

## Foraging rhythm and chick diet in little terns in three adriatic coastal wetlands

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**Abstract** — The diet and foraging rhythm of the Little Tern were studied in the Comacchio Lagoon, the Venetian Lagoon and the Po Delta, Northern Italy. Chicks were more frequently fed in the morning and the evening than in the middle of the day. Freshwater fish and shrimps were more common in the morning. The frequency of fish prey in different wetlands reflected the main habitat availability within a 4 km radius of the colony.

### Introduction

The Little Tern *Sterna albifrons* is a declining species in the Palearctic. Major threats are the direct destruction of its nesting habitat and the disruption of natural landscape processes affecting deltas and other wetlands. Mediterranean coastal habitats suitable for breeding are rapidly modified by man. The distribution and nesting requirements of the Italian population, a stronghold of the species in the Western Palearctic (Fasola 1986), and its breeding sites conservation problems (Bogliani 1986) are well known.

This paper describes chick diet in relation to nesting habitat in three coastal wetlands and the foraging rhythm of the Little Tern in the Northern Adriatic, where the largest concentration of nesting pairs recorded so far in the Mediterranean is to be found. Feeding behaviour has been poorly investigated, both within and outside the Mediterranean area. A small number of studies describe the diet (Dementiev et al. 1966, Glutz von Blotzheim and Bauer 1982, Cramp 1985), the foraging niche (Isenmann 1979, Dubois 1982, Fasola et al. 1989) and chick behaviour (Davies 1981).

### Study areas

Data were collected in three neighbouring areas: the delta of the river Po in the Northern Adriatic, where Little Terns breed on the sea shore, the Comacchio lagoon, a very old lagoon, presently banked up at the edge and managed as a fish pond, and the stretch of the Venice Lagoon to the south of Venice. In the

Comacchio lagoon and in the southern part of the Venetian lagoon the terns breed on islets. The habitats available for foraging within 4 km of the colonies, the range to within which 90% of Little Terns restrict their foraging in the Comacchio lagoon (Fasola and Bogliani 1990) were calculated on aerial photographs (Tab. 1).

### Methods

Data on diet and feeding rhythm were collected on the Comacchio Lagoon from 2 June to 5 July 1983; while data on diet were collected in the Po Delta and the Venice Lagoon from 22 to 26 June 1985 and the 20 June 1986, respectively. Observations were carried out from hides close to the nests; prey size was estimated using the bill length as a reference, without correction for possible systematic error (Goss-Custard et al. 1987). The biomass (dry weight) of prey items was calculated from specific length-dry weight equations prepared using specimens collected in the study areas and dried at 70°C to a constant weight.

### Results

#### Foraging rhythm

In the Comacchio Lagoon the frequency of prey deliveries to chicks was higher in the morning (5-9h) and afternoon (15-21h) and significantly lower in the middle part of the day (Kruskal-Wallis test,  $H = 14.16$ ,  $P < 0.01$ ,  $n = 35$ ; fig. 1).

The prey brought to the chicks differed between the first and second half of the day (data grouped before 13h and after 13h;  $\chi^2=89.1$ ,  $P<0.001$ ,  $df=3$ ; fig. 2). Freshwater fish (see Tab. 1) and crustaceans were more frequent before 13h (freshwater fish:  $\chi^2=65.4$ ,  $P<0.001$ ; crustaceans:  $\chi^2=19.2$ ,  $P<0.001$ ). Big-scale Sand Smelt *Atherina boyeri* were more common in the diet after 13h ( $\chi^2=64.8$ ,  $P<0.001$ ), and there was no difference ( $\chi^2=0.9$ , ns) for other brackish water fish.

### Comparison of chick diet in different areas

Fish was the most important food brought to the chicks in all three areas (Tab. 1). Sand Smelt was the main food in the Comacchio lagoon, both in number and in biomass; the average length of a smelt was mm 32.2 (sd 3.7; range 6-75; n=766).

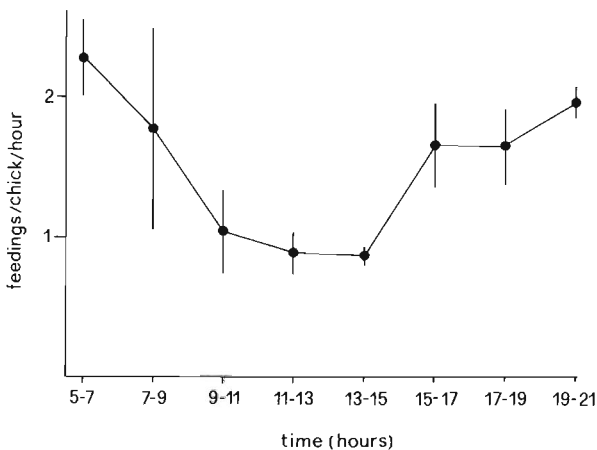


Figure 1  
Chicks feeding frequency during the day in the Comacchio Lagoon. Points show means, bars standard errors.

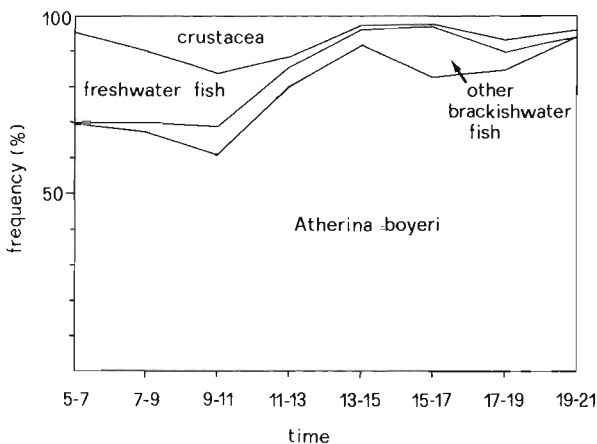


Figure 2  
Variation in the relative frequency of different prey types fed to chicks through the day in the Comacchio Lagoon.

Crustaceans were the next most common prey. Only two species of shrimps, *Palaemon elegans* and *P. adspersus*, were identified in food remains near the nests, but we were unable to distinguish between the species when observing from the hide, and indeed we are not sure that other crustaceans were not fed to chicks. The frequency distribution of shrimps lengths was bimodal, with the modes at 30 mm and 54 mm which agrees well with the mean lengths reported in the literature for *P. elegans* and *P. adspersus* (Cottiglia 1983). Prey items showed a relatively uniform mean length: Mosquito Fish *Gambusia affinis* 30.1 mm (sd 2.8, n=117); *Aphanius fasciatus* 24.8 mm (sd 7.9, n=44); Crucian Carp *Carassius carassius* 32.1 mm (sd 4.0, n=21); Gobiidae 34.3 mm (range 21-54, n=9). The main food item in the Po Delta was the Anchovy *Engraulis encrasicolus* both in frequency and biomass. The mean length is 66.0 mm (sd 14.0; n=24). This is followed by Gobiidae, mean length 36.0 mm (sd 7.0; n=11), and by Sand Smelt, mean length 52.0 mm (sd 19.0; n=12).

Gobiidae accounted for most of the biomass in the Venice Lagoon; mean length was 42.0 mm (range 10-60; n=10). The second most common item was the Sand Smelt, with a mean length of 50.0 mm (range 30-90; n=9).

The types of fish captured were directly related to the foraging habitat available around the colonies (Tab. 1). There was no difference between the frequency to prey from the different water habitats and the frequency expected on the basis of the availability of different water habitats within a radius of four km around the colony (Tab. 1), which is the Little tern's foraging range in this area (cf. above); (Comacchio lagoon -  $\chi^2=3.62$ ,  $df=2$ , ns; Po Delta, freshwater and brackish water fish were pooled to allow  $\chi^2$  testing -  $\chi^2=2.66$ ,  $df=1$ , ns).

## Discussion

The greater feeding of Little Tern chicks early and late in the day could be due either to the availability of preferred prey or to higher demand by the chicks. Indeed the foraging rhythm of the Gull-billed Tern *Gelochelidon nilotica* nesting in the Comacchio lagoon is linked to the availability of the main prey, the Ruin Lizard *Podarcis sicula* (Bogliani et al. 1990). Two other terns in the Comacchio lagoon, the Common Tern *S. hirundo* and the Sandwich Tern *S. sandvicensis* had a uniform arrival rhythm (Fasola et al. 1989). These species preyed on larger fish, which were captured far from colonies (Fasola and Bogliani 1990), and an increase in foraging rhythm was therefore more difficult.

Table 1. Food of Little Tern chicks and habitat features in three sites. The foraging habitats are percentages of water types within 4 km of the colonies. Results are expressed as frequency of occurrence (% N) and as dry weight (% DW).

	Comacchio Lagoon n = 1040		Po Delta n = 108		Venice Lagoon N = 53	
	%N	%DV	%N	%DV	%N	%DV
* fish						
B <i>Atherina boyeri</i>	73.6	69.4	20.4	15.1	24.5	17.2
B <i>Gambusia affinis</i>	11.2	4.4	9.3	0.5	1.9	0.1
B <i>Aphanius fasciatus</i>	4.2	6.8	3.7	2.1	24.5	15.6
F <i>Carassius carassius</i>	2.0	3.2	0	0	0	0
B <i>Gobiidae</i>	0.9	0.8	14.8	29.4	18.9	61.4
F <i>Scardinius erythrophthalmus</i>	0.4	0.8	0	0	0	0
F <i>Leuciscus souffia muticellus</i>						
F <i>Alburnus albidus alborella</i>	0.2	0.3	0	0	0	0
F <i>Lepomis gibbosus</i>	0.2	0.4	0	0	0	0
B <i>Syngnathus sp.</i>	0	0	2.8	0.1	11.3	0.3
M <i>Engraulis encrasicolus</i>	0	0	40.7	45.7	0	0
M <i>Sardina pilchardus</i>	0	0	4.6	6.1	0	0
crustaceans						
<i>Palaemon spp.</i>	7.2	13.9	3.7	0.9	18.9	5.4
Totals						
freshwater fish	2.8	4.7	0	0	0	0
euryaline/brackish water fish	89.9	81.4	51	47.2	81.1	94.6
marine fish	0	0	45.3	51.8	0	0
Foraging habitats						
freshwater	1.6		1.1		0	
brackish water	98.4		43.2		100	
sea	0		55.7		0	

\* main habitat of fish species: F - freshwater; B - brackish water; M - marine

Sand Smelt remained the main prey throughout the day, but their relative frequency changed, probably because of changes in the availability of alternative prey. Freshwater fish were important during the morning but very few were taken in the afternoon. This was possibly due to the greater activity of freshwater fish in the surface layer caused by a reduced concentration of dissolved oxygen in deeper layers during the night, when aquatic vegetation absorbs rather than produces oxygen, as was suggested by Kersten et al. (1991) for Little Egret *Egretta garzetta* feeding in freshwater pools. The higher frequency of crustaceans in the morning could have the same explanation.

Little Tern mainly searched for food within four km

of the colony (Fasola and Bogliani 1990). Within this radius Little Terns do not show a preference for prey from any particular water habitat, since the prey are represented in the diet in the same proportion as the main habitat availability. However, preference by the Little Terns for certain micro-habitats within each main habitat has been recognized and described (Fasola et al 1989). The Little Tern shows a low site tenacity (see McNicholl 1975) and nests mainly in ephemeral habitats, and therefore frequently changes its breeding site from year to year; its relatively low foraging habitat and prey specialization is a feature which allows the species to breed in a wide range of habitats.

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**Riassunto** — Si sono studiate la dieta ed il ritmo giornaliero di alimentazione del Fraticello in tre aree del Nord Italia: Laguna di Comacchio, laguna Veneta e delta del Po. I pulli sono alimentati con maggior frequenza al mattino ed alla sera rispetto alle ore centrali del giorno. Pesci d'acqua dolce e gamberetti sono le prede più comuni nelle ore mattutine. La frequenza dei pesci catturati in diverse zone umide rispecchia, in un raggio di 4 km dalle colonie, la disponibilità trofica di questi habitat.

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