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NEST SITE SELECTION BY EARED GREBES IN A FRANKLIN'S GULL COLONY: STRUCTURAL STABILITY PARASITES[1]

JOANNA BURGER
Department of Biological Sciences, Rutgers University, Piscataway, NJ 08855-1059

MICHAEL GOCHFELD
Environmental and Community Medicine, UMDNJ-Robert Wood Johnson Medical School, Piscataway, NJ 08855

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The adaptive significance of birds nesting in colonies relates to predation and resource allocation. Birds that breed together may also provide social stimulation which increases reproductive synchrony and exposes eggs and young to predators for a shorter period of time (Burger 1981, Wittenberger and Hunt 1985). Further, nesting in colonies may allow individuals to forage more efficiently (Ward and Zahavi 1973, Waltz 1982).

Mixed-species nesting assemblages provide the same advantages, while possibly reducing competition for space and food (Krebs 1974). Species may also derive a protective advantage from nesting with more aggressive species (Koskimies 1957, Cullen 1960, Erwin 1979, Burger and Gochfeld 1990). Observing that Western Grebes (*Aechmophorus occidentalis*) derive early warning benefits from nesting with Forster's Terns (*Sterna forsteri*), Nuechterlein (1981) proposed that the grebes are information parasites, since they derive early warning from the anti-predator calls of the terns. Similarly, Silver (*Podiceps occipitalis*) and Rolland's (*Rollandia nigricollis*) Grebes derive anti-predator advantages from nesting with Brown-hooded Gulls (*Larus maculipennis*), and thereby have higher reproductive success than grebes that nest in monospecific colonies (Burger 1984).

Herein we examine nest site selection of Eared Grebes (*Podiceps nigricollis*) nesting in a Franklin's Gull (*Larus pipixcan*) colony in northwestern Minnesota. We suggest that the grebes not only derive early warning information and anti-predator behavior from the gulls, but that they also derive nest stability not otherwise available from the sparse vegetation in an open water marsh.

Eared Grebes assemble floating nests (Palmer 1962) and are known to associate with larids throughout their breeding range (Cramp 1977, Nuechterlein 1981, Boe 1993). Recently Boe (1992) examined wetland selection by Eared Grebes and compared 26 wetlands used by grebes with 26 wetlands not used. Colonies were generally in marshes with water less than 3 m deep, and they avoided marshes with public access and fishing. However, the selection of nest sites with respect to larid nests has not been examined in detail. Grebes could nest in a relatively monospecific clump within the larger gull colony, or their nests could be truly intermixed with the gull nests.

METHODS AND STUDY AREA

In May 1994 we examined nest site selection in one of two Eared Grebe colonies found nesting with Franklin's Gulls at Agassiz National Wildlife Refuge, Marshall County, Minnesota. We estimate that the mixed colony contained about 40,000 pairs of gulls. The birds nested in Agassiz Pool, where there was emergent veg-

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etation in a wide swath around the edge of the pool and in scattered "islands" throughout the otherwise open water. The gulls nested in Hardstem Bulrush (*Scirpus acutus*) and cattails (*Typha* spp.), but the grebes only nested in areas with bulrush. At the time of nest construction in early-May, only old bulrush stems from the previous year were present, and most of these had been cut for nest material by the gulls. Water depth under the mixed colony was 125–130 cm. Agassiz Pool does not have public access, an important characteristic noted by Boe (1992) for Eared Grebe wetland selection. The area surrounding the refuge is agricultural, although it was tallgrass prairie in presettlement times (Wendt 1984).

We collected nest site characteristics at 32 grebe nests, 32 gull nests, and at 32 matched points in the center of a grebe colony. We counted 257 adults around the colony and found 142 nests with eggs. A central area 10 × 15 m contained 70 grebe and 43 gull nests. We examined the nests in the center of the grebe colony under the assumption that this was the location of the earliest nests, later borne out by the order of hatching within the colony. We selected matched points by using a table of random numbers to generate the compass direction of the matched point from the grebe nest, and then recorded characteristics of a point 1 m from the edge of the grebe nest in the random direction.

At each nest we recorded the number of eggs, nest width (widest diameter), and percent of the eggs that were covered by vegetation. At each nest and random point we recorded distance to the edge of the nearest gull nest and to the nearest gull clutch (the latter indicates how close to each other birds would be sitting), distance to the nearest vegetation, percent emergent vegetation cover within 1 m of the nest, distance to the nearest emergent vegetation that extended above the water, percent surface covered with floating vegetation within 1 m of the nest (available for nest construction), total number of live *Scirpus* stems around the nest, and whether the nest was anchored to a gull nest.

We first compared gull and grebe nests and random points using a three-way Kruskal-Wallis χ^2 test, and there were significant differences for all characteristics ($P < 0.01$) except distance to the edge of the nearest gull nest. We then compared grebe nests with gull nests, and each with the random points.

RESULTS

The gulls initiated egg-laying on 10 May 1994, while the grebes initiated egg-laying on 17 May, nesting in two compact colonies in the much larger gull colony. In each of these the grebe nests were intermixed with gull nests, and were not in a monospecific subgroup within the gull subcolony. A third grebe colony formed within the gull colony at about the time of hatching of the gulls (1 June). As many as seven grebe nests were attached to one gull nest, but usually only one to three were attached.

The grebe nests were of wet, mostly submerged vegetation, and were very compact and circular, without loose ends or ramps. The widest diameter averaged 34.7 cm (SD = 7.9), slightly larger than those reported for Europe (mean = 26 cm, maximum = 34 cm; Cramp 1977). The gull nests were large platforms with a discrete nest cup in the center, a ramp leading to the water, and were general circular or oval. The grebes generally covered their eggs with wet vegetation when they departed from the nest, whereas the gulls did not, although some vegetation fell over the eggs as the gulls flew (Table 1).

Most grebe nests were attached to the edges of the gull nest platforms, and were thus firmly anchored (Table 1). The three grebe nests that were anchored only to emergent vegetation could be easily moved away from their moorings. Nests attached to gull nests could not be moved more than a few cm.

Grebe nest site characteristics differed significantly from gull nests and the random points with respect to percent of floating vegetation around their nests, number of live *Scirpus* stems around the nest, and distance to the nest cup of the nearest neighbor (Table 1). Grebe nests had more total vegetation material, but fewer emergent, live *Scirpus* stems around their nests than did the gull nests. The random points generally had less floating vegetation, fewer emergent stems, and less total vegetation around the points than did the nests (Table 1).

DISCUSSION

It has been documented for a number of grebes (Nuechterlein 1981, Burger 1984) and other species (Cullen 1960, Erwin 1979, Burger and Gochfeld 1990) that nesting within the colonies of aggressive species, such as larids, provides them with early warning and antipredator protection that they themselves cannot provide. In the case of grebes, the gulls provide early warning; some are always flying above the colony and call loudly when they see approaching predators. The grebes then may have time to cover their eggs and slip silently into the water, emerging far from their nests and danger.

We suggest, however, that the Eared Grebes we studied also derived an additional benefit from nesting in the gull colony at Agassiz. They derived structural stability in an otherwise relatively open water area. When the gulls constructed nests in the bulrushes, only old stems from last years growth remained, and the gulls cut off most of these at the water level for nest material. The gull nests, however, were anchored to the previous-years bent over bulrushes, and were relatively secure. They did not move when pushed.

When the grebes started nest construction, very few bulrush stems emerged above the water surface. The three nests examined in our sample that were not anchored to gull nests were anchored to new bulrush stems but were easily moved by pushing, and could be totally dislodged. The nests that were anchored to gull nests could be moved a few cm, but were firmly attached to the edge of the gull nests (which were themselves hardly movable). There were an additional twelve grebe nests at the edge of the grebe colony that were not attached to the gull nests, and these also were attached to bulrush stems but were not firmly anchored.

Nests that are firmly anchored, whether they be gull or grebe nests, are less vulnerable to winds and storms than are unanchored nests. Nests that are not firmly anchored can be dislodged, blown across the open water, and overturned. Eggs and chicks on nests that are blown away can be dumped into the water, and nests

TABLE 1. Characteristics ($\bar{x} \pm$ SE) of grebe and gull nests and matched points at Agassiz National Wildlife Refuge, Marshall County, Minnesota (1994). Given are Kruskal-Wallis χ^2 (*P*).

Characteristic	Grebe	Gull	Matched	Comparisons		
				Gull with Grebe	Grebe with Matched	Gull with Matched
Clutch size	2.3 ± 0.2	3.0 ± 0.0		12.7 (0.0004)		
Nest width (cm)	34.7 ± 1.4	106 ± 3.9		47.5 (0.0001)		
Percent of egg covered	74.2 ± 5.6	10.0 ± 5.0		6.1 (0.01)		
Distance to edge of nearest gull nest (cm)	138.6 ± 18.9	132.8 ± 22.8	62.1 ± 27.3	ns	12.6 (0.01)	11.2 (0.01)
Distance to cup of nearest gull nest (cm)	168.3 ± 10.9	195.2 ± 2.6	62.1 ± 27.3	12.6 (0.01)	18.5 (0.0001)	28.3 (0.0001)
Distance to nearest vegetation (cm)	20.8 ± 1.7	22.7 ± 2.4	30.6 ± 3.4	ns	4.7 (0.03)	ns
Percent vegetation around	9.1 ± 2.5	6.4 ± 0.7	2.4 ± 0.7	ns	16.8 (0.0001)	21.7 (0.0001)
Percent floating vegetation around nest	37.9 ± 4.0	85.3 ± 2.1	31.2 ± 5.8	35.6 (0.0001)	3.6 (0.06)	28.3 (0.0001)
Number of live *Scirpus* stems around nest	4.0 ± 0.4	14.3 ± 0.8	0.8 ± 0.2	38.3 (0.0001)	33.9 (0.0001)	48.7 (0.0001)
Percent anchored to gull nest	91	0	16[a]	71.4 (0.0001)	—	—

[a] If nest were placed at this point.

blown too far from a colony are deserted by their parents. We suggest that one advantage Eared Grebes derive from nesting within a gull colony is structural stability derived from attaching their nests to the gull nests.

Franklin's Gulls do not prey on the eggs and chicks of conspecifics or other species (Burger 1974), and thus do not pose a predatory threat to the grebes. Occasionally gulls will gakker aggressively at the grebes as they slip onto their nests (unpubl. data), but they stop when the grebes are incubating.

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PLASMA CORTICOSTERONE IN BAR-TAILED GODWITS AT A MAJOR STOP-OVER SITE DURING SPRING MIGRATION[1]

Marilyn Ramenofsky
Department of Zoology, NJ-15, University of Washington, Seattle, WA 98195

Theunis Piersma
Netherlands Institute for Sea Research (NIOZ), P.O. Box 59, 1790 AB Den Burg, Texel, The Netherlands

Joop Jukema
Haerdawei 44, 8854 AC Oosterbierum, The Netherlands

Key words: Bar-tailed Godwit; body mass; corticosterone; migration.

Shorebirds that overwinter at mid-latitudes but breed in circumpolar regions in spring must cover vast distances in remarkably short periods of time (Alerstam and Lindström 1990, Drent and Piersma 1990, Evans and Davidson 1990). Such long-distance migrations involve a suite of behavioral and physiological adjustments to changes in climate and ecology many of which are not thoroughly understood (Ramenofsky 1990, Wingfield et al. 1990, Jenni-Eiermann and Jenni 1991). One of the better known features of long-distance migration is the preparatory phase that involves storage of fuels (particularly fat and protein) prior to

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