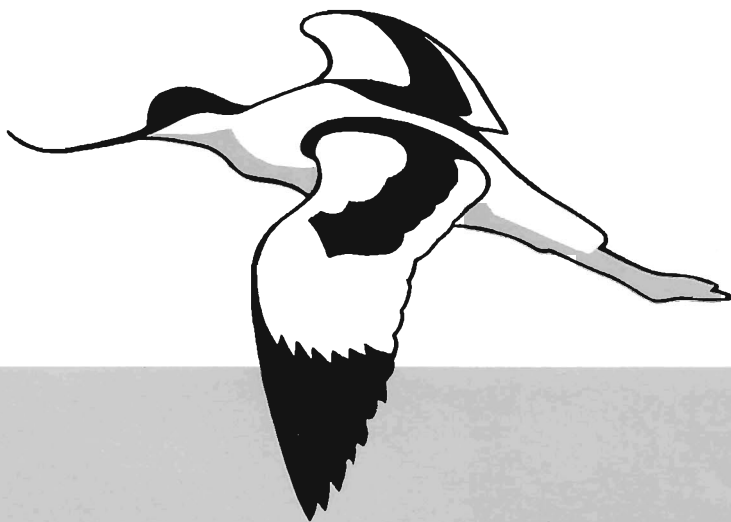


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Effects of environmental conditions on aerial feeding by Collared Pratincoles *Glareola pratincola* breeding in southwest Spain

BELEN CALVO, and ROBERT W. FURNESS

*Applied Ornithology Unit, Institute of Biomedical and Life Sciences,
Graham Kerr Building, Glasgow University, Glasgow G12 8QQ, UK.*

Abstract - During the chick-rearing period, adult Collared Pratincoles *Glareola pratincola* tended to feed in the colony or nearby on insects caught in flight. Before and after this period, they often moved further from colonies to forage in groups over areas of marshes and reeds. Daily activity was highly influenced by weather conditions. Collared Pratincole feeding density was lower on rainy, windy or cloudy or cloudy days. In general, feeding activity increased through the morning up to early afternoon and decreased after that. Food availability in marsh and reed sites was higher than in the crop site. Apart from cereals, few Collared Pratincoles fed over crops.

The Collared Pratincole *Glareola pratincola* is an insectivorous wader with small and declining numbers in southern Europe. It also occurs in north Africa and west Asia. Between 40% and 50% of the species' European population breeds in SW Spain, in an area of marshes which has mostly been reclaimed for agriculture. Although those breeding in marshland achieve a high hatching success, the general loss of habitat and high egg losses in agricultural land due to farming practices, are responsible for a large decline of Collared Pratincole numbers in the area (Calvo 1994). Collared Pratincoles feed mainly on insects captured in flight, especially above marsh and reed habitats. Crops, except for cereals where Collared Pratincoles fed mainly on Hemiptera pest species (*Aelia* spp., Family *Pentatomidae* and *Eurygaster* spp., Family *Scutelleridae*), were hardly used (Calvo 1996). The Collared Pratincole can also be opportunistic in feeding habits and may occasionally use alternative foraging strategies and areas (Sterbetz 1974, Calvo *pers. obsv.*). They can peck at invertebrates which are forced to come up to the soil surface when fields are flooded to sow rice or behind tractors ploughing a field (together with Cattle Egrets *Bubulcus ibis*). They also fly low above pool surfaces feeding on emergent insects or over fields where stubble has recently been burnt. The higher temperature creates ascendant air currents which carry insects in it. Sterbetz (1974) says that they follow cattle as there are insects associated with them and also because, when moving they make

insects come out of the vegetation. Nevertheless, they feed mainly in the air and it is this method we shall be considering in detail. In this paper we report the effect of different weather parameters on the aerial feeding of Collared Pratincoles.

The study was carried out in reclaimed marshland in southwest Spain (37°2'-37°10'N; 5°58'-6°3'W) in 1992. The area is characterised by mild winters and long hot dry summers. Rainfall occurs mainly in winter and spring, with hardly any rain during the summer months. There is a mixture of marshland fragments and agricultural land. The main crops are rice, cotton, sunflower and cereals. For a general description of the area see Barrera *et al.* (1984).

Collared Pratincole feeding density (number of birds/ha) and feeding height (under and over 5 m) were recorded by making a transect along roads passing close to several Collared Pratincole colonies (for description of methods see Calvo 1994). The transect was made twice on the same day in 19 out of 25 days to check data consistency within a day. During these transects, data on date, formation of feeding flocks, wind speed and cloudiness were recorded. When there were more than 50 individuals feeding within 500 m, it was considered to be a flock. Wind speed was measured on a three point scale following the Beaufort scale: 1. Calm (Beaufort 0, <0.6 m/s), 2. Breezy (Beaufort 1 to 3, 0.6-5.2 m/s) and 3. Windy (Beaufort >3, >5.3 m/s). Cloudiness was measured in a similar way: 1. Clear sky (no clouds), 2.

Partially cloudy (<50% clouds), 3. Cloudy ($\geq 50\%$). Rainfall data from the nearest weather station were recorded for the day before, the day of, and the day after each transect count. Data were analysed with non-parametric tests (Kruskal-Wallis and Mann-Whitney) as they were not normally distributed. Only the effect of wind on birds' feeding density was analysed using an ANOVA (analysis of variance), as the data fulfilled the requirements of parametric tests. When testing for temporal variations in feeding activity three periods were considered: "incubation" (21 April to 21 May), "chick rearing" (21 May to 26 June) and "post-breeding" (27 June to 22 July). Periods were defined using data from direct observations during three breeding seasons (1989, 1990 and 1992).

During the incubation period, the number of birds feeding at different times of the day in a feeding area (reeds and shallow waters) was also recorded. At least four counts were taken per hour from 08.00 to 22.00 from 26 April to 14 May. These were only taken during the incubation period as, after the eggs have hatched, Collared Pratincoles fed mainly near the colonies.

Feeding activity

When testing the consistency of the transect data within a day, we found that numbers counted on the first count each day were correlated with numbers on the return trip ($r_{17}=0.73$, $P<0.001$). Collared Pratincole feeding density (birds/ha) within the study transect varied significantly among the three periods ($F_{2,122}=3.76$, $P<0.05$, LSD test $P<0.05$) and was higher during the incubation period (mean=75.3, S.E.=16.9, $n=40$) than during the chick rearing period (mean=14.4, S.E.=2.8, $n=45$). The increase during the post-breeding period (mean=25.9, S.E.=6.2, $n=40$) was not significant (LSD test, $P>0.05$). The number of flocks formed also followed this pattern, decreasing during the chick-rearing period. Large groups (more than 100 individuals) were only seen during the first and last of the three periods (3 and 1, respectively).

Diurnal feeding activity increased throughout the morning, reaching a peak in the afternoon and declining in the evening (Fig. 1).

Weather effect on feeding activity

Feeding density within the transect was significantly lower on windy than on breezy or calm days ($F_{2,122}=3.83$, $P<0.05$, LSD test, $P<0.05$; Table 1).

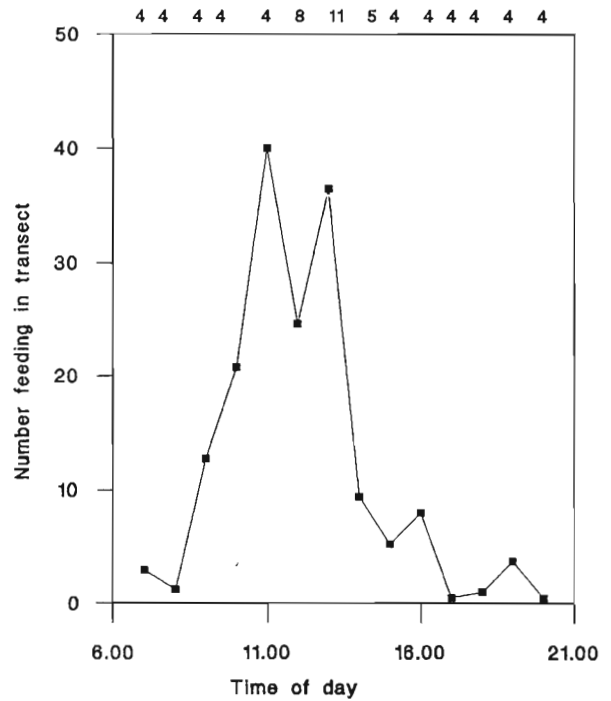


Figure 1. Mean number of Collared Pratincoles feeding over an area of reeds and cereal crops throughout the day. Number of counts on the top axis.

Flocks occurred on only one out of nine windy days. Wind also affected the height at which Collared Pratincoles fed. With stronger wind there was a higher proportion of individuals feeding under 5 m (Kruskal-Wallis, $X^2=23.4$, $n=125$, $P<0.0001$; Table 1).

Table 1 - Mean (\pm S.E.) Collared Pratincole feeding density within the transect and ratio of Collared Pratincoles below 5m to those more than 5m above ground in days with different wind speeds, with different cloud cover and with and without rain, on the sampling day and also on the next day.

	Feeding density	<5m. >5m Ratio	n
Wind			
Calm	47.3 \pm 10.38	0.6 \pm 0.1	25
Breezy	50.1 \pm 12.21	2.6 \pm 1.4	55
Windy	19.3 \pm 6.01	11.8 \pm 5.7	45
Cloudiness			
Clear sky	46.5 \pm 9.5	3.1 \pm 1.2	75
Partially cloudy	25.5 \pm 6.8	0.8 \pm 1.2	25
Cloudy	27.1 \pm 10.3	17.4 \pm 10.1	25
Rainfall (on sampling days)			
No rain	38.9 \pm 6.8	2.5 \pm 0.8	110
Rain	35.0 \pm 16.8	27.5 \pm 16.5	15
Rainfall (one day after sampling)			
No rain	40.0 \pm 7.4	3.0 \pm 0.9	100
Rain	32.0 \pm 10.4	15.3 \pm 10.1	25

Cloud cover did not significantly affect foraging activity (Kruskal-Wallis, $X^2=0.83$, $n=125$, N.S.; Table 1). On days with thick cloud cover, more birds flew lower than 5 m than on clearer days (Kruskal-Wallis, $X^2=11.7$, $n=125$, $P<0.005$; Table 1).

Feeding density of Collared Pratincoles on days with rain was not significantly different from that on days without rain ($U=744$, $Z=-0.62$, $n=125$, N.S.; Table 1), but on rainy days birds flew lower than on days without rain ($U=315$, $Z=-3.94$, $n=125$, $P<0.001$; Table 1). Looking for weather effects over longer time-periods, considering feeding activity in relation to rainfall one day after the transect was travelled, no significant differences were found ($U=1229$, $Z=-0.13$, $n=125$, N.S.; Table 1). Differences in feeding height were not significant in this case either ($U=952$, $Z=-1.87$, $n=125$, N.S.; Table 1). In no case did rain fall on the day before transects were made. Effects of rainfall on foraging behaviour appeared to be small and short-term.

The density of Collared Pratincoles recorded feeding in the air within the transect was highest during the incubation period, decreased to a minimum during the chick-rearing period and increased again afterwards. This decrease is probably due to Collared Pratincoles staying closer to their colonies (which were beyond the transect) once the eggs had hatched. They then fed near the colonies and took the food to their chicks. Numbers in the transect did not rise much after breeding as some birds had already left the area.

Feeding time of the Collared Pratincole has traditionally been considered to be at dawn and at dusk (Valverde 1960, Cramp and Simmons 1983). Contrary to this view, the pattern of daily activity obtained here was an increase during the morning which reached a peak in the afternoon and then declined in the evening (Fig. 1). In other areas, crepuscular activity has been observed. Undoubtedly, feeding activity is subject to insect prey activity and this, in turn, depends on the vegetation and soil substrate and several atmospheric parameters. Light and temperature are two factors which limit insect flight and activity. Many insect species cannot fly at low temperature (Chapman 1982) and big insects need longer to warm up than small ones (Johnson 1969). Although not a rigid rule, there are usually more insects in the air at higher temperatures (Johnson 1969). With rising temperatures, air currents carry insects upwards. On days when other factors such as rainfall or wind are not affecting the birds (see below), Collared Pratincoles feed at higher levels as the day warms. Gustafson *et al.* (1977) found that Swifts *Apus apus* flew at higher altitudes

in clear weather. Our results fit with this pattern. However, in places with high day temperatures some insect species are less active during the hottest hours (Beck 1971, Ross 1973). Collared Pratincoles feeding at dawn and dusk are a common sight in this area, but usually in specific places and for a short period of time, as if the birds were exploiting a temporary food source. Although Collared Pratincoles do not usually feed at night, they have been observed feeding by artificial light (M. Máñez, *pers.comm.*) and sporadically with a full moon (Valverde 1960).

High wind speeds inhibit insect flight but light ones can stimulate it (Freeman 1945, Johnson 1969, Chapman 1982). This pattern of activity fits well with the feeding activity of Collared Pratincoles. Numbers of birds feeding on windy days were much lower and flocks were not usually formed on such days. Also flying height was affected, birds flying lower with stronger wind.

A reduced availability of food during the breeding period may affect the breeding performance of aerial insectivores (Bryant 1975). Weather conditions can alter the birds' feeding activities and reduce food availability (Turner 1983), affecting the number of feeds received by the chick (Turner 1984) or the chick growth and survival (Bryant 1975, Beintema and Visser 1989). Also, agricultural procedures may reduce the amount of food available for bird species nesting in or near fields as shown by Potts (1978) for the Grey Partridge *Perdix perdix* and suggested by Sterbetz (1974) for the Collared Pratincole. This did not seem to be the case in the study area. A previous study of Collared Pratincole food availability, chick diet and performance in colonies in marshland and farmland in the Guadalquivir marshes area (Calvo 1994) showed chick growth rates which suggested that the food supply was adequate in both habitats and that the weather was not affecting chick performance. However food supply may be altered by extreme weather conditions like the long drought suffered in the area in recent years, which affected Collared Pratincole's breeding performance (Calvo 1996).

Resumen - Durante el periodo de cría, las Canasteras *Glareola pratincola* adultas tienden a alimentarse capturando insectos al vuelo en las colonias o cerca de ellas. Antes y después de este periodo, se desplazan a menudo a alimentarse en grupos sobre áreas de marisma y carrizales. La actividad diaria de alimentación estaba fuertemente influida por las condiciones atmosféricas. La densidad de individuos alimentándose era menor en días nublados, lluviosos o con viento. En general, la actividad de alimentación aumentaba durante la mañana hasta el comienzo de la tarde y a partir de ahí empezaba a disminuir.

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Distribution status and breeding of the White Stork *Ciconia Ciconia* in Greece

EFSTATHIOS TSACHALIDIS¹ and NICOLAOS PAPAGEORGIOU²

¹Department of forestry Drama Laboratory of ecology and wildlife management,
Technological Education Institute of Kavala, 66100 Drama, Greece

²Department of forestry and natural environment, Laboratory of wildlife and freshwater fisheries,
Aristotelian University of Thessaloniki, 56004 Thessaloniki, Greece.

Abstract - Two thousand three hundred and eighty seven nests (2387) of White Storks *Ciconia ciconia* were found in Greece during the Summer of 1993. Here are presented the geographical distribution and breeding success of the species. The average population density (StD) was found to be 8.4 pairs per 100 Km², ranging from 46.05 to 0.09 pairs per 100 Km². The average number of fledged young per nest (JZm) was 2.87, ranging from 2.3 to 5.0. The highest nest was found at an altitude of 940 m a.s.l. while the majority of the nests (76%) were found at an elevation <100 m a.s.l. The White Stork prefers as nesting sites electrical poles, both with platform (artificial nests) (53.5%) and without platform (18%). Wetland areas seems to play the most important role affecting the density and geographical distribution of the species. The lack of suitable nesting sites appear to be the critical limiting factor for the species population size.

Introduction

The White Stork *Ciconia ciconia* is one of the most familiar species of the world with wide geographical distribution. Its habit of nesting near human settlements has made it possible to have reliable information on its status, distribution and population densities for many European countries. The data show that the population abundance of the species is progressively decreasing in Europe and mainly in the western part of the continent (Bairlein and Zink 1979, Bairlein 1991, Boettcher-Strein *et al.* 1989, Chozas 1986, Dallinga and Schoenmakers 1987, Delic and Matijevic 1988, Goriup and Schulz 1990, Luthin 1987).

Greece, is considered to be one of the most important breeding areas of the species in the Balkan peninsula. However, information regarding its geographical distribution, population numbers and nesting site selection are limited (Goutner and Tsachalidis 1995, Heckenroth 1969, Holzinger 1986, Holzinger and Kunkle 1986, Jerrentrup 1989, Martens 1966, Warncke 1967). The White Stork in Greece, until 1950 had a wide geographical distribution in the whole country (Martens 1966). In recent decades the species has been restricted only to the central and northern parts of the country and to the island of Lesbos (Figure 1).

The present study was conducted on a national scale during the summer of 1993 with the following objectives:

- (1) to determine the geographical and altitudinal distribution, size and population density of the species;
- (2) to determine the characteristics of its nesting site selection.

Methods

The study was carried out from March to September 1993 in the whole country. All communities (towns and villages) were included in the census. Questionnaires and informative letters were sent to the local offices of the farm wardens.

Inquiry forms were sent to every community which was known to have, or had in the past, breeding pairs of White Storks in their territory. The information gathered was grouped according to districts and the later was used as the working unit.

From the questionnaires the following data were obtained for each district and prefecture: (a) the number of the breeding pairs, (b) type of nest - site selected, (c) number of active nests with and without fledged young and (d) mean number of fledged young per nest.

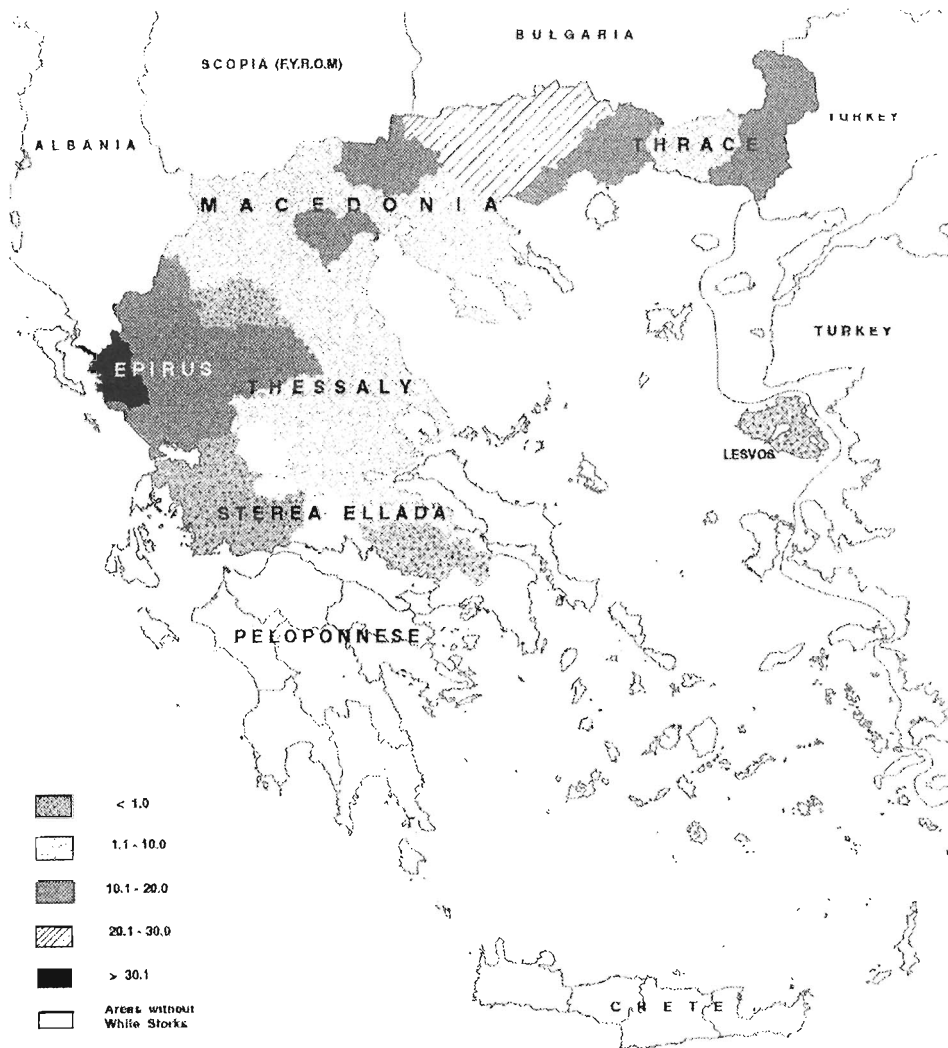


Figure 1. Geographical distribution and density (pairs/100 Km²) of White Storks in Greece.

Results

The main part of the population of the White Stork in Greece arrives between 20 of March and the beginning of April. Departure to the wintering grounds begins around the middle of August and continues until early September.

From the 1500 questionnaires returned 848 (56,5%) reported positively (presence of nests), while the rest 652 (43,4%) reported negatively. The percentage response by community varied from 92% to 47%. The rate inquiries responses was considered high enough to obtain reliable representation of the state in each district. The total number of nests (HPa) counted in the whole country was 2387. From this figure 135 nests (5,6%) were found without young (HPo) and the

rest 2252 (94,4%) were found with fledged young (HPm) (Table 1).

In order to check the reability of the answered questionnaires, we selectively made direct census by visiting 250 (29,5%) communities in different parts of the country and checked the number of the reported nests. The conducted search showed that the reported number of nests in the selected areas was close to that found by us (ranging from ± 2 to 4%). The fact that local authorities reported a correct number of nests show their growing concern for wildlife conservation in general.

As it is shown in Table 1 the total population of White Storks in Greece in 1993 was found to be 4774 individuals. From the population distribution of the White Storks in Greece it is found that the highest

Table 1. Distribution of nesting pairs, density and breeding succes per district and prefecture of the White Stork in Greece.

DISTRICT Prefecture	Lowland area (Km ²)	HPm	HPo	HPa	JZG	JZa	JZm	Number of pairs per 100 km ² (StD)
1	2	3	4	5=3+4	6	7=6/5	8=6/3	9=5/2*100
THRACE	4236	448	31	479	1193	2.49	2.66	11.31
Evros	2708	256	24	280	703	2.51	2.75	10.34
Rodopi	957	86	3	89	198	2.22	2.30	9.30
Xanthi	571	106	4	110	292	2.65	2.75	19.26
MACEDONIA	12498	1297	85	1382	3765	2.72	2.90	11.06
Kavala	497	51	-	51	129	2.53	2.53	10.26
Drama	375	105	5	110	291	2.65	2.77	29.33
Serres	1958	448	34	482	1319	2.74	2.94	24.62
Halkidiki	770	22	-	22	56	2.55	2.55	2.86
Thessaloniki	2421	192	11	203	592	2.92	3.08	8.38
Kilkis	1728	169	9	178	523	2.94	3.09	10.30
Pieria	591	18	1	19	51	2.68	2.83	3.21
Imathia	845	96	10	106	260	2.45	2.71	12.54
Pella	1153	92	9	101	251	2.49	2.73	8.76
Kozani	986	44	4	48	115	2.40	2.61	4.87
Florina	593	53	2	55	160	2.91	3.02	9.27
Kastoria	215	6	-	6	15	2.50	2.50	2.79
Grevena	366	1	-	1	3	3.00	3.00	0.27
THESSALY	5288	254	9	263	748	2.84	2.94	4.97
Magnisia	905	28	-	28	80	2.86	2.86	3.09
Larisa	2552	133	6	139	409	2.94	3.08	5.45
Karditsa	1247	29	-	29	84	2.90	2.90	2.33
Trikala	584	64	3	67	175	2.61	2.73	11.47
EPIRUS	929	155	6	161	465	2.89	3.00	17.33
Ioannina	165	17	-	17	50	2.94	2.94	10.30
Thesprotia	76	33	2	35	97	2.77	2.94	46.05
Preveza	357	50	3	53	152	2.87	3.04	14.85
Arta	331	55	1	56	166	2.96	3.02	16.92
ST. ELLADA	3318	88	4	92	254	2.76	2.89	2.77
Fthiotida	974	73	4	77	216	2.81	2.96	7.91
Viotia	1212	4	-	4	11	2.75	2.75	0.33
Etol/nia	1132	11	-	11	27	2.45	2.45	0.97
PELOPONNESE	1088	1	-	1	5	5.00	5.00	0.09
Mesinia	1088	1	-	1	5	5.00	5.00	0.09
ISLANDS	1058	9	-	9	22	2.44	2.44	0.85
Lesvos	1058	9	-	9	22	2.44	2.44	0.85
TOTAL	28415	2252	135	2387	6452	2.70	2.87	8.40

HPm : Number of nests with fledged young

HPo : Number of nests without fledged young

HPa : Number of active nests

JZG : Number of fledged young

JZa : Mean number of fledged young per active nest

JZm : Mean number of fledged young per nest

StD : Number of pairs per 100 km²

proportion is located in central and northern districts. Macedonia was found to have the highest number of nests (1382), followed by Thrace (479), Thessaly (263), Epirus (161) Sterea Ellada (92), Lesvos island (9) and Peloponnese (1). The average density (StD) of pairs per 100 Km² was 8.4, ranged from 46.05 (Thesprotia-Epirus) to 0.09 (Messinia-Peloponnese). The altitude of the nest sites ranged from 0 to 940 m above sea level. However, the majority of nests (76%) was located in an altitude ranging from 0 to 100 m a.s.l., and 13% from 101 to 200 m a.s.l. (Figure 2).

Discussion

Wetlands seems to be the most important ecological factor affecting the distribution and population abundance of the White Stork. Macedonia and Thrace districts, where the most wetland areas in Greece are located, showed the highest population density. Furthermore, the higher proportion of lowland areas and the intensive irrigation system used in the above districts is an additional contribution to the species abundance.

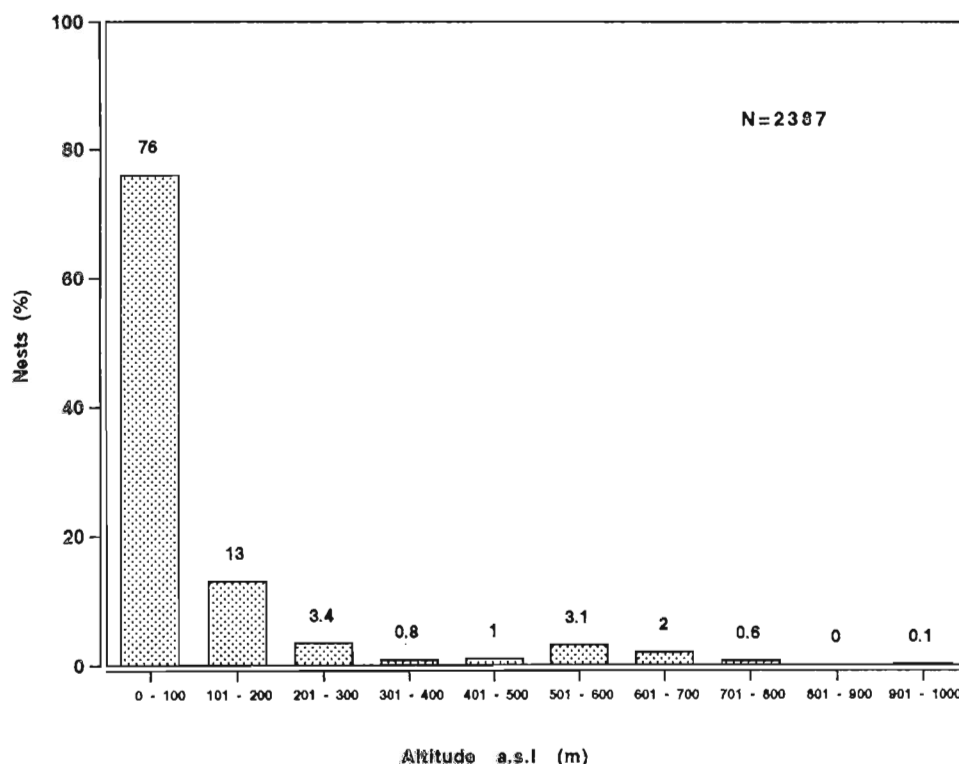


Figure 2. Altitudinal distribution of breeding White Storks in Greece.

One of the nests found in the prefecture of Florina at an altitude of 940 m a.s.l. seems to be the highest reported in Europe.

The average number of the fledged young (JZm) per nest was 2.87, ranged from 2.3 to 5.0 (Table 1). The 42.6% of the examined nests had 3 young, the 31.3% 2 young, the 18.0% 4 young, the 1.4% 5 young, while 1% had 1 young per nest (Figure 3). Only the 5.7% of the examined nests were found without young probably indicating immature breeding pairs or failure due to natural causes (predators, adverse climatic conditions, etc).

As it is shown in Figure 4, White Stork prefers to nest electrical poles with platform on their top (53.5%) and without platform (18%). Other places selected by the White Stork for nesting were church towers (9.5%) and the roof of churches (8.1%).

The high proportion of the White Stork's nests at low altitude (<100m a.s.l.) shows that the species prefers to breed in lowland areas.

The average population density of 8.4 pairs per 100 Km² shows that Greece should be considered one of the most important breeding areas in Europe. The average density (pairs/100 Km²) of White Stork was reported to be 4.9 in Bulgaria (Michev *et al.* 1989a, 1989b), 7.9 in Croatia (Muzinic 1989), 4.2 in Hungary (Jacab 1977) and 1.5 in Spain (Chozas 1986).

The White Stork has always been a protected species in Greece. Nevertheless, its population size has fallen in some prefectures (Serres) by 45% over the past 14 years (Tsachalidis, in preparation), due to mainly to direct and indirect human factors. The first include the extensive use of insecticides and the contamination of

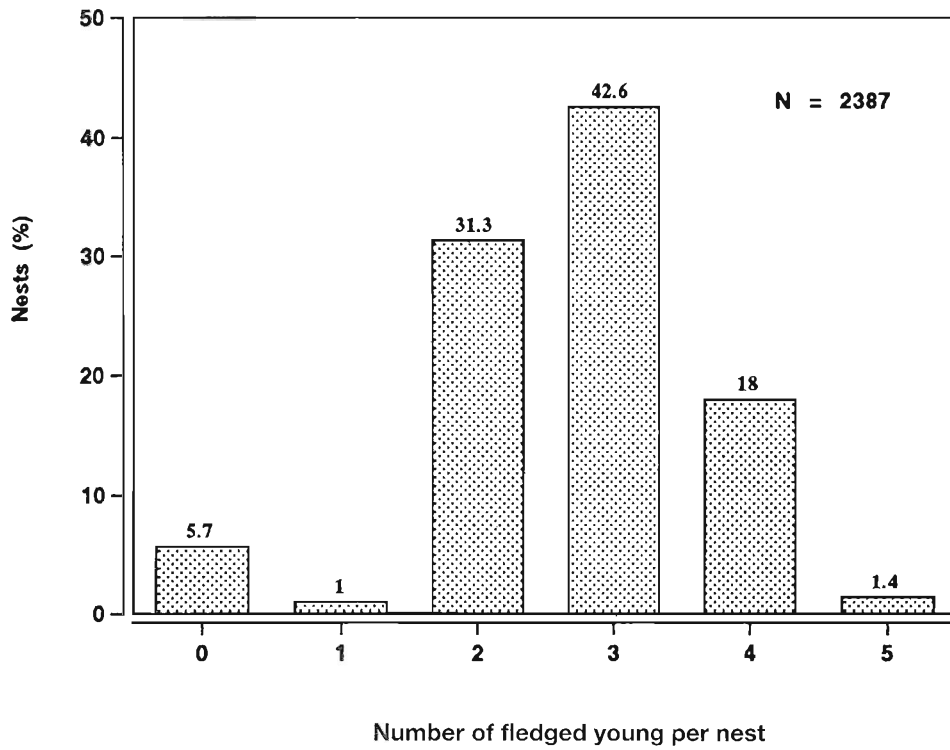


Figure 3. Percentage of the fledged young per active nest of the White Stork in Greece.

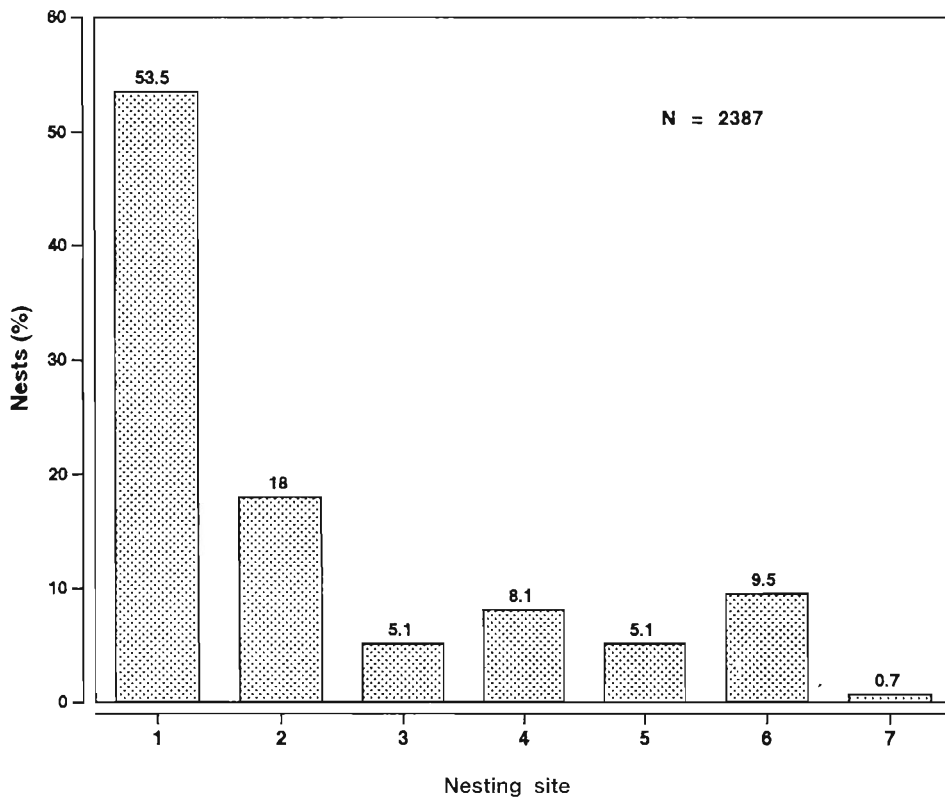


Figure 4. Preferred breeding sites of the White Stork in Greece.

(1. Electrical poles with platform, 2. Electrical poles without platform, 3. Trees, 4. Roofs of churches, 5. Buildings (houses, schools, etc.), 6. Towers of churches, 7. Others).

the soil and water by toxic chemical waste products, while the second include the drastic destruction by the farmers of old trees from their fields in order to ameliorate the mechanisation of harvesting. The lack of suitable places for nesting, seems to be the main limiting factor affecting the population size of the species in Greece. It is essential to promote public awareness and especially to induce the farmers to realise the importance of preserving old trees in their fields as nesting sites of the White Stork and to avoid extensive use of insecticides and other toxic waste products.

The practice of the Greek Electrical Company to construct and place on the top of the electrical poles specially designed platforms, seems to be the most important management tool to protect and increase the number of the White Stork in Greece.

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Riassunto - Nell'estate 1993 sono stati censiti in Grecia 2387 nidi di *Ciconia ciconia* bianca (*Ciconia ciconia*). Si è inoltre studiata la distribuzione sul territorio ed il successo riproduttivo della specie. La densità media di popolazione è 8.4 copie per 100 km² con minimi di 0.09/km² e massimi di 46.05/km². Il numero medio di giovani all'involò è 2.87 (2.3 min, 5.0 max). Il nido più alto è stato riscontrato a 940 m s.l.m. ma la maggior parte di essi (76%) è ad altitudini inferiori a 100 m s.l.m. La *Ciconia ciconia* preferisce i pali elettrici come sito di nidificazione, con piattaforma (nidi artificiali) (53%) o senza (18%). Le zone umide sembrano il fattore più importante per spiegarne la densità e la distribuzione geografica. La mancanza di siti idonei per la nidificazione invece sembra il principale fattore limitante la dimensione ottimale delle popolazioni.

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Extension of post-juvenile moult and ageing of the Cetti's warbler *Cettia cetti* in northern Italy

ANDREA PILASTRO*, STEFANO TASINAZZO^o and CARLO GUZZON^s

* Istituto Nazionale per la Fauna Selvatica, Via Ca' Fornacetta 9, 40064 Ozzano Emilia (BO) - Italy

^o Gruppo Vicentino Studi Ornitologici, c/o Museo di Storia Naturale, contrà S. Corona 2, 36100 Vicenza - Italy

^s via Roma 30/1, 33050 Marano Lagunare (UD), Italy

Abstract - The extent of the post-juvenile moult of Cetti's warbler was studied in northern Italy. Compared to previous studies, it was found to be more extended than in northern Europe populations, involving body feathers and most of wing coverts. Moreover, juvenile birds moulted rather frequently all the tertials and up to 5 inner secondaries. In 6 cases out of 102 examined (4.9%), also 2-5 primaries were moulted. Birds from first clutches moulted significantly more greater coverts than birds from second clutches. Extension of the post-juvenile moult was significantly correlated with the degree of skull pneumatization in September and October, suggesting that birds from early clutches have a more extended moult. Moreover, males moulted on average significantly more remiges and greater coverts than females. Moult limit, i.e. the contrast between moulted adult-like feathers and unmoulted juvenile feathers, was visible in all examined juvenile birds within greater coverts or, alternatively, within tertials or secondaries. Pre-nuptial moult was restricted both in terms of individuals and number of feathers involved, and never affected wing coverts or remiges. On the basis of these results, a new method for ageing Cetti's warbler, based on the contrast between moulted and unmoulted feathers, is proposed. This method allows juveniles to be told apart from adults beyond the completion of skull pneumatization, until their first complete moult.

Introduction

Among the many characters used in the field for ageing passerine birds (Svensson 1992, Pyle *et al.* 1987), those related to differences in the moult extent between juvenile and adult birds are the most reliable, since these differences are not usually prone to change until a juvenile bird wear its first adult plumage or, more generally, until a next moult cycle (Jenni & Winkler, 1994). Cetti's warbler (*Cettia cetti*) is distributed in the southern and western part of Palearctic. In this species, as in most Passerine species living in temperate regions, juveniles undergo a partial moult which usually starts soon after fledging in summer. At the same time adults undergo their annual complete moult at the end of the breeding season (Ginn & Melville, 1984; Jenni & Winkler, 1994). Pre-breeding moult, when present, is almost invariably confined to body feathers both in adults and first year birds, but large variation between populations is reported (Cramp, 1992). Therefore, the identification of a moult limit, i.e. a contrast between juvenile (unmoulted) and adult (moulted) feathers, may allow to tell apart first year birds from older ones in the period between the completion of the post-juvenile

moult and the end of their first breeding season. So far, no reliable ageing method based on plumage character has been proposed for this species. We present here data on the extent of post-juvenile moult collected in northern Italy. On the basis of these results, a new ageing method, based on plumage and moult differences between juveniles and adults, is proposed.

Materials and methods

During standard ringing operations 135 Cetti's warbler were mist netted and ringed in three localities of the eastern Po river lowland: Novoledo (VI), 45.33N, 11.33E, n=52 (years 1988-1989), Marano Lagunare (UD), 45.44N, 13.10E, n=29 (years 1993-1995) and Campotto (FE), 44.36N, 11.48E, n=54 (year 1995). Most of the birds were captured during the post-reproductive season, August-October, but many of them were later recaptured all year around.

We determined the extension of the post-juvenile moult on the wing (upper coverts and remiges) and tail feathers (rectrices). In particular, we estimated for each bird the number of renewed marginal and median coverts, greater coverts (hereafter GC), carpal. primary

coverts, remiges and rectrices. New (post-juvenile) feathers differed from the juvenile ones, the latter being reddish-brown, whereas the renewed feathers were more greenish brown. In particular, juvenile unmoulted greater coverts had a narrower reddish-brown edge, contrasting with the inner part of the feather web, which was more brown. On the contrary, moulted greater coverts had a generally more glossy coloration, characterised by a greenish-brown general tone. Moreover, the outer edge is wider than in the unmoulted GC. A similar colour pattern was observed also in carpal and alula feathers. Moulted remiges were distinctly darker and glossier than unmoulted ones. The difference between moulted and unmoulted rectrices was sometimes less evident, also because these feathers often became readily abraded. About 25% of the examined birds were scored for moult extension more than once by two different ringers or by the same ringer between October and May, after the completion of the post-juvenile moult and before the beginning of the first complete post-breeding moult. There was a high repeatability of moult scoring both between and within observers, indicating that moult limit was clearly visible through the period and that pre-breeding moult, if any, did not involve wing feathers.

If not specified, number of moulted feathers is referred to the right wing. We report here the post-juvenile moult extension only of those birds whose age was

independently confirmed by skull pneumatization stage (Svensson, 1992) or by recapture. Only birds after completion of their post-juvenile moult were considered. All year around, birds were scored for the presence or absence of growing feathers on the body (0 = no growing feathers, 1 = only a few growing feathers, 2 = intense body feather moult). Birds were sexed according to wing length (maximum chord, Bibby & Thomas, 1984; Svensson, 1992; Tasinazzo, 1993) or to the presence of brood patch and cloacal protuberance in the following breeding season.

During 1988 and 1989 breeding season 147 pulli (104 and 43 from first and second clutches respectively) were ringed at nest in the course of a study on the breeding biology near Vicenza (Tasinazzo 1993). Among these, 17 (5 from first clutches and 12 from second clutches) were recaptured later in the season, at the end of their post-juvenile moult.

Results and discussion

Although birds started moulting soon after fledging, the post-juvenile moult period was protracted from June through October, probably due to the prolonged reproductive period (about three months and a half between the earliest and the latest clutch, Tasinazzo, 1993). Birds with traces of body feathers moult were found until December (Fig. 1). Pre-breeding moult

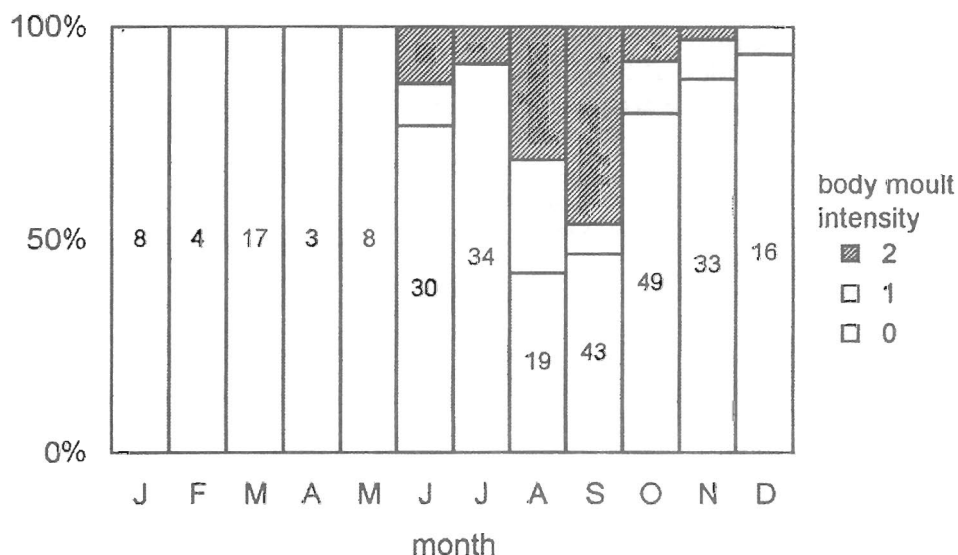


Figure 1. Frequency of first-year Cetti's warblers with moult on body (0=no moult, 1=traces of moult, 2=heavy moult) in northern Italy (n=264). Data from 5 trapping years were pooled by month of capture. Number in the bars indicates sample size.

was nearly absent in the studied populations. Among 164 birds (captures + recaptures) examined from January to May (40 first year birds, 53 adults and 71 of unknown age), only one (0.6%) showed traces of moult, limited to some contour feathers. These results confirm the observation that prebreeding moult is present only in some populations, e.g. in Great Britain (Ginn & Melville, 1983) and in the *orientalis* subspecies (Dementiev & Gladkov, 1954, cited in Cramp, 1992), but absent in Balkan countries (Stresemann, 1920) and in the *albiventris* subspecies (Williamson, 1968).

Table 1. Average number of wing and tail feathers moulted by Cetti's warbler during the post-juvenile moult in northern Italy. For wing feathers means are given for right and left wing.

		mean	SD	min	max	n
alula	right	0.77	0.72	0	3	31
	left	0.67	0.70	0	3	39
carpal	right	0.70	0.47	0	1	27
	left	0.67	0.48	0	1	27
greater coverts	right	8.36	1.96	4	10	135
	left	8.36	1.93	4	10	135
tertials	right	2.16	1.21	0	3	102
	left	2.25	1.13	0	3	102
secondaries	right	0.96	1.21	0	5	102
	left	0.98	1.19	0	5	102
primaries	right	0.16	0.77	0	5	102
	left	0.16	0.74	0	5	102
rectrices		2.00	2.93	0	10	31

During their post-juvenile moult, all the examined first year birds moulted all the marginal and median coverts, but the extension of the moult of other wing feathers varied consistently between individuals (Tab. 1).

The individual with the least extended moult renewed only 4 inner greater coverts, whereas outer greater coverts, primary coverts, alula, carpal, and remiges were unmoulted. On the other hand, the individual with the most extended moult was a male that renewed all the greater coverts, seven primary coverts, alula, carpal, three tertials, five inner secondaries and four primaries. About half of the individuals (53.3%) moulted all the greater coverts, three individuals out of 135 (2.2%) retained only one juvenile greater coverts, the remaining 44.5% having at least two old greater coverts. Most birds moulted one alula feather (54.8%), only one individual moulted all three alula feathers, two moulted two feathers, and 35.5% none. Tertials and secondaries were moulted almost invariably descendantly, and all individuals which moulted one or more secondaries had all tertials renewed as well. In particular, most commonly, all tertials and the innermost secondary was renewed (Fig. 2). Six individuals out of 102 (5.9%) were found with some (1-6) primaries moulted. Among these, four moulted the primaries eccentrically (primaries no. 3-8, numbered ascendantly), and the other two moulted 2-3 inner primaries. On Fig. 3 the extension of the moult of the wing feathers is summarised. Moult of wing feathers was usually symmetric. The number of moulted greater coverts differed between the two wings in 14.1% of the 135 cases examined (mean difference = 1.42, SD = 0.61, range 1-3, n=19). A more pronounced degree of asymmetry was found among the number of tertials and secondaries moulted,

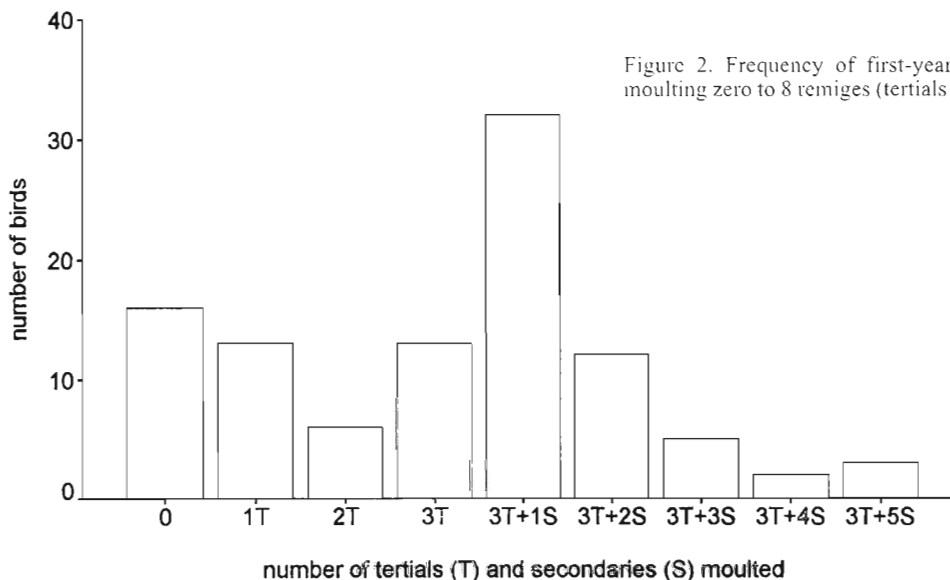


Figure 2. Frequency of first-year Cetti's warblers (n=102) moulting zero to 8 remiges (tertials and secondaries).

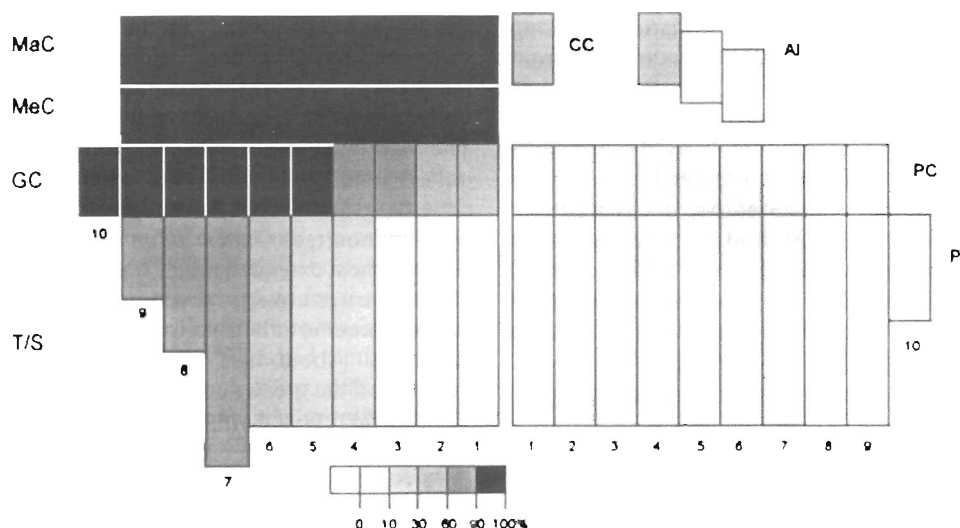


Figure 3. Extension of the post-juvenile moult of Cetti's warbler in northern Italy. The scale is referred to the frequency of moulted feathers. MaC = marginal coverts, MeC = median coverts, GC = greater coverts, PC = primary coverts, CC = carpal, AI = alula, T/S = tertials and secondaries, P = primaries.

which were different on the two wings in 30.0% of the 90 birds which moulted at least one flight feather (mean difference = 1.70, SD = 1.24, Range = 1-5, $n = 27$). For what primary moult was concerned, the number of primaries moulted on the two wings was always different by 1 or 2 feathers.

Moult of rectrices was rather irregular and nearly never symmetric. About half (48.4%) of 31 birds did not change any tail feather, the remaining ones moulting 1-2 rectrices (25.8%) or more than 2 rectrices (25.8%). Only two birds (6.5%) changed all tail feathers, but the fraction of birds completely renewing the tail might be underestimated. The number of rectrices renewed was correlated neither with the extension of the moult of the remiges nor with that of the greater coverts ($r=0.11$, n.s., $r=0.04$, n.s., $n=31$).

There was a strong correlation between the number of greater coverts moulted and the number of secondaries (tertials and secondaries) moulted ($r = 0.81$, $P < 0.0001$, $n=100$). In particular, nearly all those birds which moulted all the greater coverts, moulted all tertials and one or more secondaries (96.8%, $n=85$), only two of them having retained one or two tertials. On the other hand, birds which did not moult any tertial always retained at least four unmoulted outer greater coverts (mean = 5.60, SD = 0.99, range = 4-7, $n=15$).

Extension of post-juvenile moult was correlated with the degree of skull pneumatization. Considering only the birds captured in September and October, there was a significant positive correlation between skull pneumatization score and the number of remiges moulted ($r = 0.72$, $n = 33$, $P < 0.001$, Fig. 4), as well as

the number of moulted greater coverts ($r = 0.55$, $n = 47$, $P < 0.001$). Birds that did not moult all the greater coverts and 0 to 2 tertials, were likely to be birds from second or from replacement clutches. In fact, among the 17 pulli recaptured after they had completed their post-juvenile moult, five first clutch birds had moulted all the greater coverts on the right wing, whereas two of them had retained two and three outer GC on the left wing respectively (mean fledging date = 26 May, SD = 4.02). Birds from second clutches (mean fledging date = 21 July, SD = 2.55) retained on average 4.17 GC (SD = 0.83, range = 3-5, $n=12$), and the difference was statistically significant for both wings ($z = 3.27$, $P = 0.001$, $z = 2.86$, $P = 0.004$ for right and left wing respectively, Mann-Whitney U test). Moreover, males moulted significantly more primaries, secondaries, tertials and greater coverts than females, whereas the number of renewed rectrices did not differ significantly (Tab. 2).

Table 2. Mean number (SD) of feathers renewed during the post-juvenile moult on the right wing in male and female Cetti's warblers in northern Italy.

	males	females	n	z^1	P
greater coverts	8.78 (1.73)	7.93 (2.08)	129	2.34	0.019
primaries	0.18 (0.71)	0.02 (0.13)	97	1.42	ns
secondaries	1.23 (1.27)	0.65 (0.99)	97	2.66	0.008
tertials	2.48 (1.01)	1.95 (1.26)	97	2.14	0.03
rectrices	1.44 (1.88)	2.29 (3.35)	30	0.15	ns

¹Mann-Whitney U test

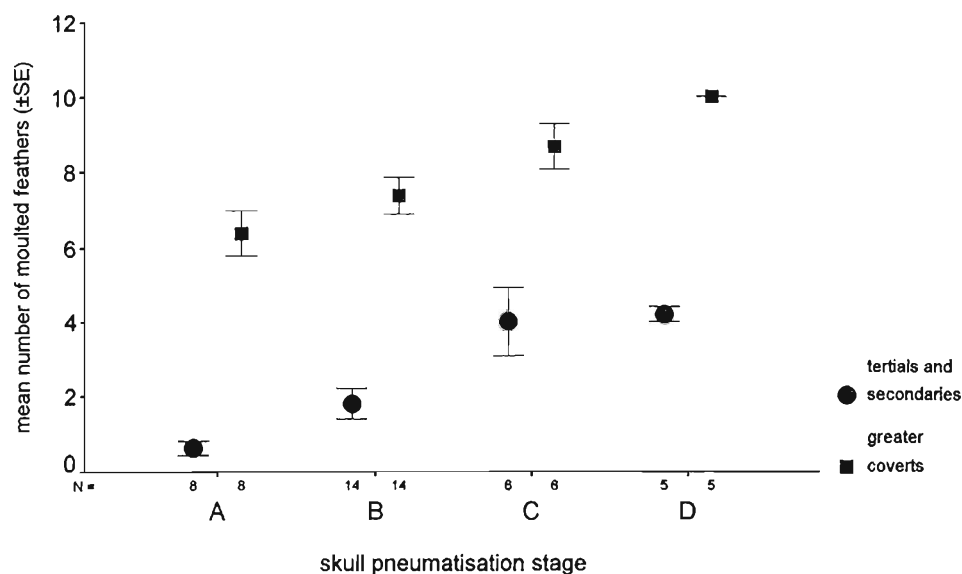


Figure 4. Mean (\pm SE) number of greater coverts and remiges (tertials + secondaries) moulted by first-year Cetti's warblers captured in September and October according to their skull pneumatisation stage (A = not pneumatised, E = completely pneumatised). Numbers above pneumatisation stage represent sample size.

North Italian population of Cetti's warbler showed a more extended post-juvenile moult than previously reported for this species (Williamson, 1968; Flint, 1972; Sultana & Gauci, 1973; Ginn & Melville, 1983). The reason for this difference is not known, but it may be a consequence of progressively anticipated breeding seasons due to warmer winters in the recent years. Regarding this point, a significant trend was found in the number of GC moulted from 1988 to 1995 (ANOVA, $F_{(4,130)}=5.27$, $P<0.001$; trend analysis, $F_{(1,130)}=14.8$, $P<0.001$) and birds with a post-juvenile moult extending to primary feathers were found only in 1994 and 1995.

On the basis of these results, we propose here a new method for ageing Cetti's warbler, based on the plumage characteristics. First year birds usually have two (one) up to six outer GC unmoulted. In this case, a contrast is particularly visible between outer GC (more reddish brown) on the one hand, and inner GC and lesser and median coverts (more glossy greenish-brown) on the other hand. The contrast between moulted and unmoulted coverts is usually sharp and evident, particularly when the width and colour of the edge of the outer web, as well as the colour of the inner web of the coverts are carefully examined. Attention must be paid because outer greater coverts, when completely moulted as well as in the adults, are slightly more reddish than the inner ones, but the colour variation is gradual, and a clear step in coloration is lacking. In the case of juveniles with all GC moulted, these do not contrast with the lesser and

median coverts which are always renewed, but contrast with the unmoulted remiges. When all greater coverts are renewed, tertials and secondaries must be carefully examined for the presence of one, more frequently four, innermost moulted feathers, which are distinctly darker and glossier. The contrast between moulted and unmoulted feathers, in particular GC and remiges, is better visible when the wing is kept half open. At least until December, the degree of abrasion may help to tell apart moulted and unmoulted flight feathers. A difficult case would be the one of a bird having moulted all the greater coverts and none of the tertials, although it was never recorded in our sample. Molt limits were still visible until the beginning of the first complete moult, and after practising, nearly all birds can be safely aged on the basis of presence/absence of a moult limit within greater coverts, tertials/secondaries and, possibly, alula and tail feathers. The extended moult of secondary and primary feather observed in a small percentage of the birds studied here and the case of an individual with skull in stage B and almost completing its primary moult (F. Farinello, personal communication) suggest that some juvenile birds may also undergo a complete post-juvenile moult. Only a systematic control of the pneumatisation stage also in adult-looking birds may reveal how frequently this happens in southern Cetti's warbler populations.

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Riassunto - Si presentano i risultati di uno studio sull'estensione della muta post-giovanile in una popolazione di U'ignoli di fiume dell'Italia settentrionale. La muta post-giovanile è risultata più estesa di quanto precedentemente riportato per le popolazioni nordeuropee e coinvolge, oltre alle penne del corpo, anche le copritrici dell'ala e un numero variabile di remiganti. La maggior parte degli uccelli esaminati aveva mutato un numero di secondarie e terziarie variabile tra 1 e 8. In 6 casi su 102 sono state mutate anche 2-5 primarie. Gli uccelli provenienti dalla prima covata mutano un numero di grandi copritrici significativamente maggiore rispetto a quelli di seconda covata. Inoltre, i maschi mutano significativamente più copritrici e remiganti delle femmine. Negli uccelli catturati in settembre ed ottobre il grado di ossificazione cranica è risultato positivamente correlato con l'estensione della muta post-giovanile. Il limite di muta dovuto al contrasto tra le copritrici e le remiganti mutate durante la muta post-giovanile e quelle non mutate era sempre visibile in tutti gli uccelli esaminati. La muta prenuziale, quando presente, è risultata sempre poco estesa e limitata alle sole penne del corpo, senza mai interessare le copritrici dell'ala e le remiganti. La presenza del contrasto di muta tra penne giovanili non mutate e penne post-giovanili mutate permette quindi di distinguere gli individui di un anno dagli individui più vecchi in tutto il periodo che va dal completamento della muta post-giovanile fino alla prima muta completa post-riproduttiva. Si propone quindi un metodo che permette di attribuire l'età agli U'ignoli di fiume di un anno di età anche oltre il momento in cui si completa l'ossificazione cranica.

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Arthropod abundance and breeding performance of Tits in deciduous, evergreen oakwoods and pine reafforestation of Sicily (Italy)

BRUNO MASSA and FABIO LO VALVO

Istituto di Entomologia agraria, Viale delle Scienze 13, 90128 Palermo - Italy

Abstract - The aims of this research, carried out in 1993-96, were: 1) to ascertain the existence of differences in resource abundance between deciduous and evergreen oakwoods; 2) to verify the overlap degree of the peak resource and the peak-demand of young Tits in the two oakwoods; 3) to study the breeding performance of Tits (*Parus major* and *P. caeruleus*) in relation to resource parameters in woodlots dominated by trees of different species which are part of the same woodland, namely evergreen *Quercus ilex*, deciduous *Quercus pubescens* and *Pinus halepensis* reafforestation. In the four years of this research clutch size, number of fledglings and arthropod abundance were higher in the oakwoods than in the pine reafforestation; the arthropod abundance coincided with the peak of demand by young, particularly in deciduous oakwood. Blue and Great Tits breeding in oakwoods appeared to be significantly more successful than in reafforestation sites; clutches generally were larger and started earlier in the oakwoods than in reafforestation. Even if differences in the arthropod abundance between deciduous and evergreen oakwoods were detected, no important differences in the breeding performance were noticed in the four years, while they were observed in the pine reafforestation in respect to oakwoods, both for Great and Blue Tit.

Introduction

According to Blondel *et al.* (1993) large clutch size and earlier laying date characterize populations of Blue Tits in continental deciduous oakwood, small clutch size and late laying date those living in insular evergreen oakwood of Corsica, while intermediate values for these traits are noticed in continental evergreen oakwoods. Cramm (1982), Isenmann *et al.* (1987), Blondel and Pradel (1990), Clamens (1990) and Blondel (1991) have pointed out that the development of vegetation and its arthropods occurs later in the Mediterranean sclerophyll than in deciduous woods; the food availability for insectivorous birds in mediterranean sclerophyll is considered scarcer than in deciduous woodland (e.g. in Corsica: Zandt *et al.* 1990), and corsican Tits, due to lower availability of caterpillars, prey upon other insects and spiders, poorer in water (Blondel and Pradel 1990). This is considered as a possible reason for scarcer production of young in corsican than in continental woods (Blondel and Pradel 1990; Martin and Bellot 1990). Dhondt *et al.* (1984) also suggest that variation in laying date between habitats reflects differences in food availability and microclimate. The aims of our research were to ascertain in the insular woodland of Sicily: 1) if differences actually exist in resource abundance (we prefer this term

instead of availability, for the reasons reported by Holmes 1990) between deciduous and evergreen oakwoods; 2) the overlap degree of the peak resource and the peak-demand of young Tits in the two types of oakwoods; 3) the breeding performance of Tits in relation to resource parameters in woodlots dominated by trees of different species which are part of the same woodland.

Methods

In December 1992 we placed 102 nestboxes in the central part of a wooded area, 1600 Ha wide, in the inland Sicily (next to Santo Stefano di Quisquina, about 600 m a.s.l., province of Agrigento), subdivided in three homogeneous areas, one dominated by the deciduous Downy oak *Quercus pubescens* (thereafter DO), another by the evergreen Holm oak *Quercus ilex* (EO), and the third constituted by a reafforestation of *Pinus halepensis* about 35 years old (PR). We placed 36 nestboxes in DO and 33 in EO and PR; they were located in such a way that territories of nesting Tits did not overlap between two different types of wood. From April to July 1993, 1994, 1995 and 1996 all the nestboxes were visited weekly and the following information was recorded: 1) date of the first egg, calculated assuming that females lay one egg each day; 2) clutch-size; 3) hatching date; 4) brood size; 5)

fledging success. Overall breeding season was calculated from the earliest lay-date to the latest one plus 28 days of egg incubation and nest attendance. In the same area and the same months, every 2-3 weeks we sampled foliage arthropods (between 1.5 and 4 m from the ground) of the tree species characterizing the woodlots, extracting them by an Univac portable suction sampler (Arnold *et al.* 1973) within branch layers of 15-20 plants for 15 minutes, to obtain absolute quantitative values of arthropods, comparable among them and relevant as food resource of typical insectivorous birds as Tits. In the four years we carried out a census of breeding Great and Blue Tits in the three habitats by the E.F.P. method (Blondel 1975), which gives the frequency of occurrence of breeding species.

Local meteorological data for the period 1980-1996 were provided by Genio Civile della Regione Siciliana (Palermo) and refer to the station Lago del Leone. Statistics were performed by the two way ANOVA.

Results

Frequency of occurrence and nestbox occupation

Two species of Tits, the Great Tit *Parus major* and the Blue Tit *P. caeruleus*, bred in the nestboxes in the four years; 104 pairs of Blue and 95 of Great Tit bred in the three habitats in the four years (Table 1). According to censuses carried out by the E.F.P. method, the frequency of occurrence of Great Tit was stable in DO (60%), EO (50%) and PR (70%), that of Blue Tit passed in DO and EO from 60% in 1993 to 70% in 1994, 1995 and 1996, while in PR decreased from 50 in 1993 to 30% in 1994 and then increased again to 50% in 1995 and 1996. Nestbox occupation (with egg laying) by Great Tit changed little in the four years in the three habitats, nestboxes occupied by Blue Tit instead increased in DO from 1993 to 1996, in EO passed from 12 in 1993 to 14 in 1994 and then

decreased to 9 in 1995 and 6 in 1996, while in PR were more or less stable in the four years. The number of nestboxes occupied by Blue Tit resulted always higher than that used by Great Tit in DO and EO, while was lower in PR (with the exception of 1994: Table 1).

Laying date

Tits showed a quite synchronous start of laying in the oakwoods in the four years, but reproduction of Blue Tit in DO lasted more. Since we did not find, both for Blue and Great Tit, any significant difference in the breeding parameters among the four years, we pooled the four breeding seasons when testing differences among the three habitats. As regards to the laying date, it was simultaneous in the four years in the two oakwoods; both Tit species bred significantly earlier in DO and EO than in PR (Table 3). Only one pair of Great Tit bred twice in the DO in 1993.

Clutch size

Clutch size of Blue Tit ranged between 7.8 and 9.5 in DO, 8.5 and 9.3 in EO and between 5.2 and 7.3 in PR, that of Great Tit between 6.4 and 9 in DO, 8 and 9 in EO, 5.5 and 7.5 in PR (Table 2). Clutches of both species were significantly smaller in PR than in DO and EO, those of Great Tit breeding in DO and EO resulted significantly different (Table 3).

Number fledged and fledging success

In the four years number of young Blue Tit fledged varied from 6.9 to 8.6 in DO, from 7.2 to 9 in EO and from 3 to 5.7 in PR, fledgling Great Tits ranged between 6 and 8.5 in DO, 5.7 and 8.7 in EO, 4.8 and 6 in PR (Table 2). Number of fledglings of both species was significantly higher in DO and EO than in PR (Table 3). Fledging success (number fledged/clutch size x 100) of Blue Tit varied between 83 and 95% in DO, 84 and 100% in EO and 41 and 96% in PR, that of Great Tit between 94 and 98% in DO, 69 and 97% in EO, 78 and 87% in PR (Figures 1-3).

Table 1 - Frequency of occurrence (%) and number of nestboxes occupied (with egg laying) by Blue Tit and Great Tit in the four years in the deciduous oakwood, evergreen oakwood and pine reafforestation of Demanio Forestale of S. Stefano di Quisquina (Sicily).

Woodlot/Year	1993		1994		1995		1996		Total	
	Blue	Great	Blue	Great	Blue	Great	Blue	Great	Blue	Great
<i>Quercus pubescens</i>	60	60	70	60	70	60	70	60		
	10	8	18	8	17	13	26	10	71	39
<i>Quercus ilex</i>	60	50	70	50	70	50	70	50		
	12	4	14	3	9	6	6	5	41	18
<i>Pinus halepensis</i>	50	70	30	70	50	70	50	70		
	9	11	3	12	6	6	4	9	22	38

Table 2 - Reproductive performance of Blue (*Parus caeruleus*) and Great Tit (*Parus major*) in three different wood habitats of Sicily in 1993, 1994, 1995 and 1996. Table shows mean value, standard deviation and sample size (in parenthesis), and variation range. Lay date = number of days from the 1st January (92 = 1st April).

Laying date	1993		1994		1995		1996	
	P. caeruleus	P. major	P. caeruleus	P. major	P. caeruleus	P. major	P. caeruleus	P. major
<i>Q. pubescens</i>	117.7 (11.2; 10)	119.6 (4.8; 8)	104 (8.7; 18)	102.1 (2.6; 8)	114.9 (11.5; 17)	114.2 (7.6; 13)	122.9 (11.2; 26)	118.4 (7.7; 10)
<i>Q. ilex</i>	110-122	112-129	96-124	98-105	103-150	105-135	103-149	108-132
	117.3 (3.1; 12)	118.5 (4.5; 4)	104.9 (8.3; 14)	107 (4.2; 3)	110.1 (8; 9)	111.7 (7; 6)	122.5 (12.4; 6)	120 (16.4; 5)
<i>P. halepensis</i>	112-123	115-126	96-121	101-110	93-123	101-120	111-142	106-146
	134.8 (6.9; 9)	124.7 (7.9; 11)	117.7 (7.6; 3)	128.2 (6.4; 12)	124.3 (4.8; 6)	126.5 (11.2; 6)	133.5 (11.9; 4)	132.4 (9.3; 9)
	127-147	110-137	107-124	121-140	118-129	118-148	125-154	116-143
Clutch-size	1993		1994		1995		1996	
	P. caeruleus	P. major	P. caeruleus	P. major	P. caeruleus	P. major	P. caeruleus	P. major
<i>Q. pubescens</i>	9.5 (1.6; 10)	8.4 (1.1; 8)	9.2 (1.2; 15)	9 (0.8; 7)	7.8 (1.9; 17)	8.1 (0.9; 12)	7.8 (2.4; 26)	6.4 (2.1; 9)
<i>Q. ilex</i>	6-12	7-10	6-11	8-10	5-11	7-10	1-12	2-9
	8.5 (2; 12)	9 (2.2; 4)	8.6 (1.7; 14)	8.3 (0.9; 3)	9.3 (1.6; 9)	8.8 (1.5; 6)	9 (4.1; 4)	8 (1.2; 5)
<i>P. halepensis</i>	3-12	6-12	7-12	7-9	6-11	7-11	8-10	8-10
	6.4 (1.3; 9)	6.7 (1; 11)	7.3 (0.5; 3)	7.5 (0.9; 8)	6 (0.8; 4)	5.5 (1.5; 6)	5.2 (2; 4)	6.4 (0.8; 7)
	4-9	5-9	7-8	6-9	5-7	3-7	2-7	5-7
Eggs hatched	1993		1994		1995		1996	
	P. caeruleus	P. major	P. caeruleus	P. major	P. caeruleus	P. major	P. caeruleus	P. major
<i>Q. pubescens</i>	7.9 (2; 10)	8.2 (1; 8)	8.8 (1.4; 13)	8.5 (0.5; 6)	6.9 (2.1; 17)	7.9 (0.9; 12)	7.4 (2.8; 26)	6.25 (2.1; 8)
<i>Q. ilex</i>	3-10	7-10	0-11	8-9	3-11	7-10	1-12	2-9
	8.4 (1.2; 11)	8.7 (2.2; 4)	7.5 (2.7; 14)	5.7 (1.2; 3)	8.5 (2.3; 9)	8.3 (1; 6)	9 (4.1; 4)	7.2 (0.8; 5)
<i>P. halepensis</i>	0-11	6-12	0-12	4-7	4-11	7-10	8-10	6-8
	5.8 (0.8; 9)	5.9 (0.8; 11)	3 (0; 1)	7.3 (1; 7)	6 (0.8; 4)	5.5 (1.5; 6)	5.2 (2; 4)	5 (1.1; 5)
	0-7	4-7	0-3	0-9	5-7	3-7	2-7	4-7
Young fledged	1993		1994		1995		1996	
	P. caeruleus	P. major	P. caeruleus	P. major	P. caeruleus	P. major	P. caeruleus	P. major
<i>Q. pubescens</i>	7.9 (2; 10)	8.2 (1; 8)	8.6 (1.2; 13)	8.5 (0.5; 6)	6.9 (2.1; 17)	7.9 (0.9; 12)	7.4 (2.8; 23)	6 (2.3; 8)
<i>Q. ilex</i>	3-10	7-10	6-11	8-9	3-11	7-10	1-12	1-9
	8.4 (1.2; 11)	8.7 (2.2; 4)	7.2 (2.9; 13)	5.7 (1.2; 3)	8.5 (2.3; 9)	8.3 (1; 6)	9 (4.1; 4)	7.2 (0.8; 5)
<i>P. halepensis</i>	6-11	6-12	3-12	4-7	4-11	7-10	8-10	6-8
	5 (1.4; 8)	5.8 (0.9; 11)	3 (0; 1)	6 (1.7; 8)	5.7 (0.9; 4)	4.8 (1.7; 6)	5 (2.1; 4)	5 (1.1; 5)
	2-7	4-7	-	3-9	5-7	2-7	2-7	4-7

Table 3 - Statistics (two way ANOVA) on breeding parameters of Blue and Great Tit living in the three woodlots dominated by three different tree species; since any significant difference in the breeding parameters among the four years has been found, they were treated as a single sample.

		Great Tit <i>Parus major</i>		Blue Tit <i>Parus caeruleus</i>	
		<i>Q. pubescens</i>	<i>Q. ilex</i>	<i>Q. pubescens</i>	<i>Q. ilex</i>
Laying date					
	<i>Q. ilex</i>	F = 0.042		0.926	
		P < 0.961		0.400	
<i>P. halepensis</i>		F = 23.122	11.729	10.646	20.017
		P < 0.001	0.001	0.001	0.001
		<i>Q. pubescens</i>	<i>Q. ilex</i>	<i>Q. pubescens</i>	<i>Q. ilex</i>
Clutch size					
	<i>Q. ilex</i>	F = 1.188		0.397	
		P < 0.311		0.001	
<i>P. halepensis</i>		F = 4.046	11.218	13.887	17.733
		P < 0.025	0.001	0.001	0.001
		<i>Q. pubescens</i>	<i>Q. ilex</i>	<i>Q. pubescens</i>	<i>Q. ilex</i>
Number hatched					
	<i>Q. ilex</i>	F = 0.003		0.635	
		P < 1.00		0.671	
<i>P. halepensis</i>		F = 9.903	6.175	6.429	10.804
		P < 0.001	0.005	0.03	0.001
		<i>Q. pubescens</i>	<i>Q. ilex</i>	<i>Q. pubescens</i>	<i>Q. ilex</i>
Number fledged					
	<i>Q. ilex</i>	F = 0.001		0.487	
		P < 1.00		0.610	
<i>P. halepensis</i>		F = 10.125	7.200	9.012	12.193
		P < 0.001	0.02	0.004	0.001

Abundance of arthropods

The trend was different in 1993, 1994, 1995 and 1996 (Figures 1, 2 and 3). Due to huge numbers of caterpillars of *Tortrix viridana* L. (Lepidoptera Tortricidae), richness resulted much higher in 1993 than in 1994, 1995 and 1996, when the moth was almost absent; this caused a reduction to half of arthropod values in DO between 1993 and 1994. In EO in 1993 figures of arthropods extracted in 15 min of sampling were much lower than in DO (due to the absence of caterpillars in EO), and in 1994, 1995 and 1996 they still decreased by about 70%. Finally in PR samples of arthropods resulted very scarce in all the four breeding seasons.

Climate trend

Local mean meteorological data for the period 1980-92 show a dry season between May and September and a rainy and humid one between October and April (Figures 4). Data from January 1993 to June 1996 are to some extent different from those above mentioned; in fact the months January, April and December 93, March and May 94 were drier than in the previous 13 years. The 1994-95 winter-spring seasons were characterized by an exceptional dryness all the months

around; on the contrary the 1995-96 winter-spring months were highly rainy and humid in respect to previous 15 years. In the rainy years laying was delayed in respect to wetter ones, and a positive correlation between the rain value in March and the day of the first egg laid has been detected (both species together: $r = 0.524$; $P = 0.009$; $fd = 22$).

Discussion

The first aim of our research was to ascertain whether differences actually exist in resource abundance between EO and DO. Even if differences in the arthropod richness between the two oak species were detected, breeding performance of the two Tit species did not show significant differences between oakwoods dominated by deciduous and evergreen trees. Arthropods were qualitatively and especially quantitatively more abundant in DO than in EO, particularly in 1993 and 1994, and to a lesser extent in 1995 and 1996. In DO arthropods were more abundant in 1993 (due to the outbreak of *Tortrix viridana*) and decreasing in the three following years; in EO we observed a similar decrease, but it was less evident for the absence of caterpillars. We may conclude that

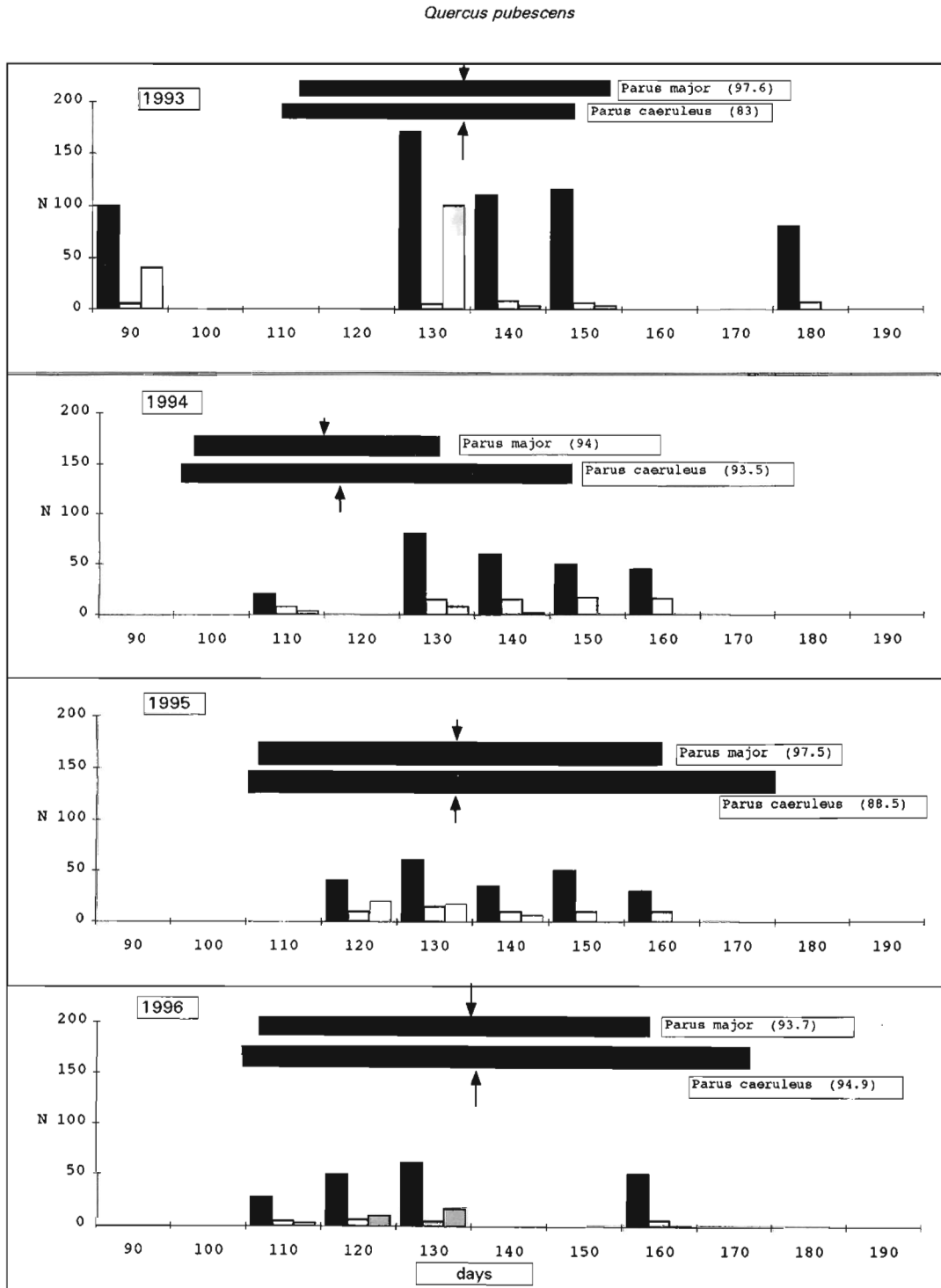


Figure 1 - Overall number of arthropods (black), caterpillars of *Tortrix viridana* (grey) and arthropod orders (white) extracted by the Univac portable suction sampler within branch layers of 15-20 plants of *Quercus pubescens* for 15 minutes. Horizontal bars indicate the breeding season of Great and Blue Tits in the *Q. pubescens* woodlot (that is from the earliest lay-date to the latest fledging-date); fledging success (number fledged/clutch size x 100) follows the scientific name of Tits. In the abscissa is reported the number of days from the 1st January (92 = 1st April). The arrow shows the peak of breeding, that is the mean laying-date + 15 days to hatch.

Quercus ilex

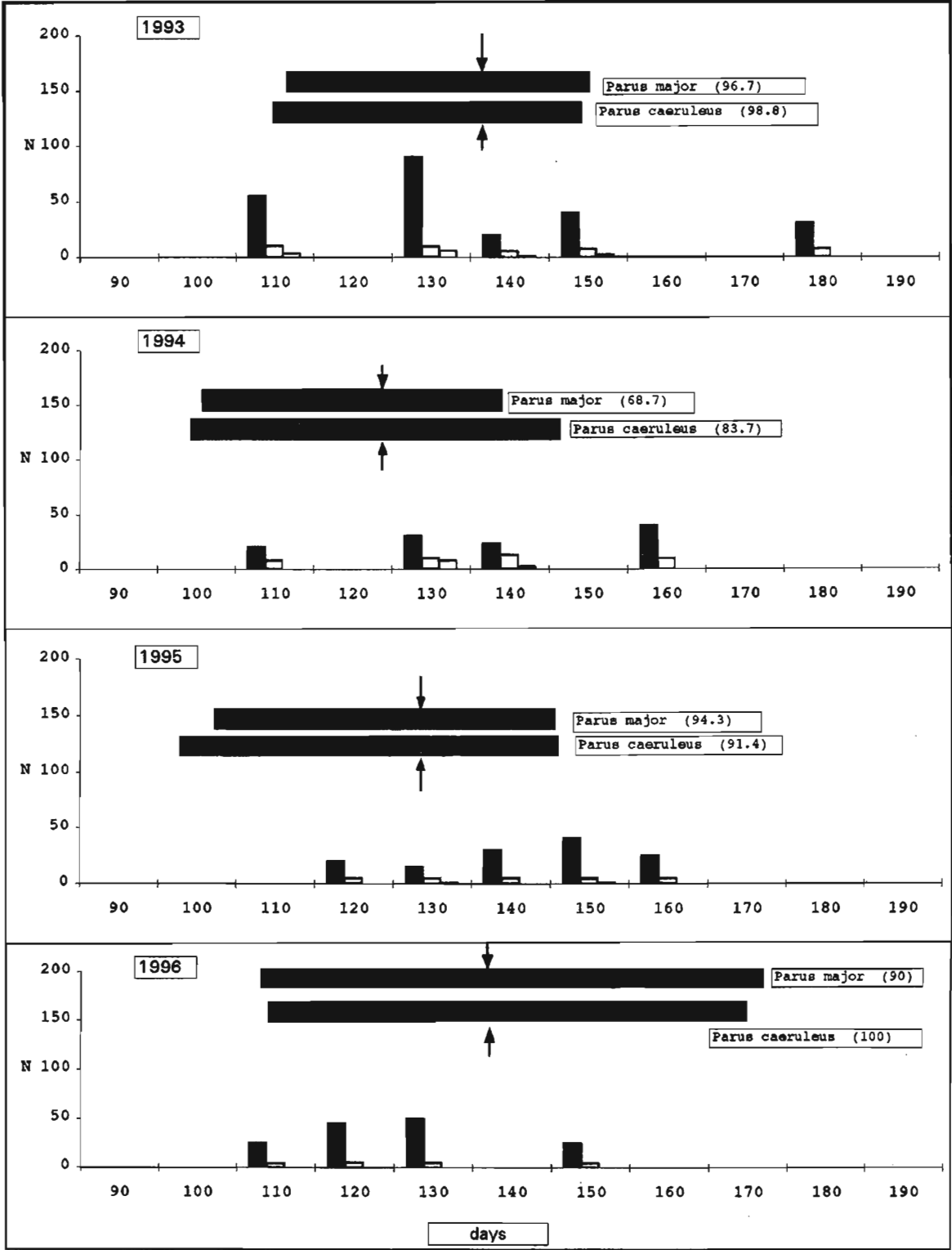


Figure 2 - As Figure 1, wood of *Quercus ilex*.

Pinus halepensis

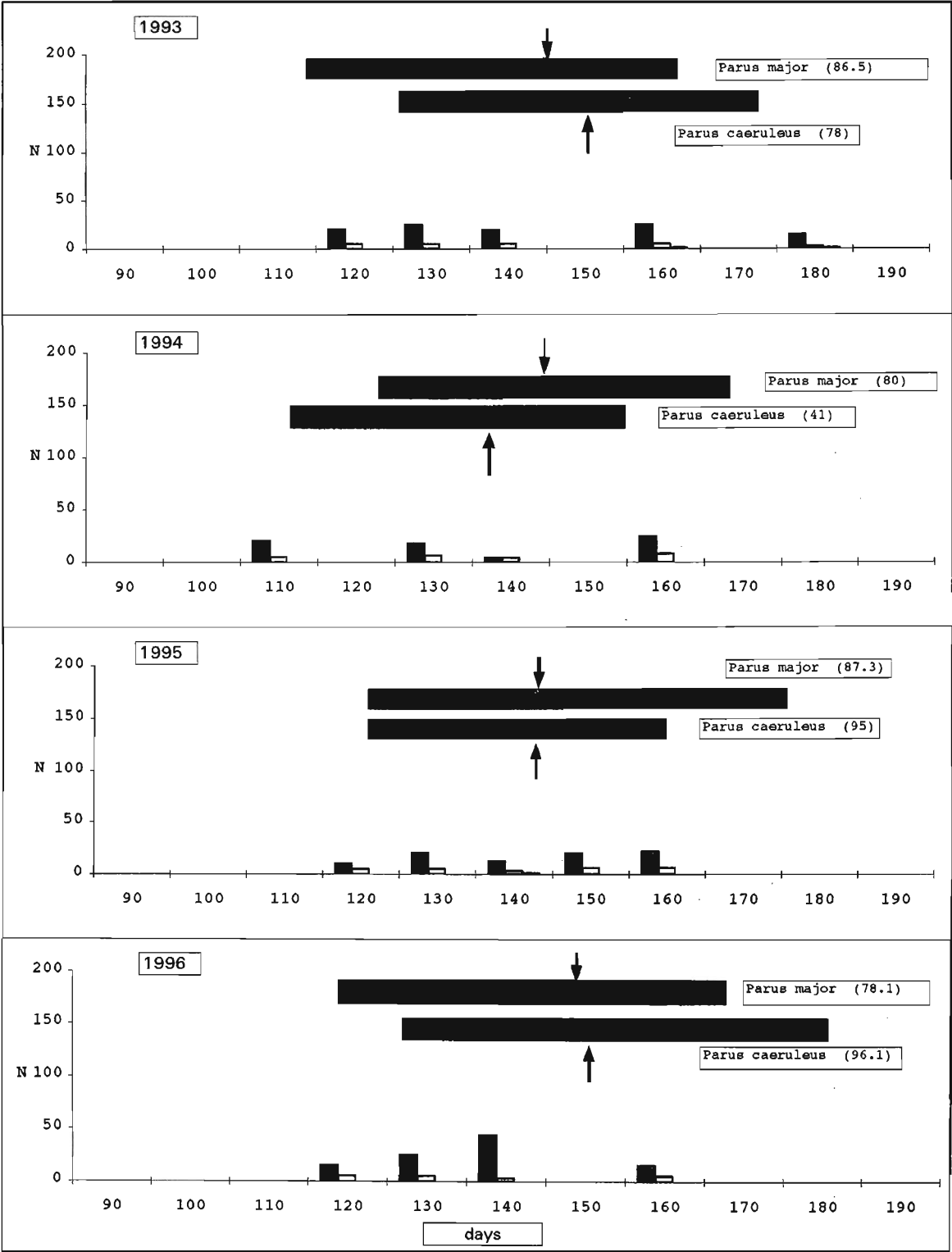


Figure 3 - As Figure 1, reafforestation of *Pinus halepensis*.

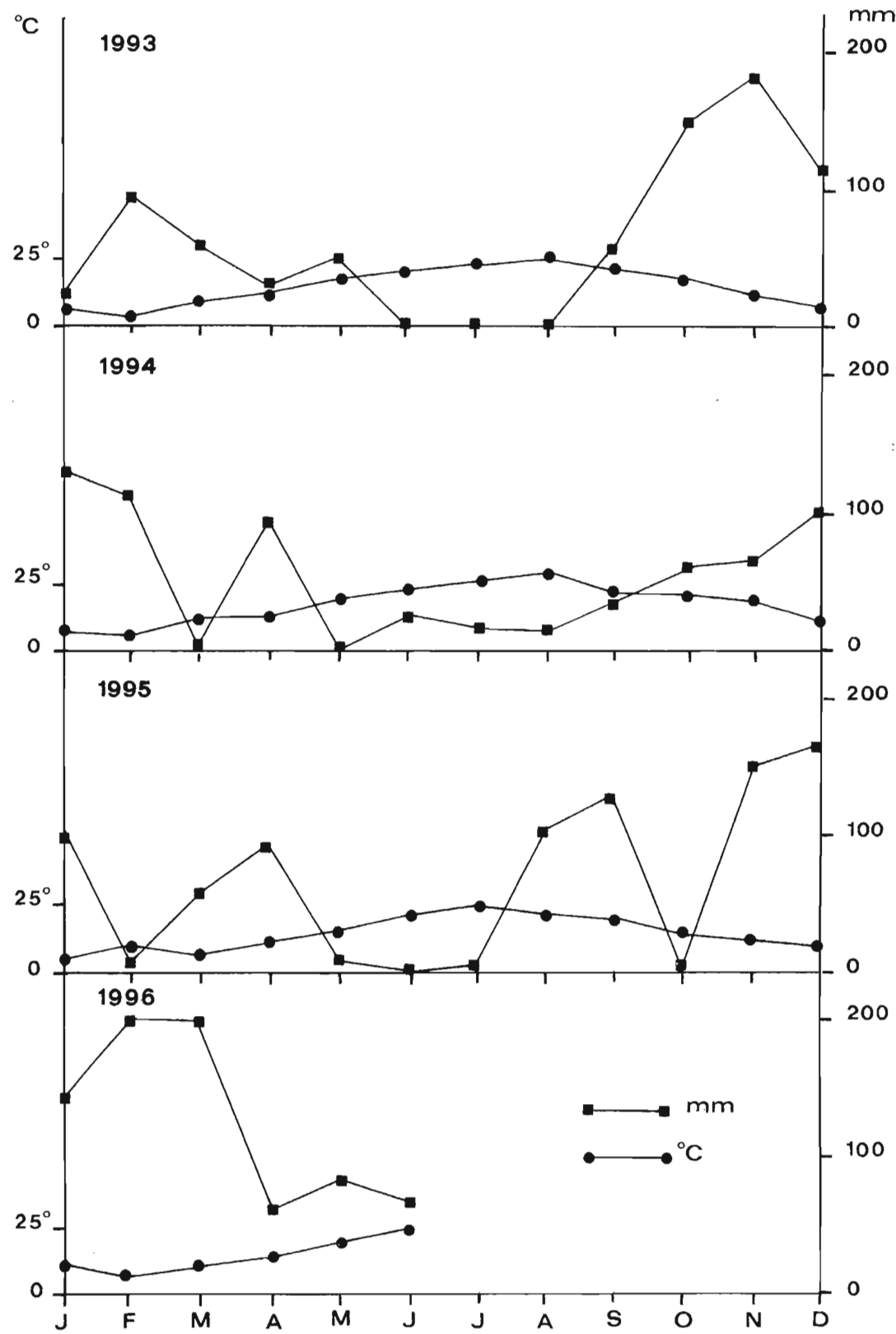


Figure 4 - Climatic trend from January to December 1993, 1994, 1995 and from January to June 1996.

evergreen oakwoods are less productive and rich in arthropods than deciduous ones. Our results seem do not agree with what was observed by some authors (e.g. Perrins and Mc Cleery 1989), who found a correlation between clutch size and annual caterpillar density. In 1993, even if resource (= caterpillars) abundance in DO was much higher than in EO, the fledging success did not differ in the two woods both for Great and Blue Tit. Captures of arthropods in DO in 1994 match well those of EO in 1993, as well as reproduction of the two species of Tits in DO in 1994 (fledging success of the two species: 93.5 and 94%) and in EO in 1993 (fledging success: 97 and 99%). Caterpillars, nevertheless, are not always important prey for Tits (e.g. Blue Tit in evergreen Iberian oakwoods: Gil Delgado *et al.* 1992). Thus the sole differences in the abundance of caterpillars of *Tortrix viridana* in 1993 in respect to other years in DO cannot account for the possible differences in the breeding trend in DO. Parallel differences also occurred in the other woodlots; as a matter of fact only in 1994, year of scarcity of caterpillars of *Tortrix viridana*, both Great and Blue Tits started earlier the reproduction both in DO (where in 1993 caterpillars were abundant) and in EO (where caterpillars were almost absent), and in 1994, 1995 and 1996, all years of caterpillar scarcity, Blue Tits increased their frequency of occurrence and nestbox occupation. The changement of food resource before, during laying and chick growth might be the reason of earlier laying in 1994 in respect to other years (cf. Martin and Bellot 1990); this changement possibly accounts for the lower fledging success of both Great (69%) and Blue Tit (84%) in EO in 1994 in respect to the other years (see Table 2). Earlier laying date recorded in 1994 cannot be related to the mere absence of caterpillars, but probably to other factors, as the anticipation of the overall abundance of insects, the microclimate, etc. The second aim of our research was to ascertain the overlap degree of the peak resource and the peak-demand of young in the two types of oakwoods. As suggested by Haywood (1993), climate may influence the resource peak, which in turn may influence the breeding success. Temperature and rain values should act through the spring development of the leaves and the associated arthropod fauna the Tits prey upon (Perrins and Mc Cleery 1989; also see Clamens (1990) who noticed a significant correlation between laying date and bud burst in deciduous oakwood). A rainy winter and an earlier summer may influence the demography of insect populations and could account for the breeding performance of Tits, and, according to the theory, earlier clutches tend to be larger than later ones (cf. Perrins 1970; Gosler 1993). As we found a correlation between the rain value in March

and the day of the first egg laid, but did not find any significant correlation between the day of the first egg laid and the clutch size or the number of young fledged, we suppose that winter-spring climate may have influenced the laying date of sicilian Tits, while their laying date possibly did not influence the clutch size and fledging success.

In the four years pairs of Blue and Great Tits breeding in oakwoods appeared to be significantly more successful than in reafforestation sites: clutches generally were larger and started earlier in the oakwoods than in reafforestation. No important differences were noticed in the breeding performance between DO and EO in the four years both for Great and Blue Tit, while they were observed in PR. In DO breeding of Tits occurred in such a way that the two peaks (abundance of arthropods and demand by young) resulted properly adjusted in the four years. In EO, where arthropods resulted less abundant than in DO but showed a gaussian curve of abundance, the demand by young Tits overlapped less with the peak of resource availability; nevertheless this did not affect the fledging success. In PR, where arthropods were monotonously scarce, the demand of young could not be adjusted to any kind of curve, and clutch size and number of young fledged was lower respect to the oakwoods. Thus it seems that both the overall abundance and the presence of a peak of arthropods during the breeding season of Tits may influence the fledging success.

Generally dry mediterranean habitats do not favour the occurrence of second clutches of Tits (but see Bellavita and Sorace (1991) who report high percentages of double clutches in central Italy); the possible reason of the double clutch of one pair of Great Tit in DO in 1993 was the high availability of caterpillars.

Our third aim was to check the breeding performance of Tits in relation to resource parameters, in woodlots dominated by trees of different species which are part of the same woodland. Previous work on the breeding biology of the Great Tit has shown that timing has a strong influence on other reproductive parameters and is critical for their success; for example, earlier fledged young tend to be heavier and have a higher probability of surviving to breed, while later-laid eggs tend to be heavier, but later clutches and broods tend to be smaller (cf. Perrins 1970, 1979, Gosler 1993). According to Blondel *et al.* (1993) in continental deciduous oakwoods of France and in insular evergreen oakwoods of Corsica Blue Tits time their laying date so that their young are in the nest around the peak of food abundance. Their results support the theory that selection favours earlier breeding and larger clutches in rich deciduous mainland habitats,

and smaller clutches and later laying dates in poor evergreen island habitats. Possibly due to gene flow between Blue Tits living in deciduous and evergreen oakwoods, birds living in continental evergreen oakwoods start laying before the optimal date (Clamens and Martin 1991). The apparent maladaptation of Blue Tits in the evergreen continental oakwood has been interpreted by Blondel *et al.* (1993) as the result of an asymmetric gene flow between rich deciduous habitats (source), where well adapted birds produce many fledglings, and poor evergreen habitats (sink) where the density is maintained through the immigration from rich habitats. Our results are not in accord with the hypothesis of genetic differences in the mean laying date in insular Blue Tit (Perret *et al.* 1989; Blondel *et al.* 1990, 1993; Lambrechts and Dias 1993). In Sicily, Downy and Holm oak respectively cover 18,677 and 9,993 Ha, pine reafforestations 56,831 Ha (Asciuto 1992); we assume that most of the sicilian broadleaved woodland populations of Great and Blue Tits are not isolated from their surroundings (e.g. pine reafforestations) and an exchange of birds between the different habitats occurs more or less regularly (cf. McCleery and Clobert 1990), particularly in our sample area where wood sites are lots of the same woodland. Values of clutch size of Blue Tit in oakwoods (7.8-9.5) lie among those known for other mediterranean continental areas (cf. Blondel *et al.* 1993; Isenmann 1987), whereas clutches in pine reafforestation (5.2-7.3) lie among those known for Corsica, Canary Is., Pantelleria Is. and North Africa (cf. Blondel *et al.* 1993; Isenmann 1987; Lo Valvo and Massa 1995). The mean laying date of Blue Tit in sicilian oakwoods (12 April-2 May; cf. Table 4) is typical of mediterranean continental areas (20 April according to Blondel *et al.* 1993 and Isenmann 1987), whereas the laying date in pine reafforestation (27 April-13 May) is among the latest of the Mediterranean (the island of Corsica: Blondel *et al.* 1993; some Iberian continental populations: Gil Delgado *et al.* 1992; see Table 4). The gene flow between deciduous and evergreen oakwood individuals could account for the insignificant differences of the breeding performance in the two oakwoods, but the low clutch size and fledging success observed in PR, habitat qualitatively and quantitatively poor in resources, disagrees with the above theory, being very unlikely the lack of gene flow between individuals living in PR and those breeding in EO and DO.

Van Balen (1973) found marked differences in the density of Great Tit pairs between mature oak *Quercus* spp. woodland (1-2.3 pairs/ha) and Pine *Pinus* spp. woods (0.1-0.4 pairs/ha). At such densities, clutch-size was similar in both habitats;

however, when population densities were similar, clutch size was much greater in oakwoods, and nestling survival rates were much lower in pine woods. Lemel (1989) however found little evidence for a difference in reproductive success of Great Tits breeding in deciduous and coniferous forest in Sweden. In general the variation we observed in many measured parameters was greater in PR oakwoods (particularly for Blue Tit), and this in itself may indicate the poorer quality and more variable environment of this semi-natural habitat. Most of western Europe is now characterized by fragmented habitats of variable, but often low, quality; small pockets of ancient natural woodland are the remnants of once extensive forest cover (Riddington and Gosler 1995); pine reafforestation revealed to be an entomologically poor habitat, much poorer than the remnants of the natural woodland. As a possible consequence of the inadequacy of the resources, Tits nesting there lay less eggs and produce less young than in natural woods immediately close to it. Lastly, we might hypothesize that some of the differences observed between oakwoods and pine reafforestation could be caused by age effects of Tits; reafforestation should be a secondary habitat, chosen by young individuals, which breed later and produce less young. Nevertheless, the low fledging success in sicilian reafforestations seems a generalized model. As a matter of fact we found a low number of fledged young of Great Tit in another sicilian pine reafforestation (Mt. Pellegrino, Palermo, 4.0 fledglings in 1993, 5.4 in 1994 and 5.0 in 1995).

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Riassunto - Abbondanza di insetti ed andamento della riproduzione delle Cince in querceti sempreverdi e decidui e rimboscamenti di pini in Sicilia.

Questa ricerca, condotta negli anni 1993-96, ha avuto come scopi: 1) valutare l'abbondanza e le eventuali differenze di risorse (artropodi) esistenti negli alberi che caratterizzano i querceti sempreverdi e quelli decidui; 2) controllare se il picco delle risorse coincide con il picco della domanda da parte dei giovani di due specie di Cince (*Parus major* e *P. caeruleus*); 3) verificare l'andamento della riproduzione ed i principali parametri riproduttivi delle due specie di Cince in tre habitat carat-

Table 4 - Breeding data of Great and Blue Tits in the Mediterranean area; numbers are referred to minima and maxima or to mean and standard deviation (in brackets) according to various sources. Laying dates are referred to the number of days from the 1st January (92 = 1st April).

	Laying-date		Clutch-size	
	Great	Blue	Great	Blue
Evergreen				
France	100-124 ^[5]	108.2(5.09) ^[4,6]	8.3-10.1 ^[5]	8.1(1.5) ^[4,6]
Spain		76-88 ^[8]		7.5-8.5 ^[8]
Spain		127(7.25) ^[5]		9.5(1.4) ^[5]
Italy	104.4(1.5) ^[2]	114.4(3.9) ^[2]	8.3(0.5) ^[2]	8.3(0.9) ^[2]
Algeria		130 ^[10]		6.6(1.4) ^[10]
Morocco		93-112 ^[1]		6.8(1.1) ^[1]
Sicily	107-120 ^[13]	105-122 ^[13]	8-9 ^[13]	8.5-9.3 ^[13]
Corsica	127-148 ^[6]	123.3-150 ^[3,6,7,9]	6-7 ^[6]	5.2-7.2 ^[3,6,7,9]
Mallorca				6.9(1.2) ^[8]
Is. Vivara			3.9-6.1 ^[11]	
Deciduous				
France		100.9(4.2) ^[4,7]		10.9(1.8) ^[4,7]
Italy	111(11) ^[2]	101.7(8.7) ^[2]	7.8(1.2) ^[2]	8.2(1.3) ^[2]
Sicily	102-120 ^[13]	104-123 ^[13]	6.4-9 ^[13]	7.8-9.5 ^[13]
Corsica		117.7(6.2) ^[7]		
Coniferous				
France	110-140 ^[6]		7.5-7.8 ^[6]	8.8(1.3) ^[7]
Italy	100.2(8.3) ^[2]	114.9(10.5) ^[2]	7.8(1.4) ^[2]	8.2(1.3) ^[2]
Morocco		135-147 ^[7]		6.7(1.3) ^[7]
Sicily	125-132 ^[13]	118-135 ^[13]	5.5-7.5 ^[13]	5.2-7.3 ^[13]
Corsica	143-158 ^[6]		7.8-8 ^[6]	6.3(0.5) ^[7]
Canary Is.				3.5(1) ^[7]
Mixed				
I. Pantelleria		104-150 ^[12]		4.5-5.5 ^[12]

References:

- 1 = Baouab et al. 1986;
2 = Bellavita and Sorace 1991;
3 = Blondel and Isenmann 1979;
4 = Dervieux et al. 1990;
5 = Gil Delgado et al. 1992;
6 = Isenmann 1982;
7 = Isenmann 1987;
8 = Isenmann et al. 1990;
9 = Lambrechts and Dias 1993;
10 = Moali and Isenmann 1990;
11 = Fusco et al. 1991;
12 = Lo Valvo and Massa 1995;
1996 unpublished data;
13 = present study.
- terizzati da alberi diversi (querceto deciduo, querceto sempreverde e rimboschimento di pini), ma facenti parte di un'unica ampia area boschiva. Nei quattro anni la dimensione della covata, il numero dei giovani involati e l'abbondanza degli artropodi sono risultati maggiori nei querceti che nel rimboschimento di pini. L'abbondanza degli artropodi è più o meno coincisa sempre con il picco della domanda da parte delle giovani Cince, in modo particolare nel querceto deciduo. La riproduzione è iniziata sempre prima (anche di 20 giorni) nei querceti rispetto al rimboschimento. Non sono emerse importanti differenze nell'andamento della riproduzione tra i due querceti, mentre sono state osservate tra i querceti ed il rimboschimento; in entrambi i querceti, nei quattro anni, dimensione della covata e numero di involati sono stati significativamente maggiori dei corrispondenti valori osservati nel rimboschimento.
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Changes in density distribution of the Hooded Crow *Corvus corone cornix* and the Magpie *Pica pica* in Northern Italy

MAURO FASOLA*, SILVIA CACCIAVILLANI*, CRISTINA MOVALLI* AND VITTORIO VIGORITA**

* Dipartimento Biologia Animale, Pz. Botta 9, 27100 Pavia, Italy

** Osservatorio faunistico, Settore Agricoltura e Foreste, Regione Lombardia, Piazza IV novembre 4, 20100 Milano, Italy

Abstract - We describe the density distribution of breeding Hooded Crows and Magpies over 12,827 km² of planitial landscape, and we quantify the changes that have occurred since 1980. Nest were censused by means of winter roadside counts. We tested this technique by applying it to 12 sample zones where the breeding pairs had been censused during the preceding reproductive season, and we calculated a conversion index from winter nest counts to breeding densities. The breeding populations for the entire study area in 1994 increased by 107% of the 1980 population for the Hooded Crow and by 27% for the Magpie. Compared to 1980, the areas with high density of Hooded Crows in 1994 expanded north- and east-ward, while the distribution of the Magpie was similar to that in 1980. The density distributions of both corvids showed a clear structure with centers of abundance and with concentric bands of decreasing abundance, a pattern probably determined by gradients of environmental factors. However, the planitial landscape of our study area is very uniform, and there is no noticeable gradient to match the density variations between the two corvids; the variations therefore remain unexplained. The 1980 distribution patterns had suggested that predation or competition by Hooded Crows could limit Magpie distribution at a geographic scale, but the 1994 data do not confirm this hypothesis.

Introduction

We describe the density distribution of the nests of Hooded Crows *Corvus corone cornix* and of Magpies *Pica pica* in the central part of Northern Italy, and we identify the changes that have occurred since 1980, when the distribution was described, with similar methods, by Fasola and Brichetti (1983). Nest distribution was studied by means of winter roadside counts, when nests are easily spotted on leafless trees. We validate this technique, and we provide an index that converts from winter counts to nest densities during the preceding reproductive season. The research was enabled by the invaluable cooperation of 16 participants in the field surveys (see Acknowledgments). The Hooded Crow and the Magpie are highly plastic in their ecological adaptations (Rolando *et al.* 1993, Saino and Meriggi 1990), and they are widespread in northern Italy. However, their distribution is not uniform, and this unevenness is puzzling because the planitial landscape in Northern Italy is very homogeneous. We critically review the hypothesis by Fasola and Brichetti (1983) that the density distribution of the two corvids in northern Italy may be influenced by interspecific competition.

Study area and methods

We recorded Hooded Crow and Magpie nest distribution over 12,827 km², throughout the planitial part of the *Regione Lombardia* (Fig. 1). This study area is slightly smaller than the one censused by Fasola and Brichetti (1983), because some NW and SE parts of the former study area were not covered. The area is completely flat with a gentle south- and east-ward slope, it is northernly and southernly bound by the foothills of the Alps and the Appennine mountains, and it is intensively cultivated with maize, rice, wheat, poplar plantations and meadows. The landscape is uniform throughout the area, except for the local predominance of certain cultivations. Natural vegetation is scanty and mainly restricted to riversides.

Nest density was recorded by means of roadside counts conducted during the winter period; the technique was the same as that previously used by Fasola and Brichetti (1983) and by Fasola *et al.* (1985). Nest density distribution was recorded throughout the study area, from 15 November to 15 February, in the years 1993, 1994 and 1995, along a square grid of transect roads spaced approximately 10

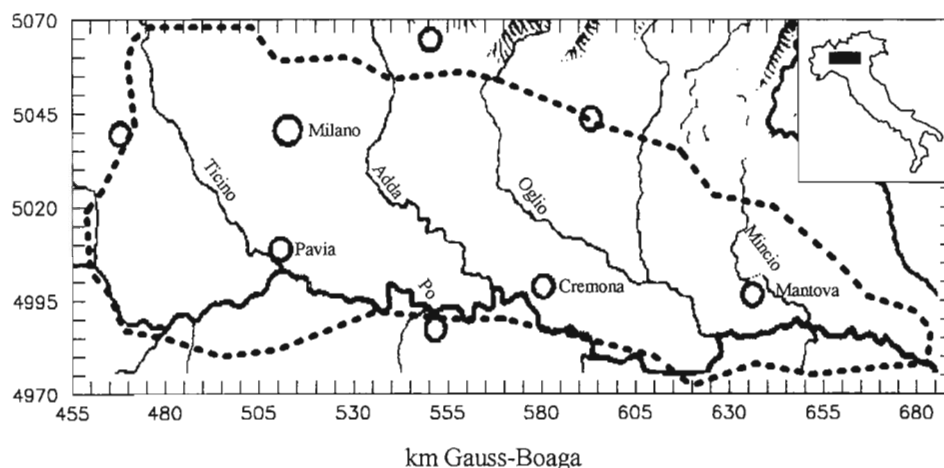


Figure 1. Study area and kilometric reference grid.

km from each other, for a total of 2,675 km of roads. The censuses were performed by 11 observers who adopted uniform techniques: driving along the survey roads, stopping every 0.5-1 km, scanning the landscape with binoculars, and marking a 100,000 scale map for all the Hooded Crow and Magpie nests identified on both sides of the road. From these maps, we calculated the number of nests per kilometer, and averaged the count for each 5 km tract of the transects. These values were converted to breeding pair densities, on the basis of the conversion index derived from the winter counts and from the estimates of the breeding densities, which were conducted in a number of sample areas (see below). To each 5 km transect, we assigned the Gauss-Boaga kilometric coordinates of its central point; from the estimated breeding pair densities, and using the graphic program SURFER, we derived the Hooded Crow and Magpie density distribution maps ("1994" maps in the Results). SURFER provides various techniques (Inverse Distance, the Kriging geostatistical technique, and Minimum Curvature) for the estimation of the distribution of a variable recorded at random points in a two-dimension space, but the output may differ greatly in relation to the technique and to the settings (Maurer 1994). We adopted Minimum Curvature, because it depicts the actual data with the least distortion, and because it is advisable when the data are evenly distributed throughout the study area, as in our case.

Again using SURFER, with exactly the same settings and over a coincident study area, we re-analyzed the nest distribution data collected by Fasola and Brichetti (1983) from 2,570 km of transect roads during the winters 1979-1982 and we derived another set of density distribution maps ("1980" maps in the

Results) to be compared with the 1994 maps.

The breeding populations for the entire study area were estimated by the measurement of the distribution maps for land surfaces with different densities (these measurements are an option provided by SURFER); by calculation of the current average density for each of these surfaces from the transect count data; by multiplication of each density by the corresponding surface, and by the summation the resulting numbers of nests.

We tested the efficacy of winter roadside censuses in the assessment of nest density by applying this technique to sample zones where pair density had been recorded during the preceding breeding season. The location of occupied and non-occupied nests was recorded on 10,000 scale maps during April and May in 1993 and in 1994, in 12 sample zones, each with surface area from 4 to 6 km², that were widely distributed throughout the study area. In December of each of the two given years, each sample zone was reassessed by another observer, who was not acquainted with the given sample zone. Each observer conducted 3-15 km of transect counts using the standard technique described above, and recorded nest locations on the 10,000 scale maps. From these repeated counts we estimated an index that converts from winter transect nest counts to breeding pair density.

Results

Validation of the winter census technique

We used the results of the winter and spring counts in the sample zones to calculate a conversion index, from the number of nests counted along the winter transects to the density of breeding pairs. This was possible only

for Hooded Crows, because Magpie density in the sample zones was too low.

A first estimate of the conversion index was obtained from the ratio "number of nests recorded along the winter transects / number of breeding pairs in spring". These two values were linearly related ($r_{23} = 0.44$, $P < 0.05$), although with high residual variance (Fig. 2,

which shows the values for the 12 sample zones in the 2 study years). The best-fit regression line between breeding pair density and number of nests recorded along the winter transects had a slope equal to 1.55, a value that was assumed as a first estimate for the conversion index.

A second estimate of the index was based on the

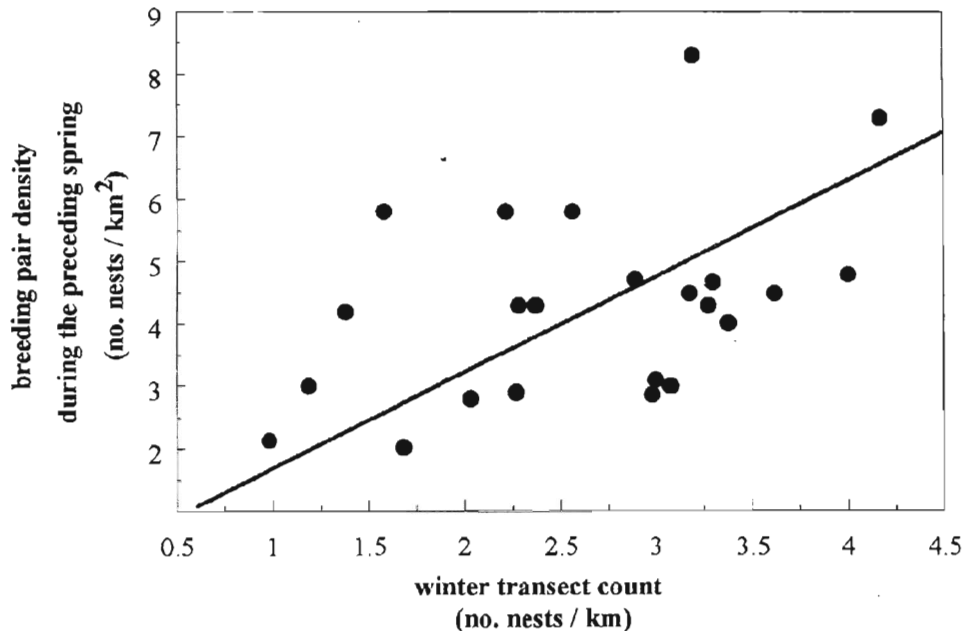


Figure 2. Relationship between Hooded Crow breeding pair density, and number of nests counted from winter transects. The best-fit regression line is "pairs = 1.55 nests in winter".

distance of the nests from the transects. Winter nests locations were compared with those recorded in the spring. During the winter transect counts, the observers spotted 41.7% of the nests that had been recorded during the preceding spring within 300 m at both sides of the transect (Tab. 1). Another 39.7% of the spring nests were not recorded; this was due partially to the disappearance of some nests and to the falling of some trees, and partially to the overlooking of other nests. Conversely, 17.2% of the nests recorded in winter had

not been spotted during the spring; most of these nests had surely been built after the peak breeding season in April and May when our breeding survey was conducted, and they were presumably attributable to late breeders or to replacement clutches. From the data in Tab. 1, we estimated a conversion index for Hooded Crows as follows:

- 1) the average distance of all the recorded nests from the winter transects (nests recorded at both counts, and nests recorded only in winter, Tab. 1) was 183 m,

Table 1. Correctness of nest species identification, and Hooded Crow nests recorded during the winter and the spring counts. The values are based on 1156 nests recorded in the 12 study zones.

	nests correctly attributed to their species		Hooded Crow nests (only those correctly attributed):		
	Magpie	Hooded Crow	recorded at both counts	recorded only in winter	recorded only in spring
total nests (%)	99,0	99,6	41.7	17.2	39.7
distance from transect (average in m)			229	128	159

therefore the average observation belt at both sides was 366 m

- 2) since in winter 39.7% of the spring nests were overlooked, but 17.2% other nests were recorded, the observation belt should be corrected to $366 \cdot (1 - 0.397 + 0.172) = 283$
- 3) for an effective 283-m-wide observation belt, the nest density in no./km² should be “no./km in winter / 0.283”, or “no./km in winter * 3.53”
- 4) however, only 1 out of 2.3 of the nests present in spring had eggs or chicks, and the remaining nests were old, incomplete or non-used; therefore the conversion factor for “no. nests in winter/km of transect” into “no. breeding pairs/km²” is $3.53/2.3 = 1.54$.

The conversion index deduced from the ratio “nests in winter / breeding pairs” (1.55), and that deduced from the nest distance (1.54), were both very close to the index (1.60) calculated by Fasola *et al.* (1985) with similar methods but from different data. We adopted the intermediate value, 1.55, as an index for converting the “no. nests/km in winter” into “no. breeding pair / km²” in Hooded Crows. For the Magpie, no new

estimate was available, and we adopted the conversion index (0.80) estimated by Fasola *et al.* (1985). The lower value of the Magpie index is related to the higher number of non-occupied nests in this species; in our sample zones only 1 nest was occupied, on average, for every 3.8 nests present.

The observers correctly identified the species for over 99% of the nests in the 12 sample zones (Tab. 1). The performance of the 10 observers was measured as the ratio no. nests/km counted in winter-no. breeding pairs/km²; no significant difference in observer performance emerged (ANOVA test based on the transects, from 3 to 8, censused by each observer in the sample zones, $F_9 = 0.28$, NS).

Density distribution

Fig. 3 and 4 depict the density distribution of the two species, as estimated from the winter counts and the conversion indexes. The maps for 1980 are in general similar, but in detail different from those produced by Fasola and Brichetti (1983), who interpolated intuitively the same density data that we have now mapped using an automatic algorithm.

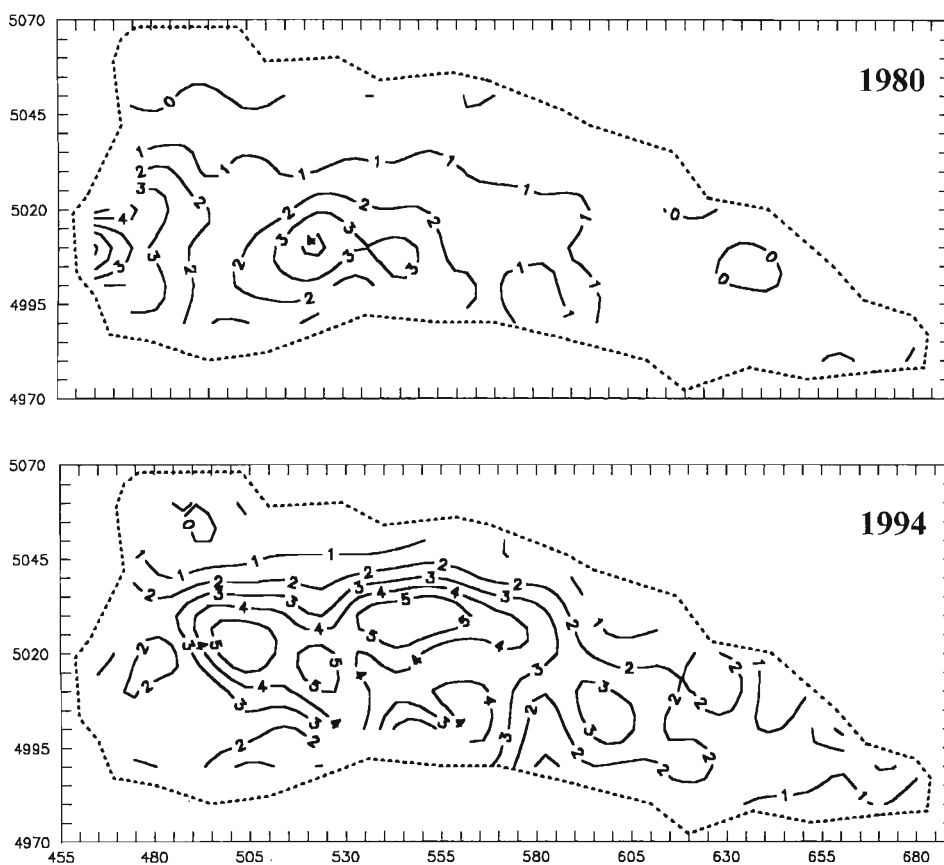


Figure 3. Hooded Crow density distribution. The isolines bound zones with density equal to or higher than a given value (no. pairs / km², scaled to unity).

The Hooded Crow (Fig. 3) in 1980 had its stronghold in the central and in the western parts of the study area, but at the northern and the eastern parts its density was very low or zero. In 1994, the areas of high density had expanded north- and east-ward, and only very small areas with zero density remained at the NW side of the study area.

The 1994 distribution of the Magpie (Fig. 4) was

similar to that of 1980. Over most of the study area the densities were low. The boundaries of the 1994 zero density zones seem to differ greatly from those of the 1980 zones, but rather than to a real change, this is likely due to uncertain ties in the output of the graphic algorithm when dealing with sparse presences. The zone of high density in the NW seemed to have slightly retracted in 1994, while the

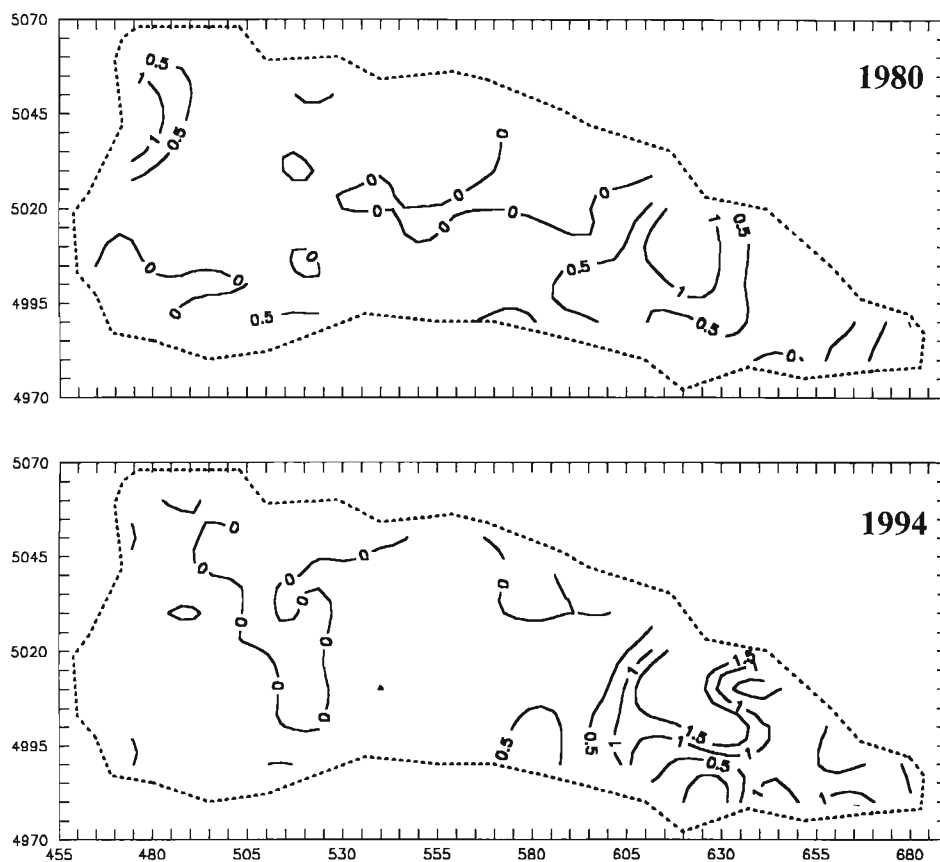


Figure 4. Magpie density distribution. The isolines bound zones with density equal to or higher than a given value (no. pairs /km², scaled to 0.5).

eastern zone of highest density had slightly expanded.

Breeding population

In comparison with the 1980 figures, the 1994 population of the two species (Tab. 2, 3) had increased by 107% for the Hooded Crow and by 27% for the Magpie, thanks to the increase in their maximum densities, and to the expansion of the surfaces with high densities around the traditional stronghold areas. The total number of individuals is certainly much higher than the number of breeders, since in our study

area only 30-40% of the Hooded Crows breed (Fasola *et al.* 1988, G. Bogliani pers. com.).

Discussion

The density distributions of both Hooded Crow and Magpie showed a clear structure with centers of abundance and with concentric bands of decreasing abundance. Such a pattern is common for the density distribution of animal species, and it is probably

Table 2. Estimate of the total breeding population of Hooded Crows for the entire study area.

	breeding pair density lower or equal to:							
	0	1	2	3	4	5	6	7
surfaces (km ²) in 1980	735	5709	3505	1727	1043	104	3	0
in 1994	81	1096	3246	3895	2041	1626	763	79
average density (pairs/km ²) in 1980		0.56	1.51	2.43	3.33	4.39	5.89	
in 1994		0.60	1.57	2.50	3.42	4.40	5.57	7.31
total number of nests in 1980					16630			
in 1994					34452			

Table 3. Estimate of the total breeding population of Magpies for the entire study area.

	breeding pair density lower or equal to:						
	0	0.5	1	1.5	2	2.5	
surfaces (km ²) in 1980	1881	8347	1871	602	126	0	
in 1994	1838	7856	1802	670	366	295	
average density (pairs/km ²) in 1980		0.28	0.79	1.25	2.16		
in 1994		0.27	0.74	1.29	2.29	3.42	
total number of nests in 1980				4885			
in 1994				6199			

determined by gradients of abiotic or biotic environmental factors. However, the planital landscape of the study area is very uniform, and there are no noticeable habitat gradients which parallel the density variations of the two Corvids. Such variations therefore remain unexplained.

From the 1980 distribution data of Hooded Crows and Magpies in our study area, Fasola and Brichetti (1983) concluded that their partially complementary distributions could be due to their competitive or predatory interactions. Indeed, where the two species are syntopic, Magpie nests are frequently preyed upon by Hooded Crows, are placed far from Crow nests, and are located near buildings or roads presumably to limit Crow predation (Fasola *et al.* 1988).

However, the 1994 data do not confirm the idea that predation or competition by Hooded Crows limits Magpie distribution at geographic scale. First, the eastward expansion of the Hooded Crow in 1994 did not produce a corresponding decrease in the Magpie. Second, in 1980 the frequencies of the 5-km transects with given densities of Crows and Magpies showed a significant deviation from a random distribution, since the transects with high densities of both species were less frequent than expected (Fig. 3 in Fasola and

Brichetti 1983). However, the 1994 data did not confirm this pattern, since the frequency distribution of the transects did not deviate significantly from random. It has repeatedly been confirmed that competition is pervasive in assemblages of similar species (Schoener 1983, Gurevitch *et al.* 1992), but Wiens (1989) warned that we should be cautious in adopting the "MacArthurian paradigm" that competition is a major determinant of species distribution at geographical scale.

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Food of Italian Sparrow *Passer italiae* nestlings in Central Italy

LAURA MONDINO*, FULVIO FRATICELLI** and CARLO CONSIGLIO***

* Via Tespi 110, 00125 Roma, Italy.

** WWF Italia, via Garigliano 57, 00198 Roma, Italy.

*** Dipartimento di Biologia Animale e dell'Uomo, Università "La Sapienza", viale dell'Università 32, 00185 Roma, Italy.

Abstract - The diet of *Passer italiae* nestlings was studied in a wood of Central Italy. All samples contained arthropods, and shell fragments, seeds and gravel were also abundant. Diet diversity changed with age, being maximum at about 8 days of age. Diversity also increased with the number of nestlings. Differences were found with diet of nestlings of *Passer domesticus* and *Passer montanus*. Predation on eggs and nestlings was high.

Introduction

The Italian Sparrow *Passer italiae*, a stabilized hybrid between House Sparrow *Passer domesticus* and Spanish Sparrow *Passer hispaniolensis* (Mayr 1963; Johnston 1969; Massa 1989), is endemic in Italy. A very few researches have been made about this species (Lo Valvo & Lo Verde 1987; Bogliani & Brangi 1990; Brichetti *et al.* 1993, Sorace 1993) and no one about food of nestlings. In this study we have analized nestling food in a Mediterranean wood.

Methods

The research was made in the WWF Natural Oasis "Bosco di Palo" in Ladispoli, near Rome, Italy. The phytosociologic framing of this site can be reported to the *Lathiro-Quercetum cerris* association (Lucchese & Pignatti 1990). Its structure was described by Fraticelli & Sarrocco (1984) and a floristic list is reported in Lucchese (1990). In the area there were 35 nestboxes which were controlled every two days from April to July 1993. Every time the presence of building material (grass, leaves, etc.), eggs and nestlings was recorded and faecal sacks were collected. They were kept in 70% alcohol and were later analyzed by a stereoscopic microscope with the method of Kleintjes & Dahlsten (1992). The fragments were identified and their presences in the samples were noted. Statistical counts were made on the samples, each containing all the faecal sacks collected in the same nest on the same day.

Table 1. Diet of Italian Sparrow in 59 samples.

ITEM	NUMBER OF SAMPLES	PERCENTAGE OF SAMPLES
ANIMAL MATTER	59	100.0
of which:		
Pulmonata	14	23.8
Opiliones	36	61.0
Araneae	12	20.3
Orthoptera	9	15.1
of which: <i>Gryllotalpidae</i>	2	3.4
Dermaptera	8	13.6
Isoptera	3	5.1
Hemiptera	41	69.5
Neuroptera	1	1.7
Lepidoptera (larvae)	47	79.7
Diptera	1	1.7
Hymenoptera	25	42.4
of which: <i>Formicidae</i>	5	8.5
Coleoptera	52	88.1
of which: <i>Carabidae</i>	2	3.4
<i>Staphylinidae</i>	4	6.8
<i>Scarabaeidae</i>	2	3.4
<i>Cerambycidae</i>	1	1.7
<i>Curculionidae</i>	13	22.0
VEGETAL MATTER	36	61.0
of which:		
Seeds	21	35.6
Other plants	24	40.7
GRIT	41	69.5

Table 2. Diet of Italian Sparrow nestlings in different periods. The first figures refer to absolute numbers of samples; the second ones (in brackets) to percentages of samples containing the item on the total number of samples of the same period.

PERIODS	A	B	C	D
	19-31 May	1-15 June	16 June - 2 July	13-29 July
NUMBER OF SAMPLES	13	24	10	12
ANIMAL MATTER	13 (100)	24 (100)	10 (100)	12 (100)
of which:				
Pulmonata	2 (15)	10 (42)	0 (0)	2 (17)
Opiliones	5 (39)	21 (88)	5 (50)	5 (42)
Araneae	1 (8)	3 (13)	2 (20)	6 (50)
Orthoptera	1 (8)	2 (8)	0 (0)	6 (50)
of which: <i>Gryllotalpidae</i>	0 (0)	2 (8)	0 (0)	0 (0)
Dermaptera	0 (0)	6 (25)	1 (10)	1 (8)
Isoptera	3 (23)	0 (0)	0 (0)	0 (0)
Hemiptera	6 (46)	18 (75)	10 (100)	7 (58)
Neuroptera	1 (8)	0 (0)	0 (0)	0 (0)
Lepidoptera (larvae)	11 (85)	19 (79)	7 (70)	10 (83)
Diptera	0 (0)	1 (4)	0 (0)	0 (0)
Hymenoptera	2 (15)	11 (46)	8 (80)	4 (33)
of which: <i>Formicidae</i>	0 (0)	1 (4)	4 (40)	0 (0)
Coleoptera	10 (78)	21 (88)	10 (100)	11 (92)
of which: <i>Carabidae</i>	1 (8)	0 (0)	0 (0)	1 (8)
<i>Staphylinidae</i>	2 (15)	1 (4)	1 (10)	0 (0)
<i>Scarabaeidae</i>	1 (8)	0 (0)	1 (10)	0 (0)
<i>Cerambycidae</i>	1 (8)	0 (0)	0 (0)	0 (0)
<i>Curculionidae</i>	0 (0)	1 (4)	4 (40)	8 (67)
VEGETAL MATTER	10 (77)	17 (71)	5 (50)	4 (33)
of which:				
Seeds	4 (31)	7 (29)	4 (40)	4 (33)
Other plants	9 (69)	13 (54)	2 (20)	0 (0)
GRIT	6 (64)	17 (71)	8 (80)	10 (83)

We grouped the samples in 5 periods: "A" from 16 to 31 May; "B" from 1 to 15 June; "C" from 16 June to 2 July; "D" from 3 to 12 July and "E" from 13 to 29 July (Table 2). The "D" period coincided with the interval between first and second broods, therefore it did not contain any samples.

Moreover, we grouped the samples in four nestling ages: I, from 1 to 3 days old; II, from 4 to 6; III, from 7 to 9; and IV, from 10 to fledging (Table 3), and in three groups after brood size: 2, 3, 4 and more nestlings (Table 4). Chi square tests were calculated from the sums of all samples containing or not containing a given item in each group (seasonal, age or brood size group).

Results

Only 6 (17%) nestboxes were occupied by Italian Sparrows. In seven of 9 broods observed nestlings hatched and in 4 of them the nestlings fledged. We

collected 211 faecal sacks in 59 samples, and therefore each sample contained a mean of 3.4 faecal sacks.

Italian Sparrow nestling food was composed mainly of animal food: we found fragments of arthropods in all samples and vegetal matter only in 54.2% of samples. Moreover, we found grit in a high percentage of samples. A detailed list of matter (Table 1) shows the prevalence of Coleoptera, which were present in 88.1% of the samples. Among these, the only identified species was *Anomala devota* (Rutelidae). Among Hymenoptera there were *Crematogaster scutellaris* (Formicidae) and various Apoidea species. Isoptera were represented by *Reticulitermes lucifugus* (Rhinotermitidae) and Dermaptera by *Forficula auricularia*.

The test for association between Hymenoptera and brood size (2-3 vs. 4 or more) was highly significant (chi square=9.64, df=1, $p<0.01$).

Food diversity, as estimated by the Shannon index

Table 3. Diet of Italian Sparrow nestlings in different ages. The first figures refer to absolute numbers of samples; the second ones (in brackets) to percentages of samples containing the item on the total number of samples of the same age group.

AGE GROUP AGE (DAYS)	I 1-3	II 4-6	III 7-9	IV 10 AND MORE
NUMBER OF SAMPLES	11	17	16	15
ANIMAL MATTER	11 (100)	17 (100)	16 (100)	15 (100)
of which:				
Pulmonata	0 (0)	6 (35)	5 (31)	3 (20)
Opiliones	7 (64)	10 (59)	12 (75)	7 (47)
Araneae	3 (27)	2 (12)	4 (25)	3 (20)
Orthoptera	1 (9)	1 (6)	5 (31)	2 (13)
of which: <i>Gryllotalpidae</i>	1 (9)	0 (0)	1 (6)	0 (0)
Dermaptera	2 (18)	1 (6)	4 (25)	1 (7)
Isoptera	0 (0)	2 (12)	0 (0)	1 (7)
Hemiptera	10 (91)	9 (53)	12 (75)	10 (67)
Neuroptera	1 (9)	0 (0)	0 (0)	0 (0)
Lepidoptera (larvae)	10 (91)	16 (94)	10 (62)	11 (73)
Diptera	1 (9)	0 (0)	0 (0)	0 (0)
Hymenoptera	3 (27)	7 (41)	10 (62)	5 (33)
of which: <i>Formicidae</i>	1 (9)	2 (12)	0 (0)	2 (13)
Coleoptera	8 (73)	15 (88)	14 (88)	15 (100)
of which: <i>Carabidae</i>	0 (0)	1 (6)	0 (0)	1 (7)
<i>Staphylinidae</i>	0 (0)	2 (12)	0 (0)	2 (14)
<i>Scarabaeidae</i>	0 (0)	1 (6)	0 (0)	1 (7)
<i>Cerambycidae</i>	0 (0)	1 (6)	0 (0)	0 (0)
<i>Curculionidae</i>	3 (27)	2 (12)	5 (31)	3 (20)
VEGETAL MATTER	5 (45)	12 (71)	12 (75)	7 (47)
of which:				
Seeds	3 (27)	4 (24)	9 (56)	5 (33)
Other plants	3 (27)	9 (53)	8 (50)	4 (27)
GRIT	4 (36)	11 (65)	15 (94)	11 (73)

(H'), showed variation with nestling age (Figure 1) and with number of nestlings in brood (Figure 2).

Discussion

The diet of Italian Sparrow nestlings change as the season proceeds and probably reflects what is made available by the environment both in the animal and vegetal fields, as it was found also by Anderson (1984) and Ivanov (1986) in House Sparrow and Tree Sparrow *Passer montanus* respectively. These authors used a different study method in different environments, so the following comparison must be considered only in a general way.

Coleoptera, Lepidoptera and Opiliones are about stable during the whole breeding season, while they were found to decrease in House Sparrow diet when season proceeds (Ivanov 1986). Orthoptera reach their maximum at the end of July, like in House Sparrow (Ivanov 1986). With nestling growing and then

probably with the increase of their digestive ability, Lepidoptera larvae decrease and Coleoptera increase. Isoptera, wings of which were found, were noticed in a range of only 3 days (23-25 May), probably because there was a swarming. Dermaptera and Apoidea were not found in House Sparrow nor Tree Sparrow diets (Seel 1966; Mirza 1972; Anderson 1984; Ivanov 1986). The presence of Apoidea in the diet of Italian Sparrow suggests that this species is able to remove the sting, as other species remove heads of insects (Dahlsten & Herman 1965). We found a low percentage of Diptera, that were instead found to be a dominant element in House Sparrow and Tree Sparrow diet (Seel 1966; Anderson 1984; Ivanov 1986). This non coincidence could be due to different methods of study and not necessarily to a diversity of diet, too.

In the faecal sacks fragments of shells of small Pulmonata were found; they could be important in the diet in order to bring calcium, since they were also found in the stomachs of some females of House

Table 4 - Diet of Italian Sparrow nestlings of different brood sizes. The first figures refer to absolute numbers of samples; the second ones (in brackets) to percentages of samples containing the item on the total number of samples of the same brood size group.

BROOD SIZE	2 NESTLINGS	3 NESTLINGS	4 NESTLINGS AND MORE
NUMBER OF SAMPLES	6	20	33
ANIMAL MATTER	6 (100)	20 (100)	33 (100)
of which:			
Pulmonata	2 (33)	1 (5)	11 (33)
Opiliones	3 (50)	10 (50)	23 (70)
Araneae	3 (50)	2 (10)	7 (21)
Orthoptera	3 (50)	3 (15)	3 (9)
of which: <i>Gryllotalpidae</i>	0 (0)	0 (0)	2 (6)
Dermaptera	0 (0)	1 (5)	7 (21)
Isoptera	0 (0)	3 (15)	0 (0)
Hemiptera	3 (50)	12 (60)	26 (79)
Neuroptera	0 (0)	0 (0)	1 (3)
Lepidoptera (larvae)	6 (100)	17 (85)	24 (73)
Diptera	0 (0)	0 (0)	1 (3)
Hymenoptera	2 (33)	3 (15)	20 (61)
of which: <i>Formicidae</i>	0 (0)	0 (0)	5 (15)
Coleoptera	6 (100)	17 (85)	29 (88)
of which: <i>Carabidae</i>	0 (0)	1 (5)	1 (3)
<i>Staphylinidae</i>	0 (0)	3 (15)	1 (3)
<i>Scarabaeidae</i>	0 (0)	1 (5)	1 (3)
<i>Cerambycidae</i>	0 (0)	1 (5)	0 (0)
<i>Curculionidae</i>	4 (67)	2 (10)	7 (21)
VEGETAL MATTER	3 (50)	13 (65)	20 (61)
of which:			
Seeds	3 (50)	6 (30)	12 (36)
Other plants	0 (0)	11 (55)	13 (39)
GRIT	6 (100)	11 (55)	24 (73)

Sparrow in the breeding season (Pinowska 1975). The same explanation can be due for grit, besides the fact that it could be important to facilitate trituration of food. Grit was also found in Spanish Sparrow diet in a region comparable for climate (Alonso 1985).

Diet diversity changes with age and reaches its maximum at about 8 days of age (Figure 1), when the nestlings have reached their maximum weight (Summers-Smith 1963), because at that time food demand is maximal, and adults are forced to increase the amount of food even by reducing time for selection and amplifying their feeding niche, as it was found also by Krebs *et al.* (1977) in Great Tit *Parus major*. Seed percentage was highest at about the tenth day, probably because nestlings became accustomed to feed what would be their main food in the future.

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Riassunto - L'alimentazione dei pulli di Passera d'Italia *Passer italiae* è stata studiata in un'area dell'Italia centrale attraverso l'analisi delle sacche fecali. Tutti i campioni contenevano Artropodi; erano anche abbondanti semi, frammenti di nicchi di Gasteropodi terrestri e piccoli sassolini. L'indice di diversità della dieta cambiava con l'età e raggiungeva il suo massimo intorno a 8 giorni di età; esso cresceva anche in rapporto al numero di pulli. È stata riscontrata un'alta predazione sia sulle uova che nei confronti dei nidiacei.

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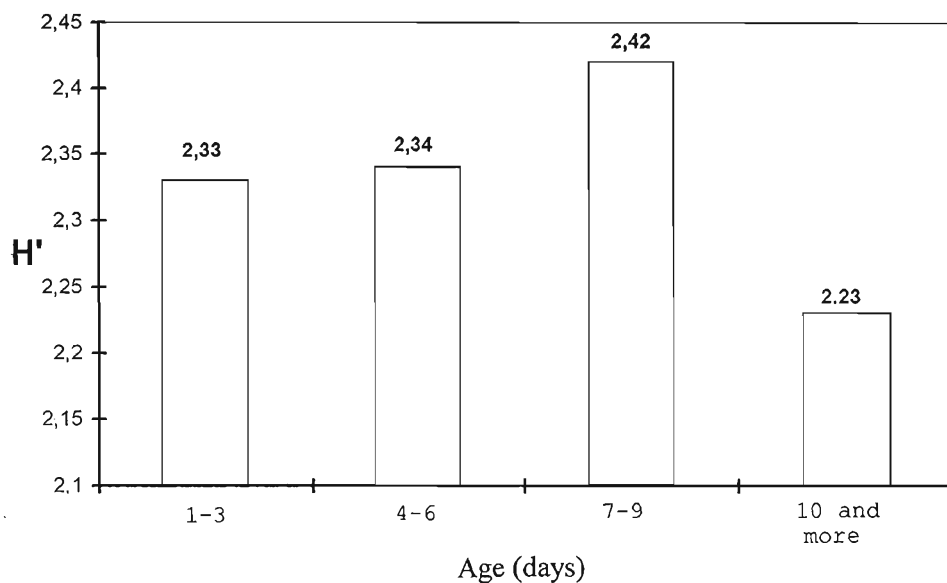


Figure 1. Diversity index (H') of the diet of Italian Sparrow nestlings of different ages (days).

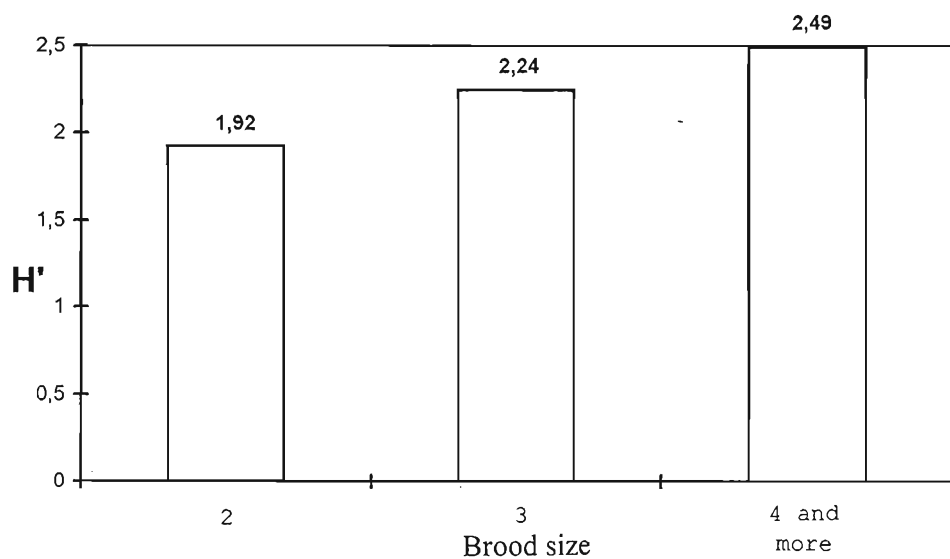


Figure 2. Diversity index (H') of the diet of Italian Sparrow nestlings of different brood sizes.

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Feeding success and relationships of some species of waterbirds in the «Valli di Comacchio» (Italy)

LUCA BIDDAI*

Dip. Biologia Animale, Università di Torino, Via Accademia Albertina 17, 10100 Torino - Italy

Abstract - The feeding success of Black-headed gull, Common tern and Little egret was studied in the "Valli di Comacchio" lagoon (northeastern Italy), both in presence and absence of intra and interspecific interactions. Sometimes gulls and terns feed on the same areas and on particular occasions aggregate with other waterbirds, but little is known about the feeding success and behavioural interactions among them. The aim of this work was to evaluate the interactions and the feeding success of gulls and terns foraging syntopically with Little egrets. The Little egret had a very high feeding success, but the intraspecific territorialism strongly reduced the time available to fish. The Common tern had difficulties to dive because of the presence of Black-headed gull swimming in the water. The gull was equally successful both in presence and absence of intra and interspecific competition. Then, the observed feeding rate were higher than data from literature; this let to suppose that the birds were attracted by a favourable food supply. I suggest that the observed species are independently attracted to a rich food source.

Introduction

The foraging behaviour of the Little egret *Egretta garzetta*, Black-headed gull *Larus ridibundus* and Common tern *Sterna hirundo* in the Eastern Italian wetlands has been described (Boldrighini *et al.*, 1988; Fasola *et al.*, 1989; Fasola and Bogliani, 1990). Usually their feeding niches don't overlap, because of the different habits of the three species. The Little egret forages along the shore or near the shingle banks, where the water level is low (height under the tarsus) and, sometimes, perched on rocks (Cramp and Simmons, 1983; Fasola, 1986). Usually the Common tern feeds at some distance from shore (Erwin, 1977; Fasola and Bogliani, 1984; Duffy, 1986). The Black-headed gull feeds also in open water, but usually in low current (Vernon, 1972; Gotmark, 1984). In the salted lagoons the gulls try to become more eclectic, visiting areas with shallow and medium-high water, often joining with Little egrets and Common terns (the association here described; Saino *et al.*, 1988).

Some quantitative analyses have been carried out to evaluate the feeding success (Dunn, 1973; Frugis, 1975; Fasola, 1993) and the interspecific behaviour of waterbirds in multi-species assemblages (Ashmole and Ashmole, 1967; Sealy, 1973; Hulsman, 1976; Schneider, 1982; Duffy, 1986; Fasola, 1994). Recently some authors focused their attention on the interactions between species over patches of prey, such as species' dominance interactions, mutualistic locating of prey

and kleptoparasitism (Hoffman *et al.*, 1981; Duffy, 1983, 1986). These local and temporary situations can force the birds to aggregate over shoals of prey, where success of foraging attempts were affected by group density. In fact, wading birds have been shown to join aggregations because of foraging benefits (Caldwell, 1981; Hafner *et al.*, 1982; Erwin *et al.*, 1985). These benefits accrue because of social facilitation or because aggregations tends to occur in the best feeding sites (Krebs, 1974; Cezilly *et al.*, 1990). Groups typically form where prey availability is high, defensibility is low and distribution of prey is patchily (Bell, 1991). Master *et al.* (1993) suggested as the major benefits gained by feeding participants in mixed-species may include increased feeding success and reduced energy expenditure. Particularly the authors stressed the importance of the benefits deriving from the position of a particular species within an aggregation, the foraging behaviours, the prey characteristics, the prey responses to disturbance by predators and habitat structure. Finally, few studies attempted to predict how a given species respond flexibly to the variability of foraging resources through space-time (Wiens and Rotenberry, 1979; Wheelwright, 1986; Becker *et al.*, 1987; Twedt *et al.*, 1991). Recently, Fasola (1994) investigated whether resource use concentrates opportunistically upon the locally available resources, is determined by the independent preferences of each consumer, or is constrained by competition among coexisting species. Particularly, in some species prey size has been found

as the main factor in segregating syntopic species of birds (Hespenheide, 1975; Reynolds and Meslow, 1984; Cooper *et al.*, 1990). On the occasion here described Common gulls, Common terns and Little egrets exploit the same trophic resource, because of the easy availability of the source of food and the favourable site. The present study reports the relationships among the three species and the feeding success rate in a gate of a fishing canal.

Methods

The study was carried out along a ditch of the Comacchio lagoon (RA, North-East Italy). The canal was used by some species of fish during the daily and seasonal migrations from lagoons to sea related to the reproductive seasons. It is already known that many species of fish, following a saline gradient, entered fresh-water for mating and migrate back to the sea with the fries. The presence of the gate made the density of fish so much that it represented an important food source for piscivorous birds. In the research period the crossing of sand-smelt *Atherina boyeri* and mullets *Mugil cephalus* was remarkable. The canal was composed by 24 small gates (less than 1 m wide), separated each other by two piers of cement. Each grid permitted the feeding on the water. The quantity of fish migrating in the canal was estimated by measuring the amount of fish (sand-smelt) present in the surface of the water facing every grid. Three categories were adopted:

- 1 - HIGH DENSITY GRIDS - HDG. The surface of the water was fully covered by fish (100%)
- 2 - MEDIUM DENSITY GRIDS - MDG. The covering ranged from 25 to 75%.
- 3 - LOW DENSITY GRIDS - LDG. The covering was less than 25%.

Data were collected from 15/6 to 5/7 1990 (presumably during the breeding season for most individuals), in different hours of the same day and on subsequent days. The observations were made from a

hide settled on one side of the canal, close to the gate (about 5 meters far from the water and 15 m from the centre of the gate). From this point I observed 225 birds (75 for each species), for standard observation periods of 5 min each. For each focal bird, position of the individual, intra and interspecific behaviour were recorded. All the aggressive interactions among foraging birds were recorded. The feeding success (number of preys captured per unit of time) was estimated by counting the number of fishes caught during each observation session. The number of preys were detected by using a 60X telescope and the feeding rate was evaluate in presence and absence of any kind of antagonistic displays, in order to detect the influence of the competition. A sample of 50 Common terns were also observed diving 20-50 m far from the gate, in order to quantify the feeding success in the open water of the canal (less abundance of prey). In order to uniform the data I included in the analysis only the birds seen foraging on sand-smelts.

Because of the large size and the maintenance of fixed position for long time, the existence of natural markers (such as size, legs and eyes color, presence or absence of breeding plumage, etc.) was occasionally useful to identify few egrets, particularly birds tending to take possession of fixed perch.

Results

Little egrets, Black-headed gulls and Common terns foraged together on a gate of the sluice, where the concentration of fish was highest; the density of sand-smelts was high and uniform close to the grid, decreasing from the middle of the canal to the external grids.

Intra and interspecific behaviour

While fishing the Little egret held a grid and all the grids were occupied. Some individuals keep "fixed" position. This was confirmed by observing the same bird reoccupying repeatedly the same grid during long observation sessions (1-4 hours). All the birds seen on the HDG and, secondarily, on the MDG showed a strong tendency to the territoriality, but it was never

Tab.1 a - Number of birds (as percentage) of the three species displaying aggressions between conspecifics and heterospecifics (combined).

b - Average number of preys captured (per minute) in presence or absence of aggressions. Values are given as mean \pm SD.

	Percentage of birds (a)		Prey capture rate (b)	
	Presence of DT	Absence of DT	Presence of DT	Absence of DT
<i>Little Egret</i>	69	31	7.78 \pm 3.31	2.14 \pm 0.98
<i>Black-headed Gull</i>	25	75	6.26 \pm 2.54	6.50 \pm 1.98
<i>Common Tern</i>	0	100		1.80 \pm 0.23

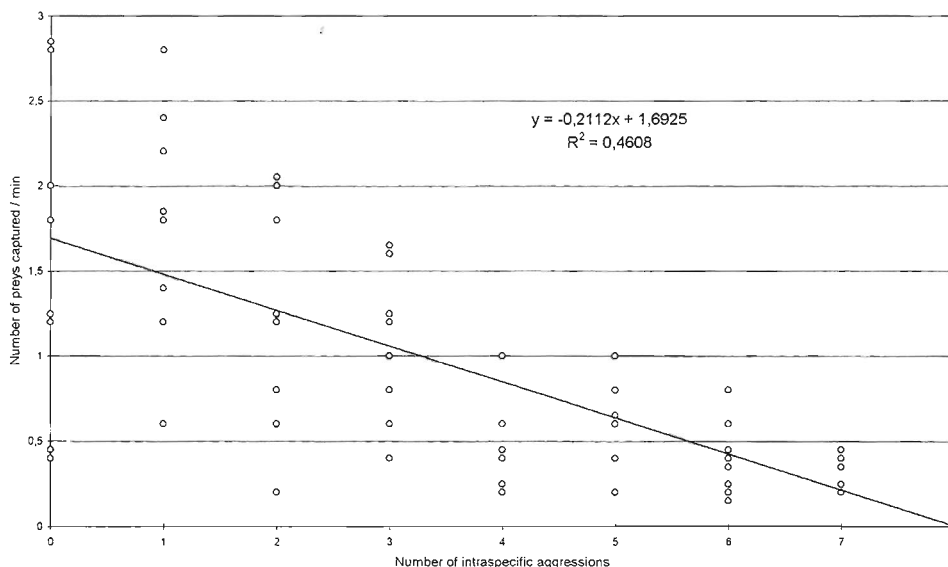


Fig. 1 - Aggression rate among conspecifics Little egrets (no. aggressions / standard observation session) in relation to average food intake. The average number of prey is related to unit of time (minute), while the number of aggressions is referred to the sample unit of observation (5').

observed in birds feeding in the external grids (LDG). The difference in mean number of antagonistic displays of the three situations was significant (ANOVA, $F_{2,52} = 5.44$, $P < 0.01$). The birds holding an HDG didn't tolerate the presence of conspecifics in the individual feeding territory (the grid and the touching water), neither their presence on the near foot-bridge. Newcomers often tried to hold fully or to a some extent a feeding position. Usually the newcomers were attacked and forced to leave the site. The only way to occupy the HDG was the arrival of a dominant bird.

The activity of territorial defence was shown by the 69% of the egrets and reduced the time available for feeding (see Tab. 1 a). The egrets showed 1-8 aggressive displays for sample of 5', capturing only 27.5% of prey if compared to birds not engaged in defense of feeding territory, and the difference was significant (Mann-Whitney U-test, $n=49$ and 20 , $U=63.9$, $P < 0.01$). The correlation between number of antagonistic displays and fishing success was also significant (ANOVA, $F_{8,50} = 6.71$, $P < 0.01$; see Fig. 1).

The Black-headed gull fed swimming and took the fishes just under the water surface. This technique caused to avoid the maintenance of a stable territory and, then, less time spent in territorial displays. The defense of a temporary feeding site took place through a short pursuit ending with the removal of the invader. The structures related to the grid made the gulls tame and they preferred to alternate the foraging with short escaping. However 25% of the birds feeding near the gate showed antagonistic displays. A maximum

number of 2 interactions for 5' were recorded. This activity was extremely fast and didn't lower the fishing success (Mann-Whitney U-test, $n=18$ and 52 , $U=55$, n.s.). None events of intraspecific kleptoparasitism has been documented. The gull (2 cases) showed a kleptoparasitic behaviour toward the egret, displaying a mobbing that induced the heron to leave the prey (a mullet about 20 cm long), suddenly caught by the gull. Then, the gull swimming in the water recovered the fishes caught and fallen from the egrets (usually 3-5 sand-smelts were captured together and only a part of them were ingested). The presence near the gate of the gulls didn't affect the feeding activity of the egrets, but reduced the water surface useful to dive to the Common tern.

The Common tern fed diving and so it couldn't catch prey too close to the gate. It didn't show any kind of territorial interactions and was limited only by the number of gulls swimming in the water. Few attempts of food-piracy were recorded, but all were unsuccessful.

Feeding success

The egrets captured an average of 7.78 ± 3.31 SD preys per minute if undisturbed and only 2.14 ± 0.98 in presence of DT, with a decrease of feeding rate success of 3.6 times (Mann-Whitney U-test, $U=299.5$, $P < 0.01$). Sometimes the egrets fed only upon a medium-size prey, with a feeding success of 1 ± 0.67 preys per minute. The number of DT affected the feeding success in a proportional dimension way, as showed in Tab. 2.

The gulls captured 6.26 ± 2.54 preys per minute in the first case and 6.5 ± 1.98 in the second one ($U=123.5$, n.s.). If compared with gull, the feeding technique of the egret resulted more effective of 19%, assuming that both species captured the same tipology of prey (as confirmed by observations).

The Common terns captured an average of 1.8 ± 0.23 preys per minute. The fishing success was 65.5% outside and 81% close to the grid, despite of the interspecific disturbance. The disturbance coming from the presence of the gulls prevented the tern from diving at the same extent as some meters out of the gate, where it had slightly more successful plunges ($U=344.5$, n.s.).

Discussion

Terns, gulls and egrets are scarcely influenced each other in the feeding site. Aggressions will be infrequent against heterospecifics; the aggressions occur frequently between conspecifics and are related to the intensity of competition for the individual feeding site.

The presence of the gulls swimming close to the gate reduce strongly the possibility of foraging of the Common terns. Anyway, the terns have a low feeding success also in open areas far from the gate. The availability of food didn't force the terns to food-piracy, and the data from literature underlined as this behaviour is related to birds fish-carrying to the colony. In this area, some authors (Canova and Fasola, 1993) suggested that the time spent in foraging trips is related to prey catching success. Because of the presence of closer colonies with chicks, many of the birds foraging in the canal were carrying food to the nest. The high availability and the absence of competition could confirm the hypothesis that the "following" behaviour by low success tern is totally unrelated to the feeding success of more efficient foragers.

The Common gulls appeared able to optimize foraging in the particular site described, gaining the best results. In fact, the rates of food intake in presence and absence of competition are comparable and showed as the time spent in antagonistic activities was scanty and little affected the foraging behaviour. Yet well described (Vernon, 1972), the clearest interspecific behaviour of the gull was the kleptoparasitism. It was performed only toward the Little egret when the egret captured a large size fish. In this case the risk of a wound by a strong reaction of the egret appears rewarded by the energy input; when the egret is feeding on small preys, seems easy and suitable to collect the fishes fallen from the beak.

The Little egrets foraging in the most favourable

position (central grids of the canal) have to engage in aggressive interactions toward conspecifics, in order to maintain the feeding territory. Assuming that the defense of territory was performed only by some "dominant" birds placed on the central grids, the foraging close to the territory of the "dominant" seemed to be advantageous. In this case the shorter time spent in territorial displays permits to capture more preys, notwithstanding of the marginal grids. During foraging, the egrets are known to be the most aggressive species among herons. The number of aggressions between conspecifics herons occurred at low rate (one case every 15 hours of exposition to another foraging Little egrets) and a peak has been described for the interactions with Night herons, that was attacked once every 3 hours (Fasola, 1994). In coastal lagoons of Camargue (Watmough, 1978), a rate of 5.9 attacks/h toward Night heron appeared still low if compared with the present data of egrets exploiting the most favourable position of the canal.

Both gulls and terns captured a large amount of preys per unit of time. The values for the gulls were higher than the 1.6 ± 1.0 for adults and 0.8 ± 0.05 preys/minute for Juveniles known for the species in close similar environments, such as coastal lagoons on the Po delta (Frugis, 1975). Data from literature showed a low feeding success rate for terns also, ranging from 0.12 at neap tides up to 0.66 preys/minute in rising spring tides in estuary area (Taylor, 1983); in open sea 0.23 to 0.5 preys item per min (Dunn, 1973); overall rate proposed by Erwin (1977) 0.34 prey item per min; 0.2-0.3 prey captured per min in Atlantic sea (Safina and Burger, 1989). Also the fishing success is higher than the data reported elsewhere (22 to 39%, Dunn, 1973; 54,7% Cramp and Simmons, 1983). In similar environmental tipologies (middle Po river) a predator efficiency of 50.3% was reported by Boldregghini *et al.* (1988), and confirmed previous data (Bogliani, unpublished data). Egrets also are known to feed mainly on saltwater fishes in the Po delta (Fasola *et al.*, 1993), with particular regarding to small prey items (Fasola *et al.*, 1981; Fasola, 1994). In the Lagoon of Comacchio the egrets fed mainly on fish, and has been described how most of their food intake comes from only one or two prey categories (Fasola *et al.*, 1993). The relation between seasonal abundance of prey and the food exploited has been highlighted by the same authors.

The comparison of the fishing success in different foraging sites could be misleading of the energetic input because of the diversity of preys on which the birds fed upon. However, studies on the diet of the related species Little tern *Sterna albifrons* in the same area (Bogliani *et al.*, 1992) confirmed as the sand-smelt is largely the main preys caught in the "Valli di

Comacchio" lagoon, both in number of prey items and biomass. Fasola and Bogliani (1990) discussed the relative length of preys captured and these results are well in accordance with the present observations. Boldregghini *et al.* (1988), by investigating comparatively the feeding habits of Little and Common terns in the Lagoon of Comacchio, suggested that sand-smelts are only a minor fraction of the whole preys carried to the chicks by Common terns nesting and that other fishes with similar low weight/length ratio are preferred. This confirmed the occasional exploitation of an exceptional food supply described in the feeding site. To date, the lack of information on the difference in the diet of adults and chicks and the absence of knowledge on the digestibility rate of different fishes, are strong limitations when attempting to undertake comparisons. The general picture of the particular situation here described suggests that the three species are optimal and opportunistic foragers, despite of the numerically high interspecific aggregation.

I believe that the birds were forced to forage in the site because of the high food supply, also considering the concentration close to the grid. Indeed, Fasola *et al.* (1993) by evaluating the diet of Little egret and other herons in Northern Italy, underlined as prey types varied markedly in frequency throughout the season, with patterns that presumably reflect the seasonal availability of different prey types. These consumers appeared adaptable, and would suffer little pressure from both intra-species and inter-species competition (Morse, 1971). This is well in accordance with the hypothesis that the segregation observed within animal assemblages is related to non-interactive resource use, and not dependent by competitive pressures (Connell, 1980; Wiens, 1989). In fact competition is considered to be more pronounced in predators, large-sized animals and in freshwater habitats (Schoener, 1974, 1983; Connell, 1983; Gurevitch *et al.*, 1992). Evidences of benefits of foraging in mixed-species seem to be contrasting. Some species of american herons exhibited a significant increase in capture rate and efficiency, while others do not (Master *et al.*, 1993). The Little egrets improved their foraging success in southern France (Hafner *et al.*, 1982; Cezilly *et al.*, 1990). and the importance of prey uniformity was noted. On the same species Erwin *et al.* (1985) found a different pattern, suggesting a reduced capture efficiency in larger flocks.

In conclusion, the wide overlap in species composition suggests that waders foraging aggregations have not coevolved to collaborate in more efficiently exploiting prey, but that species are independently attracted to rich food sources. Differences in flock size and composition over different types of prey may arise because species' differences in foraging ability make

exploitation of some situations more profitable than others for each species.

A direction for future research in the same area could be to investigate the fishing efficiency in different conditions of species aggregations and prey density.

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Short communications

Passerine birds preyed by the four-lined snake *Elaphe quatuorlineata*: some remarks on the predatory tactic and the relevance of avian prey for reproductive female snakes

FRANCESCO M. ANGELICI*, ERNESTO FILIPPI**, LUCA LUISELLI**

* Dipartimento di Biologia Animale e dell'Uomo, Università di Roma «La Sapienza», viale dell'Università 32, I-00185 Roma, Italia.

** Dipartimento di Biologia Animale e dell'Uomo, Università di Roma «La Sapienza», via A. Borelli 50, I-00161 Roma, Italia.

Birds are occasional prey of several snakes in the Italian peninsula, including both viperids and colubrids (Angelici *et al.*, 1994). Recent studies also demonstrated that ornithophagy and arboreal habits by snakes are not correlated, that means that birds and their eggs are dietary components not more important for arboreal than for terrestrial snakes (Shine, 1983; Luiselli & Rugiero, 1993). Birds are occasionally preyed not only by semi-arboreal snakes but also by strictly terrestrial snakes, such as *Natrix natrix* (Luiselli *et al.*, 1996a), *Vipera ammodytes* (Luiselli, 1996), and *V. aspis* (Luiselli & Agrimi, 1991).

Among the palearctic snakes, the four-lined snake *Elaphe quatuorlineata* is the principal predator of birds: in fact, depending on the population, from about 15% to about 80% of the whole spectrum of prey of this snake is constituted by birds and their eggs (e.g. see Capizzi *et al.*, 1995).

During a long-term ecological research on snake ecology in a hilly territory of central Italy (Mounts of Tolfa, Latium, central Italy), we made a series of field observations on bird-eating by four-lined snakes and on the relevance of avian prey for the reproductive female snakes. In this paper we present the data on this issue. Data given here were collected between spring 1991 and autumn 1995 in Rota, a ruderal locality of the Mounts of Tolfa (about 150 m a.s.l., 42°08'N, 12°00'E), characterized by Mediterranean-temperate climate with cold winters (normally without snow covering) and hot and dry summers. The data were collected during the course of a thesis research by one of the authors (Filippi, 1995).

Food items were obtained from living snakes: the animals were captured by hand, and squeezed in the abdomen to obtain any ingested remain (see Luiselli & Agrimi, 1991, for the methods employed). The total number of animals examined in relation to month of

capture is given in Table 1. The given number is cumulative of both individuals captured once and individuals captured multiply. The various animals examined were individually recognized because they were permanently marked by «ventral scale-clipping» throughout the study period (Luiselli *et al.*, 1996; Filippi *et al.*, 1996). The reproductive status of the females was determined by the mass-length ratio.

The statistical analyses were done with a STATISTICA (version 4.5, per Windows) microcomputer package, all tests being two tailed and with α set at 5%. Passerine birds (genera *Sylvia*, *Passer*, *Serinus*, *Carduelis*) constituted one of the main prey type of the four-lined snakes in the Mounts of Tolfa (for a list of the species preyed see Capizzi and Luiselli, 1996). Birds were preyed significantly more often (i) in springtime (April to June) than in the rest of the year also taking into account the different samples of animals examined in the various months (χ^2 test, $df = 1$, (April-June versus July-October), $p < 0.001$;

Table 1 - Numbers of snakes examined (NS), and numbers of birds found in snake stomachs (NB), in relation to season and sampling effort (SE, i.e. number of days per month spent in the field between spring 1991 and autumn 1995). The months of November, December, January, February and March are excluded because snakes do not feed in these periods. For more details, see text.

Month	NS	NB	SE
April	32	3	32
May	34	18	44
June	33	7	40
July	32	1	24
August	0	0	24
September	32	1	20
October	42	2	14

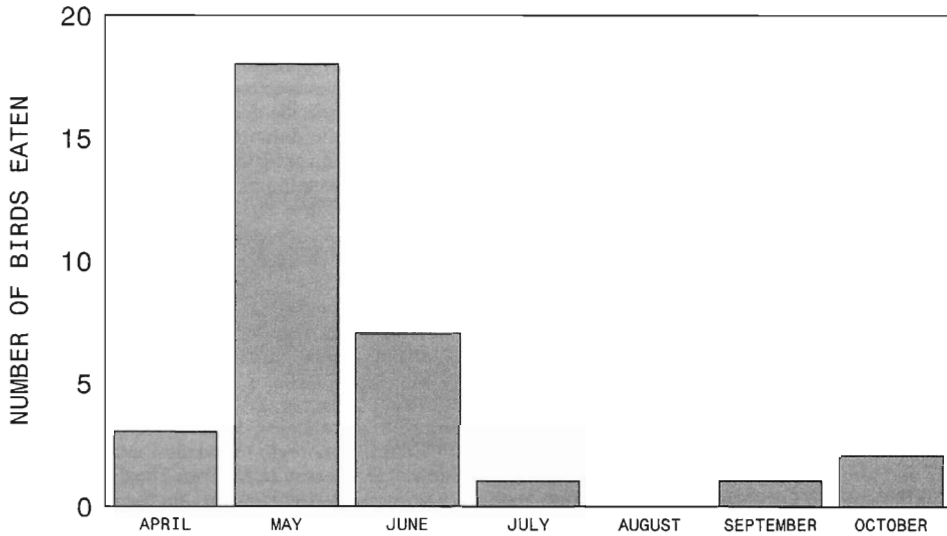


Figure 1. Numbers of birds eaten by snakes in relation to month. Note that in April-June the snakes fed upon birds more often than in the rest of the year. This difference is statistically significant (see text for more details).

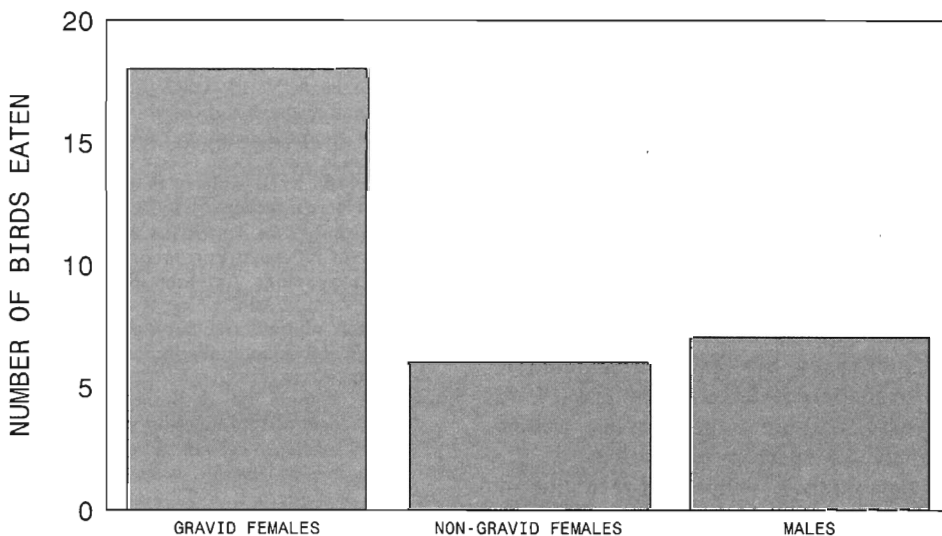


Figure 2. Numbers of birds eaten by *Elaphe quatuorlineata* gravid females, males and non-gravid females in the territory of the Mounts of Tolfa. The difference between gravid females and the other two categories of individuals is statistically significant (see text for more details).

see Table 1 and Figure 1), and (ii) by gravid females than by males or non-gravid females (χ^2 test with $df = 1$, $p < 0.001$ in all pairwise comparisons, see Figure 2). Point (i) could be explained by considering that the nesting period of most passerine birds in the study area occurs during the spring months, when the snakes could be able to easily found the nests other than the adults. Point (ii) could be explained by considering that the gravid female snakes are very stationary during pregnancy (Filippi *et al.*, 1996), and thus, for

reconstructing their fat reserves necessary for reproduction to take place, they need to feed on «easily catchable» prey, as passerine birds probably are (e.g. see Shine, 1983).

We observed a case of ambush predation by a four-lined snake upon a male Tree sparrow *Passer montanus* at 14:33 h of June, 28, 1995. The finding was made along the banks of the stream «Fosso Verginese», when this site was surveyed for snakes. We encountered a gravid female snake (total length:

146.5 cm; weight: 881 g) motionless at the borders of a pond (about 2 x 1 m surface), where two Tree sparrows were wetting. The snake attacked one of the sparrows after hambushing for about 3 minutes, and then swallowed its prey without suffocation.

This latter behaviour is quite atypical, as the four-lined snake is known to suffocate its prey before swallowing (Bruno & Maugeri, 1990). It is possible that this peculiar behaviour might depend on the small size of the sparrow. Our unpublished observations on captive *Elaphe* snakes suggest that these snakes always suffocate large prey (e.g. *Rattus norvegicus*) but usually swallow the prey still alive when it is small sized (e.g. *Apodemus sylvaticus*).

Can we hypothesize that four-lined snakes usually wait for «wetting» birds staying in hambush at the borders of small ponds? Our data on this issue are obviously too scarce for stressing firm conclusions. However, we should notice that gravid and moulting four-lined snakes may spend several hours in water of ponds and streams during the hottest daylight hours (Filippi *et al.*, 1996), and thus is arguable that they can encounter avian prey during these phases.

The data given at above indicates that four-lined snakes are potential threat for passerine bird populations, especially in springtime when sparrows (genus *Passer*) nest. In this regard, it has been demonstrated that mortality rates of adults tend to increase during the breeding season (April to August) from about 2-3% per month to about 5% per month for reasons independent on predation (Summers-Smith, 1988). If we consider that (i) snakes are low-energy predators which feed at very irregular time intervals (Luiselli & Agrimi, 1991) and that (ii) four-lined snakes are characterized by very low population densities even in favourable habitats (Filippi, 1995; Rugiero & Luiselli, 1996), we suggest that they cannot be serious threats for sparrow populations at all, although more data on the percentage of predation in relation to bird population size and number of nests in the snake «familiar area» are required before firm conclusions can be stressed.

Acknowledgements - We thank Brenda Bolton, Paola Enrico, Fatima Evangelisti, and Matthew Fforde for helpful field-work and discussion on the predation of snakes upon birds.

Riassunto - In un'area dell'Italia centrale (monti della Tolfa, Lazio) sono stati raccolti alcuni dati sulla predazione del cervone *Elaphe quatuorlineata* su uccelli Passeriformi. Viene descritto un inconsueto comportamento predatorio da parte di una femmina gravida di cervone su un passero mattugio *Passer montanus* adulto durante il bagno. Viene dimostrato che gran parte degli eventi predatori del cervone a carico dei Passeriformi si verifica durante i mesi primaverili, e che sono soprattutto le femmine gravide a condurre attività predatoria a carico degli uccelli.

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Shell size relationships in the consumption of gastropods by migrant Song Thrushes *Turdus philomelos*

GONZÁLEZ-SOLÍS¹, J., ABELLA, J. C.² and AYMÍ, R.³

¹Dept. de Biologia Animal (Vertebrats), Univ. de Barcelona, Av. Diagonal 645, Barcelona - 08028, Spain.

Tel: (34-3) 402 14 56. Fax: (34-3) 411 08 87. E-mail: jacob@porthos.bio.ub.es

²Dept. de Biologia Animal (Vertebrats), Univ. de Barcelona, Av. Diagonal 645, Barcelona - 08028, Spain.

Tel: (34-3) 402 14 56. Fax: (34-3) 411 08 87.

³Grup Català d'Anellament, Museu de Zoologia. Ap. 593. Barcelona - 08080, Spain.

Tel: (34-3) 319 69 12. Fax: (34-3) 310 49 99.

It is well known that gastropods constitute one of the most important food resources for some thrushes (Simms 1978). This is particularly true for the Song Thrush *Turdus philomelos*, which uses "anvils" to break open the shells of medium-sized or large gastropods, that otherwise cannot be completely swallowed (Morris 1954, Herring 1984, Henty 1986). Previous studies of the species of gastropods preyed on by Song Thrushes have been carried out using the shells collected at the anvils (Goodhart 1958, Cameron 1969, Fraticelli 1982, Sueur 1985, Hartley 1987). However, this method gives biased information, as pointed out by Sueur (1985) and Hartley (1987), since it fails to take into account either the small-sized species or the juvenile forms of larger species which can be completely ingested. Moreover, some studies on the diet of this species consider the item "gastropods" without reference to size or consider only adult forms (Davies and Snow 1965, Dyrce 1969, Tejero *et al.* 1984, Debussche and Isenmann 1985).

We describe gastropod size and species consumed by Song thrushes in Spain during the autumn migration on the basis of stomach contents.

We analyzed the contents of 155 stomach collected from Song Thrushes shot by hunters. For the analysis procedures see González-Solís and Ruiz (1990).

Samples came from three different sources: (1) Mallorca (Balearic Islands) c. 39.35N 2.39E (n=55); (2) Montsià (Tarragona, NE Spain) c. 40.43N 0.34E (n=45); and (3) Ribera d'Ebre (Tarragona, NE Spain) 41.17N 00.40E (n=55). Birds from samples 1 and 2 were caught in October 1986, and those from sample 3 in October 1989. At this time Song Thrushes are migrating through the Mediterranean area (Santos 1982). We determined the gastropod species and

measured the high of the shell when the gastropod was whole. We also determined the number of gastropods present in each stomach based on the number of whole individuals. Small fragments of shell that were impossible to determine were considered "undetermined" and quantified as one gastropod. The consumption of gastropods by Song Thrushes was calculated as the corresponding percentage of occurrence in respect to the total number of stomachs; abundance was estimated as the percentage over the total number of prey.

Fifteen snail species were identified (Table 1).

Table 1. Frequency percentatges of gastropod species found in 92 stomachs of Song Thrush for each area. * Approximate size of an adult individual, according to Bech (1990).

	Mallor. (n=68)	Mont. (n=51)	R. Ebre (n=20)	size* (mm)
<i>Theba pisana</i>	11.8	54.9	0.0	14-20
<i>Cochlicella acuta</i>	8.3	0.0	0.0	10-15
<i>Cochlicella ventricosa</i>	11.8	0.0	0.0	8-12
<i>Xeroplexa sp.</i>	2.9	0.0	15.0	3-6
<i>Xerotricha apicina</i>	22.0	0.0	5.0	3.5-5
<i>Clausilia bidentata</i>	1.5	0.0	0.0	13
<i>Trochoidea elegans</i>	1.5	0.0	0.0	6-8
<i>Helix aspersa</i>	0.0	3.9	0.0	14-20
<i>Ferussacia folliculus</i>	0.0	3.9	5.0	8-9
<i>Abida sp.</i>	0.0	2.0	0.0	6-10
<i>Granopupa granum</i>	0.0	2.0	0.0	3-5
<i>Pomatias elegans</i>	0.0	0.0	5.0	10-17
<i>Monacha carthusiana</i>	0.0	0.0	10.0	6-9
<i>Vallonia sp.</i>	0.0	0.0	5.0	1.2
<i>Trochoidea (Xerocrassa) murcica grata</i>	0.0	0.0	10.0	4-5.5
<i>Undetermined</i>	39.7	33.3	45.0	

Gastropods showed a variable percentage of occurrence between 31-51%, with abundances between 15-38% (Table 2). Birds collected in Mallorca consumed primarily three species: *Xerotracha apicina*, *Cochlicella ventricosa* and *Theba pisana*. In Montsià, birds fed mainly on *Theba pisana*, whereas those from Ribera d'Ebre preyed upon *Xeroplexa* spp., *Monacha carthusiana* and *Trochoidea murcica*. The shell size of these gastropods was in all cases less than 1 cm. No gastropods without shells were recorded.

Table 2. Sample size, total number of gastropods, percentage presence (% P) and percentage abundance (% N) of gastropods found in the stomachs.

Origin	N stomachs	N gastropods	% P	% N
Montsià	45	51	51.16	38.34
Mallorca	55	68	61.81	20.24
Ribera d'Ebre	55	20	30.91	15.27

In the case of *T. pisana* and *H. aspersa*, the individuals recorded were juvenile forms. The remaining individuals were adults from species that do not reach more than 1cm in width or depth. These species have not previously been reported in the Song Thrush's diet (Table 1).

Several researchers have stated that gastropods smaller than 1cm are swallowed whole (Goodhart 1958, Tejero *et al.* 1984, Debussche and Isenmann 1985), which agrees with our results. Larger individuals are consumed without the shells, after being broken on anvils. When analyzing stomachs contents, varying digestibility can produce a bias in favour of the detectability of the small gastropods. However, the presence of other soft-bodied prey in the stomach does not justify the total absence of snails without shells.

The consumption of small snails seems primarily related to their availability. The passage of Song Thrushes through NE Iberia and the Balearics in autumn coincides with an abundance of invertebrates because of the rainfall and mild weather after the summer drought (see e.g. Santos 1982), and also with the abundance of juvenile forms of several gastropod species (per. obs.). Thus, in the Mediterranean area, gastropods are present in the diet of the Song Thrush both during migration and wintering (Fratelli 1982, Tejero *et al.* 1984, Debussche and Isenmann 1985, González-Solís and Ruiz 1991).

It is commonly assumed that avian diet analysis provides merely an approximation of the actual food ingested (Rosenberger and Cooper 1990). In the case of the gastropods, Song Thrush prey on

them throughout the year using anvils for larger individuals or swallowing the smaller ones whole. However, the analysis of stomach contents from autumn (present study) and winter (Tejero *et al.* 1984, Debussche and Isenmann 1985) suggests that small gastropods are a common resource, widely used by Song Thrush, though this is not the case of the larger gastropods as is suggested from the study of anvils. It is difficult to determine whether birds select a fixed sized gastropod. Further studies are required to find out if the costs of handling snails on anvils in terms of time invested or risk of predation are compensated by their larger contents or if this behaviour is restricted to specialized individuals.

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Resumen - Los gasterópodos constituyen uno de los principales recursos tróficos del Zorzal común *Turdus philomelos*. Anteriores estudios sobre las especies de gasterópodos consumidas por el Zorzal común se han basado en las conchas recolectadas en "anvils", donde los zorzales rompen las conchas de los gasterópodos de tallas superiores a 1cm, para obtener su contenido. Sin embargo, este método está claramente sesgado, puesto que no registra los gasterópodos de pequeña talla que son ingeridos enteros. En este trabajo se describen las tallas y especies de gasterópodos consumidos por el Zorzal, durante su paso otoñal por España, en base al análisis del contenido de 155 estómagos, provenientes de tres localidades de Catalunya. Se identificaron 15 especies distintas de gasterópodos. El porcentaje de presencia varió entre 31-51% mientras que el de frecuencia varió entre 15-38%, según la localidad. No se halló ningún gasterópodo desprovisto de concha, a pesar de que se hallaron otras presas blandas como larvas de insecto. Todos los gasterópodos fueron deglutidos enteros y la talla de la concha, usualmente entera, fue menor a 1cm en todos los casos. El consumo de pequeños gasterópodos parece estar primordialmente relacionado con la disponibilidad de las distintas especies en cada localidad. El análisis de los contenidos estomacales sugiere que los gasterópodos de pequeña talla son un recurso habitual para el Zorzal común. Asimismo, el consumo de gasterópodos de tallas superiores a 1 cm no parece estar muy extendido, en contra de lo que pueden sugerir los estudios basados en "anvils".

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Birds in the diet of the Barn Owl (*Tyto alba*) in an agricultural habitat of northern Italy

FRANCA GUIDALI* and GIORGIO PIGOZZI°

*Dipartimento di Biologia, Sezione di Ecologia, Università di Milano, Via Celoria 26, 20133 Milano

°Dipartimento di Biologia, Sezione di Zoologia - SN, Università di Milano, Via Celoria 26, 20133 Milano

Few data are available on the diet of Barn Owls (*Tyto alba*) in northern Italy (Groppali 1987, Boldregghini *et al.* 1988, Vicini and Malaguzzi 1988, Bon *et al.* 1992) and, more importantly, avian prey has been poorly documented in the Italian ornithological literature. Most papers usually list birds as unidentified (e.g. Bon *et al.* 1992), possibly as a result of identification problems due to the osteologic homogeneity of birds (Noriega *et al.* 1993). In addition avian prey may be decapitated (Glue 1967) and the fragility of the skull adds further problems to the identification of smaller birds, particularly insect-eaters (Glue 1972). We describe a case of ornithophagy from an agricultural area in the Po Valley in northern Italy.

The study area was located near the village of Casalmoro (Mantova) (45° 15' 10" N, 10° 25' 40" E). Cultivated fields, mainly of maize and sunflowers (40%), wheat (5%), vegetables and fodder (35%), made up approximately 80% of the land surveyed in search of Barn Owl roosting and perching sites. The remaining land consisted of woody areas (2%), grazing fields (6%) and abandoned fields, roads and buildings (8%).

During October 1991, we collected complete undatable pellets (i.e. no fragments, no broken ends, no splitting or loosening of pellets) in seven sites (four abandoned silos and three haylofts) where we observed Barn Owls on several occasions. We identified and quantified remains of birds on the basis of skulls and osteologic characters that present a marked variability among different species of Passeriformes, following the indications given by Moreno (1985, 1986, 1987). Mammal remains were identified on the basis of skulls or dentaries characteristics. Avian bones of diagnostic interest were measured to the nearest mm using a dial calliper. All remains were identified to the finest possible taxonomic category.

Biomass estimates were derived from the Italian ornithological and theriological literature (see Di Palma and Massa 1981). We determined the biomass contribution of each prey category to the owl's diet by multiplying the number of individuals in the pellets by the body mass of that prey. In the case of unidentified prey, we assumed that the biomass was similar to the mean value of the most closely related identified taxon. The 207 pellets analysed yielded 681 prey items (Table 1), of which rodents and insectivores were the most frequent.

Table 1. Barn Owl prey derived from pellets (N = 207) collected in the Po Valley, northern Italy.

Prey	Number Biomass		
	N	(%)	(%)
Mammals	605	88.8	84.0
Rodents	346	50.8	70.7
Insectivores	259	38.0	13.3
Birds	69	10.2	15.4
<i>Passer domesticus</i>	45	6.6	10.0
<i>Passer montanus</i>	3	0.4	0.6
<i>Passer</i> spp.	9	1.3	2.0
<i>Carduelis carduelis</i>	1	0.2	0.2
<i>Turdus philomelos</i>	1	0.2	0.3
Unidentified Passeriformes	10	1.5	2.3
Amphibians	4	0.6	0.6
Insects	3	0.4	0.0
Total Prey	681	100.0	100.0

Sixty-nine (10.2%) of the preys were birds. Apart from the unidentified small Passeriformes (belonging

to a weight class < 60 g), the most common preys were House Sparrow (*Passer domesticus*) and Tree Sparrow (*Passer montanus*); the former species accounted for 6.3% and 9.6% of the vertebrate prey by number and biomass, respectively, while the latter accounted for 0.2% and 0.2% of the vertebrate prey by number and biomass respectively.

The occurrence of bird remains proved similar among six of the seven sites, with values comprised between 2% and 16% (by number). The only exception was an abandoned silo (E) where birds occurred in 92% of the 24 collected pellets (Table 2) and made up approximately 67% and 82% of total prey by number and biomass, respectively. Pellets collected at silo (E) contained approximately half (49.3%) of the total number of avian remains found in this study. Sparrows (*Passer* spp.) made minor contributions (< 16%) to the total number of prey recovered in the other abandoned silos.

Table 2. Occurrence of avian remains in Barn Owl (*Tyto alba*) pellets collected in four silos (A, D, E, F) and three haylofts (B, C, G) in the Po valley, northern Italy.

	Number of pellets	Number of prey	Number of birds	Birds (%)
Silo (A)	62	227	4	1.8
Silo (D)	21	77	12	15.6
Silo (E)	24	51	34	66.7
Hayloft (B)	15	61	3	4.9
Hayloft (C)	21	75	7	9.3
Hayloft (G)	13	32	3	9.4

A large proportion of pellets (79.7%) contained the remains of a single bird; however, we also found the simultaneous occurrence of two (14.5%) and even three birds (5.8%) in a pellet. The smallest number of prey per pellet (2.12) was recorded in the sample where most avian remains were found (silo E), while the highest value (4.07) occurred in a small pellet sample collected at a hayloft (B). This is not surprising as it seems reasonable to expect a smaller number of prey in those pellets that already contain the bulky skulls and bones of a bird (Table 2).

However, the expected negative correlation between the occurrence of avian remains and number of prey per pellet was not significant ($r_s = -0.40$, $N = 7$, $P > 0.05$). The possibility that small sample sizes may affect this relationship should be taken into account when interpreting this result.

On no occasion did we find any bird species nesting

inside the abandoned silos or the haylofts. However, the abandoned silo (E) was located approximately 50 m from an old inhabited building where House Sparrows and Swallows (*Hirundo rustica*) used to nest and occurred in large numbers during the summer period. On the contrary, the availability of trees and indirectly of Tree Sparrow nests, is rather scarce within the study area, which may partly explain the low predation of this bird by Barn Owls. No remains of Swallows were found in the pellet sample collected at the abandoned silo (E) and we suspect that this prey may be too difficult to catch. No studies in Italy (see Contoli, 1988), have documented a proportion of birds in the diet of barn owls as large as that reported at silo (E).

However, Schmidt (1972) found that House Sparrows made up 93% of the avian prey by number in Barn Owl pellets from Hungary; Tree Sparrows made a minor contribution (5%) to the total number of avian prey, while the occurrence of other bird species was negligible. More recently, Jentzsch (1988) reported that House Sparrows made up 87.3% and 88.1% of avian prey by number and biomass, respectively. Other studies have also shown cases of high ornithophagy, although these are an exception to the general mammalian-based diet (Herrera 1974, De Bruijn 1979, Libois *et al.* 1983, Hardy 1989).

Finally, anecdotal observations suggest that individual Barn Owls may be highly successful in catching House Sparrow (Sage 1962) and Starlings (Fernandez Cruz and Garcia Rodriguez 1971) available in large numbers near their roost sites.

Lacking information on the spatial and temporal availability of small rodents, we cannot evaluate at present whether the high incidence of Sparrows (primarily *Passer domesticus*) resulted from a decline in rodent populations or was simply a dietary response to a temporary concentration and abundance of communal - roosting birds or to climatic conditions (see Brosset 1956, Sage 1962, Fernandez Cruz and Garcia Rodriguez 1971, Bayle 1979, De Bruijn 1979). A further alternative is that ornithophagy might reflect significant differences in predatory behaviour by individual Barn Owls which consistently exploit selected bird species either seasonally (Jentzsch 1988) or throughout the year (Vargas *et al.* 1982). Further investigations on pellets, collected at monthly intervals at silo (E) as well as at other Barn Owl roosting sites, may help to explain the occurrence and importance of ornithophagy in the feeding ecology of a predator which relies primarily upon small mammals (Bunn *et al.* 1982, Marti 1988).

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Riassunto - In un campione di 207 borre di barbagianni (*Tyto alba*), raccolte in una zona agricola della Pianura Padana, sono stati rilevati resti di 69 Passeriformi, appartenenti principalmente a passerii (*Passer domesticus* (62.3%), *Passer montanus* (4.4%) and *Passer* spp. (13%)). Gli uccelli costituiscono il 10% della dieta in termini di frequenza numerica ed il 15% in termini di biomassa. La maggior parte dei resti di uccelli è stata raccolta in un silo abbandonato dove costituivano la componente principale della dieta sia in termini di frequenza numerica (67%) che di biomassa (82%).

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Great Reed Warblers *Acrocephalus arundinaceus arundinaceus*
performing complete remex moult before post-breeding migration

ARIELE MAGNANI * and LORENZO SERRA **

* Via Repubblica 101, 47046 Misano Adriatico RN

** Via P. S. Tosi 9, 47037 Rimini RN

The European populations of the Great Reed Warbler *Acrocephalus arundinaceus arundinaceus* perform a moult strategy which generally involves, both for adult and first-year birds, a partial summer moult on the breeding grounds, a complete moult in the wintering areas and a partial pre-breeding moult in late winter, prior to spring migration (Cramp 1992, Svensson 1992). Nevertheless, the beginning, suspension and completing of primary moult have already been reported for a minority of adults (Martinez 1984, Olioso and Pambour 1989, Sultana and Gauci 1976, Spina 1990) and, more recently, first-year birds (King 1994) trapped in southern Europe. Despite the rather high frequency and wide distribution of such observations, the origin of these birds was never ascertained, although an eastern origin for the major part of the birds trapped on passage in western Europe has been supposed (Martinez 1984, Olioso and Pambour 1989). In eight years of ringing activity (1988-1995) carried out at some small wetlands scattered close to the southern edge of the Po Plain, Italy, we trapped a total of 20 adult Great Reed Warblers (August 17 inds, September 1 and October 2). Such small figures reflect a low density of breeding pairs as well as a scarce presence of migrants, because trapping effort

was rather high during the study period, with a total of more than 16,000 birds ringed in reedbeds between August and October. Great Reed Warblers were aged according to iris and mouth colours and state of plumage. Only the two birds trapped in October were in active primary moult and near to complete it (Tab. 1). The first individual (A) was caught at an inland pond (La Badia PS, 43° 48'N, 12° 39'E) on 14.10.1989 and showed a body mass of 30.5 g and very low subcutaneous fat deposits, score 2 according to Busse (1970). The second one (B) was caught three times at the same river mouth (Foce Conca RN, 43° 58'N, 12° 43'E): the first time on 20.08.1993, it had a body mass of 40.5 g, fat score 5, a regressing brood patch and no active or suspended moult; the second one on 14.10.1994, it had a body mass of 33.5 g, fat score 2 and active remex moult; the third one on 6.09.1995, it had a body mass of 50.0 g, fat score 5 and the two innermost primaries renewed on the left wing only. Body mass and fat score of the individuals moulting in October were far from pre-migratory values, neither seemed to resemble those of freshly landed birds. Considering the migratory strategy of this species, featured by long-stage flights and rather rapid stop-overs (Cramp 1992), we suppose we dealt with

Table 1. Flight feather moult scores of two adult Great Reed Warblers caught in north-eastern Italy. Primaries numbered descendantly, secondaries ascendantly and rectrices centrifugally (cf. Ginn and Melville 1983).

Ind.	Date	Secondaries										Primaries										Rectrices					
		9	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	
A	14.10.89	l.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	5	
		r.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	
B	14.10.94	l.	4	5	5	1	1	1	3	4	5	5	5	5	5	5	3	2	2	0	4	4	4	4	4	4	
		r.	5	5	5	0	1	1	2	4	5	5	5	5	5	4	4	3	3	0	4	4	4	4	4	4	

locally breeding birds prior to migration. Moreover, the high intensity rate of primary moult in the individual B in October (3-4 primaries simultaneously growing) could, in this case, exclude any hypothesis of active moult during migration, as suggested by King (1994), because of the reduced flight capability and high energetic requirements of moult. Further reasons for considering at least individual B as a local breeder are the presence of the brood patch when ringed in August and its retraps in the same reedbed spot in the following two years.

Body mass values and fat loads of individual B in August 1993 and September 1995 indicated, on contrary, typical pre-migratory conditions. It seems therefore that the same individual had adopted different moult strategies and migratory timing in different years. This fact could confirm the influence of proximate factors, like protracted breeding period or poor feeding conditions, on the genetic determination of the migratory behaviour.

The low figures of our sample do not allow any speculation on the frequency of complete remex moult on the breeding quarters, but indicate that further studies on the southern populations of Great Reed Warbler could reveal a complex geographical distribution and wider diffusion of different moult strategies.

Riassunto - Vengono segnalati due Cannareccioni adulti in muta, catturati a scopo di inanellamento in zone umide situate presso il limite meridionale della Pianura Padana. Entrambi i soggetti, in ottobre, stavano per completare la muta delle remiganti e delle timoniere. Per almeno uno di questi individui si suppone un'origine locale.

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Dati sulle patologie dei Rapaci in Sicilia

MAURIZIO SIRACUSA

Dipartimento di Biologia animale dell'Università,
Via Androne, 81 - 95124 Catania

La patologia degli uccelli da preda è un aspetto della loro biologia ancora poco conosciuto e studiato. Dall'analisi di novecento lavori pubblicati da Raptor Research Foundation durante il periodo 1967-1986 appena il 15% tratta questo argomento (Olendorff, 1989). In particolare sono quasi assenti dati riferibili alle popolazioni della regione mediterranea.

Tabella n. 1 - Specie e numero di individui distribuiti nel corso del triennio 1990-92; n = totale individui, s = numero specie.

	1990	1991	1992
<i>Pernis apivorus</i>	3	3	12
<i>Milvus migrans</i>	1	-	-
<i>Milvus milvus</i>	1	2	-
<i>Circus aeruginosus</i>	1	1	1
<i>Circus cyaneus</i>	5	9	10
<i>Accipiter nisus</i>	2	3	1
<i>Buteo buteo</i>	-	1	-
<i>Aquila chrysaetos</i>	32	19	23
<i>Pandion haliaetus</i>	-	1	-
<i>Falco tinnunculus</i>	-	1	2
<i>Falco vespertinus</i>	27	29	39
<i>Falco eleonorae</i>	-	-	1
<i>Falco biarmicus</i>	-	2	1
<i>Falco peregrinus</i>	-	1	-
<i>Tyto alba</i>	1	-	2
<i>Otus scops</i>	13	17	15
<i>Athene noctua</i>	-	5	14
<i>Strix aluco</i>	-	7	6
<i>Asio flammeus</i>	2	-	-
	2	1	4
	n=95	n=105	n=126
	s=12	s= 16	s= 14

Sono stati esaminati 326 rapaci (Accipitriformi, Falconiformi e Strigiformi) pervenuti al Centro Recupero Fauna Selvatica (CRFS) gestito dal Fondo Siciliano per la Natura di Catania (Autorizzazione: Assessorato Agr. e Foreste decreto N. 7 del 19 Marzo 1990 e Comune di

Catania del 23 Marzo 1990 - prot. 130/90). Ogni animale è stato sottoposto ad un esame obiettivo generale, sono stati raccolti dati anamnestici (quando possibile) e, se necessario, si è fatto ricorso ad un esame radiografico con apparecchio Elettrom Ray 70 mA 100 KW. Alcuni degli animali deceduti o sacrificati, perché ormai irrecuperabili, sono stati sottoposti ad esame necroscopico seguendo quanto riportato da Franson (1987). Sono stati identificati dieci diversi tipi di patologie, distribuite per classi di frequenza ed osservata la variabilità nel corso di due anni (1991-1992).

I 326 individui pervenuti appartengono a 20 diverse specie (tab. 1).

Tabella n. 2 - Confronto delle patologie riscontrate in tre diversi studi. Non sono riportati i casi di individui rinvenuti nidiacei e in cattività.

Patologie	Sicilia (pres. studio) %	Italia (Falcone 1987) %	Iowa (Fix e Barrows 1990) %
Fratture	39	51.46	50
Ferite	13.5	3.55	-
Traumi vari	7.3	8.96	11
Avvelenamento	2.7	3.75	3
Stato di debilitazione	6.2	18.33	5
Malattie parassitarie	1.2	0.62	3.3
infettive			
Trauma cranico	4.2	-	7
Dislocazione	-	-	7
Altri	7.8	-	6.7
	n=259	n=480	n=60

Il 65.6% del totale appartiene alle seguenti specie: *Falco tinnunculus*, *Buteo buteo* e *Tyto alba*, in assoluto le specie più comuni in Sicilia. In tabella 2 sono riportate le patologie osservate. La frattura è la patologia riscontrata con maggiore frequenza (39%), causata o da colpi di arma da

fuoco o da impatto con autoveicoli (solo Strigiformi). Le ali sono interessate nell'84.2% dei casi e le zampe nel 14.7%. Fratture esposte o pregresse sono state osservate nel 10.5% e 12.6% delle volte. Queste percentuali sono simili a quanto riferito da Del Bue e Mezzatesta (1987). La debilitazione (da riferire al termine inglese "starvation" sensu Keymer et alii 1981) ha una frequenza di diagnosi pari al 6.2% ed è la causa naturale più frequente; osservata in 6 specie soprattutto durante il periodo autunno-inverno, essa è considerata la causa principale di morte soprattutto dei giovani al primo inverno o nei casi di sovrappopolazione (Brown e Amadon, 1968; Hirons et alii, 1979; Snow, 1960; Southern, 1970) conseguentemente a scarsa disponibilità di cibo, stress sociale e/o migratorio e altre cause.

Tabella n. 3 - Specie e mesi in cui sono stati osservati casi di debilitazione; n = numero individui.

	n.	%
<i>Falco tinnunculus</i>	5	35.8
<i>Buteo buteo</i>	4	28.6
<i>Otus scops</i>	3	21.4
<i>Pernis apivorus</i>	1	7.1
<i>Asio flammeus</i>	1	7.1
Gennaio	-	-
Febbraio	1	6.25
Marzo	-	-
Aprile	3	18.75
Maggio	-	-
Giugno	-	-
Luglio	1	6.25
Agosto	3	18.75
Settembre	-	-
Ottobre	1	6.25
Novembre	5	31.25
Dicembre	2	12.5

La percentuale riferita alla debilitazione è solo indicativa, in quanto è riferita ad animali non ammalati gravemente e ritrovati ancora in vita; ovviamente altri Rapaci, gravemente ammalati, muoiono e non vengono reperiti dall'uomo. Solo sette individui appartenenti a tre diverse specie presentavano sintomi di avvelenamento. Non sono stati effettuati esami tossicologici ed è impossibile pertanto discriminare il tipo di sostanze responsabili. Pur non disponendo di dati diretti (livelli di contaminazione nei tessuti, uova e prede), sembra tuttavia che i casi di contaminazione chimica con effetti sul successo riproduttivo osservati in Sicilia in specie

particolarmente sensibili (Massa 1980; Massa et alii 1991; Shenk et alii 1985) consente di escludere una contaminazione chimica almeno a lungo termine.

Solo in pochissimi casi è stato possibile osservare malattie infettive o parassitarie (1.2%) come osservato da altri Autori (tab. 3). Redig et alii (1983) hanno osservato una variabilità di questa causa dal 4 al 18% nel corso di 11 anni.

Gli studi sulla mortalità indicano che le malattie giocano un ruolo insignificante sul controllo delle popolazioni di Rapaci (Greenwood 1977) perché la coevoluzione tra patogenicità dell'agente patogeno e resistenza dell'ospite ha raggiunto un equilibrio ben tollerabile da quest'ultimo; tuttavia alcuni casi confermano che esse possono causare una morbidità e mortalità significativa soprattutto nelle piccole popolazioni isolate (Cooper 1989; Mc Orist 1989); le informazioni tuttora disponibili sono comunque insufficienti (Reece 1989).

Nonostante il fatto che questo metodo di stima delle cause di mortalità sia riferito solo ad animali feriti non in modo grave, quindi trovati ancora in vita e ricoverati, e di conseguenza non possa fornire stime attendibili riferibili alla popolazione complessiva, secondo i risultati di questa ricerca è possibile attribuire a cause antropiche dirette o indirette il 92.5% dei ricoveri. L'azione diretta dell'uomo (bracconaggio, prelievo di pulli e cattura) è la principale causa del ricovero (non meno dell'80% dei casi). La distribuzione mensile dei ricoveri per cause antropiche (caccia ed impatto contro autoveicoli) in *Falco tinnunculus*, *Buteo buteo* e *Tyto alba* evidenzia che il 61.5-70.4% si hanno nel periodo autunno-inverno, fatto che potrebbe mitigare gli effetti di un eventuale surplus di mortalità causato dall'uomo. Quest'ultima quando si aggiunge a quella naturale, provoca un declino della popolazione. I dati disponibili sono comunque insufficienti per conclusioni definitive.

Abstract. The analysis of 326 birds of prey injured between 1990 and 1993 belonging to 20 species consented to identify ten different pathological states. 65.6% of the total number of birds examined were *Falco tinnunculus*, *Buteo buteo* and *Tyto alba*; 92.5% of the birds have been injured as consequence of direct and indirect human action (80% were due to poaching, capture, hunting, ecc.). Among the natural causes, starvation has been found observed in 6.2% of individuals; it involved 6 different species, chiefly in the autumn-winter seasons. Poisoning and parasitic and infectious diseases resulted rarely observed (respectively 2.7 and 1.2% of individuals).

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Reproductive parameters and nestling growth in Hoopoe *Upupa epops* in an area of Central Italy

G. BALDI* e A. SORACE**

* Oasi WWF Macchiagrande, Via dell'Olivetello C15, 00057 - Maccarese (Roma)

** S.R.O.P.U. c/o Via Roberto Crippa 60, D/8, 00125 - (Acilia) Roma

Available data on the breeding biology of the Hoopoe *Upupa epops* are rather scanty and specific studies are episodic (e.g. Kubik 1960) the main information being reviewed in Glutz von Blotzheim (1980), Cramp (1985), Fry *et al.* (1988). The aim of this contribution is to provide data on the reproductive parameters and the nestling growth of Hoopoes nesting in artificial nest-boxes.

The study area is located inside the WWF oasis of Macchiagrande (41° 52' N, 12° 17' E), a mediterranean scrub surrounded by grassland along the coast of the Central Tyrrhenian sea (about 240 ha). Overall nine nest-boxes were used. Six of them were installed during the winter 1990, while other three boxes were added during the winter of 1995. The nest boxes (25 cm x 25 cm x 35 cm, hole diameter=6 cm) were placed between 3-5 m above the ground, attached to trees, with random exposure, spaced at least 100 m each other. Data were collected during five years (1990-95). The inspection of the nest-boxes was carried out weekly for the whole breeding season; in 1992 and 1993 it lasted only until mid June.

As regards the reproductive parameters, we assumed that females lay one egg per day (Bussmann 1950, but see Fry *et al.* 1988) and that the onset of incubation occurred after the first egg was laid (Cramp 1985; pers. obs.). For each clutch we considered: hatching success = (hatched eggs/laid eggs) x 100; fledging success = (fledged young/hatched eggs) x 100; breeding success = (fledged young/laid eggs) x 100.

The eggs were measured with a gauge (± 0.1 mm). In 1994 the chicks from four nest-boxes were weighed with an electronic balance (± 0.1 g) every two to four days from the date in which their hatching was detected. Individual recognition of the nestlings was assured by coloured ring, by differences in size (see results) and by marking of claws with nail varnish. In the spring of 1995 several females were captured on the nest in order to check the nest site fidelity.

The percentage of occupation in the study years was fairly high, however in the first year none of the nest-boxes were used and in the second year only two clutches were laid (Figure 1).

During the study period the earliest laying date was

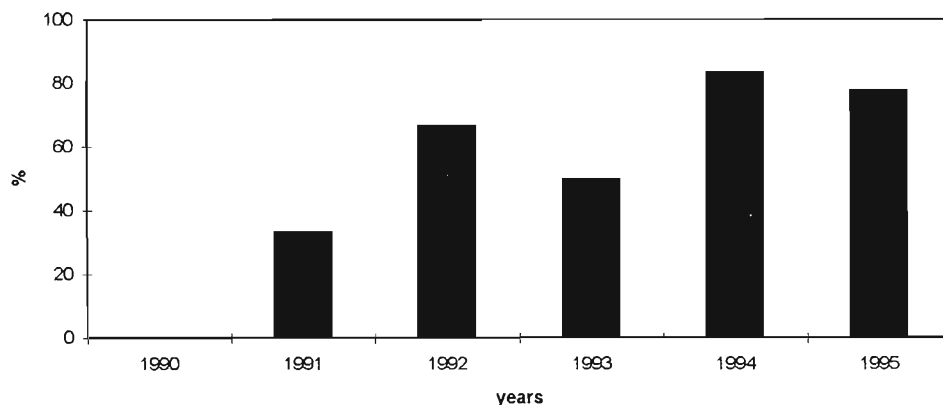


Fig. 1. Nest-box utilization (%) in the study years.

April 10 and the earliest fledging date was May 18. However, in 1995 no eggs were found before April 26 and the fledging date of the chicks ranged between June 3 and August 3.

The dates of laying grouped into periods of ten days show two peaks (Figure 2). It must be noted that in one

of the five nests of 1994 and in two of seven nests of 1995, a clutch was laid after the first brood fledged; the dates of the beginning of these possible second broods ranged between June 3 and July 4. Therefore the second peak could be due to the laying of the second clutches.

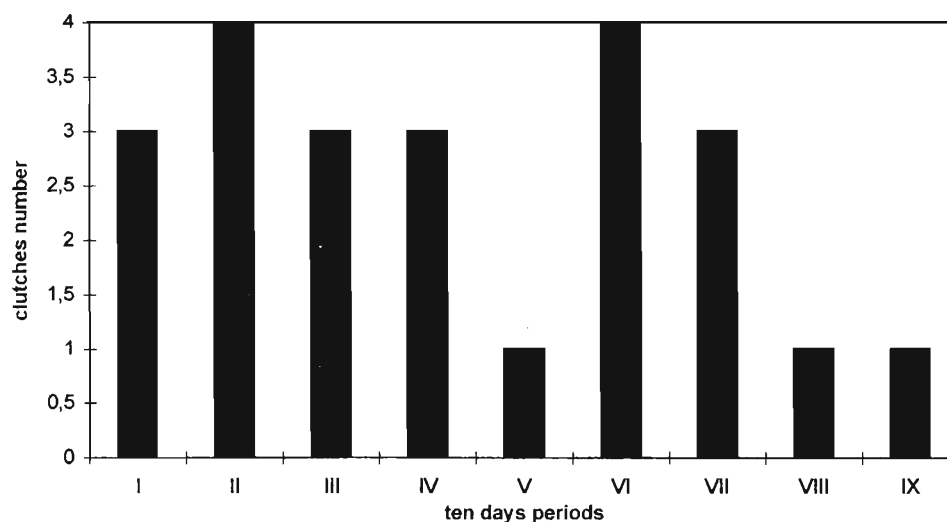


Fig. 2. Number of clutches laid each ten days (first period=April 10-20).

No significant differences in clutch size laid in different months were observed (Mann-Whitney test). However, the average clutch size in April was 7.7 (s.d.=1.0; n=6), in May 7.0 (s.d.=1.0; n=3), in June 7.2 (s.d.=1.3; n=8). Moreover, in the three nests with a second brood, the size of the apparent first clutch was

on the average higher ($\bar{x}=7.7$; s.d.=0.6) than the second ($\bar{x}=6.3$; s.d.=1.5).

It is likely that predation was not the only factor affecting hatching and fledging success (Table 1), because if we do not consider the preyed clutches, the hatching success rise to 81.8%, while fledging remains unaffected.

Tab. 1. Reproductive parameters of Hoopoe after pooling the study years (n=number of clutches; except for nestling period and egg size where n= number of nestlings or eggs).

	Clutch size	Incubation period	Nestling period	Hatching success	Fledging success	Breeding success	Length of eggs	Width of Eggs
mean	7.3	16.6	25.4	65.5	79.4	52.0	25.4	17,4
s.d.	1.1	0.9	1.6	36.3	22.4	33.2	0.9	0,6
n	18	5	22	20	16	20	67	68

In all clutches the asynchronous hatching of eggs led to nestlings of clearly different size in the first days after hatching (Figure 3-4). All the chicks that starved were the last hatched of their clutches. In a nest the death of three chicks occurred in the period in which a halt in growth was observed for the two chicks successfully fledged (Figure 3).

The mean mass of three chicks measured in the hatching day was 2.9 g (s.d. = 0.2). Overall the mass of the chicks rapidly increased up to a maximum

(ranging between 69 and 84 g) and showed a reduction the days before fledging (60-73 g). This trend was observed in 19 of 21 successfully fledged chicks. However, in several instances the mass of the last hatched chick increased very gradually or even diminished, reaching the fledging value only in the last days of nestling period when some of its siblings had already fledged or were losing weight (Figure 4). In 1995 one of the three females examined on the nest was found to have been ringed as a chick the previous year.

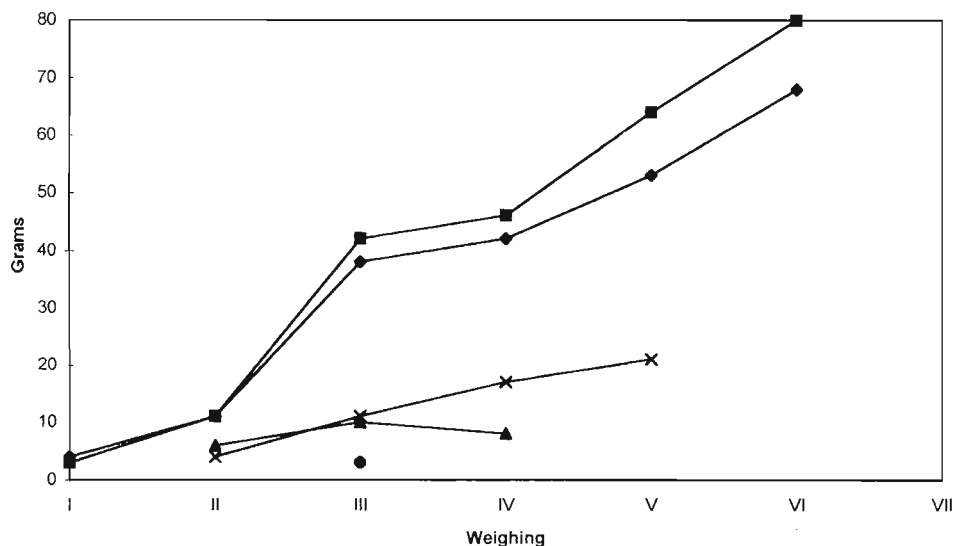


Fig. 3. Mass increase in a nest where three out of five chicks died.

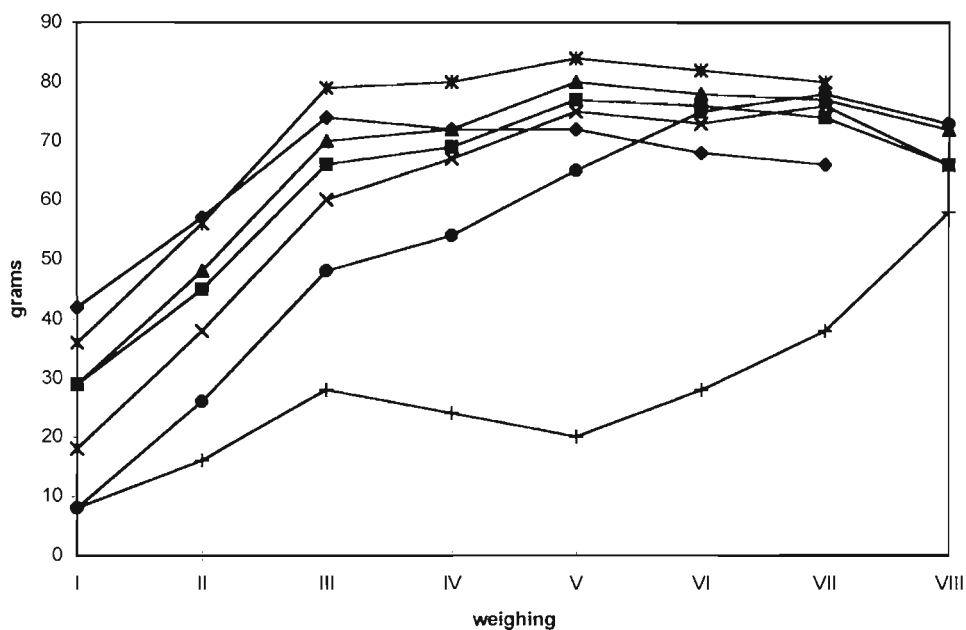


Fig. 4. Mass increase of seven Hoopoe chicks from a brood in which all chicks fledged successfully.

Only at the end of the spring of 1991 females of Hoopoe had turned their attention to the nests boxes. However, in the following years the nest-boxes showed a high percentage of occupation which would encourage the undertaking of analogous experiments by using artificial nests for Hoopoe in other areas. Our data (Table 1) are similar to those reported by other authors (Kubik 1960, Glutz von Blotzheim 1980, Cramp 1985, Fry *et al.* 1988) and the growth

curve for the chicks shows the sygmoidal form typical of many altricial birds species (Ricklefs 1968). The number of second brood was apparently high, as reported for southern population of Hoopoe (Cramp 1985).

The anomalous weight increase of some of the chicks and the observation that the death of the chicks occurred only for the last hatched, apparently during periods of scarce availability of food and not caused

by predation, seem consistent with the "brood-reduction" hypothesis (Lack 1968, but see Magrath 1990).

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Riassunto - Vengono riportati alcuni dati, raccolti nelle stagioni riproduttive 1990-95 nell'oasi WWF di Macchiagrande (Roma), sui principali parametri riproduttivi, sulle dimensioni delle uova e sull'incremento ponderale dei pulcini di Upupa. I risultati sembrerebbero in accordo con le poche informazioni disponibili in Europa sulla specie. L'uso di nidi-artificiali sembra un buon mezzo per studiare la biologia riproduttiva dell'Upupa.

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Book reviews

Cignini B. e Zapparoli M. (a cura di) 1996. *Atlante degli uccelli nidificanti a Roma*. Fratelli Palombi editori. Roma, 126 pp.

Anche la Città Eterna dispone ora di un suo Atlante ornitologico. L'Atlante degli uccelli nidificanti a Roma, curato dai due colleghi Bruno Cignini e Marzio Zapparoli, va infatti ora ad aggiungersi all'elenco degli atlanti italiani già pubblicati, dopo quelli di Napoli, Firenze, Livorno e Cremona. L'Atlante della capitale è certamente di grande interesse per tutti coloro che si occupano di ornitologia ed ecologia urbana. Il comune di Roma, infatti, è il più vasto e popolato d'Italia e ospita oggi circa tre milioni di abitanti. L'area presa in esame nello studio è rappresentata da quella parte del Comune compresa all'interno del Grande Raccordo Anulare, per una superficie di ben 360 kmq!

I dati sono stati raccolti da 67 rilevatori, ornitologi professionisti e dilettanti, per un arco di tempo che va dal 1989 al 1993. I rilevamenti hanno riguardato la sola stagione riproduttiva, dal primo marzo al trenta luglio, in modo da tener conto del teorico prolungamento del periodo riproduttivo manifestato da alcune specie in ambiente urbano.

La metodologia adottata ricalca fedelmente quella del Progetto Atlante Italiano, con le stesse categorie di nidificazione (possibile, probabile, certa). L'area è stata suddivisa in 360 unità di rilevamento UTM (quadranti di 1 km x 1 km). Gli autori hanno voluto giustamente evidenziare le principali tipologie ambientali e sono state quindi distinte in arancione le aree edificate, in verde le aree non costruite ed in celeste le aree golenali (del Tevere e dell'Aniene). Le specie rilevate sono state 75, un valore sostanzialmente comparabile con quello di altre città italiane. Sulla base della distribuzione ornitica Cignini e Zapparoli hanno anche tentato un'analisi della qualità ambientale dell'area presa in esame. Le conclusioni di questa analisi hanno permesso di confermare il pregio naturalistico delle aree da tutelare già prescelte dalla Regione Lazio e di indicare altri settori di rilevante importanza a livello comunale.

L'opera mi sembra valida, impostata e redatta con chia-

rezza ed equilibrio. Dopo una simpatica presentazione di Augusto Vigna Taglianti, vengono illustrate le caratteristiche salienti dell'area di studio (aspetti geografici, geologici, floristici e botanici), i metodi impiegati ed i risultati complessivi ottenuti. Segue l'analisi dettagliata delle diverse specie rilevate, ciascuna corredata a tutta pagina di testo, cartina distributiva ed illustrazione che ritrae gli animali nell'ambiente urbano. Le specie vengono inquadrare corologicamente ed i dati storici relativi alla loro passata presenza in città attentamente vagliati. Le cartine sono di facile ed immediata lettura ed i disegni a china di Massimiliano Lipperi risultano particolarmente gradevoli sotto il profilo artistico e sostanzialmente corretti sotto quello ornitologico.

L'Atlante fornisce diversi spunti di riflessione. È di un certo interesse notare che meno di metà della superficie urbana considerata è edificata, ed infatti circa 195 dei 360 kmq campionati sono occupati da aree verdi, ville storiche, prati, incolti e aree golenali. Si ripresenta quindi anche in questa occasione l'irrisolto problema della definizione e delimitazione dell'ambiente urbano. Nel caso specifico, è facile rendersi conto che molte delle specie nidificanti a Roma, in realtà non frequentano affatto le aree edificate (le zone, a mio avviso, più autenticamente "urbane"), confinate come sono ai soli quadranti verdi (Ghiandaia, Rigogolo, Allodola, Averla piccola e capirossa ecc.) o celesti (Martin pescatore, Germano reale ecc.). Beninteso, le stesse identiche considerazioni riguardano praticamente tutti gli atlanti urbani finora pubblicati. Ritengo comunque che l'attuale mancanza di criteri generali di definizione dell'ambito urbano sia particolarmente dannosa perché tende ad inficiare in partenza le analisi comparative tra le diverse città.

Voglio rilevare per finire che anche a Roma, come in altre città italiane, sono state osservate specie esotiche (la Maina comune, ad esempio) che, sfuggite alla cattività, si riproducono liberamente, anche se in modo saltuario. Questo è un chiaro indice di inquinamento faunistico, fenomeno che purtroppo è in rapida crescita ed interessa vari gruppi animali e gran parte del territorio italiano.

Antonio Rolando

Pinowski, J., B.P. Kavanagh e B. Pinowska (editori) 1995. *Nestling mortality of granivorous birds due to microorganisms and toxic substances: synthesis*. PWN-Polish Scientific Publishers. Varsavia, 437 pp.

Questo è l'ultimo dei libri prodotti dal Gruppo di Lavoro sugli Uccelli Granivori, costituitosi a partire dal 1976 in seno all'associazione internazionale per l'ecologia (INTECOL). Animatore del gruppo è Jan Pinowski, noto per la sua intensa attività internazionale culminata nell'organizzazione di due simposi nell'ambito dei congressi di Ecologia e Ornitologia tenutisi rispettivamente in Giappone e Nuova Zelanda nel 1990. I ricercatori polacchi, che costituiscono il nucleo numericamente più forte dell'associazione, si dedicano prevalentemente a indagini inerenti l'ecologia del genere *Passer* in ambiente urbano e suburbano. Il presente volume, finanziato dall'Accademia polacca delle Scienze, accoglie 23 articoli (scritti in inglese) che, per la maggior parte, presentano i risultati di ricerche condotte sui passeri di Varsavia e dintorni. La Passera mattugia *P. montanus* e quella oltremontana *P. domesticus* sono le due specie nettamente più studiate (più di quattro quinti dei contributi sono a loro dedicati), e solo quattro articoli riportano dati relativi alla Tortora dal collare, al Colombaccio e ad alcune specie indiane di tessitori (gen. *Ploceus*) e tortore (gen. *Streptotelia*).

La maggior parte dei lavori è riconducibile all'ecologia applicata. Si va dall'analisi della concentrazione dei metalli pesanti nell'ambiente urbano allo studio della presenza degli stessi elementi nei pulli esposti a diverse condizioni di inquinamento atmosferico.

Vengono anche esaminate le conseguenze dell'accumulo degli insetticidi cloroorganici nelle uova e nei nidiacei e l'effetto dei microorganismi (batteri e funghi) sugli embrioni.

Di particolare interesse le ricerche focalizzate sui principali parametri riproduttivi. Sia il successo alla schiusa che quello all'involto sono risultati essere maggiori nelle aree non inquinate rispetto a quelle inquinate. La variazione della dimensione di covata è risultata dipendere dalla concentrazione corporea di elementi fisiologicamente rilevanti per la deposizione delle uova (Fe, Mg e Ca), la cui disponibilità ambientale sarebbe inversamente correlata al tasso di inquinamento ambientale.

Alcuni contributi sono a carattere prevalentemente metodologico. Barkowska, Kruszewicz e Haman, per esempio, testano il modello di crescita ponderale dei pulli proposto da Richard impiegando dati raccolti sulla Passera oltremontana e sulla Passera mattugia. L'articolo di David Parkin relativo alle tecniche di DNA fingerprinting, oltre ad aumentare il tasso di internazionalità, evidenzia che una buona percentuale di pulli di Passera oltremontana (15%) viene allevata da maschi che non sono i loro padri biologici, con ciò dimostrando che la copulazione extra-coppia è relativamente frequente.

Il volume si configura prevalentemente come una raccolta di articoli di ecologia urbana avente gli uccelli come materiale di studio. L'enfasi infatti (tranne pochissime eccezioni) è sull'effetto dell'inquinamento o dei microorganismi patogeni su specie che possono facilmente offrire campioni (uova, pulli o adulti) analizzabili in laboratorio. In questo campo la ricerca nei paesi dell'Europa orientale è molto attiva, e ciò non deve sorprendere se si pensa che, accanto alle indubbie competenze accademiche, l'impatto dell'inquinamento in molte città industriali è stato ed è tuttora assai forte.

Il libro è acquistabile per 40 dollari presso: the library of the Institute of Ecology, PAS, Dziekanów Leśny k. Warszawy, ul. M. Konopnickiej 1, 05-092 Lomianki (Poland).

Antonio Rolando

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