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The Condor 91:997–998

ON THE FLUSHING BEHAVIOR OF INCUBATING WHITE TERNS[1]

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Key words: White Tern; Gygis alba; *flushing; nest sites; behavior; Laysan Island.*

White Terns (*Gygis alba*) breed on small islands throughout the tropical Pacific, Indian, and South Atlantic oceans. The single egg usually is laid on a rock, a rock ledge, or a bare branch rather than in a nest built by the adults (Howell 1978). On some substrates (e.g., branches and smooth rocks), eggs are easily dislodged by strong winds or by the sudden departure of incubating adults (Ashmole 1968, Howell 1978, Houston 1979, Rauzon and Kenyon 1984). Perhaps because they are so vulnerable, eggs are seldom left uncovered (Howell 1978), and adults are extremely careful when settling upon and rising from their eggs (Dorward 1963). Hatchlings, which have long toes and sharp claws, cling tightly to the nest substrate (Dorward 1963, Howell 1978, Rauzon and Kenyon 1984) and are less likely to fall from nests than are unattended eggs.

We compared the flushing behavior of White Terns nesting on coral rocks vs. those nesting in trees. We hypothesized that if eggs laid in trees are more vulnerable to displacement, then tree-nesting terns should sit tighter on their eggs than do rock-nesting terns.

We observed nesting White Terns on Laysan Island (25°46′N, 171°44′W) in the Northwestern Hawaiian Islands from September to November 1988. White Terns breed year-round on Laysan and nest primarily on small coral rocks and on rock ledges (Ely and Clapp 1973). Twenty-five of the 30 nests we observed were on coral rocks and five were in trees (four in *Tournefortia argentea* and one in *Casuarina equisetifolia*).

Between 29 September and 3 November, we recorded flushing distances of incubating White Terns at seven rock nests and five tree nests. Tern nests chosen for observation occurred along a route that we traveled daily in pursuit of other duties. Flushing distances were recorded only during the first half of the 36-day incubation period (Howell 1978, Miles 1986), which we confirmed from known egg-laying dates or by backdating from hatching dates. Once each day for seven consecutive days, a single observer approached a nest (from the same direction each time) while walking in open view of the incubating adult. The observer stopped when the adult flew, and then paced (each step approximately 1 m) to the nest to measure the flushing distance. Cases in which adults did not flush were given a value of 0.5 m, which was the closest distance that we approached nests. Recording times were staggered so that similar numbers of measurements were obtained for each nest during morning, midday, and afternoon.

White Terns nesting in trees sat very tight on their eggs, always allowing us to approach to 2 m or less and often not flushing at all (Table 1). In contrast, rock-nesting terns flushed at much greater (and more variable) distances, never allowing us closer than 2 m from the nest (Table 1). The mean flushing distance for rock-nesting terns was significantly greater than that for tree-nesting terns (18.4 vs. 0.7 m; Mann-Whitney $U = 35$, $P = 0.004$).

The striking difference in flushing behavior between tree-nesting and rock-nesting White Terns supports our hypothesis that flushing behavior is influenced by the vulnerability of eggs to displacement. On Laysan, all rocks selected by nesting White Terns had shallow indentations in which terns laid their eggs. Eggs rested securely in these pockets and appeared relatively safe from displacement. In contrast, eggs laid on tree branches appeared precariously balanced and could have been easily dislodged by strong winds or by sudden movements of adults. Indeed, one egg fell to the

[1] Received 3 April 1989. Final acceptance 12 June 1989.

TABLE 1. Flushing distances and nest heights of White Terns nesting on Laysan Island, September to November 1988.

	Flushing distance (m)			Nest height (cm)
	$\bar{x}$	SD	Range	
Tree nests				
S Camp	0.5	0.0	0.5–0.5	79
Casuarina	0.5	0.0	0.5–0.5	161
Noddy[a]	0.5	0.0	0.5–0.5	65
S Camp II	0.9	0.4	0.5–1.5	89
Camp	1.1	0.5	0.5–2	22
Rock nests				
Camp N	4.5	2.2	2–8	7
Puka Beach II	4.6	1.0	3–6	15
Far North	5.8	4.4	3–14	29
Puka Beach I	10.0	4.4	6–18	8
NW Beach	16.1	6.6	7–24	6
Pupland	30.0	16.2	11–58	12
W Beach	58.0	17.8	23–75	11

[a] $n = 7$ for all nests but Noddy ($n = 2$).

ground and broke when an adult knocked it from a tree branch after we had ceased measuring flushing distances.

Rock nests were closer to the ground than were tree nests ($\bar{x}$ = 12.6 vs. 83.2 cm; $t = 3.7$, df = 10, $P = 0.004$; Table 1), and perhaps rock-nesting terns flew sooner because they perceived us to be a greater threat than did tree-nesting terns. All tree nests were within 1.6 m of the ground, however, and without climbing, we had easy access to nests of both types.

Each tree-nesting White Tern had several unused coral rocks near its nest. Given the increased potential for egg displacement at tree nests, why did White Terns on Laysan not nest exclusively on rocks? We offer three possible answers to this question.

First, rock nests may be more vulnerable to predation than are tree nests. Although White Terns have no natural mammalian predators (Howell 1978, Houston 1979), Bristle-thighed Curlews (*Numenius tahitiensis*) feed on seabird eggs (Ely and Clapp 1973) and are mobbed by White Terns (pers. observ.). Most tree nests are safe from Bristle-thighed Curlews, which forage only on the ground (pers. observ.). Rock nests may also be more vulnerable to predation by frigatebirds than are tree nests. Dorward (1963) noted that Sooty Tern (*Sterna fuscata*) chicks, which reside in open ground nests, often are taken by Ascension Frigatebirds (*Fregata aquila*), whereas White Tern chicks on cliffs are safe from frigatebird predation. Great Frigatebirds (*F. minor*) are common on Laysan and could easily capture tern chicks at rock nests. Second, tern eggs may be more easily damaged on rocks than on trees. Dorward (1963) noted that several White Tern eggs laid on rocks had cracks "presumably made in laying," and he suggested that eggs laid in trees do not suffer such misfortunes. Lastly Houston (1979) speculated that White Terns nest in trees to reduce the likelihood of parasite infestation. Although untested, these are reasonable explanations for the use of tree nests by White Terns that have other suitable nest substrates available to them.

Clearly, White Terns nesting on tree branches sit tighter on their eggs than do those nesting on rocks. We suggest that this phenomenon reflects differences in the vulnerability of eggs to displacement. One possible test of our hypothesis would be to compare flushing distances at tern nests before and after moving eggs from tree branches to rocks and vice versa. We note, however, that such an experiment would not be appropriate at a wildlife refuge such as Laysan Island.

Stewart Fefer, Ken McDermond, and Craig Rowland issued permits and provided logistical support for our work in the Hawaiian Islands National Wildlife Refuge. Funding was provided by the Alaska Fish and Wildlife Research Center and the Montana Cooperative Wildlife Research Unit, both of the U.S. Fish and Wildlife Service. The manuscript was improved by the comments of Dick Hutto, Dorothy Miles, Roly Redmond, and an anonymous referee. We thank them all.

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