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Short communication

Henslow's swimming crab (*Polybius henslowii*) as an important food for yellow-legged gulls (*Larus cachinnans*) in NW Spain

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An analysis of the contents of 2562 pellets sampled from 1987 to 1993 at breeding colonies and roosting sites showed that Henslow's swimming crabs (*Polybius henslowii*) are by far the most important marine prey for yellow-legged gulls (*Larus cachinnans*) on the coasts of Galicia (north-western Spain), occurring in 36.4% of pellets. The results also suggest that yellow-legged gulls in Galicia are to a great extent marine foragers. Galicia has one of the largest yellow-legged gull populations in western Europe, largely dominating the seabird community. *Polybius henslowii* is the most abundant decapod crab over the continental shelf of Galicia. It enters coastal waters in large shoals and frequently stays close to the sea surface. Compared with the diets of other yellow-legged gull populations or any of the other closely related gull species, such as the herring (*L. argentatus*) and the lesser black-backed gull (*L. fuscus*), *Polybius henslowii* appears as a characteristic and even exclusive prey of yellow-legged gull populations in the Iberian Atlantic. There is also some evidence that the regular irruption of large *Polybius henslowii* shoals is a phenomenon peculiar to Iberian Atlantic waters.

Key words: Atlantic Iberian coasts, diet, Galicia, *Polybius henslowii*, yellow-legged gull.

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Introduction

About 50 000 pairs of yellow-legged gulls (*Larus cachinnans*) are estimated to breed in 60 colonies scattered along the 1675 km of coastline of Galicia (43°48′N–41°52′N 9°20′–7°01′W), north-western Spain (Munilla, 1997), while winter waterbird counts for 1994 and 1995 give a minimum estimate of about 125 000 birds (Xunta de Galicia, unpublished data). Comparing these figures with data from other yellow-legged gull populations in Western Europe, Galicia emerges as one of the main population centres of the species (i.e. Beaubrun, 1993). In Galicia, yellow-legged gulls clearly dominate the breeding seabird community as the rest of the breeding species account altogether for a small percentage (6%) of total seabird numbers (see Bárcena *et al.*, 1987). Annual waterbird counts, only valid for inshore species, show that about 70% of wintering seabirds are yellow-legged gulls.

Henslow's swimming crab (*Polybius henslowii*) is a benthic species with pelagic phases, and is distributed from the British Isles to Morocco and the Mediterranean (Della Croce, 1961; Hayward and Ryland, 1995). In Galicia, trawled samples show that this crustacean could account for more than 90% of decapod crab biomass of the continental shelf (González-Gurriarán and Olaso, 1987). Although it is not considered as a permanent member of inshore marine ecosystems, *Polybius henslowii* enters coastal waters in loose shoals found close to the sea surface (González-Gurriarán, 1987). This peculiar behaviour involves such large numbers that it formerly led to the development of a specialized fishery for soil fertilizer (González-Gurriarán and Méndez, 1986). Therefore, in the marine ecosystem off Galicia, the numerical predominance of yellow-legged gulls in seabird communities is paralleled by the importance, in terms of relative numbers and biomass, of Henslow's swimming crabs in decapod crab communities.

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In this paper, some of the basic features of the trophic interaction between yellow-legged gulls and Henslow's swimming crabs are described, including the relative importance of the crabs in the diet of the gulls as well as the size of prey taken.

Materials and methods

A total of 2562 recently regurgitated yellow-legged gull pellets, collected between January and August 1987–1993 at seven breeding colonies and four roosting sites, were analysed under a zoom binocular microscope. Food remains were first separated into major food categories: refuse annelid, crustacean, gastropod, bivalve, cephalopod, echinoderm, fish, bird, mammal, and vegetation, and were further identified, whenever possible, to family, genus, or species level. *Polybius* remains were readily identified from exoskeleton fragments with the aid of a reference collection, since crab pellets lacking recognizable cheliped parts were rare and many included several intact chelae. As a rule, quantification was made from those fragments which gave the highest number of items for each taxon. In crab pellets, the number of items was estimated by pairing chelipeds, represented either by entire chelae or just tips of dactyli and propodi. The results of food analyses are reported here as percent frequency of occurrence of a specific food type in a pellet sample.

Distances from pivot to dactylus tip (see Lee and Seed, 1992) of 1 235 chelae found in 417 pellets selected at random from the entire sample were measured to the nearest 0.01 mm by means of a digital caliper. For every pellet, only right or left dactyli were measured. Dactylus length of a further sample of 313 Henslow's swimming crabs caught by fishing vessels in August 1996 was measured in relation to maximum carapace width (measured between the fifth anterolateral spines, see Freire and González-Gurriarán, 1992).

Contingency tables (Siegel, 1956) were used to test for significant differences in the frequency of occurrence of *Polybius* between locations as well as sampling periods, while Student's t-test and ANOVA (Zar, 1984) were applied to morphometric measurements. All tests were run on original data and results were accepted as significant at the 5% level.

Results

Overall, *Polybius henslowii* ranked second in percent frequency of occurrence in the diet of yellow-legged gulls in Galicia, refuse being the most frequently encountered food category (Table 1). Amongst marine organisms, *Polybius* was the commonest prey, followed by mussels (*Mytilus galloprovincialis*) and blue whiting (*Micromesistius poutassou*). A total of 1 410 pellets (55%) consisted entirely of marine prey remains, while 633 (25%) were composed entirely of *Polybius* exoskeleton fragments. Of 9 684 marine prey items, 3 841 (40%) were identified as Henslow's swimming crabs.

Table 1. Occurrence and number of items of types of food with a frequency of occurrence over 5% in pellets (n = 2562) of yellow-legged gulls collected in Galicia. The most abundant prey taxa within every type of food are also shown.

Type of food	Occurrence N	Occurrence %	Number of items
Refuse	1028	40.1	
All crustaceans	1121	43.7	4768
Polybius henslowii	933	36.4	3841
All fish	824	32.2	1532
Micromesistius poutassou	250	9.8	562
All bivalves	358	14.0	1926
Mytilus galloprovincialis	347	13.5	1883

The occurrence of *Polybius* in pooled pellet samples collected at different breeding colonies varied from 16% to 69% ($\chi^2 = 403.47$, $p < 0.0001$), while the occurrence at roosts varied from 14% to 81%. Percentages over the years 1987, 1989, 1990, 1991, and 1993 (the missing years having less than three sampling localities) appeared to be more uniform, but still varied significantly from 31% to 48% ($\chi^2 = 44.65$, $p < 0.0001$). The frequency of occurrence in pellets collected from January to April (32%) was significantly lower than the frequency of occurrence in pellets collected from May to August (37%; $\chi^2 = 4.32$, $p < 0.05$).

Lengths of dactyli from yellow-legged gull pellets averaged 14.12 ± 0.06 mm (4.70 to 21.61 mm range). There were no statistically significant differences between the lengths of 165 right and 161 left dactyli of 74 pellets selected at random out of the Arousa sample ($t = 0.23$, $p > 0.80$). Linear regressions between dactylus length (DL) and carapace width (CW) for fresh specimens were: $CW = 8.138 + 2.089$ DL (range of dactyli: 7.98–22.58 mm, $r^2 = 0.896$) for the entire sample ($n = 313$); $CW = 3.778 + 2.463$ DL (range of dactyli: 11.01–17.37 mm, $r^2 = 0.865$) for females ($n = 47$); and $CW = 5.191 + 2.242$ DL (range of dactyli: 7.98–22.58 mm, $r^2 = 0.900$) for males ($n = 255$). However, these regressions must not be regarded as conclusive, since smaller size classes were probably underepresented. Pooled data showed significant differences in dactylus length between sampling localities ($F = 17.99$, $p < 0.0001$) as well as among years ($F = 58.55$, $p < 0.0001$).

Discussion

These results suggest that *Polybius henslowii* is an important component of the diet of yellow-legged gulls in Galicia, evidenced by high frequencies of occurrence in pellets from most sampling sites as well as over several years. There are few records of yellow-legged gull diets where crabs are regularly found in high proportions (see Isenmann, 1976; Glutz von Blotzheim and Bauer, 1982), but crabs may be fairly common in the diet of related gull species. For example, the shore crab (*Carcinus maenas*) appears as one of the key intertidal prey items in the diet of Atlantic coast populations of the herring gull (*Larus argentatus*) (Harris, 1965; Hartwig and Söhl, 1975; Spaans, 1971; Noordhuis and Spaans, 1992; Dernedde, 1994). There are few examples of exploitation of any swimming crab species by populations of any of the large gulls in the Western Palearctic (see Cramp and Simmons, 1983; Götmark, 1984). However, portunid crabs of the *Liocarcinus* genus have been recorded as food for herring gull (Lohmer and Vauk, 1969; Hartwig and Söhl, 1975; Spaans, 1971), lesser black-backed gull (Verbeek, 1977; Noordhuis and Spaans, 1992), and Audouin's gull (*Larus audouinii*) (Witt *et al.*, 1981). Furthermore, Harris (1965) includes the velvet crab (*Necora puber*) amongst the prey items of the herring gull.

Shoals of *Polybius* in coastal waters seem to be found mainly in the Iberian Atlantic and adjacent waters (Della Croce, 1961). It is not surprising, then, that the only recorded instances of *Polybius* as an important food for gulls come from yellow-legged gull populations in Portugal (Luis, 1982) and the Cantabrian Sea (Alvarez-Laó and Méndez, 1995), as well as from wintering lesser black-backed gulls in Portuguese waters (Tait, 1924). However, *Polybius henslowii* does feature in the diet of Audouin's gull in the Chafarinas Islands, west of the Almeria–Oran front that separates Atlantic from Mediterranean waters (Witt *et al.*, 1981). It is also notable that Stewart *et al.* (1984) recorded large numbers of herring gulls feeding on shoals of live, pelagic red crabs (*Pleuroncodes planipes*) in southern California in the winter of 1983. They explained the unusual abundance of gulls (a 100-fold increase with respect to usual winter numbers in the area) as a result of the abundance of red crabs, which in turn was a consequence of an intense El Niño event.

The ultimate factors determining the arrival of *Polybius henslowii* in coastal waters are poorly understood (González-Gurriarán, 1987). Trawling studies in Galicia have shown that the species may be a potentially abundant source of food. On the continental shelf, maximum values reached 201 459 crabs (2.5 t biomass) per trawling hour (González-Gurriarán and Olaso, 1987), while at sampling stations in coastal waters, average densities ranged from 0.21 to 16.6 crabs 100 m^{-2} (Romero *et al.*, 1982; Iglesias and González-Gurriarán, 1984; González-Gurriarán, 1987; González-Gurriarán *et al.*, 1991) with maximum values of 157.5 crabs 100 m^{-2}. However, Henslow's swimming crabs seem to be very susceptible to predation by large gulls, because they often live very close to the surface (Della Croce, 1961; González-Gurriarán and Méndez, 1986), allowing their capture by plunging, dipping, and surface seizing (pers. obs.).

The sudden invasions of *Polybius* shoals may also explain the spatial and temporal differences in the frequency of occurrence of this portunid in gull diets. As for differences in sizes taken by gulls, they are likely to reflect the size of crabs available in the environment at any given moment as shoals tend to be quite homogeneous in their size (González-Gurriarán, 1987). Linear regression estimates of average carapace width of sizes taken by yellow-legged gulls in Galicia (37.65 $\pm$ 0.12 mm) match quite well with average sizes obtained by González-Gurriarán (1987) at six sampling stations (range of carapace widths: 36.31 $\pm$ 0.29 mm to 37.65 $\pm$ 0.20 mm).

In conclusion, yellow-legged gulls in Galicia take advantage of a unique food source that is unpredictable in time and space but which, when it is present, is abundant and accessible (see Pons, 1994). This situation might also apply to other yellow-legged gull populations where they have access to shoals of *Polybius*.

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