THE WILSON BULLETIN
A QUARTERLY JOURNAL OF ORNITHOLOGY
Published by the Wilson Ornithological Society

VOL. 114, NO. 1 March 2002 PAGES 1–152

Wilson Bull., 114(1), 2002, pp. 1–10

DESCRIPTION OF NESTS, EGGS, AND NESTLINGS OF THE ENDANGERED NIGHTINGALE REED-WARBLER ON SAIPAN, MICRONESIA

STEPHEN M. MOSHER[1,2,3,5] AND STEVEN G. FANCY[1,4]

ABSTRACT.—We describe the first verified nests, eggs, and nestlings of the Nightingale Reed-Warbler (*Acrocephalus luscinia*), an endangered species endemic to the Mariana Islands, Micronesia. Nest composition, nest dimensions, and eggs were studied on the island of Saipan. Nests were located within three habitat types: upland introduced tangantangan (*Leucaena leucocephala*) forest, a native mangrove (*Bruguiera gymnorrhiza*) wetland, and a native reed (*Phragmites karka*) wetland. Nesting substrates included five native and two introduced tree species and one native reed species. Nests were composed primarily of dry vine stems, needle-like branchlets of ironwood (*Casuarina equisetifolia*), and tangantangan petioles. Nests were compact to bulky in construction and were secured to a forked arrangement of branches or stems. The background color of eggs ranged from white to cream to ivory-buff. Eggs were spotted, speckled, and blotched with gray, brown, black, and rust colored markings. Clutch size was 2–4, with a mode of two. Hatchlings were altricial with closed eyelids and devoid of natal down with dark gray to black skin. Nestlings examined prior to fledging resembled the adult plumage, except for the lack of the yellow supercilium found in adults. The nests and eggs have some characteristics similar to those of other Acrocephaline warblers found throughout Micronesia and Polynesia. *Received 29 September 2000, accepted 18 March 2002.*

The breeding biology of most endemic passerines in the Northern Mariana Islands is poorly known and the Nightingale Reed-Warbler (*Acrocephalus luscinia luscinia*) on the island of Saipan is no exception. The lack of reproductive information about the Nightingale Reed-Warbler hinders the development of management practices for conserving this species on Saipan. The reasons for this lack of vital life history information is, in part, due to relatively few field investigations going beyond presence/absence surveys of bird species in the Northern Mariana Islands. Some exceptions to this were Craig (1989, 1990, 1992), who studied the foraging ecology of Bridled White-eyes (*Zosterops conspicillatus*) and Golden White-eyes (*Cleptornis marchei*), as

[1] USGS Pacific Island Ecosystems Research Center, P.O. Box 44, Hawaii National Park, HI 96718-0044, USA.

[2] College of Natural Resources, Fish and Wildlife Dept., Univ. of Idaho, Moscow, ID 83844-1136, USA.

[3] Current address: USGS Brown Treesnake Project, P.O. Box 8255, MOU-3, Dededo, GU 96929-8255, USA.

[4] Current address: USDI National Park Service, Natural Resource Information Div., 1201 Oak Ridge Dr., Suite 200, Fort Collins, CO 80525-5589, USA.

[5] Corresponding author; E-mail: noca_68@yahoo.com

←

FRONTISPIECE. Nightingale Reed-Warbler (*Acrocephalus luscinia*) nestlings at 14 days of age on the island of Saipan, Northern Mariana Islands, 11 February 1998. Nest constructed of dry exotic vine species and placed in introduced *Leucaena leucocephala*. Photograph by SMM.

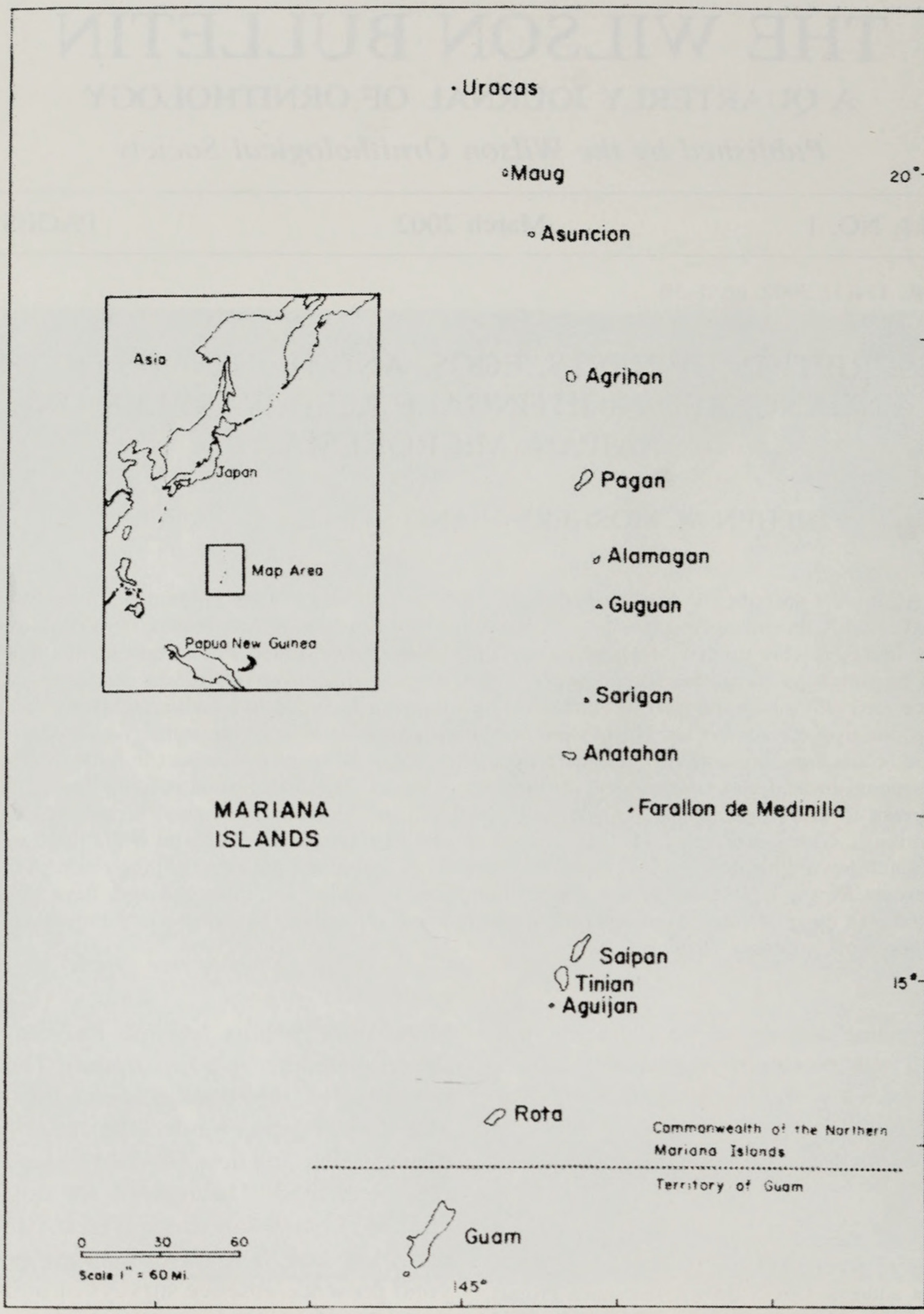

FIG. 1. Map of the Mariana Islands.

well as territoriality and habitat use of Nightingale Reed-Warblers, and Stinson and Stinson (1994), who studied breeding ecology of Golden White-eyes. Of the 16 native forest bird species found in the Mariana Islands archipelago, only five have been subjects of natural history or ecological investigations (Rodda et al. 1998).

The Nightingale Reed-Warbler is a long-billed, Old World warbler currently found on the islands of Saipan, Alamagan, and Aguijan within the Marianas archipelago (Pratt et al. 1987, U.S. Fish and Wildlife Service 1998; Fig. 1). The reed-warbler has become extinct on the islands of Guam and Pagan during the latter half of the Twentieth Century (Reichel et al. 1992) and prehistorically on the island of Tinian (Steadman 1999). The current population estimate for Nightingale Reed-Warblers in the Mariana Islands is approximately 4,572–4,577 individuals: 1–6 on Aguijan, 346 on Alamagan, and 4,225 on Saipan (U.S. Fish and Wildlife Service 1998, Commonwealth of the Northern Mariana Islands–Div. of Fish and Wildlife 2000). At this time there is no information on the breeding ecology of reed-warblers on Alamagan and Aguijan. Here we present the first detailed description of Nightingale Reed-Warbler nest structure and composition, and the first recorded descriptions of eggs and nestlings for this species. We also include additional information on nest substrate and placement.

STUDY AREA AND METHODS

Saipan (15° 10′ N, 145° 45′ E) is located in the central region of the 15-island Mariana archipelago. The Marianas form a north-south chain of islands about midway between Japan and New Guinea in the western Pacific. Saipan is the second largest island in the Marianas with a land area of 123 km^2. The island is of limestone and volcanic origin approximately 22 km long and 6 km wide (Fig. 1), with a maximum elevation of 474 m. The climate is tropical with an annual mean temperature of 28.3° C. The humidity is high with monthly means between 79 and 86%. Mean annual rainfall is about 213 cm. Saipan has a dry season from December to June and a wet season from July to November (Young 1989). Typhoons can occur during any month, but are most frequent from August to December, with a mean of one typhoon per year affecting the Mariana Islands (Young 1989, Mueller-Dombois and Fosberg 1998).

This study focused on three habitat types utilized by reed-warblers: upland introduced tangantangan (*Leucaena leucocephala*) complexes, a tall native reed (*Phragmites karka*) wetland, and a native mangrove (*Bruguiera gymnorrhiza*) wetland. Upland tangantangan habitats were dominated by monotypic stands of tangantangan with no understory, as well as tangantangan/sword grass (*Miscanthus floridulus*) and/or elephant grass (*Pennisetum purpureum*) mosaics. Some stands of tangantangan had a dense understory of introduced lantana (*Lantana camara*) and others had scattered native shrubs. The tall reed wetland consisted of a dense monotypic stand of *Phragmites* with a mosaic of native and introduced tree and shrub species surrounding the wetland. The mangrove wetland consisted of small stands of mangroves, dense thickets of sea-hibiscus (*Hibiscus tiliaceus*) and rosewood (*Thespesia populnea*), scattered stands of tall ironwood trees (*Casuarina equisetifolia*), and other native and introduced tree and shrub species. The amount of understory vegetation varied throughout the mangrove wetland.

We conducted research between mid-January 1997 and mid-July 1998 in the Marpi region, Naftan Peninsula, Chalan Lao Lao region, and American Memorial Park. Nest searching was conducted by active searches of known reed-warbler territories throughout the year and with the aid of radio marked birds at the initiation of the study. Nests were examined and measured after fledging or failure to obtain detailed descriptions. Eggs were measured and weighed using electronic calipers and a Pesola scale. Nestling descriptions were obtained by viewing into the nest with a mirror pole and binoculars and during the banding of nestlings prior to fledging. We recorded measurements of mass, unflattened wing chord, exposed culmen, culmen, tail length, and tail feather count for nestlings prior to fledging.

RESULTS

Nesting behavior.—A total of 100 reed-warbler nests were located on Saipan between mid-January 1997 and mid-July 1998. We located 84 nests in upland introduced tangantangan forest, 15 in a native mangrove wetland complex and one in a native reed wetland. Fifty-one of these nests were active when found (four during building, 12 prior to egg laying, 26 during incubation, and nine during brooding). We found no reed-warblers nesting in native limestone forest even when their territories included limestone forest fragments or were adjacent to limestone forest. Reed-warblers that inhabited the reed wetland were not found to nest outside of the reed bed in the wooded area surrounding the wetland. We observed reed-warblers carrying nesting material into the reed wetland on several occasions. Juvenile reed-warblers were heard making begging calls within the dense reeds, but no active nests were located.

Two peak nesting periods were observed during the study, one from January through March and the other from July through September. Active nests were located during all months, except November and December. Twenty-seven of the active nests were located during January through March (dry season) and 20 during July through September (wet season). This study covered two dry season nesting periods and one wet season nesting period. Reed-warblers had a principal nesting area within a given territory, where several nests from previous nesting attempts sometimes were found in close proximity to one another. Locating the principal nesting area of

TABLE 1. Materials used in Nightingale Reed-Warbler (*Acrocephalus luscinia*) nests in two habitats on Saipan, 1997–1998. Values are number of nests (%) in which the listed material occurred.

Material	Upland tangantangan (n = 67 nests) Outer	Upland tangantangan (n = 67 nests) Lining	Mangrove wetland (n = 9 nests) Outer	Mangrove wetland (n = 9 nests) Lining
Vines[a]	67 (100)	4 (6)	9 (100)	0 (0)
Dry grass blades[b]	15 (22)	1 (1)	1 (11)	0 (0)
Dry bark strips[c]	15 (22)	0 (0)	1 (11)	0 (0)
Spider web casings	7 (10)	0 (0)	0 (0)	0 (0)
Petioles[c]	4 (6)	66 (99)	0 (0)	2 (22)
Branchlets[d]	3 (4)	8 (12)	8 (89)	9 (100)
Twig[c]	1 (1)	0 (0)	0 (0)	0 (0)
Leaf	1 (1)	0 (0)	0 (0)	0 (0)

[a] *Momordica charantia* and/or *Passiflora foetida*.
[b] *Pennisetum purpureum* and/or unknown spp.
[c] *Leucaena leucocephala*.
[d] *Casuarina equisetifolia*.

a reed-warbler pair facilitated future search efforts.

Females gathered nesting material and constructed the nest while the male sang from a nearby perch. On a few occasions we observed males carrying nesting material to the nest, whereupon the female received and placed the material. One male was observed attempting to place nesting material into the nest, but upon unsuccessful placement returned to singing from an adjacent perch. We observed two nests that were constructed directly on top of old deteriorating nest material. On three occasions nests in the beginning stages of construction were dismantled and reconstructed with the same nesting material in a nearby tree. We never observed a nest used more then once.

Nest composition.—We examined 73 nests to determine the composition of the outer nest structure and cup lining, including nests from upland tangantangan forest (n = 67), a mangrove wetland (n = 9), and a reed wetland (n = 1). Table 1 summarizes the nesting material found in nests from upland tangantangan forest and a mangrove wetland forest. Dry vine stems and tendrils of introduced bitter melon (*Momordica charantia*) and wild passionfruit (*Passiflora foetida*) consistently were the primary component used to form the outer structure. The only exception to this was a nest found in the mangrove wetland, which was constructed entirely of ironwood branchlets. The cup lining of nests found in upland tangantangan forest were almost exclusively composed of tangantangan petioles, while nests in the mangrove wetland had a larger amount of ironwood branchlets incorporated into the cup lining. Ironwood branchlets were incorporated into the nest structure when ironwood trees were located near the nest site. The one nest found in the native reed wetland had an outer structure of dry vines, dry coarse reed blades, and one spider web casing, and a cup lined with reed panicles.

Nest structure.—Nests were of two forms: (1) tightly woven compact nests, or (2) larger tightly woven nests with bulky outer material. Nests had open cups that were circular to ovoid in shape. In some nests the inner rim was tightly woven to form an overhanging lip, which may aid in keeping eggs in the nest during high winds. We measured 66 nests from among the three habitat types studied. Outer nest diameter was 106 mm ± 10, 83–127 mm (mean ± SD, range), and height was 90 mm ± 20, 57–177 mm. Cup diameter was 65 mm ± 6, 46–86 mm, and cup depth was 45 mm ± 7, 29–58 mm. Rim width at the lip was 20 mm ± 4, 12–28 mm, and rim width at base of the cup was 28 mm ± 6, 17–48 mm. The nest found in the native reed wetland was a loose compact nest with an outer diameter of 117 mm, height of 98 mm, cup diameter of 56.5 mm, cup depth of 43 mm, rim width at lip of 25 mm, and a rim width at base of 32 mm.

Nest placement.—Reed-warblers used seven tree species as nesting substrates. In upland habitat 79 (94%) of the nests were found in introduced tangantangan trees, four (5%) in native lipstick trees (*Ochrosia mariannensis*), and one (1%) in an introduced madras thorn tree (*Pithecellobium dulce*). We found 15 nests in the mangrove wetland forest including six (40%) in native ironwood trees, four (27%) in native sea-hibiscus, three (20%) in mangrove, one (7%) in rosewood, and one in madras thorn. The nest found in the reed wetland was attached to reed stems. Vegetative cover above, below, and around nests varied among substrates.

Nest placement within tangantangan consisted of nests being attached to the main stem/trunk and several lateral branches with at least one branch supporting the bottom of

FIG. 2. Placement and structure of Nightingale Reed-Warbler (*Acrocephalus luscinia*) nests, Saipan, February 1997 to July 1998. (A) Typical nest placement within introduced *Leucaena leucocephala.* (B) Typhoon-damaged *Leucaena leucocephala* trunk with lateral placement of the nest. (C) Nest placement in fork of native *Ochrosia mariannensis.* (D) Nest attached to drooping branch of indigenous *Casuarina equisetifolia.* Photographs by SMM.

the nest (Fig. 2a). Some nests located in tangantangan were constructed on the top of typhoon-damaged trunks supported by regrowth branchlets (Fig. 2b). Nests found in native lipstick trees were supported by the main trunk and 3–5 branches that forked from the center of the tree (Fig. 2c). Four of six nests in ironwood trees were attached to high drooping branches that extended away from the main trunk (Fig. 2d). The one exception to the above placement types was a nest located at the terminal end of a lateral branch of a mangrove tree. The nest found in the reed wetland was supported by three vertical reed stems and two leaning stems, which supported the bottom of the nest.

Nests were securely attached to support branches/stems with vines either looping around supports or weaving around the support and concealing the support branch/stem within the structure of the nest. In all substrates used for nesting, there always was a branch or stem supporting the base of the nest.

We measured 83 nest trees. Mean nest height was 4.3 m ± 1.3, 2.3–10.0 m and nest tree height was 6.1 m ± 3.4, 3.4–25.0 m. Diameter (dbh) of nest trees was 60.7 mm ± 59.7, 17.7–318.3 mm. Mean number of support branches for 76 nest trees was 3.9 ± 1.2, 2–8 with a mode of four. Diameter of support branches, including the main stem, was 8.0 mm ± 4.6, 1.8–30.5 (n = 282 supports). The nest found in the reed wetland was 2.2 m high and 0.8 m below the tops of the reeds.

Eggs.—Eggs were subelliptical and varied from dull white to cream to ivory-buff. Eggs were spotted, speckled, and blotched with irregularly shaped markings usually well distributed over the entire shell, commonly with a heavier zone of overlapping markings around the broader end. Markings were gray, brown, black, and rust in color, and ranged in size from pinpoints to one that was 2.3 mm in diameter (Fig. 3). The depth of the markings was variable within the cuticle. Egg surface was smooth and nonglossy, with a slightly granular appearance. Mean egg length (n = 50) was 23 mm ± 1.2, 21.0–25.8 mm and width was 16.9 mm ± 0.5, 15.9–18.0 mm. Mean egg mass (n = 49, age unknown) was 3.1 g ± 0.5, 2–3.8 g. Clutch size was 2.5 ± 0.7, 2–4, with a mode of 2 (n = 20 nests).

Nestlings.—Nestlings hatched with closed eyelids, dark gray to black skin, and totally devoid of natal down, with bright yellow gape flanges. Prior to fledging, nestlings (n = 43) were almost completely feathered, except around the eyes, ears, chin, and throat (Fig. 4). Plumage was brown on all dorsal surfaces with thin buff edges around primaries, secondaries, and on the tips of the rectrices. The breast, belly, vent, thighs, and undertail coverts were light yellow to cream, with the flanks brownish yellow to buff. The maxilla was grayish black with broad yellow edges, while the lower mandible was fleshy pink with broad yellow edges. Three rictal bristles were visible on each side of the mouth above the gape flanges. The palate was reddish pink and the tongue yellow with two oblong brown

FIG. 3. Nightingale Reed-Warbler (*Acrocephalus luscinia*) eggs, Saipan, 1998. Photograph by SMM.

FIG. 4. Nightingale Reed-Warbler (*Acrocephalus luscinia*) nestling at day 12, Saipan, 7 October 1997. Photograph by SMM.

spots just below the tongue spurs. Legs and toes were grayish blue and foot pads yellowish, with strong well-developed claws black above and yellowish below. The iris was brownish. The egg tooth was still present on the tip of the bill 2–3 days prior to fledging. Nestlings lacked the pale yellow supercilium and black lores present in the adult plumage.

We measured 42 nestlings prior to fledging at an age of approximately 14 ± 2 days. Mean mass of nestlings was 28.4 g ± 2.7, 24–35 g, wing chord was 50.3 mm ± 4.9, 39–58 mm, exposed culmen was 17.7 mm ± 1.7, 15.1–22.9 mm, culmen was 10.4 mm ± 0.9, 8.4–11.6 mm, and tail length was 13.3 mm ± 4.0, 4.0–20.5 mm. The mean number of tail feathers for 41 nestlings was 10.2 ± 0.8, 9–12, with a mode of 10.

DISCUSSION

Prior nest descriptions.—M. Alfred Marche found the first presumed Nightingale Reed-Warbler nest in June 1887 in a wetland on Guam (Oustalet 1895). It was a laterally compressed oval cup, with a height of 50 mm and an outer diameter of 120 mm, and was constructed of rush stems and grass blades roughly woven together. There was no mention of how the nest was determined to be that of a reed-warbler. The nest was found in a wetland, likely a native reed wetland where reed-warblers commonly were found by early observers on Guam (Baker 1951, Reichel et al. 1992). Oustalet's nest measurements were similar to the one nest found during this study in a reed wetland on Saipan. Our Saipan nest was similar in width to his Guam nest, but was 48 mm taller. There was no mention by Oustalet of how the nest was placed and secured. The difference in nesting material found in the Guam nest, rush stems and grass blades verses predominately dry vine stems with some reed blades in the Saipan nest, may reflect differences in the availability or selection of nesting materials between the birds once found on Guam and the ones presently on Saipan.

Engbring et al. (1986) described a nest they found in 1982 as a large bulky nest of grasses. The nest was located in the fork of a tangantangan tree 6 m above the ground. The nest was not collected because of the presence of a young fledgling begging near the nest. The nest found by Engbring et al. (1986) fits the nest placement profile of a reed-warbler nest in upland tangantangan forest, but their description that the nest was composed of grasses does not follow the findings of this study. It is possible the nest was composed primarily of vines that were mistakenly identified as grasses.

R. J. Craig (unpubl. data) found an empty nest in 1988 within a known reed-warbler territory, approximately 4 m above the ground in a 4.6-m tangantangan tree. In a drawing by Craig (unpubl. data), the nest appears to be attached to upper canopy branches with at least three small diameter support branchlets. Craig's drawing of the nest depicts the same structure, placement, and attachment in the fork of a tangantangan tree, as was found in this study. Craig mentioned that the nest was constructed of fine and coarse material with strands of fibers hanging below the nest, a depiction resembling the appearance of a nest composed of dry vine stems. He estimated the nest was 150 mm in height with an outer diameter of 150 mm. His height estimate was within the range of variation we found among the nests we measured, but the outer nest diameter was about 23 mm wider than the largest nest we found.

Nesting behavior.—We found reed-warblers nested primarily from January through March and again from July through September. This is consistent with prior observations of territorial behavior (Craig 1992). Male reed-warblers are highly territorial and defend territories by singing (Craig 1992). Craig (1992) observed an increase in occupied territories during January through February and during May with a subsequent decline in territory occupancy by September, which he attributed to a decline in breeding activity. Furthermore, surveys conducted by Craig (1996) during January and July of 1991 and 1992 revealed an increase in the number of singing males during those months.

The small number of nests found in wetland habitats compared to upland tangantangan habitat probably does not reflect low densities of reed-warblers, but rather the relative difficulty in locating reed-warblers and their nests in dense wetland vegetation. Close proximity of several nests from a breeding pair's separate attempts also has been observed in other Pacific reed-warblers: *Acrocephalus syrinx* of the Caroline Islands (Finsch 1881), *A. aequinoctialis* of the Line Islands (Schreiber 1979) and *A. taiti* of Henderson Island (Graves 1992). Construction of the nest by the female with little or no help from the male also has been observed in the Tahitian Reed-Warbler (*A. caffer*), Tuamotu Reed-Warbler (*A. atyphus*), and the Marquesan Reed-Warbler (*A. mendanae*; Bruner 1974), as well as the European Reed-Warbler (*A. scirpaceus*; Brown and Davies 1949). Building and dismantling newly constructed nests and then rebuilding them with the same material in a different location has been observed frequently in the European Reed-Warbler (Brown and Davies 1949).

Nest composition.—Of the other reed-warblers recognized in the Pacific, only the Line Island Reed-Warbler, Tahitian Reed-Warbler, Marquesan Reed-Warbler, and Tuamotu Reed-Warbler are known to use vines in the outer nest structure (Tristram 1883, Holyoak 1973, Bruner 1974). Coconut fibers and grasses are the most common nesting materials documented among eight of the 11 other Pacific Island reed-warblers (Tristram 1883, Hartert 1900, Kirby 1925, Yamashina 1932, Gallagher 1960, Williams 1960, Brandt 1962, Holyoak 1973, Bruner 1974, Schreiber 1979, Graves 1992, Brooke and Hartley 1995, Buden 1996, Morin et al. 1997). Pacific Island reed-warblers appear to be generalists in their selection of nesting materials, using the most common materials available within their respective habitats.

The Nightingale Reed-Warbler also is opportunistic in its use of nesting materials. Dry stems of bitter gourd and wild passionfruit constituted the bulk of nesting material found in most nests. These two plant species were common ground and understory flora within the three habitat types studied. Neither species of vine is native to the Mariana Islands, with bitter gourd native to tropical or subtropical Asia and Africa and wild passionfruit native to tropical America (Whistler 1994).

The reed *Phragmites karka* is found in fresh and brackish water marshes and is indigenous to the Mariana Islands and the western Pacific (Stemmermann 1981). The only nest that contained a large amount of grass blades and panicles incorporated into the nest body and cup lining was the nest located in the reed wetland where these two components were abundant. Brown and Davies (1949) found that European Reed-Warbler used dry *Phragmites* panicles almost exclusively for lining nest cups and to a lesser degree in the outer nest structure.

The use of spider webs for securing nests to substrates, as well as for binding nesting materials together is found in a number of species within the families Tryannidae and Muscicapidae (Baicich and Harrison 1997). However, the function of spider web casings in the outer structure of Nightingale Reed-Warbler nests is unclear, as they did not appear to aid in binding nesting material together or in securing the nest to the substrate.

Eggs and nestlings.—The nest found on Guam by Marche in 1887 contained three eggs, but they were not described because they were rotten upon reaching their final destination (Oustalet 1895). The three-egg clutch in Marche's nest was within the range found on Saipan during this study (2–4). The clutch size of the Nightingale Reed-Warbler falls in the middle among Pacific Island reed-warblers with one egg in the Cook Islands Reed-Warbler (*A. kerearako*) and up to five in the Henderson Island and Marquesan reed-warblers (Bruner 1974, Holyoak 1980, Brooke and Hartley 1995).

The background color of Nightingale Reed-Warbler eggs was consistently dull white to ivory buff, whereas most other Pacific Island reed-warbler eggs range from pale blue to olive. Spots, speckles, and blotches (usually brown or black) are found on eggs of all Pacific Island reed-warblers (Tristram 1883, Hartert 1900, Yamashina 1932, Williams 1960, Brandt 1962, Pearson 1962, Bruner 1974, Schreiber 1979, Holyoak 1980, Brooke and Hartley 1995, Morin et al. 1997).

Nestlings prior to fledging (2–3 days) had similar plumage characteristics as adults on most dorsal (brownish) and ventral (yellowish) surfaces (Baker 1951). Plumage around the eye was one of the last tracts to be feathered. This resulted in a lack of the adult's pale yellow supercilium and black lores among fledglings. Most passerines have 12 tail feathers (Gill 1995), but the significance of the variation in the number of tail feathers of Nightingale Reed-Warbler nestlings, nine to 12 with a mode of 10, is not understood.

Additional information collected on Nightingale Reed-Warbler nesting behavior and success, as well as nest site selections, will be the focus of future publications. Ecological investigations into the breeding biology on the island of Alamagan in the Mariana Islands would be another important step toward the future recovery of this species.

ACKNOWLEDGMENTS

Funding for field work was provided by the U.S. Fish and Wildlife Service and USGS Pacific Island Ecosystems Research Center. We thank R. Seman and S. Vogt of the Commonwealth of the Northern Mariana Islands Div. of Fish and Wildlife and C. Sayon of the American Memorial Park (U.S. National Park Service) for logistic support. We especially thank S. Burnham, N. Chelgren, J. Foster, N. Johnson, M. Luanglue, D. Magnus, C. Nishida, and J. Toll for their invaluable field assistance in nest searching and monitoring. We also thank D. Murray for translation of Oustalet (1895) and J. Fujimoto for translation of Yamashina (1932). J. M. Scott provided helpful comments on earlier drafts of this paper.

LITERATURE CITED

BAICICH, P. J. AND C. J. O. HARRISON. 1997. A guide to the nests, eggs, and nestlings of North American birds. Academic Press, San Diego, California.

BAKER, R. H. 1951. The avifauna of Micronesia, its origin, evolution, and distribution. Univ. Kansas Publ. Mus. Nat. Hist. 3:1–359.

BRANDT, J. H. 1962. Nests and eggs of the birds of the Truk Islands. Condor 64:416–437.

BROOKE, M. DE L. AND I. R. HARTLEY. 1995. Nesting Henderson Reed-warblers (*Acrocephalus vaughani taiti*) studied by DNA fingerprinting: unrelated coalitions in a stable habitat? Auk 112:77–86.

BROWN, P. E. AND M. G. DAVIES. 1949. Reed-Warblers: an introduction to their breeding-biology and behaviour. Foy Publications, East Molesey, Surrey, United Kingdom.

BRUNER, P. L. 1974. Behavior, ecology, and taxonomic status of three southeastern Pacific warblers of the genus *Acrocephalus*. M.Sc. thesis, Louisiana State Univ., Baton Rouge.

BUDEN, D. W. 1996. Reptiles, birds, and mammals of Ant Atoll, eastern Caroline Islands. Micronesica 29:21–36.

COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS–DIV. OF FISH AND WILDLIFE. 2000. Wildlife and vegetation surveys: Alamagan 2000. Div. Fish Wildl. Tech. Rep. #4. Saipan, Commonwealth of the Northern Mariana Islands.

CRAIG, R. J. 1989. Observations on the foraging ecology and social behavior of the Bridled White-eye. Condor 91:187–192.

CRAIG, R. J. 1990. Foraging behavior and microhabitat use of two species of White-eyes (Zosteropidae) on Saipan, Micronesica. Auk 107:500–505.

CRAIG, R. J. 1992. Territoriality, habitat use and ecological distinctness of an endangered Pacific island reed-warbler. J. Field Ornithol. 63:436–444.

CRAIG, R. J. 1996. Seasonal population surveys and natural history of a Micronesian bird community. Wilson Bull. 108:246–267.

ENGBRING, J., F. L. RAMSEY, AND V. J. WILDMAN. 1986. Micronesian forest bird survey, 1982: Saipan, Tinian, Agiguan, and Rota. U.S. Fish and Wildlife Service, Honolulu, Hawaii.

FINSCH, O. 1881. Ornithological letters from the Pacific, no. 6: Ponapé. Ibis 5:109–115.

GALLAGHER, M. D. 1960. Bird notes from Christmas Island, Pacific Ocean. Ibis 102:489–502.

GILL, F. B. 1995. Ornithology, 2nd ed. W. H. Freeman, New York.

GRAVES, G. R. 1992. The endemic land birds of Henderson Island, southeastern Polynesia: notes on natural history and conservation. Wilson Bull. 104:32–43.

HARTERT, E. 1900. The birds of Ruk in the Central Carolines. Novit. Zoologicae 7:1–11.

HOLYOAK, D. T. 1973. Notes on the birds of Rangiroa, Tuamotu Archipelago, and the surrounding ocean. Bull. Br. Ornithol. Club 93:26–32.

HOLYOAK, D. T. 1980. Guide to Cook Islands birds. D. T. Holyoak.

KIRBY, H., JR. 1925. The birds of Fanning Island, central Pacific Ocean. Condor 27:185–196.

MORIN, M. P., S. CONANT, AND P. CONANT. 1997. Laysan and Nihoa Millerbird (*Acrocephalus familiaris*). No. 302 *in* The birds of North America (A. Poole and F. Gill, Eds.). Academy of Natural Sciences, Philadelphia, Pennsylvania, and the American Ornithologists' Union, Washington, D.C.

MUELLER-DOMBOIS, D. AND F. R. FOSBERG. 1998. Vegetation of the tropical Pacific Islands. Ecological studies vol. 132. Springer, New York.

OUSTALET, M. E. 1895. Les mammifères et les oiseaux des Iles Mariannes. Nouv. Arch. Mus. Hist. Nat. Paris 7:141–228.

PEARSON, A. J. 1962. Field notes on the birds of Ocean Island and Nauru during 1961. Ibis 104:421–424.

PRATT, H. D., P. L. BRUNER, AND D. G. BERRETT. 1987. A field guide to the birds of Hawaii and the tropical Pacific. Princeton Univ. Press, Princeton, New Jersey.

REICHEL, J. D., G. J. WILES, AND P. O. GLASS. 1992. Island extinctions: the case of the endangered Nightingale Reed-Warbler. Wilson Bull. 104:44–54.

RODDA, G. H., E. W. CAMPBELL, III, AND S. R. DERRICKSON. 1998. Avian conservation research in the Mariana Islands, western Pacific Ocean. Pp. 367–381 *in* Avian conservation: research and management (J. M. Marzluff and R. Sallabanks, Eds.). Island Press, Washington, D.C.

SCHREIBER, R. W. 1979. The egg and nest of the Bokikokiko *Acrocephalus aequinoctialis*. Bull. Br. Ornithol. Club 99:120–124.

STEADMAN, D. W. 1999. The prehistory of vertebrates, especially birds, on Tinian, Aguiguan, and Rota, Northern Mariana Islands. Micronesica 31:319–345.

STEMMERMANN, L. 1981. A guide to Pacific wetland plants. U.S. Army Corps of Engineers, Honolulu, Hawaii.

STINSON, C. M. AND D. W. STINSON. 1994. Nest sites, clutch size and incubation behavior in the Golden White-eye. J. Field Ornithol. 65:65–69.

TRISTRAM, H. B. 1883. On the position of the Acrocephaline genus *Tatare*, with descriptions of two new species of the genus *Acrocephalus*. Ibis 1:38–46.

U.S. FISH AND WILDLIFE SERVICE. 1998. Recovery plan for the Nightingale Reed-warbler, *Acrocephalus luscinia*. U.S. Fish and Wildlife Service, Portland, Oregon.

WHISTLER, W. A. 1994. Wayside plants of the islands: a guide to the lowland flora of the Pacific islands. Isle Botanica, Honolulu, Hawaii.

WILLIAMS, G. R. 1960. The birds of the Pitcairn Islands, central south Pacific Ocean. Ibis 102:58–70.

YAMASHINA, Y. 1932. On a collection of birds' eggs from Micronesia. Tori Bull. Ornithol. Soc. Jpn. 7: 393–413.

YOUNG, F. J. 1989. Soil survey of the islands of Aguijan, Rota, Saipan, and Tinian, Commonwealth of the Northern Mariana Islands. USDA Soil Conservation Service, Washington, D.C.