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NEST-SITE CHARACTERISTICS OF RED-TAILED TROPICBIRDS ON ROSE ATOLL, AMERICAN SAMOA

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Abstract.—We examined nest sites of Red-tailed Tropicbirds (*Phaethon rubricauda*) on Rose Island of the Rose Atoll National Wildlife Refuge, American Samoa, to determine habitat features important for nest-site selection of this species. We quantified habitat characteristics at 27 nest sites and at 27 random sites during September 1991. All nests were located under beach heliotrope (*Messerschmidia argentea*) shrubs or pisonia (*Pisonia grandis*) trees. Nest sites were placed farther under the nest shrub, had more stems in the nest space, and greater percent shade cover than random sites. Nest sites averaged 24.9 m from their nearest neighbor, ≥20 m greater than has been reported elsewhere for this colonial species. We suggest that an overpopulation of Polynesian rats (*Rattus exelans*) may have influenced nest-site selection by Red-tailed Tropicbirds on Rose Island.

CARACTERÍSTICAS DEL LUGAR DE ANIDAMIENTO DE *PHAETHON RUBRICAUDA* EN EL ATOLÓN ROSE, SAMOA AMERICANA

Sinopsis.—Examinamos los lugares donde anida *Phaethon rubricauda* en el Atolón Rose, Samoa Americana, para determinar los parámetros del habitat que eran importantes para la selección del lugar de anidamiento por parte del ave. Cuantificamos las características del habitat en 27 lugares de anidamiento y en 27 puntos tomados al azar durante septiembre del 1991. Todos los nidos fueron localizados bajo arbustos de *Messerschmidia argentea* o árboles de *Pisonia grandis*. Los lugares utilizados para anidar tenían mayor número de tallos y mayor porcentaje de cubierta de sombra y los lugares examinados al azar. Los lugares de anidamiento promediaron 24.9 m del vecino más cercano, esto es >20 m más que lo informado previamente para esta especie que es colonial. Creemos que la enorme cantidad de ratas (*Rattus exelans*) en la localidad haya influenciado en la selección del lugar de anidamiento por parte de las aves.

Relatively little is known about the habitat characteristics of Red-tailed Tropicbirds (*Phaethon rubricauda*) nest sites on small islands. Clark et al. (1983, 1990) suggested that preferences for specific vegetative characteristics may limit the number of suitable nest sites available for this species. For example, on Christmas Island Red-tailed Tropicbirds selected nest sites under shrubs or trees that provided more nest cover (>70%) and had fewer stems than surrounding areas (Clark et al. 1983, 1990). Shade provided by cover is especially important for Red-tailed Tropicbird chicks, which are incapable of thermoregulation via gular flutter (Howell and Bartholomew 1962, Stonehouse 1962). Other studies on Red-tailed Tropicbird nesting ecology also suggest that these ground nesting birds require full or partial shade cover for nests to be successful (Howell and Bartholomew 1969, Prys-Jones and Peet 1980).

Red-tailed Tropicbirds may have selected areas with fewer stems because they have reduced hind limbs placed far back on their body that render them incapable of walking; instead they rely on a series of forward lunges for locomotion on land (Howell and Bartholomew 1962). A large

number of stems under a nest shrub or tree might drastically limit their movement. On Kure Atoll, where Red-tailed Tropicbirds nest under dense stands of *Scaevola taccada,* Fleet (1972) suggested that tropicbirds' impaired movement limits their use to areas within 3 m of an opening.

We were interested in quantifying the habitat characteristics of Red-tailed Tropicbird nest sites on Rose Island, in part because no studies have quantified bird habitat on Rose Atoll National Wildlife Refuge, American Samoa. Thus, information on the habitat characteristics may be useful to refuge managers. Our objective was to compare the habitat characteristics of Red-tailed Tropicbird nest sites with randomly selected sites on Rose Island.

STUDY AREA AND METHODS

Our study was conducted on Rose Island of the Rose Atoll National Wildlife Refuge (14°32′52″S, 168°08′34″W), an uninhabited possession of American Samoa that lies 125 km ESE of Tau Island, in the Manua group, the most eastern of the inhabited Samoan Islands. This atoll is one of the smallest known (Sachet 1954). Rose Island, the larger of the two islands on the atoll consists of approximately 5.2 ha of land. The island is generally flat and sandy, with a maximum elevation of 3.1 m above sea level. Vegetation on Rose Island consisted of five plant communities: *Messerschmidia,* open *Pisonia,* closed *Pisonia,* mixed *Messerschmidia/Pisonia,* and *Boerhavia* (Amerson et al. 1982).

We quantified the habitat characteristics at all Red-tailed Tropicbird nests on Rose Island during a 3-wk period in September 1991. Random sites were established by randomly selecting a point from pre-established grid points placed at 30 m intervals across the island. A random numbers table was used to obtain a compass bearing and distance to travel from the grid point where we selected the nearest tree or shrub. Random sites were randomly placed into one of eight 45° octants centered on the tree or shrub and a random numbers table was used to place the nest between the trunk and the outside perimeter edge of the shrub/tree canopy.

At each nest and random site we measured 10 nest habitat variables, as described by Clark et al. (1990): SPECIES, the species of shrub or tree under which a nest was placed; SUBSTRATE, the predominant substrate at the nest site (coral rubble, humus, or soil); ASPECT, the compass orientation of the nest relative to the trunk of the shrub or tree; NEAREST, the shortest distance (m) between the perimeter edge of the shrub or tree containing a nest and the perimeter edge of the nearest shrub or tree of any species; HEIGHT, the maximum height (m) of the shrub or tree under which a nest was placed; PERIMETER, the distance (m) around the perimeter edge of a shrub or tree containing a nest; EDGE, the shortest straight-line distance (m) between the nest and the outside perimeter of the shrub or tree containing the nest; STEMS, the number of stems in the nest space intersecting a 0.5-m^2 area centered on the nest; SHADE, percent shade covering a 0.5-m^2 area centered on the nest, estimated to the nearest 10% (all shade measurements were taken between

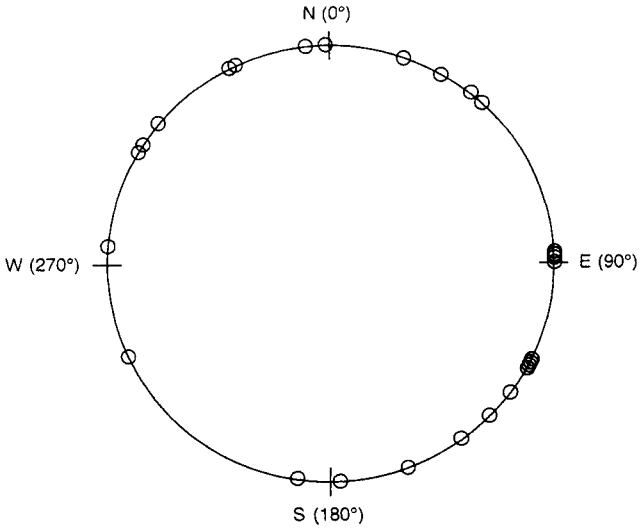

FIGURE 1. Aspect of 27 Red-tailed Tropicbird nest sites relative to the trunk of the shrub or nest tree they were placed under, Rose Island, American Samoa, September 1991.

1100–1300 h); and COVER, percent vegetative cover on the outer surface of a shrub 0.6 m in height along the arc described by the octant containing the nest, estimated to the nearest 10%.

We used Chi-Square tests of independence to test for differences between actual nest sites and random nest sites for SPECIES and SUBSTRATE. Rayleigh's test was used to test the null hypothesis of random orientation of actual nest sites (Zar 1984). A separate analysis for compass orientation of random nests was not performed because they were positioned randomly. Continuous variables were tested for normality using Kolmogorov-Smirnov goodness of fit tests. Comparisons of habitat variables between nest sites and random sites were done using *t*-tests when data were normal and Mann-Whitney U-tests when the data deviated from normality. We used $\alpha = 0.05$ for all analyses.

RESULTS

Twenty-seven Red-tailed Tropicbird nests were found. The majority of nests (78%) and random (74%) sites were found under beach heliotrope (*Messerschmidia argentea*) shrubs; all remaining nests were located under pisonia (*Pisonia grandis*) trees ($\chi^2 = 0.1$, df = 1, $P = 0.750$). Frequency of substrate types differed between nest (77.8% coral rubble and 22.2% soil) and random sites (59.3% coral rubble, 22.2% humus, and 18.5% soil) ($\chi^2 = 7.7$, df = 2, $P = 0.021$). Nest sites were positioned randomly with respect to orientation to the center of the shrub or tree under which they were placed ($r = 5.8$, $P = 0.397$) (Fig. 1). All sites, both nests and random, had NEAREST distance values of zero, indicating that the edge

TABLE 1. Comparison of habitat characteristics (mean ± SE) of Red-tailed Tropicbird nest sites (n = 27) and random sites (n = 27) on Rose Island, Rose Atoll National Wildlife Refuge, American Samoa, September 1991. See text for description of variables.

Variable	Nest-site	Random site	Test-statistic	P
HEIGHT (m)	7.6 ± 1.3	7.1 ± 1.0	U[a] = 326.5	0.510
PERIMETER (m)	25.7 ± 1.7	22.6 ± 1.6	t[b] = −1.360	0.181
EDGE (m)	2.1 ± 0.2	0.8 ± 0.2	U = 144.0	<0.001
STEMS	3.8 ± 0.9	1.3 ± 0.3	U = 157.5	<0.001
SHADE (%)	90.4 ± 14.0	57.8 ± 36.1	t = 4.375	<0.001
COVER (%)	8.9 ± 18.7	5.2 ± 11.9	t = 0.869	0.389
NEIGHBOR (m)	24.9 ± 3.2	29.6 ± 2.4	t = 1.14	0.259

[a] Mann-Whitney U-test.
[b] t-test.

of all nest shrubs and trees overlapped at some point with the perimeter edge of the adjacent shrub/tree. EDGE and STEMS were significantly greater at nest sites than at random sites (Table 1). Similarly, nest sites had higher percent SHADE covering than random sites (Table 1).

DISCUSSION

Red-tailed Tropicbirds on Rose Atoll placed their nests farther under shrubs/trees, in areas with a greater number of nest-space stems and more shade cover than at random sites. In our study, distance from the nest to the perimeter edge of the shrub or tree the nest was located under was nearly twice as great as distances previously reported for this species (Clark et al. 1990). Clark et al. (1983) suggested that tropicbirds place their nests close to the edge of shrubs to allow them to stall into the wind in flight close to the nest site, dropping as close to their nest as possible. Placing nests at greater distances from the nest shrub's perimeter edge (i.e., farther under the shrub/tree) may increase the risk of displacing eggs or chicks (Howell and Bartholomew 1969) and increase the energy expenditure of adults trying to reach their nests using their awkward terrestrial locomotion. Although nests sites on Rose Island had slightly more (yet not significant) cover than random sites (8.9 and 5.2%, respectively), percent vegetative cover was considerably less than reported for Red-tailed Tropicbird nest sites on Christmas Island (>70%) (Clark et al. 1983, 1990). Similarly, nest sites had more nest space stems and greater percent shade than random sites, suggesting that Red-tailed Tropicbirds may have selected areas that provided protection from the sun. Although sites with fewer stems would enhance access to the nest, they also would provide less shade. Red-tailed Tropicbirds may have selected areas with high numbers of nest space stems to enhance shade cover, thereby allowing adults and chicks to more effectively thermoregulate (Howell and Bartholomew 1962).

Perhaps Red-tailed Tropicbirds on Rose Island placed their nests farther from the edge of the shrub than reported elsewhere, at sites with a

high number of nest space stems to compensate for a lack of nest-level vegetative cover resulting from an over population of non-native Polynesian rats (*Rattus exelans*). Rats were first reported on Rose Atoll in the early 1900s (Setchell 1924) and their numbers have increased unchecked in the absence of predators. Except for a small area of *Boerhavia tetranda,* rats had removed all vegetative cover on the island ≤60 cm (Anonymous 1992) that might have provided nest-site cover. In addition, nests sites on Rose Island were considerably farther from their nearest neighbor (24.9 m) than reported on Kure Atoll (1.5 m) (Fleet 1972) and Christmas Island (5.7 m) (Clark et al. 1990), respectively. We acknowledge that we do not have any nest habitat information before rats were on the island, nonetheless we believe it is possible that their presence may have influenced nest-site selection on Rose Island. We recommend that this aspect of Red-tailed Tropicbird ecology be investigated further.

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