Habitat Selection of Little Terns in the Evros Delta, Greece

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Abstract.—Habitat used by Little Terns was studied from 1984 to 1986 in the Evros Delta, Thrace, northern Greece. The two types of major available habitat (coastal and saltmarsh) supported 10 and 12 colonies respectively. Coastal colonies were larger and more isolated from access to ground predators. Most nests in all colonies were close to water. Three substrates were used: sand (coastal), sand-mud and shells (saltmarsh). Except for one colony on sand, nest density was generally higher on shells and most nests were in low vegetation cover (≤ 40%, average 15%). Although predation and flooding varied yearly, their impact was generally greater in the coastal habitat. Five other colonial Charadriiformes species (Avocets, Collared Pratincoles, Common Terns, Gull-billed Terns and Mediterranean Gulls) nested in or close to a number of Little Tern colonies. None of the association coefficients were significant. *Received 14 June 1989, accepted 17 July 1990.*

Key words—*Sterna albifrons*, nesting habitant, flooding, Evros Delta, Greece.

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The Little Tern (*Sterna albifrons*) has a worldwide but mainly northern hemisphere distribution (Cramp 1985). Evans (1986) estimated that 70% of the nominate race breeds within the Mediterranean and stressed the need for studies in the eastern part of this region. Qualitative information on habitat use of Little Terns in the Mediterranean region is available (Makatsch 1968, Brichetti and Foschi 1986, Meininger *et al.* 1986), but most quantitative data are for riverine habitats (Fasola and Bogliani 1984, Fasola 1986). Few studies report details of Little Terns in estuarine habitats (Atta 1986, Fasola 1986, Fasola *et al.* 1989). The purpose of this paper is to describe the use of breeding habitat of Little Terns in the estuary of the river Evros (hereafter Evros Delta) including details on vegetation preferences, association with other breeding Charadriiformes and relationship of habitat selection to nest losses.

Study Area and Methods

Little Terns breed in the seaward part of the Evros Delta, a region including coastal habitat characterized by a sandy substrate and the presence of ammophilous vegetation (Babalonas 1979, Goutner 1986) and a saltmarsh habitat characterized by sandy-mud substrate and halophytic vegetation (Babalonas 1979, Goutner 1985). The study area included parts of both habitats with beaches, sand-bars, sandy islets and the Drana lagoon, enclosed by dikes and containing islets in its interior (Fig. 1).

Field visits took place in June and July 1984 and from May to August in 1985 and 1986. A colony was defined as any aggregation of two or more nests situated more than 200 m from another group of such nests. Each colony was visited two to six times during the egg laying and hatching period and the following data taken: (1) number of nests with eggs (2) area of the colony measured by connecting the outermost nests by straight lines (Thompson and Slack 1982), (3) distance between the upper limit of the tide and the geographical center of the colony, (4) substrate type, (5) distance to the closest con-

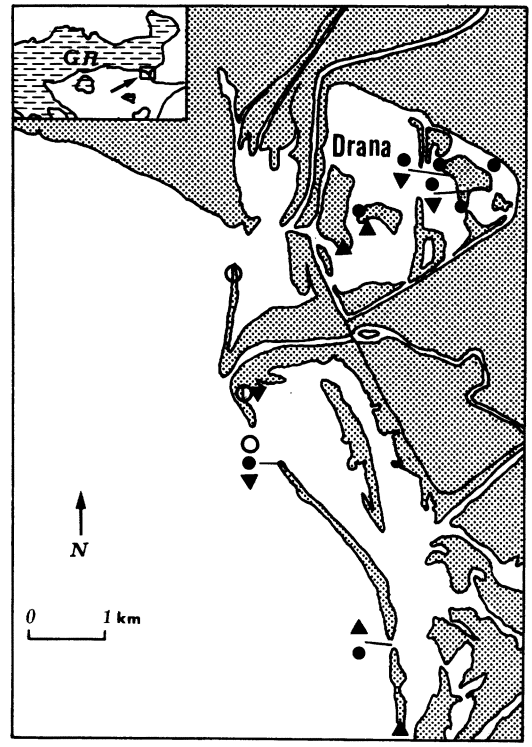

Figure 1. Map of the study area in the Evros Delta. Stippled areas represent land. Symbols represent colony sites; open circles, 1984; triangles, 1985; closed circles, 1986. The insert places the study area in the context of Greece as a whole.

specific nest and (6) vegetation cover. Vegetation cover was estimated visually using a 0.5 X 0.5 m grid divided into 10 X 10 squares placed with the central square above each nest in the colony. The same procedure repeated within colony areas by randomly throwing the grid along transects (see Soots and Parnel 1975, Blokpoel *et al.* 1978, Goutner 1987) until the entire area was covered. In colonies with ≤ 50 nests (N = 5) closest conspecific distance and cover were taken for all nests. To reduce disturbance in the three largest colonies, data were taken from a random sample of nests along transects within each colony so that all microhabitat types were represented. Nest data analyses was restricted to colonies of more than three pairs. Association between Little Terns and other colonial Charadriiformes nesting in the same localities was assessed with two tailed exact tests for 2 X 2 tables (Bailey 1979). I considered that a species was associated with Little Terns when their nests were intermixed and/or when their colonies were closer than 100 m.

RESULTS

Population distribution, colony size and colony site selection

For the period 1981 to 1986, the number of Little Terns pairs in the saltmarsh habitat was correlated with the total number present in the study area (Fig. 2, $r_s = + 0.9$, $P < 0.05$, Spearman Rank Correlation Coefficient). The mean number of pairs in 17 colonies where birds completed egg laying was 46 ± 64 (1 SD, median 18, range 3-277). Of a total of 22 colonies found from 1984 to 1986, five were destroyed before laying had been completed. Colonies were significantly larger in the coastal habitat (110 ± 98, N = 5, vs 21 ± 18, N = 12, $P < 0.01$ Mann-Whitney U-test). The mean distances of islet colony sites from the nearest mainland (measured on maps) were greater in the coastal than in the saltmarsh habitat (221 m, range 55-481 m, vs 137 m, range

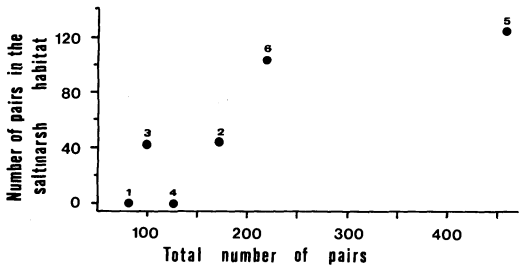

Figure 2. Relationship of the Little Tern breeding population in the saltmarsh habitat to that of the total population in the study area. The numbers 1-6 correspond to the years 1981-1986.

Table 1. The number and distance of Little Tern colonies from the closest water body.

Year	Distance from water (m)		
	< 5	5-25	26-80
1984	1	2	–
1985	6	1	1
1986	7	3	3
Totals (Percent)	14 (63.6)	6 (27.3)	2 (9.1)

10 -363). The mean distances of these colony sites from the nearest unused sites (which in all cases were other islets) were also greater in the coastal habitat (129 m, range 55-352 m, vs 69 m, range 10 - 121 m). Twenty colonies were less than 25 m from water (Table 1). Water depth on the landward side was less than 1.30 m. Twenty colonies were 25-35 cm above the high water limit and two (coastal habitat) were about 1 m above high water.

Substrates and densities

Little Terns used three types of substrate: sand, a mixture of sand and mud (thereafter sand-mud), and shells (of the bivalve *Cerastoderma glaucum*). Sand was available only in the coastal habitat while the two other substrates were available in the saltmarsh habitat. Of 22 colonies 10 (45%) were on sand, six (27%) on sand-mud, four (18%) on shells and two (9%) on both sand-mud and shells. Nest densities in colonies varied within the same substrate from year to year and also among substrates in each particular year. While the highest density was found in 1985 on sand, the overall nest density was highest on shells (Table 2).

Vegetation

Ten (45%) of the 22 colonies were among vegetation, eight (36%) at sites with vegetation but with no nests within it and four (18%) in vegetation free areas. Data for nest site cover are available for eight colonies established among vegetation, four in each major habitat. Average cover varied from 1.6% to 46.4%, with an overall average of 15.0%. Most nests were in the lower (0-10%) cover category even though not in proportion to the availability of this category (Fig. 3). A significant preference

Table 2. The number of Little Tern nests per ha in colonies on the three substrates used during the study years. The range in density is indicated where appropriate. Number in parenthesis are number of colonies.

		Sand	Sand-mud	Shells
1984		1407 (1)	–	–
1985		163-10296 (2)	251-3706 (4)	2851 (1)
1986		47-1235 (2)	649-890 (3)	1606-6589 (2)
	$\bar{X} \pm 1$ S.D.	2630 ± 4323 (5)	1385 ± 1313 (7)	3404 ± 1908 (4)[1]
Overall				
	Median	1235	824	1407

[1]One colony site was commonly used in both years.

for nesting among sparse-to-moderate vegetation appeared in three colonies (1, 2 and 3 in Fig. 3) and a significant preference for nesting in denser vegetation appeared in two (5 and 6 in Fig. 3). Twenty-two plant species were found at colonies with vegetation (Table 3). In the coastal colonies, *Atriplex tataraica, Suaeda maritima, Salicornia europaea* and *Aeluropus litoralis* were the most important plants near nests. In the saltmarsh habitat, *Halocnemum strobilaceum* was the most common plant species.

Nesting associates

The closest distance between conspecific nests varied from 32 cm to 1143 cm with an overall average of 233 cm (N = 440). Coefficients of association were examined between Little Terns and other colonial Charadriiformes including Avocets, Collared Pratincoles, Common Terns, Gull-billed Terns and Mediterranean Gulls; in no cases were these trends significant (Table 4). This suggests that there was no obligatory association between Little Terns and the five species mentioned.

Predation and flooding

Of a total of 959 nests found from 1984 to 1986, 582 (61%) were destroyed either

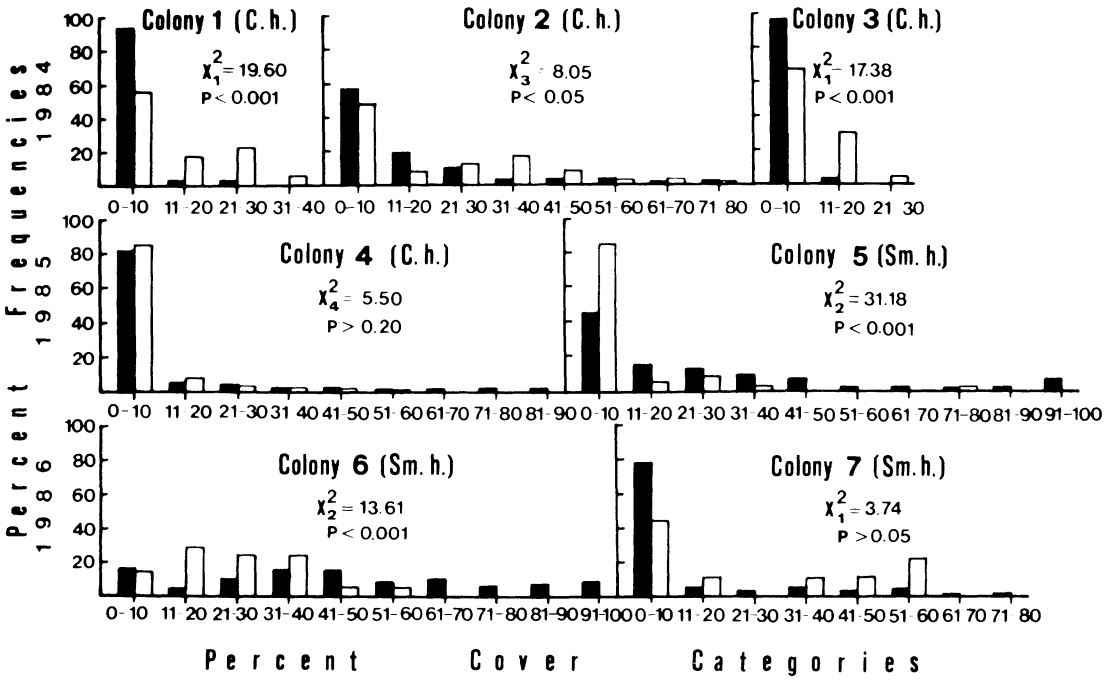

Figure 3. Percent cover categories in seven Little Terns colonies. Closed columns: random samples. Open columns: samples near nests. For sample sizes see Table 3. C. h. = Coastal habitat. Sm. h. = Saltmarsh habitat. Small numerals following the statistical symbols are degrees of freedom.

Table 3. Present frequencies of plant species in Little Tern colonies. Colony numbers refer to Fig. 3. A: Random samples. B: samples near Little Tern nests. Numbers in parenthesis are sample sizes.

	Coastal habitat								Saltmarsh habitat					
	Colony 1		Colony 2		Colony 3		Colony 4		Colony 5		Colony 6		Colony 7	
	A N=58	B N=65	A N=58	B N=27	A N=64	B N=18	A N=289	B N=154	A N=145	B N=69	A N=71	B N=21	A N=153	B N=9
Artiplex tatarica	7.8	50.0	3.4	1.5	13.8	63.0	–	–	–	–	–	–	–	–
Suaeda maritima	4.7	27.8	60.3	64.3	24.1	40.7	0.0	1.4	0.7	3.1	–	–	–	–
Suaeda splendes	–	–	–	–	–	–	8.3	6.5	1.4	0.0	–	–	–	–
Salicournia europaea	17.2	44.4	0.0	1.5	5.2	3.7	21.1	48.5	6.2	4.7	–	–	–	–
Arthrocnemum fruticosum	–	–	–	–	–	–	2.1	6.5	17.2	1.6	1.4	0.0	–	–
Aeluropus litoralis	–	–	10.3	16.9	–	–	15.2	16.7	6.2	4.7	–	–	–	–
Salsola soda	–	–	–	–	–	–	6.2	10.9	–	–	–	–	–	–
Salsola kali	–	–	3.4	3.1	–	–	–	–	–	–	–	–	–	–
Halimione portulacoides	–	–	–	–	22.4	14.8	1.7	0.7	9.0	0.0	–	–	–	–
Halocnemum strobilaceum	–	–	–	–	–	–	0.0	0.7	66.2	54.7	93.0	85.7	23.5	55.6
Puccinellia distans	1.6	0.0	–	–	3.4	11.1	0.3	0.0	–	–	–	–	–	–
Puccinellia festuciformis	–	–	–	–	–	–	–	–	0.7	0.0	–	–	–	–
Artemisia s. santonicum	–	–	–	–	–	–	1.4	7.2	–	–	–	–	–	–
Xanthium strumarium	–	–	–	–	–	–	0.3	0.0	–	–	–	–	–	–
Phragmites australis	–	–	–	–	–	–	2.8	0.0	–	–	–	–	–	–
Lolium perene	–	–	–	–	10.3	7.4	–	–	–	–	–	–	–	
Plantago coronopus	–	–	–	–	0.0	3.7	–	–	–	–	–	–	–	–
Chenopodium album	–	–	–	–	3.4	0.0	–	–	–	–	–	–	–	–
Agrostis sp.	–	–	–	–	–	–	0.3	0.0	–	–	–	–	–	–
Bromus sp.	–	–	–	–	–	–	–	–	2.7	0.0	–	–	–	–
Limonium bellidifolium	–	–	–	–	–	–	–	–	0.7	0.0	–	–	–	–
Limonium gmelinii	–	–	–	–	–	–	–	–	1.4	0.0	–	–	–	–

Table 4. Probabilities (P), coefficients of association (V)[1] of Little Terns with other coexisting colonial Charadriiformes and number of colonies from 1981 to 1986 (N = 40).

	R. a.	*G. p.*	*S. h.*	*G. n.*	*L. m.*
P	0.08	0.11	0.29	0.26	0.35
V	–0.26	–0.23	–0.09	+0.16	+0.09
Both species present	8	9	21	8	6
Little Terns absent	5	5	7	1	1
Other species absent	23	22	10	23	25
Both species absent	4	4	2	8	8

R. a.: *Recurvirostra avosetta*, G. p.: *Glareola pratincola*, S. h: *Sterna hirundo*, G. n: *Gleochelidon nilotica*, L. M: *Larus melanocephalus*.

[1]V = ad - bc /[(a+b) (c+d) (a+c) (b+d)]$^{1/2}$ (Krebs 1972) where a = species x any y present; b = species x absent, species y present; c = species x present, species y absent; d = both species absent.

by predation or flooding. Predation was by rats, foxes, corvids and gulls (in order of importance); flooding took place during strong winds (3-4 on the Beaufort scale). The effects of these factors differed from year to year in both major habitats (Table 5). Nest predation was the more important factor and its impact was greater in the coastal habitat as was flooding.

DISCUSSION

Data on the nesting distribution and nest location of Little Terns in the Evros Delta (Britton and Hafner 1978, Goutner and Kattoulas 1984, this study) suggest that their numbers and colony sizes were larger in coastal than in saltmarsh habitats. This pattern suggests selection for coastal habitat (cf. Jernigan *et al.* 1978). As Little Terns have been known to breed in the Evros Delta for many years (Bauer and Müller 1969), it is possible that they initially nested on the coastal islets since the Drana lagoon was not available until its completion in 1975. Settlement on coastal islets may have been encouraged by their isolation which was greater in earlier years than now due to greater distances to mainland . That Little Terns achieve protection by using islands has been reported for other areas in Europe (Wesołowski *et al.* 1985, Fasola 1986). Preference for proximity to water and low elevation have also been found for Little Terns in Europe and for *Sterna antillarum*, (e.g. Jernigan *et al.* 1978, Thompson and Slack 1982).

Considerably more Little Terns nested in the saltmarsh habitat in 1985 and 1986 than in previous years. The population of Little Terns greatly increased in 1985 and populations of other breeding larids using the coastal habitat also increased (Fasola *et al.* 1989). The especially high density of Little Tern nests on sand in 1985 may suggest a reduction in suitable habitat elsewhere. Reduction of available space because of competition with other colonial nesters could result in moving to the saltmarsh habitat. Interactions leading to displacement among larids breeding in the same localities are commonly reported (Mor-

Table 5. Nest predation and flooding in the coastal and saltmarsh habitats from 1984 to 1986 in the Evros Delta.

Year	Habitat	Nests predated by Nests (N)	Nests destroyed (percent)	flooding (percent)
1984	Coastal	126	110 (87.3)	0
	Saltmarsh	0	0 (0.0)	0
1985	Coastal	376	185 (49.2)	68 (18.1)
	Saltmarsh[1]	165	30 (18.2)	5 (3.0)
1986	Coastal	147	15 (10.2)	80 (54.4)
	Saltmarsh[1]	145	11 (7.6)	78 (53.8)
Overall	Coastal	649	310 (88.3)	148 (64.1)
	Saltmarsh	310	41 (11.7)	83 (35.9)

[1]Reflects predation on sand-mud as no nests on shell were predated.

ris and Hunter 1976, Burger and Lesser 1978, Burger and Shisler 1978, Erwin *et al.* 1981, Blokpoel and Tessier 1986). Another factor that might explain the shift to the saltmarsh habitat in 1985 is the predation pattern observed in 1984; nests in the coastal habitat suffered high predation rates. Predators in a nesting area is a crucial factor acting against selection of such sites by Least Terns and seabirds in general (Buekley and Buckley 1980, Burger 1984, Kotliar and Burger 1986). Movements within a general area may be facilitated by strong group adherence postulated for species such as Little Terns that nest in unsuitable habitats (McNicholl 1975). In 1985, nest losses of Little Terns were lower in the saltmarsh than in coastal habitat and this may has attracted a higher proportion of the total population in 1986. Furthermore, four of seven Little Tern colonies in the saltmarsh habitat were on shells and there was no predation of nests on this substrate. Although corvids and foxes were frequently present in the proximity of nests on shells, I attributed the lack of predation to effective camouflage of eggs provided by this substrate.

The greater exposure of nests in coastal habitat colonies did not always cause greater flooding losses. Flooding in saltmarshes (especially in 1986) resulted from Little Terns using low elevation sites, unvegetated (shell) or with low cover available only peripherally on islets. As Little Terns prefer low cover (Jernigan *et al.* 1978, Thompson and Slack 1982, Fasola 1986, Kotliar and Burger 1986), they avoided higher but densely vegetated sites in the interior of the islets where nests were safer from flooding.

In some colonies percent frequencies of particular plants were higher near nests than in random samples but in others these frequencies were similar. Larids may prefer or avoid particular plants in their colonies (Burger 1976, Burger and Lesser 1978), although the type of vegetation may sometimes be less important than cover (Burger and Gochfeld 1981). The reasons that Little Terns selected or avoided particular plants were not investigated in this study.

Little Terns are mentioned as associated with other waterbirds, especially Common Terns and in some cases the association was positive (Fasola and Bogliani 1984, Wesolowski *et al.* 1985) or negative (Soots and Parnel 1975, Jernigan *et al.* 1978). In this study none of the associations were significant. The fact that Little Terns were found at least on some occasions nesting together with all of the five species suggests that in the Evros Delta there was a mutual tolerance where they coexisted.

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