# Food and Feeding Sites of the Eurasian Spoonbill (*Platalea leucorodia*) in Southwestern Spain

EDUARDO AGUILERA, CRISTINA RAMO AND CLAUDINE DE LE COURT

Estación Biológica de Doñana
CSIC, Apartado 1056
41080 Sevilla, Spain

**Abstract.**—We analyzed the food composition of 47 regurgitations and 11 stomach contents from nestling Eurasian Spoonbills (*Platalea leucorodia*) in the colony of the estuary of the Odiel River (southwestern Spain). With a single exception, all prey consumed by nestlings were saltwater aquatic animals. Fish, particularly killifish (*Fundulus* spp.), were the most common and abundant component of the diet, accounting for 71% of the prey items. Prawns (Palaemonidae) appeared in half the food samples and accounted for 19% of the prey items. Relative abundance of potential prey at foraging habitats and in the diet suggests that fish were preferred over other prey types. The mean body length of the fish found in the food sample was greater than that at foraging habitats.

**Key Words.**—Eurasian Spoonbill, nestling diet, Odiel estuary, *Platalea leucorodia*, southwestern Spain.

**Resumen.**—Se describe la dieta de la Espátula (*Platalea leucorodia*) a partir del examen de 47 regurgitaciones y 11 contenidos estomacales de pollos procedentes del estuario del río Odiel (Suroeste de España). Salvo el Cangrejo Rojo (*Procambarus clarkii*), que fue encontrado en un estómago, todas las presas consumidas por los pollos fueron animales de agua salada. Los peces, y en particular el Samarugo (*Fundulus* spp.), fueron las presas mas comunes y abundantes en la dieta, representando el 71% de los animales ingeridos. Les siguen en importancia los camarones (Palaemonidae), que representan el 19% de las presas. La comparación entre la abundancia relativa de presas potenciales en los hábitats donde se alimentan las espátulas y la encontrada en la dieta sugiere que las presas preferidas son los peces. La longitud media de los peces ingeridos por los pollos de espátulas fue mayor que la de los provenientes de nuestros muestreos del hábitat.

Colonial Waterbirds 19 (Special Publication 1):159-166, 1996

The Eurasian Spoonbill (*Platalea leucorodia*), a colonial waterbird with a formerly wide distribution throughout the Paleartic, has dramatically decreased during the last centuries (Brouwer 1964, Van Wetten 1986). On the Atlantic coasts of Europe, spoonbills presently have relatively stable breeding populations in the Netherlands and Spain. These populations winter on the coasts of west Africa (Poorter 1982). There are two breeding colonies in Spain, both in the southwest. One is located in the freshwater marshes of the Guadalquivir River (Aguilera and Alvarez 1990) and the other in the estuary of the Odiel River.

The feeding ecology of the Eurasian Spoonbill is poorly known. Their foraging habitats include a wide variety of shallow water areas with fresh, brackish or salt water, avoiding those with rocky bottom, thick vegetation and swift current (Hancock *et al.* 1992). The diet consists of small fishes, amphibians, reptiles, crustaceans, mollusca, worms, leeches and plant material (Cramp and Simmons 1977). In the Netherlands, at the start of the breeding season, spoonbills forage in freshwater areas where they mainly feed on small fish (sticklebacks). Later in the breeding season, they shift foraging grounds to tidal flats, feeding mainly on prawns (Van Wetten and Wintermans 1986). In this study we present the first data on the diet of spoonbills in Spain and describe prey availability at foraging sites.

## STUDY AREA AND METHODS

The study was conducted at the Odiel estuary, southwestern Spain, a Natural Park of complex saltmarshes, tidal lagoons and salinas (Fig. 1). Salt marshes are strongly influenced by the tidal regime, becoming flooded during high tide and dry when the tide is low. Only during equinoctial tides some temporal lagoons are formed, allowing the growth of some animals adapted to this habitat (Rubio and Figueroa 1983). Spoonbills breed at the Odiel estuary since 1956 (Mountford 1958). In 1977, when the colony was first censused, 110 pairs were breeding (Andalus 1980). Since then, the breeding population progressively increased until it stabilized at about 350-450 pairs in 1986 (Aguilera, unpubl. data).

Food data are based on the examination of 47 regurgitations from nestlings, collected during ringing operations, and 11 stomach contents of chicks found freshly dead in the colony, generally after severe storms. Food

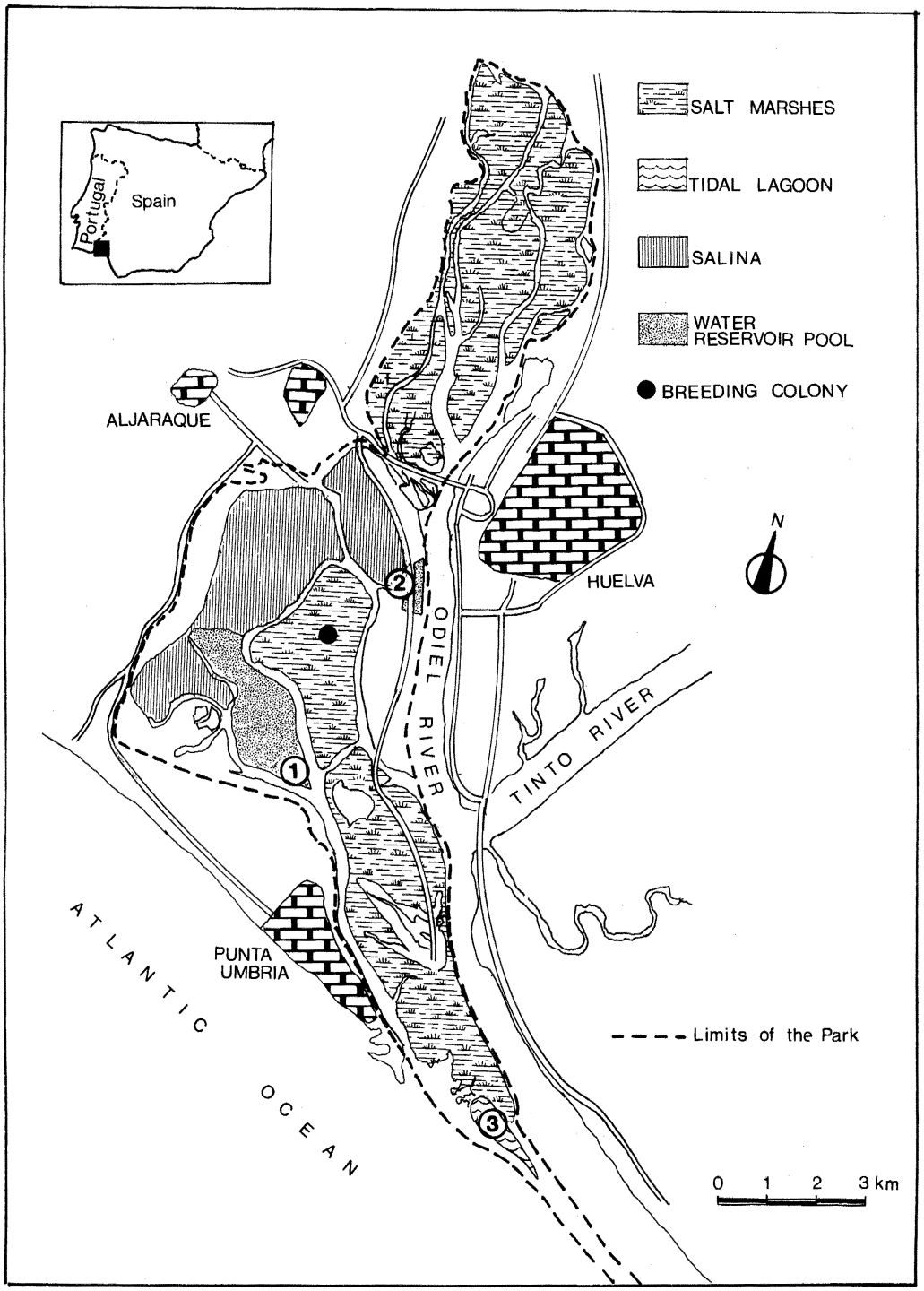


**Figure 1. Map of the Odiel Natural Park. Sites where aquatic prey were sampled are numbered 1 to 3. The location of the breeding colony is also indicated.**

samples were collected in 1983-1993 between April and June. Some samples (19 regurgitations and 2 stomachs) were too digested to allow prey species determination and counts of individual prey items. These samples were excluded from calculations of proportions of prey items in the sample, but they were considered for estimating the frequency of occurrence of prey taxa. Crustaceans were identified to the family level and whenever possi-

ble to species. Fishes were identified to species. Other taxa, of much less importance as components of the diet of spoonbills, were identified to order. When prey were found undigested, lengths were measured to the nearest mm.

Fluctuations in the density of prey throughout the year were determined by monthly samples taken with a 1-$m^2$ throw-trap (Kushlan 1981) from April 1990 to April 1991. To compare the nestling diet with prey availability at foraging sites we only took into account those samples collected from April to June. Samples were taken at sites where water levels ranged between 20 and 40 cm and where spoonbills were regularly feeding. Because the use of this method is limited by characteristics of the site such as dense vegetation, irregular relief or small area, we restricted samples to three trapping sites (Fig. 1).

Site 1, La Liebre, is a 270-ha water reservoir in the salina complex. There is continuous water movement, with pumping from a main channel to the reservoir and from the reservoir to other tanks. Salinity during the sample period ranged from 4.9 g/l to 5.8 g/l ($\bar{X}$=5.25, SD=0.4). We collected 9-10 samples per month, amounting 118 samples. Site 2, Bacuta, is a 30-ha water reservoir where the water turnover is rapid. In the same period, salinity ranged from 4.2 g/l to 5.5 g/l ($\bar{X}$=4.85, SD=0.6). We collected 3-10 samples per month, totaling 72 samples. Site 3 is a tidal lagoon, salinity at low tides ranging from 3.5 g/l to 4.4 g/l ($\bar{X}$=3.8, SD=0.4). At this site we collected 10 samples per month, totaling 110 samples. Combined data of prey densities and sizes at those sites, from April to June, were used for comparisons with prey consumed by nestling spoonbills.

## RESULTS

### Food composition

Fish were the most important prey in the diet of spoonbill nestlings. They were present in 57 of 58 samples and accounted for 71% of the prey items (Table 1). Three fish species were identified, killifish (*Fundulus* spp.) represented more than 50% of the individual prey number. Crustaceans were the second group in order of importance. They included unidentified prawns (Palaemonidae), crabs (*Carcinus maenas*), crayfish (*Procambarus clarkii*) and isopods. Prawns were present in 50% of the samples and represented 19% of the prey items. The other crustaceans were much less important both in terms of relative prey number and occurrence in the sample (Table 1). Crayfish was the only freshwater crustacean in the diet of spoonbills. It was present in one stomach, being the only prey species found in it. Other taxa included in the diet were aquatic insects (Coleoptera and Heteroptera), spiders (Araneae) and Mollusca (Bivalvia and Gastropoda). All these prey occurred in low numbers (7% of all individual food items combined, Table 1) and, because its small size and biomass, they were of minor importance. Mean fish length was 49.96 mm (SD = 10.9 mm, range = 15-85 mm, N = 187; Fig. 1), while the mean length of prawns was 28.23 mm (SD = 4.65 mm, range = 24-40 mm, N = 17). All the insects, spiders and isopods were smaller than 10 mm.

### Prey abundance at foraging sites

After a first examination of the food consumed by spoonbills, we define potential prey of this species as all fish, prawns and crabs that appeared in our samples. Density of killifish and smelt (*Atherina boyeri*) was

**Table 1. Prey found in regurgitations and stomach contents from nestling Eurasian Spoonbills in the Odiel colony.**

| Prey category | Occurrence | Prey items |
|---|---|---|
| Fishes | 98.3 | 71.2 |
| *Fundulus* spp. | | 56.7 |
| *Atherina boyeri* | | 14.2 |
| *Solea* spp. | | 0.2 |
| Prawns (Palaemonidae) | 50.0 | 19.3 |
| Crabs (*Carcinus maenas*) | 6.9 | 0.9 |
| Crayfish (*Procambarus clarkii*) | 1.7 | 1.3 |
| Isopoda | 5.2 | 1.8 |
| Coleoptera | 12.1 | 2.4 |
| Heteroptera | 1.7 | 0.2 |
| Arachnida | 1.7 | 1.3 |
| Bivalvia | 3.5 | 0.2 |
| Gastropoda | 5.2 | 1.3 |
| Total (N) | 58 | 451 |

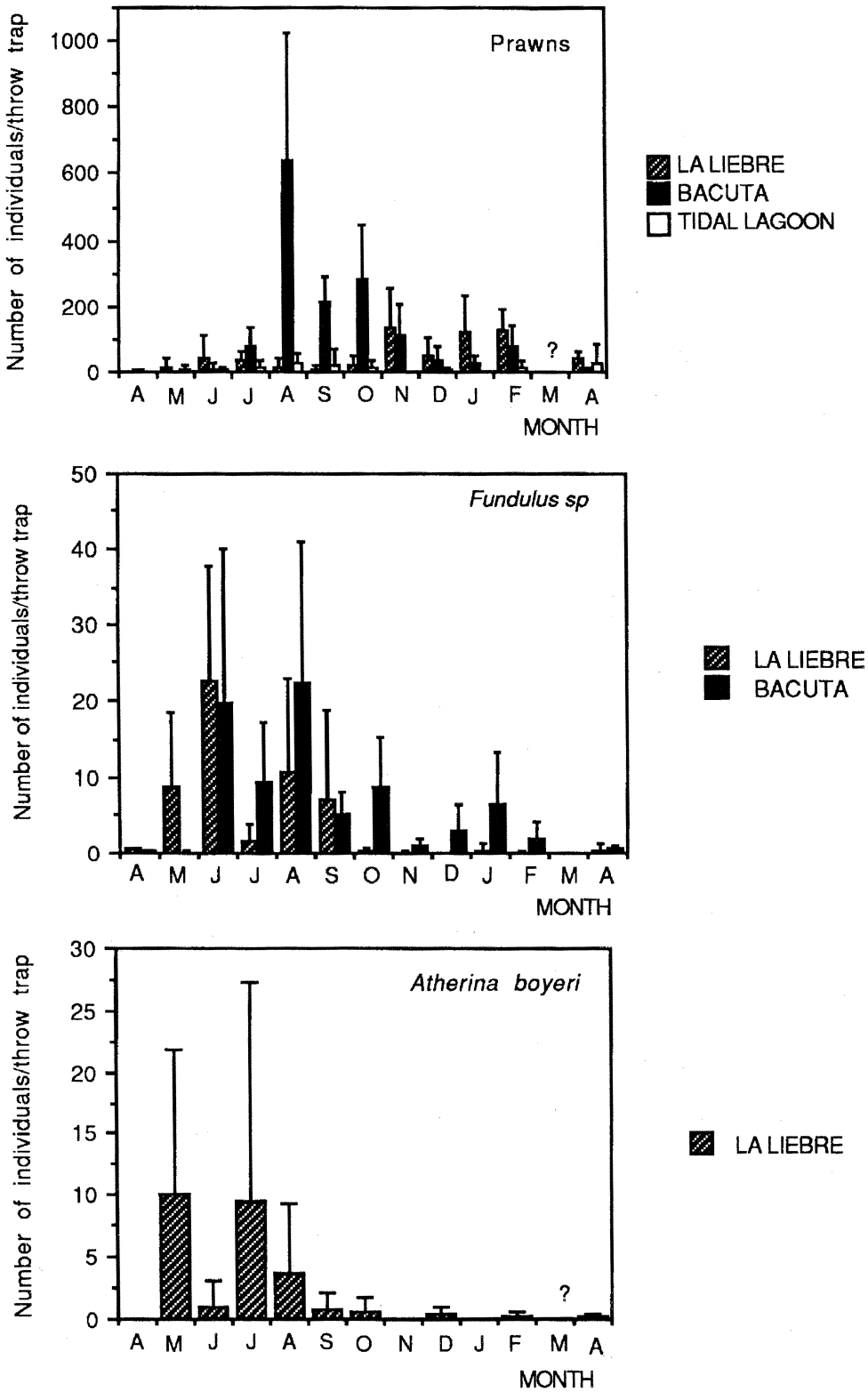


**Figure 2. Densities of the main prey consumed by nestling spoonbills at sampling sites.**

highest during spring and summer, reaching maximum values of 22.5 individuals/$m^2$ in June and 10 individuals/$m^2$ in May, respectively. Density of prawns was highest during summer and autumn reaching a maximum value of 642 individual/$m^2$ in August in Bacuta (Fig. 2).

A total of 1,667 potential prey were captured in 85 trap-throws during April-June 1991. Of these, 48.6% were fish, 49.6% prawns and 1.8% crabs. Ten fish species were identified in our samples, three of them representing more than 95% of the individuals. Killifish was the most abundant fish in the samples (N = 516) followed by sand goby (*Pomatoschistus minutus*, N = 148) and by smelt (N = 109). All prawns belonged to the family Palaemonidae. At La Liebre and Bacuta, *Palaemonetes varians* was the dominant species while at the tidal lagoon, *Palaemon elegans* and *P. serratus* were the most abundant.

The two main fish species in the diet, killifish and smelt, were absent from the tidal lagoon during April-June (Table 2), However, smelts were captured in that site out of this period. Killifish occurred at similar densities in both La Liebre and Bacuta, while smelt was only collected in La Liebre.

### Prey consumed vs. prey at foraging sites

Fish were consumed by spoonbills in a greater proportion than expected from their relative abundance at foraging sites ($\chi_1^2$=71.6, P<0.001). Although we detected at least 10 fish species at foraging sites (Table 2), only three species were found in the food samples (Table 1). Killifish was the most common prey of the spoonbills and also was the most abundant fish at foraging sites. However, it was consumed in a proportion larger than expected from their relative abundance among all fishes (79.7% vs. 63.5%, respectively; $\chi_1^2$=28.1, P<0.001). The same was found in the case of smelt (19% vs. 13.4%; $\chi_1^2$=7.6, P<0.01). The mean body length of both killifish and smelt found in regurgitations and stomachs combined was significantly longer than of those captured at foraging sites (killifish: 47.7 mm vs. 24.12 mm, respectively; Student t-test, $t_{681}$=33.3, P<0.001; smelt: 64.4 mm vs. 18.2 mm; $t_{134}$; = 50.2, P<0.001; Fig. 3). Sand goby was also common at foraging sites and, in fact, represented a greater proportion of the total fish number than smelt (18.2% vs. 13.4%, respectively), but it was absent from the food sample. On the other hand, prawns were eaten in a significantly lower proportion than they were found at foraging sites (19.3% vs. 49.6%, respectively; $\chi_1^2$=132.5, P<0.001), while no significant differences were found in the case of crabs (0.9% in food samples vs. 1.8% at foraging sites; $\chi_1^2$=0.96, P=0.32).

## DISCUSSION

With the exception of crayfish, all the prey ingested by nestling spoonbills at the Odiel colony were saltwater animals. Spoonbills fed on a narrow range of species, which probably reflects the low diversity of profitable prey present in the estuary. Prey that are consumed by spoonbills in other areas, such

**Table 2. Densities of prey per throw-traps in three locations of the Odiel Reserve during April-June 1991. Values are means (SD) number of individuals and biomass (g).**

| | La Liebre | | Bacuta | | Tidal Lagoon | |
|---|---|---|---|---|---|---|
| Prey | Indiv. | Biomass | Indiv. | Biomass | Indiv. | Biomass |
| Fishes | 15.2 (12.9) | 5.1 (4.2) | 8.9 (9.7) | 7.6 (4.2) | 3.9 (1.4) | 2.9 (0.8) |
| *Fundulus* spp. | 10.5 (11.1) | 4.6 (4.3) | 6.7 (11.2) | 2.3 (3.0) | — | — |
| *Atherina boyeri* | 3.6 (4.5) | 0.2 (0.4) | — | — | — | — |
| *Pomatoschistus minutus* | 1.0 (0.8) | 0.2 (0.2) | 1.2 (2.1) | 0.3 (0.5) | 3.3 (1.4) | 0.7 (0.4) |
| *Liza* spp. | — | — | 1.0 (0.9) | 5.0 (2.5) | 0.2 (0.1) | 1.5 (1.1) |
| Other fishes | — | — | — | — | 0.4 (0.3) | 0.6 (0.7) |
| Prawns (Palaemonidae) | 19.2 (20.6) | 2.3 (2.2) | 3.1 (5.1) | 0.5 (0.6) | 4.9 (4.5) | 2.2 (2.2) |
| Crabs (*Carcinus maenas*) | — | — | — | — | 0.9 (0.4) | 1.2 (0.9) |
| Number of throw-traps | 30 | | 25 | | 30 | |

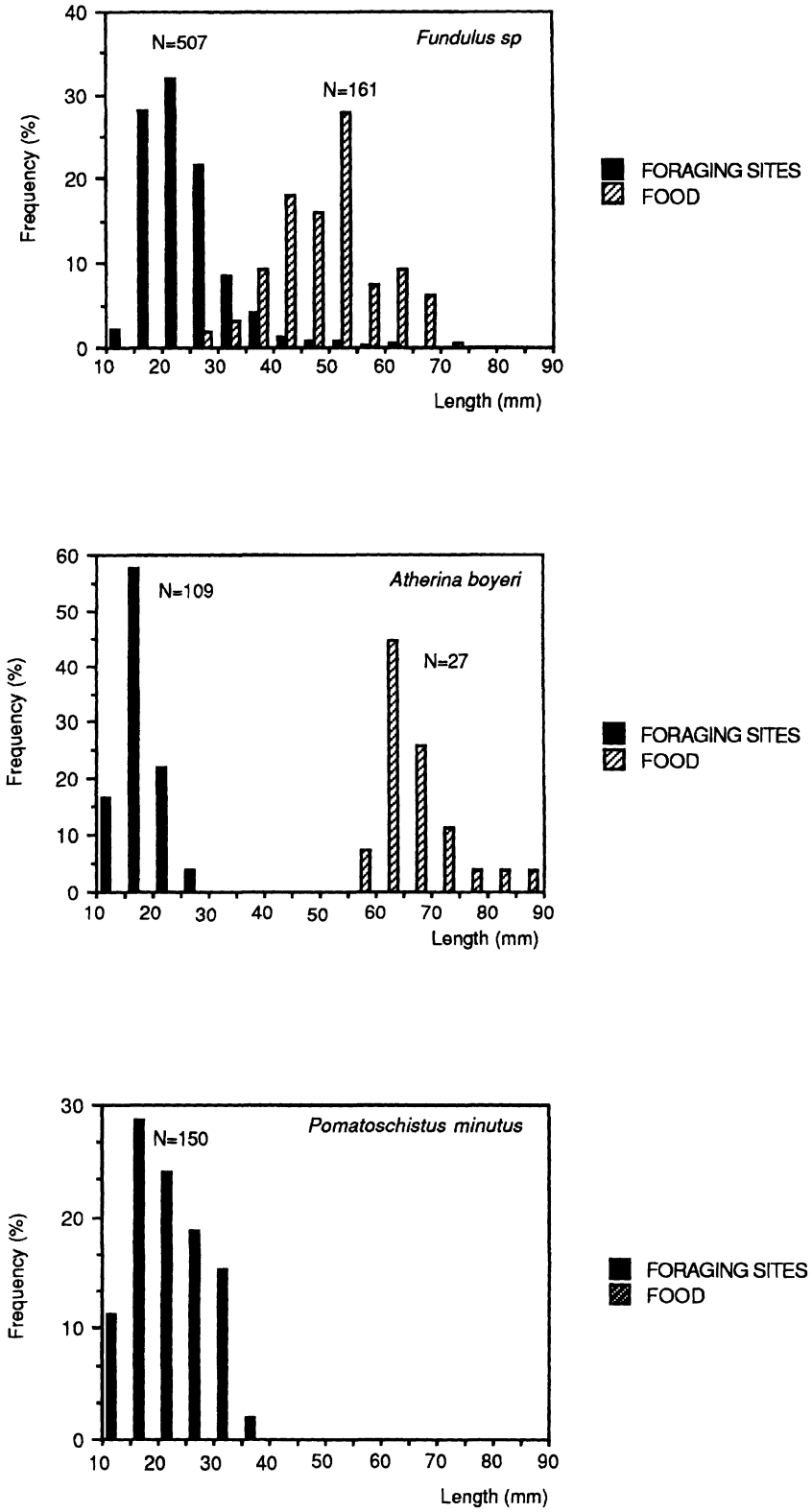


**Figure 3. Size distribution of the fish consumed by nestling spoonbills and those collected at foraging sites.**

as tadpoles, frogs or aquatic insects (Dementiev *et al.* 1969, Cramp and Simmons 1977) were absent at the Odiel estuary.

Fish predominated over aquatic invertebrates and among those, killifish, a *Fundulus* species whose taxonomy is still uncertain (Van der Zee 1988, Delgado *et al.* 1991), made up more than half the total prey items and an even larger proportion of the biomass. This prey was also the most abundant at foraging sites. Still, it was eaten in a proportion greater than expected from their relative abundance at foraging sites. Sand goby was common, although always at low densities, at the three sampling sites, but it was not present in the food samples. This species is a small, slim fish that rarely reaches a length of 5 cm (more than 80% of the individuals captured at foraging sites were less than 30 mm long). Its small size and low densities probably account for its absence among the prey captured by spoonbills. On the other hand, prawns were eaten in a relative lower proportion than expected. Like sand gobies, most individuals collected at foraging sites were very small and probably unprofitable for spoonbills (see also van Wetten and Wintemans 1986 for similar results in the Netherlands). Lengths of fish ingested by nestling spoonbills ranged between 20 and 87 mm, most of them falling in the 40-65 mm category. The average length of the fish eaten was longer than that of conspecifics captured at foraging sites. This suggests that spoonbills may prefer to capture larger individuals. Alternatively, larger fish may be better at avoiding the trap and hence their abundance may be underestimated in the samples (Kushlan 1981, Jacobsen and Kushlan 1987).

In the Odiel estuary, most spoonbills start breeding in February and March, when densities of their main prey is yet low. Peaks in densities of fish occur in May and June, the period in which the number of old nestlings at the colony reaches its maximum. On the other hand, the highest densities of prawns occur in summer, when semi-dependent fledglings are yet in the area and begin to forage on their own, before migrating.

Comparisons among the prey consumed by spoonbills and that present at foraging sites must be interpreted with caution. First, food samples were taken over a long period (1983-1993), while samples at foraging sites were collected during a single year. Second, an extensive part of the foraging habitats of spoonbills in the estuary has not been sampled. This includes the edge of the main streams in the marsh, temporal saltwater pools and the complex net of drainage channels and ditches that forms the marsh. In addition, although of minor importance, there are some freshwater habitats nearby the estuary, such as little lagoons and streams, where spoonbills sometimes were seen foraging and which were not sampled.

Despite these limitations, there are two points suggesting that those sites are representative of the whole habitat used by spoonbills to forage. First, it is the close similarity between the prey found in the diet and those found at sampling sites. Second, it is the proportion that the sampled habitats represents in relation to the total area available to the spoonbills to forage. Unaltered salt marshes cover approximately 3,900 ha and the habitats represented by the sampling sites cover about 500 ha, but most of the salt marsh area is occupied by dry grounds. Spoonbills, in fact, can only forage at temporal lagoons, the edges of main streams, ditches and little channels, and mainly when the tide is low. On the other hand, the construction and flooding in 1978 of the big water reservoir, La Liebre, and other associated ponds that feed the salina, coincides with the increase in the numbers of breeding spoonbills in this colony, suggesting the importance of these sites as foraging habitats for this population. However, we still need more detailed studies that combine an evaluation of habitat selection by the spoonbills with sampling of available prey in a wider variety of habitats.

ACKNOWLEDGMENTS

We thank the Agencia de Medio Ambiente and particularly J. C. Rubio, director of the staff of the Paraje Natural de las Marismas del Odiel, for permission and support during the fieldwork. Many people helped in the field, especially Isidro Barroso, Benjamín Busto, Luis García, Hector Garrido, Miguel Maneiro, Elena Mingens, Eduardo Tomás, Enrique Urbina and Manolo Vazquez. Manolo Librero identified the crustaceans and

José Hernando the fish. Comments by Tomas Redondo and two anonymous referees on an earlier version of the manuscript improved the paper. This study was funded by the Spanish Comisión Interministerial de Ciencia y Tecnología, Project no. 87-0316

## LITERATURE CITED

Aguilera, E. and F. Alvarez. 1990. Copulations and mate guarding of the Spoonbill *Platalea leucorodia.* Behaviour 110:1-22.

Andalus. 1980. Informe sobre las colonias de Ardeidos y Treskiornítidos de la Isla de Enmedio (Marismas de Huelva). Pages 27-34 *in* Actas I Reunión Iberoamericana de Zoólogos de Vertebrados (J. Castroviejo, M. Delibes and S. Moreno, Eds.). La Rábida, Spain.

Brouwer, G. A. 1964. Some data on the status of the Spoonbill, *Platalea leucorodia,* in Europe, especially in the Netherlands. Zoöl. Meded. (Leiden) 39:481-521.

Cramp, S. C. and K. E. L. Simmons. 1977. Handbook of the birds of Europe, the Middle East, and North Africa: the birds of the western Paleartic. Volume 1. London: Oxford University Press, London.

Delgado, J. V., A. Alonso, M. E. Camacho, J. Lobillo and J. M. Selma. 1991. Cytotaxonomy of a cyprinodontid population in southwestern Spain. Doñana Acta Vertebrata 18:251-257.

Dementiev, G. P., R. N. Meklenbursev, A. M. Sudilovskaya and E. P. Spangenberg. 1969. Birds of the Soviet Union. Israel Program for Scientifical Translations, Jerusalem, Israel.

Hancock, J. A., J. A. Kushlan and M. P. Kahl. 1992. Storks, ibises and spoonbills of the world. Academic Press, London.

Jacobsen, T. and J. A. Kushlan. 1987. Sources of sampling bias in enclosure fish trapping: Effects on estimates of densities and diversity. Fisheries Research 5:401-412.

Kushlan, J. A. 1981. Sampling characteristics of enclosure fish traps. Transactions of the American Fisheries Society 110:557-562.

Mountford, G. 1958. Portrait of a wilderness: The story of the Coto Doñana expeditions. Hutchison and Co., London.

Poorter, E. P. R. 1982. Migration et dispersion des Spatules néerlandaises. L'Oiseau et la Revue Francaise d'Ornithologie 4:305-334.

Rubio, J. and M. E. Figueroa. 1983. Medio físico, vegetación y evolución de las marismas de los rios Odiel y Tinto. Estudios Territoriales 9:59-86.

Van der Zee, J. R. 1988. Notes on the "Old World" killifish association. Jaka 21:1-2.

Van Wetten, J. C. J. 1986. The status and distribution of the Spoonbill *Platalea leucorodia.* Instituut voor Taxonomiche Zoologie, Universiteit van Amsterdam.

Van Wetten, J. C. J. and G. J. M. Wintermans. 1986. The food ecology of the Spoonbill *Platalea leucorodia.* Instituut voor Taxonomiche Zoologie, Universiteit van Amsterdam.