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Observations of the breeding biology of the Elfin Woods Warbler.—The endemic Elfin Woods Warbler (*Dendroica angelae*) was first described in 1972 from the Caribbean National Forest, Luquillo Mountains, Puerto Rico (18°19'N, 66°45'W) (Kepler and Parkes 1972). Initially thought to be restricted to the Luquillo Mountains (Kepler and Parkes 1972), the species was later reported in other mountain ranges on the island, although it is still considered rare (Willis 1972, Gochfeld et al. 1973, Perez-Rivera and Maldonado 1977). The first Elfin Woods Warbler nest was found in the Luquillo Mountains by Wiley (1985). Between 1977 and 1985, Wiley (1985) located four additional nests in the Luquillo Mountains, but detailed observations on breeding biology are lacking. I found Elfin Woods Warbler nesting in aerial leaf litter in the Maricao State Forest in western Puerto Rico. I here present the first observations of its breeding biology. The species currently is being considered for threatened or endangered status (U.S. Fish and Wildlife Service 1989).

Study area.—The Maricao State Forest is located in the Cordillera Central mountain range in western Puerto Rico (18°09'N, 66°58'W) and covers 4150 ha. Mean annual rainfall is 2346 mm, mean annual temperature is 22°C, and relative humidity fluctuates between 60% and 90% (Colon et al. 1976 in Cruz and Delanoy 1984). Three life zones are recognized within Maricao State Forest boundaries: subtropical moist, subtropical wet, and subtropical lower montane (Ewel and Whitmore 1973). Five plant associations also exist there: Maricao mixed-hardwood, forests derived on volcanic soils, Maricao windy ridge, lower montane palm forest, and *Podocarpus* mixed-hardwood.

Methods and materials.—The following variables were measured at active nest sites: percent ground cover (ocular tube), percent canopy cover (ocular tube), shrub density (counting number of shrubs along two perpendicular transects within the sampling plot that were intercepted by my outstretched arms), diameter at breast height (dbh) of trees (diameter tape), canopy height (clinometer), nest height (clinometer), and altitude (altimeter and topographic map) (James and Shugart 1970, Cruz and Delanoy 1984). All measurements were made within a 0.01-ha circular plot centered on the nest. Nest components were identified, whenever possible, as to plant species. Nest measurements included inner diameter, outer diameter, height, and depth, all measured with a dial caliper (±0.1 mm). I used 7 × 35 binoculars to observe the warblers. No blind was used, but the warblers appeared to behave normally. Time spent by adult Elfin Woods Warblers at the nest was recorded to the nearest second using a stopwatch, and the number of visits to the nest was counted. The standard observation period was 08:00–11:00, with observations varying from one to five days between 4 April and 8 May 1990. Each observation period was subdivided into hourly intervals to assess behavior differences during the morning. Arthropods brought to the nest were identified as to order, whenever possible.

Results.—I discovered a nest under construction on 30 March 1990 at an elevation of 750 m within the *Podocarpus* mixed-hardwood association, of the subtropical lower montane Life Zone. A second nest was found in the same area on 27 April 1990.

Trees within the 0.01-ha circular plot of the first nest included *Cecropia peltata* (1),

Byrsonima wadsworthii (1), *Podocarpus coriacea* (3), *Linociera dominguensis* (1), *Magnolia borinquensis* (1), and the tree fern *Cyathea aquilina* (4), all of which ranged from 7.6 cm to 15.2 cm in diameter at breast height. The sample plot had 70% ground cover, 80% canopy cover, shrub density of 450 stems/ha, and a mean canopy height of 10.6 m.

The nest was placed at 7.6 m above ground within dry aerial (suspended) leaf litter, which consists of dead leaves that have fallen from canopy trees and have become entangled or caught among vegetation and/or vines (Munn and Terborgh 1979, Gradwhol and Greenberg 1982, Rosenberg 1990). The first nest was placed within three *Cecropia* leaves suspended on an upright fork of the inner portions of a 7.8-m tall *B. wadsworthii* tree.

The second nest also was within a dry *Cecropia* leaf, but was only 1.3 m above ground. This nest was found destroyed by predators on 29 April 1990. No observations of nest building, parental behavior, or microhabitat were recorded at the second nest.

The first nest was a tightly woven, open cup made of black rootlets and fibers from tree fern stems or both, dry leaves of *Chusquea abietifolia* and *B. wadsworthii,* and dry strands of *Panicum maximum* leaves. The rootlets are flexible when moist, but become like small wire springs when dry, thereby serving as an inner framework that preserves the shape of the nest basket (Collias and Collias 1984). The interior of the cup was lined with fibers of *C. abietifolia,* dry grass leaves (probably strands from *Arthrostylidium sarmentosum*), and some vegetal down. The second warbler nest contained all of the above materials as well as some down feathers. The first nest measured 45.3 mm inner diameter, 79.5 mm outer diameter, 51.9 mm high, and 38 mm deep and has been deposited in the Western Foundation for Vertebrate Zoology, Los Angeles, California.

The first nest was built by both parents. The female usually arrived at the nest first, producing a "chip" contact note (very similar to that of wintering Black-throated Blue Warblers [*Dendroica caerulescens*]). The female did not leave the nest until the male made a similar contact note. The male then entered the nest while the female remained on a nearby perch. After another exchange of notes, the male emerged from the nest site and both flew from the nest. This pair of Elfin Woods Warblers approached their nest furtively by at least seven different routes. I observed them together while bringing nest materials to the nest from 30 March to 6 April 1990. From 9 to 25 April, the only activities I observed near the nest were singing by the male and only the male entering the nest. The pair were not observed together, and the female was not seen. From 27 April to 9 May, both parents brought food items to the nest, and begging calls from at least two individuals could be heard. No activity was observed after 9 May. The nest was collected on 17 May. On 11 June, I observed adult Elfin Woods Warblers feeding an immature 200 m away from the nest-site described here, but I do not know if this was the pair from the first nest.

Average time (±SD) spent by parents at the nest during period 1 (N = 33 visits, $\bar{x}$ = 33.9 ± 69.4 sec, range 3–320 sec) was longer than mean time spent at nest during period 2 (N = 53 visits, $\bar{x}$ = 16.2 ± 23.3 sec, range 1–105 sec) and period 3 (N = 62 visits, $\bar{x}$ = 11.9 ± 17.6 sec, range 1–80 sec). Time spent by parents at the nest decreased after 09:00.

Both the male and female brought food items to the nest. On 20 (16.1%) of 124 trips, food items were identified: nine lepidopteran adults, nine orthopteran adults, and two lepidoptera larvae.

Discussion.—Both Elfin Woods Warbler nests were associated with aerial leaf litter. There are at least two possible reasons for such a concealed nest-site. One is reduced exposure to predation. Possible avian predators that may have exerted selective pressure for nest-site selection of the Elfin Woods Warbler include the now extirpated White-necked Crow (*Corvus leucognaphalus*) (known to have preyed upon passerine nestlings), Sharp-shinned Hawk (*Accipiter striatus*), and Pearly-eyed Thrasher (*Margaropus fuscatus*), which are common nest predators at Maricao (Wetmore 1927, Biaggi 1983, Delanoy and Cruz 1988). Several

genera of carnivorous mammals (known only from fossil remains) and two endemic snakes also may have exerted selective pressure for nest-site selection of the Elfin Woods Warbler (Biaggi 1983). At Maricao State Forest, roof rats (*Rattus rattus*) and small indian mongooses (*Herpestes auropunctatus*) (recently introduced exotics) are presently major predators of bird eggs and chicks. Nest-site choice and behavior exhibited by the Elfin Woods Warblers before entering and leaving the nest suggest predation as a likely selective factor for nest-site selection of this species.

Other functions of domed or covered nests are shedding rain and/or providing shade (Collias and Collias 1984). Skutch (1967), Collias and Collias (1984), and Stiles and Skutch (1989) noted that some wood warblers in Costa Rica, as well as other small passerines in the tropics, conceal their nests by placement (e.g., ground leaf litter, vegetation) as well as by structure (roofed nests). The Elfin Woods Warbler follows the tendency of 15 West Indian wood warblers (Bond 1985) of selecting nest-sites at low to moderate heights (1.3–7.6 m) above ground, but placement of nests among aerial leaf litter is unique among wood warblers. In this case, the three dry *Cecropia* leaves (successful nest) and one *Cecropia* leaf (unsuccessful nest) provided the equivalent of a roof for the Elfin Woods Warbler nests. However, the dead *Cecropia* leaves disintegrated during nest collection, suggesting that while *Cecropia* leaves provide effective concealment, nest sites are fragile. Therefore, the apparent strategy for this species is to be as furtive as possible in entering and leaving the nest, because if the nest is discovered by a predator, it can easily be destroyed because of the structural fragility of the *Cecropia* leaves.

The nest location made it impossible to gather data on clutch size, and number of hatchlings or fledglings, but presence of at least two hatchlings could be inferred (by asynchronous begging calls). Apparently, nesting of Elfin Woods Warblers occurs between April and May, because all five Elfin Woods Warbler nests found by Wiley (pers. comm.) were at egg stage in April, while immatures were observed by Kepler and Parkes (1972) during the summer months (May–July) of 1971.

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Vulnerability and mortality of young Australian Magpies on roads.—The process of development from hatching to the adult varies in the time required for each stage, the amount of learning required to master the necessary skills, and the type of learning or skill required. Nevertheless, the young of all birds must learn to cope with a variety of hazards once they leave the relative safety of the nest. Often the early aspects of learning that take place before or after fledging are ignored, although Bateson (Proc. 19th Int. Ornithol. Congr. 1116–1126, 1988) and others have extensively studied imprinting. The period following departure from the nest is particularly traumatic because young birds must learn to forage by themselves, to recognize appropriate foraging and roosting habitats, and to avoid predators and other dangers. One problem for many species in the modern world is to avoid vehicles on roads, particularly those birds that scavenge on animals hit by cars. This problem is increasing as more roads are built and as dirt roads are paved.

Study area and methods.—This study was conducted along primary and secondary roads in the South Island, New Zealand from 4 November to 8 December 1990. We travelled a