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

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

Introduction

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

Methods

Study sites

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

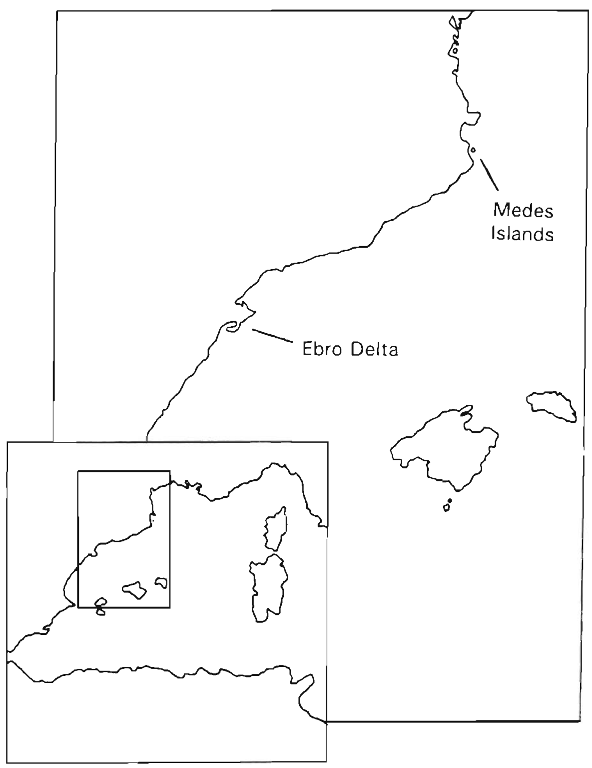

Figure 1. Map of the study areas, indicating colony sites.

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The Medes Islands are calcareous rocks just 0.9 km off the coast, with an area of 20 ha. The vegetation is formed by nitrofilous communities. This site holds one of the largest breeding colonies of Yellow-legged Gulls in the world, with ca. 13500 pairs in 1993, after suffering intensive culling in 1992 (Bosch *et al.* 1994). There are many refuse tips in the surrounding area (Motis 1989), which have been there since the nineteen sixties (Carrera 1987).
The Ebro Delta colony holds a smaller breeding colony, with ca. 1100 pairs. The colony is found on a sandy, flat peninsula of 2000 ha., with small dunes covered by halophilous vegetation. The area has fewer refuse tips than the Medes Islands zone.

Diet

Diet composition was studied during the breeding season from the diet of fledging chicks, which provides a good indication of the food items collected by the adults (Mudge and Ferns 1982).
Data on diets were collected in both colonies using the same method. We assumed that there was low interannual variability in the diet at the two colonies, given that the number of refuse tips and the fishing activity did not change between years. Chicks, when handled for measuring or ringing, regurgitate largely undigested food. These regurgitates were collected and preserved for identification at the laboratory using our reference collections of fish and invertebrates from the same areas. When partially digested, fish were identified with a 10-40x binocular lens using scales and otoliths, but identification was often possible from the entire fish bodies. We did not consider the plant remains found, since we assumed that their ingestion was associated with the consumption of worms and other terrestrial preys (Harris 1965, Fox *et al.* 1990, this study). The quantification procedures always followed the rule of minimum numbers. We calculated the dry weight of each item using an oven and keeping the samples at 60 °C until they reached constant weight. For semidigested preys, dry weight was estimated from reference collection (for fish), and predictive functions (for invertebrates) stated by Rogers *et al.* (1977) and Diaz and Diaz (1990).
Since the categorization procedures might have a decisive influence on the interpretation of diet analyses (Cooper *et al.* 1990), we used two separate criteria to establish prey categories: taxonomy and foraging habitat. Thus, two outcomes were obtained, each one of which was mainly associated with different prey attributes. The taxonomic categories were mainly based on Order level to avoid analytical difficulties coming from an excess of groups with many zero counts (Cooper *et al.* 1990). This also allows comparisons with most other papers on gull feeding ecology, and refers to a universal code.
Foraging habitats were assigned for each prey, to assess where gulls forage. We assumed that fresh marine fish came from fishing vessel discards, since the Yellow-legged Gull is not specialized in active fishing (Witt *et al.* 1981, Carrera 1987, Català *et al.* 1990).
To assess the relevance of the different prey categories in the diet, with either taxonomic or feeding habitat grouping, the following descriptors were used: prey number (N); numeric percentage (% N); percentage of occurrence (percentage of regurgitations containing the prey category, % P); and biomass percentage of each food category (% B). We used the biomass percentage to compare diet composition between the colonies, since this is the descriptor most related to an energy approach to diet.
The width of the trophic niche was measured in relation to foraging habitats by Brillouin's diversity index (Pielou 1975), and a jack-knife procedure was used to estimate diversity at the population level, together with the associated variance (Zahl 1977).
Prey biomass percentages consumed in each regurgitate (both at taxonomic and typological levels) were compared between colonies by the Mann-Whitney U test. Diversities were compared using a modified Student -t statistic (Hutcheson 1970).

Growth of the colonies

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

Results

Diet composition

We analyzed a total of 85 regurgitates: 51 from the Ebro Delta (99 preys identified) and 34 from the Medes Islands (200 preys identified). The relative importance of the different preys identified and the foraging habitats assigned are shown in Tables 1 and 2. Coleoptera and Diptera included both imago and larvae stages, whereas the remaining categories of arthropods were only formed by imagos; Gastropoda included only slugs.
Diet from the Medes colony shows a higher biomass percentage of garbage than the Ebro Delta colony ($U = 624$, $Z = -1.480$, $P = 0.015$). Moreover, preys from crops found in the Medes Islands colony (earthworms, slugs, arthropods and fruits) were more diverse than in the Ebro Delta colony (only olives). Conversely, the Ebro Delta chicks consumed a higher biomass percen-

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

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

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

Growth of colony populations

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

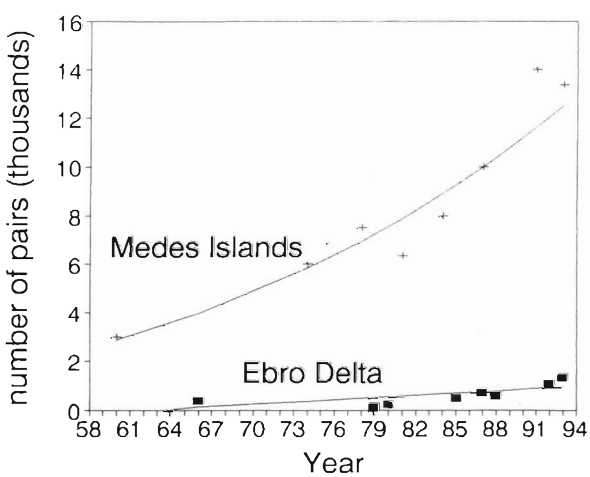

Figure 2. Colony growth of the two study sites in the last three decades. Censuses from Balcells 1964, Westerhagen and Pons 1966, Maluquer 1981, Carrera and Vilagrasa 1984, Carrera 1987, Fortià and Hontangas 1991, Oro and Martínez 1992, Bosch *et al.* 1994.

Discussion

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

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

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

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

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