Nest Site Characteristics of Audouin's Gull in the Eastern Mediterranean

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Abstract.—Nest site characteristics were studied in five Audouin's Gull (*Larus audouinii*) colonies breeding on small rocky islands in the Aegean Sea, eastern Mediterranean. Although rocks and vegetation constituted the habitat of Audouin's Gulls, there were many intercolony differences in the use of these habitat features, especially those related to vegetation. Discriminant Function Analysis (DFA) indicated that vegetation parameters effectively identified habitat variables at nests. Different habitat variables discriminated between nest and random quadrats in three colonies. Percent rock cover around nests varied. The gulls nested relatively far from the available protruding rocks without a tendency to nest near rock crevices and, in two colonies, rock height had no relation with nest placement. In two of three of the colonies, gulls nested farther from vegetation, in lower vegetation, and in one colony percent vegetation cover at nests was higher than that generally available. Differences in vegetation types on each island partly accounted for such differences. Bushy plants seemed to be more important for the protection of larger chicks, rather than for nest sites, whereas the halophyte *Limonium vulgare* was mostly used for egg support. *Received 2 March 1999, accepted 18 April 1999.*

Key words.—Audouin's Gull, *Larus audouinii*, nest site characteristics, breeding, habitat, vegetation, Mediterranean, Greece.

Waterbirds 23(1): 74-83, 2000

Audouin's Gull (*Larus audouinii*) is a medium-sized gull which breeds only in the Mediterranean region. It has been categorized as a species of global conservation concern (Tucker and Heath 1994). At the end of the 1970s, the species was considered threatened with extinction (only 600-800 pairs; Witt 1976). However, the world breeding population has dramatically increased during the last two decades (now estimated at ca. 18,600 pairs), although 70% are concentrated at the Ebro Delta colony, Spain (Oro 1998). Cramp and Simmons (1985) stated that "(at the end of the seventies) probably more than 40 pairs occurred in about 12 colonies" in Greece. Recent surveys carried out by the Hellenic Ornithological Society (HOS) in the Aegean Sea discovered much higher populations: in 1997, at least 530 pairs were found in 20 colonies (HOS, unpubl. data).

The selection of a suitable colony site is important in the avoidance of predation and islands or inaccessible sites are often selected to avoid terrestrial predators (Buckley and Buckley 1980). Gulls are mostly colonial birds and it seems that the choice of breeding habitat and nesting sites is not random (*i.e.*, Burger and Lesser 1980; Becker and Erdelen 1986; Vermeer and Devito 1987). The presence of a suitable nest site may play a major role in the choice of breeding habitat (Bosch and Sol 1998). Nest site selection is a function of the characteristics within the immediate vicinity of the nest, as well as characteristics of the habitat patch surrounding the nest (Saliva and Burger 1989). Gulls should select characteristics that will increase reproductive success (Burger and Gochfeld 1988). Features of the microhabitat such as vegetation and rocks may be important in providing protection from predators and inclement weather conditions (Burger and Gochfeld 1981; Saliva and Burger 1989) and regulating the thermal environment at nests (Parsons and Chao 1983; Jehl and Mahoney 1987; Saliva and Burger 1989). In addition to predation, a combination of other factors, including territorial behavior and climatic conditions, determine nest site selection in gulls (Burger and Shisler 1978). Visibility of neighbors around nests affects the choice of vegetation or rocks around nests (Burger 1977; Cezilly and Quenette 1988).

Information on nesting habitat selection in Audouin's Gull is limited to some island colonies in Spain and Italy (Bradley 1986; Lambertini 1986; Monbailliu and Torre 1986). This paper reports the first quantitative information on nest site characteristics of Audouin's Gull in the eastern Mediterranean. Our aim was to describe and compare nest site characteristics among Audouin's Gull colonies situated in different parts of the Aegean Sea.

STUDY AREAS AND METHODS

The colonies were located on uninhabited rocky islands composed primarily of calcareous substrate. Four of them belong to the Dodecanese Archipelago (east Aegean Sea) and one to the Kytherian Sea, south of the Peloponnese. To protect the species, only general descriptions will be given of each breeding site.

The central Dodecanese colony (hereafter Lipsos colony) was situated on a peninsula of an island (22.5 ha) with rough terrain and considerable altitudinal differences. The eastern Dodecanese colony (Agathonisi colony) was located along the west coast of an almost level rocky island (12.7 ha). The western Dodecanese colony (Kinaros colony) was found on the west coast of an island with gentle slopes (17.5 ha). The north Dodecanese colony (Fourni colony) was located on the south eastern side of an island with rocky cliffs and rough terrain (c. 20 ha) and the Kythera colony was on a small rocky island, situated near the island of Kythera (c. three ha). Trees were absent from all study islands, which were dominated by low xerophytic vegetation such as phryganic (garrigue), grasses and occasionally maquis, while, at low-level sites sprayed by sea water, some halophytes were present. All colonies were situated on the lower parts of the islands, close to the sea.

Habitat data were collected during successive visits to each colony from late May to late June 1997, coinciding with the period from late incubation to late hatching of Audouin's Gull. For the quantitative description of the nesting habitat we used a one × one m quadrat divided by metal wire into 25 squares of 20 × 20 cm (Goutner 1992; Bosch and Sol 1998). The quadrat was placed above nests in a random direction, with the nest occupying the central square. The same procedure was repeated at random points within each colony (that is, the area enclosed by the peripheral nests) using tables of random numbers. In each quadrat sample, we recorded the number of 20 × 20 cm squares covered by each plant species (or group of related plant species) and the number of squares covered by rocks. Cover provided by each plant species, total vegetation and total rock cover as percentages were estimated by multiplying the respective number of squares by the number four. We also recorded the frequency of each plant in the sampled quadrats and the distance to the center of the nest (or, in the case of random samples, from the center of the central square of the quadrat) to the dominant and to nearest vegetation. We measured the maximum vegetation height in each quadrat sample, that is the height of the highest plant (ground to top); distance to nest center (or, in the case of the random samples, from the center of the central square of the quadrat) to the nearest protruding rock, maximum height (base to top) of this protruding rock (hereafter maximum rock height), and distance to the nearest rock crevice. The selection of the last parameter was based on preliminary observations during previous years indicating that, besides vegetation, chicks also used rock crevices in the vicinity of nests for cover (see also Brown and Morris 1995). Distances and heights were measured using a tape measure to the nearest cm. The data were collected at both nests and random sites at three colonies, but only at nests in the other two (Kinaros and Kythera).

Statistical analyses

Data from each colony were checked for normality (with Shapiro and Wilks, and Lilliefors tests) and comparisons were then made between nests and random samples using Student t-tests (with Levene's test) or Mann-Whitney U-tests, where appropriate. Data collected at nests were compared among colonies using two-way ANOVAs or Kruskal-Wallis χ^2 tests, where appropriate, with Scheffe-tests or Mann-Whitney U-tests respectively to assess differences. Multiple comparisons were Bonferroni corrected. To determine the most important nest-site factors which were probably selected by the gulls, nest and random data were subjected to Discriminant Function Analysis (DFA). The same procedure was applied for a multicolony comparison (five colonies). Correlated variables were excluded from the analyses. To overcome problems related to normality, data were standardized by subtracting from each value the mean and dividing it by its standard deviation. Chi-square tests or Fisher Exact tests (where appropriate) were used to assess differences in the frequency of occurrence of the different plant species found in nest and random quadrats. All statistical procedures were performed on the SPSS statistical package and the alpha level of significance was set at 0.05.

RESULTS

Mean percent rock cover was significantly higher near nests in two colonies (Lipsos, Fourni), but no significant difference occurred at Agathonisi colony (Table 1). The maximum rock height was insignificantly different in Lipsos and Agathonisi colonies, whereas it was higher near nests in Fourni colony. In these three colonies, the mean distance to the nearest protruding rock was significantly greater in nest than in random samples, but the mean distance to nearest rock crevice was similar in the two sample

Table 1. Nest site characteristics in Audouin's Gull colonies in the eastern Mediterranean.

		Lipsos				Agathonisi				Fourni				Kinaros (N = 15)		Kythera (N = 39)	
Characteristic	Site	X ± SD	N	Range	Statistics	X ± SD	N	Range	Statistics	X ± SD	N	Range	Statistics	X ± SD	Range	X ± SD	Range
Rock cover (%)	nest	70 ± 18	26	40-96	Z_1* = - 5.64, P < 0.001	48 ± 18	26	12-78	t_{46} = - 0.84, n.s.	39 ± 11	20	26-72	t_{32} = 2.91, P = 0.007	46 ± 18	12-76	33 ± 13	12-64
	random	97 ± 5	24	82-100		54 ± 31	22	10-96		26 ± 14	14	12-62					
Maximum rock height (cm)	nest	26 ± 10	26	10-48	t_{48} = -1.35, n.s.	22 ± 3	26	16-26	t_{42} = 0.40, n.s.	23 ± 2	19	18-26	t_{30} = 2.72, P = 0.011	n.d.	—	n.d.	—
	random	31 ± 15	24	12-67		23 ± 12	18	5-50		21 ± 9	14	12-47					
Distance to nearest protruding rock (cm)	nest	15 ± 10	26	6-52	Z_1 = - 6.43, P < 0.001	12 ± 6	26	7-34	Z_1 = - 4.33, P < 0.001	13 ± 3	19	11-20	U_1 = 47, P = 0.002	14 ± 5	6-22	17 ± 7	5-40
	random	0	24	—		9 ± 13	20	0-52		6 ± 9	14	0-30					
Distance to nearest rock crevice (cm)	nest	34 ± 15	24	13-83	Z_1 = - 0.98, n.s.	30 ± 13	22	7-55	t_{35} = - 1.46, n.s.	28 ± 10	18	14-44	t_{27} = 0.71, n.s.	28 ± 11	11-60	46 ± 26	10-110
	random	28 ± 14	24	0-50		36 ± 15	15	12-65		32 ± 18	11	8-53					
Vegetation cover (%)	nest	23 ± 16	26	0-56	Z_1 = - 4.70, P < 0.001	47 ± 19	26	16-84	t_{43} = - 0.37, n.s.	54 ± 12	20	24-70	t_{32} = 3.47, P = 0.002	42 ± 14	12-68	49 ± 17	20-84
	random	3 ± 5	24	0-18		49 ± 27	19	4-86		70 ± 14	14	34-84					
Maximum vegetation height (cm)	nest	19 ± 7	24	3-33	Z_1 = - 3.11, P = 0.002	24 ± 13	26	13-81	t_{43} = - 2.04, P = 0.048	24 ± 9	19	10-50	t_{31} = 2.05, P = 0.049	23 ± 8	13-44	54 ± 10	30-70
	random	13 ± 5	13	5-20		29 ± 11	19	15-48		30 ± 9	14	17-43					
Distance to dominant vegetation (cm)	nest	10 ± 3	24	4-20	t_{35} = - 2.67, P = 0.02	10 ± 3	26	0-16	Z_1 = - 2.77, P = 0.006	13 ± 3	19	11-24	U_1 = 15, P < 0.001	13 ± 9	5-36	16 ± 7	10-50
	random	22 ± 17	13	0-50		7 ± 9	19	0-30		5 ± 4	14	0-14					
Distance to any vegetation (cm)	nest	10 ± 3	24	4-20	t_{35} = - 4.82, P < 0.001	10 ± 2	26	3-15	Z_1 = - 4.33, P < 0.001	11 ± 3	19	1-16	U_1 = 4, P < 0.001	8 ± 3	4-12	37 ± 22	15-100
	random	22 ± 17	13	0-50		4 ± 6	18	0-22		2 ± 3	14	0-7					

*Mann-Whitney U-test, n.d. : no data.

types. Percent vegetation cover was significantly higher near nests at Lipsos colony, significantly higher at random quadrats at Fourni colony, but not significantly difference at Agathonisi colony. Maximum vegetation height was significantly higher near nests at Lipsos colony but significantly higher in random quadrats in the other two colonies. The mean distances to dominant vegetation and to any vegetation were significantly higher in random quadrats in Lipsos colony, whereas they were significantly higher in nest quadrats in the other two colonies.

In the DFA between nest and random data, percent vegetation-cover was excluded from the analyses in all three colonies, being highly correlated with percent rock cover. Distance to dominant vegetation was excluded from Lipsos data analysis, being highly correlated with distance to any vegetation. Different variables were selected by the model in each case in producing one significant function. At the Lipsos colony, significant correlations of this function were found with percent rock cover and distance to nearest protruding rock (Table 2), indicating that rock variables were important in producing the function and sufficient to discriminate between nest and random quadrats. At Agathonisi colony, correlation was found with the distance to any vegetation and, at the Fourni colony, with the distance to any vegetation and distance to the nearest protruding rock. In the DFA, the overall classification rate, that is the success rate of predicting the membership of nest or random quadrats, was high in all cases (Lipsos: 88.0%; Agathonisi: 86.4%; Fourni: 93.4%).

At Kinaros colony, percent mean rock and vegetation cover were similar near nests of Audouin's Gulls (46% and 42% respectively, Table 1). Rocks, rock crevices and short vegetation occurred at short distances to nests. At Kythera colony, mean percent vegetation cover was higher than mean percent rock cover around Audouin's Gull nests (49% vs. 33%, Table 1). Dominant and any vegetation, rocks, and rock crevices were relatively distant from nest sites, whereas vegetation was generally tall.

Audouin's Gull nest-site characteristics differed significantly among colonies studied (Table 3). For percent rock cover, the great difference among colonies was mainly due to the significantly higher mean rock cover on Lipsos colony. In contrast, the difference in percent vegetation cover occurred because cover around nests on Lipsos was significantly lower than in most other colonies. No differences were found between other colonies (where percent vegetation cover ranged from 0% to 56%). The mean distance to dominant vegetation differed significantly,

Table 2. Summary of Discriminant Function Analysis of variables measured in Audouin's Gull colonies.

	Between nest and random quadrats			Nest quadrats (all five colonies)	
	Leipsi	Agathonisi	Fourni	Function I	Function II
Eigenvalue	1.27710	1.29700	5.46570	4.79040	0.47310
% of variance	100	100	100	90.47	8.94
Canonical correlation	0.74890	0.75140	0.91940	0.90960	0.56670
Wilk's Lambda	0.43920	0.43530	0.15470	0.11370	0.65820
Chi-square statistic	26.33	24.53	48.529	239.187	46.006
df	2	1	2	20	12
P	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Pooled within groups correlations between discriminating variables and canonical discriminant function					
Rock cover (%)	0.84395	0.16697	-0.12129	—	—
Maximum rock height	0.10134	0.12654	0.23683	—	—
Distance to nearest protruding rock	-0.82879	-0.20523	0.40973	0.02122	0.10441
Distance to nearest rock crevice	-0.13856	-0.14479	0.08543	0.18383	-0.19631
Vegetation cover (%)	—	—	—	0.12141	0.80683
Maximum vegetation height	-0.32491	0.03980	-0.24790	0.70846	0.10328
Distance to dominant vegetation	—	0.29593	0.08962	0.19093	0.25079
Distance to any vegetation	0.17825	1	0.75374	0.46721	-0.02476

mostly due to much higher mean values at the Kythera and Fourni colonies. The mean distance of nests to the nearest rock crevice was similar at all colonies (range 28-34 cm) except Kythera (46 cm). The mean nearest protruding rock distance also differed significantly, with a maximum value at Kythera (17 cm) and a minimum value in Agathonisi colony (12 cm). The mean rock height marginally differed because of the difference between Lipsos colony (26 cm) and Agathonisi (22 cm). The mean distance to any vegetation was significantly different among colonies; it was highest at Kythera (37 cm) and lowest at Kinaros (8 cm). Mean vegetation height also differed significantly; it was also highest at Kythera colony.

A DFA was performed incorporating six variables from all five colonies studied (rock height was not available for Kinaros and Kythera colonies, and percent rock cover was excluded, being highly correlated with percent vegetation cover). The DFA selected five variables (all except distance to rock) and produced four functions, two of which were significant. The correlations between function I and maximum vegetation height and between function II and percent vegetation cover showed high positive loadings, indicating that vegetation parameters were sufficient to discriminate nests from random quadrats among the five Audouin's Gull colonies (Table 2). Overall classification rate of DFA for the five colonies was 68.1%. The model correctly classified 97.4% of Kythera nest quadrats, 86.4% of Lipsos, 77.8% of Fourni, 27.3% of Agathonisi and 13.3% of Kinaros colonies, suggesting that the DFA was good in discriminating only the first three colonies, based on vegetation parameters.

At least 23 plant species were found in the colonies studied. The Fourni and Agathonisi colonies had the highest plant species diversity. Graminae and Compositae occurred in all colonies and, in three of them, frequencies were similar in nest and random quadrats (χ^2 or Fisher Exact tests); and cover was also similar, suggesting use related to their availability (Table 4). At Lipsos and Agathonisi colonies, the dominant vegetation near nests, in terms of frequency of occurrence and coverage, was

Table 3. Comparison of nest-site characteristics in Audouin's Gull among five colonies. ANOVAs or Kruskal-Wallis χ^2 tests were used. In this table, P level for multiple comparisons is 0.005 due to Bonferroni corrections.

Characteristic	Statistics	Total P	1 vs. 2	1 vs. 3	1 vs. 4	1 vs. 5	2 vs. 3	2 vs. 4	2 vs. 5	3 vs. 4	3 vs. 5	4 vs. 5
Rock cover (%)	$F_{4,121} = 22.33$	<0.001	<0.001	<0.001	<0.001	0.001	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Maximum rock height (cm)*	$\chi^2_2 = 3.13$	0.05	n.s.	n.s.	—	—	n.s.	—	—	—	—	—
Distance to nearest protruding rock (cm)	$\chi^2_4 = 11.49$	0.022	n.s.	n.s.	n.s.	n.s.	n.s.	0.001	n.s.	n.s.	n.s.	n.s.
Distance to rock crevice (cm)	$F_{4,113} = 3.97$	0.005	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Vegetation cover (%)	$F_{4,121} = 14.02$	<0.001	<0.001	<0.001	<0.001	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Maximum vegetation height (cm)	$\chi^2_4 = 75.43$	<0.001	n.s.	n.s.	<0.001	n.s.	<0.001	<0.001	n.s.	n.s.	n.s.	<0.001
Distance to dominant vegetation (cm)	$\chi^2_4 = 38.13$	<0.001	n.s.	0.001	<0.001	n.s.	0.002	<0.001	n.s.	n.s.	n.s.	n.s.
Distance to any vegetation (cm)	$\chi^2_4 = 85.54$	<0.001	n.s.	n.s.	<0.001	n.s.	n.s.	<0.001	n.s.	<0.001	<0.001	<0.001

1: Lipsos; 2: Agathonisi; 3: Fourni; 4: Kythera; 5: Kinaros.
*Comparisons only among Lipsos, Agathonisi and Fourni.

the halophyte *Limonium vulgare*, occurring significantly more frequently near nests, although at Lipsos it provided much higher cover near nests than in random quadrats. At Fourni, apart from the dominant Graminae and Compositae, *Sarcopoterium spinosum* was similarly frequent in both sample types providing much lower cover near nests, and *Thymus* sp. was significantly more frequent at nests though average cover provided was not considerably greater than in random samples. At Kinaros colony, the most important plant near nests in terms of both frequency of occurrence and cover (93% and 18% respectively) was the shrubby *Frankenia hirsuta* (Table 4). Halophytes such as *Suaeda* and *Salicornia* (the latter absent in other colonies) were frequent but provided low cover. At Kythera colony, the most frequent plants near nests were *Elymus factus*, followed by *Frankenia hirsuta*, *Lavatera arborea* and *Brassica cretica*, whereas other plants were much less frequent.

DISCUSSION

Audouin's Gull in this study did not show any strong tendency to use particular habitat features. No uniform pattern occurred, although some characteristics such as the distance of the nest site from rocks and vegetation seemed to be more important. Advantages that have been attributed to the occurrence of rocks in the vicinity of gull nests are provision of cover, shade from the sun, protection from wind, and concealment from avian predators (Burger and Gochfeld 1981). In all the colonies we studied, although rock crevices were not found in the immediate vicinity of nests, they were used by small chicks for concealment during our visits. Presence of rock crevices in gulls' territories encourages chicks to stay in their own territory, so they are rarely attacked by neighbors during disturbance (Brown and Morris 1995). Older chicks were not usually confined near nests but could move away, below rocks or under bushes.

Heat waves and high diurnal temperatures may cause egg and chick mortality in gulls (Dawson *et al.* 1976; Salzman 1982; Jehl and Mahoney 1987). During incubation, especially in warm climates, increases in ground temperature may greatly affect thermoregulatory behavior and heat defense in adult gulls (Heerman's Gull, *L. heermanni*; Bartholomew and Dawson 1979). In the rocky environment of our study areas, which were exposed to the hot summer sun during the chick fledging period (late June and July), the highest ground temperatures encountered during mid-day (more than 40°C) would have been lethal for chicks. It would not seem beneficial to the Audouin's Gulls to nest near big protruding rocks. On the other hand, rock cover near nests would provide rock shadow and heat after sunset (Burger and Gochfeld 1981) for chicks.

Vegetation composition on each island studied presented particularities and these may in part have accounted for the observed differences in nest site vegetation characteristics. Vegetation features such as maximum vegetation height and cover differed greatly among colonies. Larids, especially smaller ones, frequently avoid dense vegetation probably so that birds do not risk becoming entangled in dense vegetation with a terrestrial predator (Burger and Lesser 1978; Blokpoel *et al.* 1978; Brower and Spaans 1994). Other species seem to prefer vegetation to avoid predators; the variability seems to be related to the suite of predators in an area (Saliva and Burger 1989). Nevertheless, in this study, vegeation does not appear to be important for nest cover at the Lipsos and Agathonisi colonies, while *Frankenia* may provide chick cover at nests in the Kinaros and Kythera colonies.

The tendency to nest among vegetation at Lipsos seemed to be due to particularities of the peninsula where the colony was situated, including very rough rock terrain and great slopes. The nests were constructed beside or even among the leaves of *Limonium*, a short broad-leaved plant, which generally provides little protective coverage, at least from above. This plant was greatly preferred probably because it provided good support for the eggs which could have otherwise rolled out of nests. At Fourni, *Pistacia*, an abundant plant forming low dense bushes, was absent at nest quadrats. During our visits over the fledging period, many chicks were

Table 4. Vegetation composition at nests and random sites at colonies of Audouin's Gull in the eastern Mediterranean.

		Lipsos (n*: N = 26, r**: N = 22)		Agathonisi (n: N = 26, r: N = 22)		Fourni (n: N = 20, r: N = 24)		Kinaros (n: N = 15)		Kythera (n: N = 39)	
Plants	Site	Freq. (%)	$\bar{X}$ % cover ± SD	Freq. (%)	$\bar{X}$ % cover ± SD	Freq. (%)	$\bar{X}$ % cover ± SD	Freq. (%)	$\bar{X}$ % cover ± SD	Freq. (%)	$\bar{X}$ % cover ± SD
Salicornia sp.	nest	—	—	—	—	—	—	33.3	5.9 ± 9.2	—	—
	random	—	—	—	—	—	—	n.d.	n.d.	—	—
Atriplex sp.	nest	—	—	19.2	4.7 ± 12.9	—	—	—	—	—	—
	random	—	—	—	—	—	—	—	—	—	—
Suaeda spp.	nest	—	—	—	—	—	—	53.3	10.4 ± 12.4	—	—
	random	4.2	0.2 ± 0.6	—	—	—	—	n.d.	n.d.	—	—
Silene sedoides	nest	7.7	0.4 ± 1.6	—	—	—	—	6.7	0.3 ± 1.0	—	—
	random	—	—	—	—	—	—	n.d.	n.d.	—	—
Capparis spinosa	nest	—	—	—	—	—	—	—	—	2.6	—
	random	—	—	9.1	1.7 ± 5.0	—	—	—	—	n.d.	—
Brassica cretica	nest	—	—	—	—	—	—	—	—	30.8	—
	random	—	—	—	—	—	—	—	—	n.d.	—
Sarcopoterium spinosum	nest	—	—	—	—	85	10.9 ± 9.8	—	—	—	—
	random	—	—	—	—	85.7	5.2 ± 23.5	—	—	—	—
Leguminosae	nest	—	—	—	—	—	—	26.7	2.4 ± 5.0	—	—
	random	—	—	—	—	—	—	n.d.	n.d.	—	—
Geraniacea	nest	—	—	—	—	—	—	—	—	—	—
	random	12.5	1.2 ± 2.6	—	—	—	—	—	—	—	—
Euphorbia sp.	nest	—	—	—	—	—	—	—	—	—	—
	random	—	—	—	—	7.1	0.3 ± 1.1	—	—	—	—
Pistacia lentiscus	nest	—	—	—	—	—	—	—	—	—	—
	random	—	—	—	—	14.3	3.4 ± 9.0	—	—	—	—
Lavatera arborea	nest	—	—	15.4	1.6 ± 4.8	—	—	—	—	30.8	—
	random	—	—	4.5	0.3 ± 1.4	—	—	—	—	n.d.	—

n*: nest samples.
r**: random samples.
n.d.: no data.
A: $^{-2}\chi^2_1 = 11.9$, P = 0.005.
B: Fisher Exact test, P = 0.015.
C: $^{-2}\chi^2_1 = 11.1$, P = 0.008.

Table 4. (Continued) Vegetation composition at nests and random sites at colonies of Audouin's Gull in the eastern Mediterranean.

		Lipsos (n*: N = 26, r**: N = 22)		Agathonisi (n: N = 26, r: N = 22)		Fourni (n: N = 20, r: N = 24)		Kinaros (n: N = 15)		Kythera (n: N = 39)	
Plants	Site	Freq. (%)	$\bar{X}$ % cover ±SD	Freq. (%)	$\bar{X}$ % cover ±SD	Freq. (%)	$\bar{X}$ % cover ±SD	Freq. (%)	$\bar{X}$ % cover ±SD	Freq. (%)	$\bar{X}$ % cover ±SD
Frankenia hirsuta	nest	3.9	0.1 ± 0.4	7.7	0.2 ± 0.6	—	—	93.3	18.3 ± 9.4	56.4	—
	random	—	—	—	—	—	—	n.d.	n.d.	n.d.	—
Limonium vulgare	nest	88.5	22.1 ± 15.6 *A*	100 *B*	25.2 ± 15.5	—	—	—	—	—	—
	random	37.5	4.5 ± 5.1	77.3	26.6 ± 19.9	—	—	—	—	—	—
Convolvulus sp.	nest	—	—	—	—	30	4.6 ± 8.0	—	—	—	—
	random	—	—	—	—	28.6	2.7 ± 0.9	—	—	—	—
Labiatae	nest	—	—	7.7	1.3 ± 5.9	5	0.2 ± 0.9	—	—	—	—
	random	—	—	—	—	—	—	—	—	—	—
Thymus sp.	nest	—	—	—	—	60 *C*	9.7 ± 11.3	—	—	—	—
	random	—	—	—	—	7.1	4.2 ± 15.5	—	—	—	—
Plantago sp.	nest	—	—	—	—	—	—	—	—	—	—
	random	—	—	9.1	3.0 ± 9.0	—	—	—	—	—	—
Urginea maritima	nest	—	—	—	—	5	0.5 ± 2.2	—	—	—	—
	random	—	—	—	—	—	—	—	—	—	—
Asparagus aphyllus	nest	—	—	3.8	0.1 ± 0.4	—	—	—	—	—	—
	random	—	—	—	—	—	—	—	—	—	—
Allium sp.	nest	—	—	—	—	—	—	—	—	17.9	—
	random	—	—	—	—	—	—	—	—	n.d.	—
Elymus factus	nest	—	—	—	—	—	—	—	—	71.8	—
	random	—	—	—	—	—	—	—	—	n.d.	—
Phagnalon sp.	nest	—	—	—	—	—	—	—	—	—	—
	random	—	—	—	—	14.3	1.7 ± 4.4	—	—	—	—
Other Graminae	nest	3.9	0.3 ± 1.6	65.4	13.0 ± 15.1	100	27.4 ± 11.6	80	4.7 ± 4.8	2.6	—
and/or Compositae	random	4.2	0.5 ± 1.7	72.7	17.9 ± 19.3	92.9	28.0 ± 19.5	n.d.	n.d.	n.d.	—

n*: nest samples.
r**: random samples.
n.d.: no data.
A: $^{-2}\chi^2_1$ = 11.9, P = 0.005.
B: Fisher Exact test, P = 0.015.
C: $^{-2}\chi^2_1$ = 11.1, P = 0.008.

found hidden among *Pistacia,* suggesting that it was important as a chick-refuge in this colony. Other species, such as the thorny *Capparis* and *Sarcopoterium,* may have discouraged nesting or use by chicks, and they were generally absent in nest quadrats. These imply that the type of vegetation is important in determining nest distribution in colonies of Audouin's Gulls.

Vegetation has been reported to affect nest distribution at other colonies of Audouin's Gull in the Mediterranean: at Chafarinas, Spain, gulls used vegetation available in their territories as chick refuges, and, in those lacking vegetation, chicks make longer trips in search of protective cover against heat and predators (Bradley 1986). At Isola dell' Asinara, Italy, Audouin's Gulls nest in low herbaceous plants, such as grasses that are situated in higher vegetation or near rock outcrops (Monbailliu and Torre 1986). In the Tuscan Archipelago, Italy, 90% of Audouin's Gull colonies included bushes or grasses, with a slight preference for medium-vegetation coverage (50%-75%) with higher bushes, 61-100 cm high (Lambertini 1986). In colonies where vegetation cover was generally higher than recorded in our colonies (23%-54%), vertical stratification of vegetation was considered to be an important factor, probably because higher vegetation allows chicks to hide under the lower strata.

In conclusion, some of nest site characteristics in Audouin's Gull colonies in the Aegean seemed to be selected to protect eggs and small chicks against weather and predators, rather than for the later protection of larger chicks.

ACKNOWLEDGMENTS

This research was conducted within the framework of the LIFE project carried out by the Hellenic Ornithological Society "The conservation of *Larus audouinii* in Greece", engagement no. B4-3200/96/498. We thank the European Community and the Ministry of Environment, Housing and Public Works for financial support, the Ministry of Agriculture and the Greek military authorities for permits to work and for access to the islands, respectively. Thanks to captains Kostas Papakonstantinou and Panagos Kabosos for transportation and to HOS for logistic support. Dr. Claire Papazoglou and Dr. Haralambos Alivizatos advised on statistical matters.

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