costituirà un forum di discussione su diversi temi di ricerca, conservazione e gestione, divulgherà le informazioni e, ove possibile, risponderà a richieste di consulenza.

Scopi

Come nel caso di altri gruppi di ricerca dell' IWRB, il Gruppo di ricerca sui Cormorani è aperto a individui e istituzioni che sono attivamente coinvolti o interessati a qualsiasi aspetto della biologia ed ecologia dei Cormorani, incluso l'impatto di questi uccelli sulla pesca. Ricercatori professionisti e amatoriali, quali ornitologi, conservazionisti e biologi della pesca, sono benvenuti. E' già stato prodotto un volantino, disponibile agli indirizzi in calce, che illustra esaurientemente il contesto in cui il Gruppo è sorto e i suoi scopi.

Inizialmente focalizzato su *P. carbo*, il Gruppo ha poi espresso l'intenzione di comprendere nelle sue attivita le specie di Cormorani di tutto il mondo. Una spettacolare crescita di popolazione, simile a quella di *P. c. sinensis* in Europa, si è verificata nel Cormorano dalla doppia cresta *P. auritus* nel Nord America. Combinare la conoscenza e le esperienze sulla biologia di queste due specie e sul loro presunto impatto sulla pesca, da ambedue i lati dell'Atlantico, appare utile a tutti gli interessati.

Al contrario diverse specie di Cormorani sono rare e minacciate. La costituzione del Gruppo di ricerca sui Cormorani può essere di aiuto nello stimolare la ricerca su queste e altre specie di Cormorani in tutto il mondo.

Organizzazione

Il Gruppo sarà coordinato da Mennobart R. van Eerden della Direzione Generale per la Gestione delle Acque dei Paesi Bassi, che ha studiato *P. c . sinensis* in Europa per più di dieci anni . Jeff Kirby, capo della ricerca al Wildfowl and Wetlands Trust, svolgerà le funzioni di coordinatore assistente. Altri incarichi ufficiali potranno essere attribuiti a tempo debito, ma è intenzione del Gruppo non diventare troppo grande troppo in fretta, ma ridefinire periodicamente la necessità di altri collaboratori. La struttura del Gruppo si sviluppera e diverra più chiara nei prossimi mesi. Molto dipenderà dall'atteggiamento delle persone interessate.

Bollettino

Il Gruppo di ricerca sui cormorani ha intenzione di produrre un esauriente bollettino ogni anno (in novembre), comprendente brevi comunicazioni scientifiche, riassunti dei progetti di ricerca in corso, notizie sulle attività e misure di conservazione, una bibliografia sui Cormorani etc. Qualsiasi contributo deve essere inviato all'indirizzo in calce; la scadenza improrogabile per il Bollettino 1994 è stata fissata al 15 settembre 1994. Si prega di inviare i contributi stampati su carta, ma anche, se possibile, su floppy disc in Word Perfect o formato Ascii. I disegni e le figure debbono essere chiari e soltanto in bianco e nero. Si cercherà di usare tutto il materiale ricevuto, ma ci si riserva il diritto di esercitare un controllo editoriale.

Ulteriori informazioni

Chi desidera ricevere il Bollettino o informazioni sul prossimo Convegno (probabilmente in Italia nel 1995) o ottenere ulteriori informazioni su qualsiasi aspetto del Gruppo può rivolgersi al seguente indirizzo:

Cormorant Research Group
Attention: Jeff Kirby
c/o The Wildfowl & Wetlands Trust
Slimbridge Gloucester GL2 7BT United Kingdom

o al "consigliere speciale" per l'Italia

Paolo Boldreghini
Istituto di Zoocolture, Università di Bologna
Via S. Giacomo, 9
40126 Bologna

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.

I manoscritti vanno spediti a:

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Dipartimento di Biologia Animale,
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Instructions to authors

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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., Ioalè 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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