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Roosting behavior of Prothonotary Warblers in the non-breeding season.—Many birds aggregate and form communal nighttime roosts during nonbreeding periods. Morton (1980) found evidence suggesting that Prothonotary Warblers (*Protonotaria citrea*) roost communally in Panama. This was considered unusual, since migrant parulid warblers roost solitarily and even defend their nighttime roost positions against entry by other individuals (Morton 1980). This note provides additional information on roosting behavior in Prothonotary Warblers, based on two new data sets obtained during studies of wintering warblers in Panama and Costa Rica.

Over two seasons at a study site in Tivivies, Puntarenas, Costa Rica (November 1990 through March 1991 and November 1991 through February 1992), Prothonotary Warblers were observed moving singly and in groups between a mangrove forest, where they roosted at night, and the adjacent hillside where they foraged during the day. Data were collected here because the dryland forest configuration concentrated passerines within a narrow area. Second-growth forest on the hillside had been allowed to grow back so that it formed a wedge of habitat decreasing in width from the upper slope down to the mangrove edge, where it was about only 15 m wide and bordered on either side by open cattle pasture. Data were collected by a single observer for half-hour periods after sunrise and before sunset, every day from the end of November to the middle of January during the second winter season. The total number of Prothonotary Warblers moving past the observation point in a given half-hour observation period varied from 50 to 115 individuals (median = 70; mean $\pm$ SD = 72 ± 18 ; N = 68). Other species (Northern Orioles [*Icterus galbula*] Yellow-crowned Euphonias [*Euphonia luteicapilla*], Masked Tityra [*Tityra semifasciata*], Yellow-throated Vireo [*Vireo flavifrons*], White-lored Gnatcatcher [*Poliophtila albilorus*], and Tennessee Warbler [*Vermivora peregrina*]) were seen moving past the point at the same time, but Prothonotary Warblers were the only species observed flying in groups of three or more.

Observations also were made at a second-growth stand of trees on Far Fan Road, adjacent to the Pan American Highway, southeast of Panama City, Republic of Panama. On 10 December 1973 and 11 January 1974, Prothonotary Warblers were observed near dusk gathering in and around an isolated roadside tree about 8 m tall and covered with vines. The tree was surrounded by a grassy area and located directly opposite the Balboa Gun Club. The warblers arrived at this pre-roost staging tree singly and in small groups. Eventually they flew off as a flock, after it became too dark to follow them visually, in the direction of a row of *Casuarina* trees at the Balboa Gun Club. Flocks of 12 or more Prothonotary Warblers were seen foraging in the Far Fan Road area at various times of the day on a regular basis during this same year.

Seventeen years later, on 20 February 1991, Prothonotary Warblers were seen staging in the same tree as during the previous observation. In three searches during that day, no warblers were seen foraging within an area extending several hundred meters from the staging tree. Loss of vegetation, in comparison with that previously present, was noted for the surrounding habitat. With assistance from three additional people, we monitored this location prior to dusk that evening. From 17:00 to 18:00 h EST, ten Prothonotary Warblers were seen moving about in the area, perching from one to 6 m up on the staging tree and eventually gathering in a nearby grove of *Luehea* trees. Among the individuals seen were males and females, adult and second-year birds. Up to the time of their departure for the roost, some warblers continued to forage in low shrubs and trees but at decreased frequencies relative to that of normal daytime foraging. At 18:10 h, roughly 20 min past sunset, eight birds were seen moving away from the staging area in a group, by 18:18 h this group appeared to split up into at least two smaller flocks. They flew the same direction from the

staging area towards the Balboa Gun Club as had the birds observed in 1973–1974, but we were unable to follow them to the exact roost site due to darkness. On driving over to the gun club, we found a large number of Great-tailed Grackles (*Quiscalus mexicanus*) and Clay-colored Robins (*Turdus grayii*) gathering in a row of *Casuarina* trees where they were roosting. It was unclear whether or not the warblers joined this larger aggregation.

Explanations of communal roosting behavior have revolved around thermoregulatory arguments (e.g., Chaplin 1982), predator protection (e.g., Hamilton et al. 1967), and the transfer of foraging information (e.g., Ward and Zahavi 1973; but see also Mock et al. 1988). Based on our observations of Prothonotary Warblers, we suggest that a scarcity of suitable roosting sites also may lead to such behavior. Differences in roosting requirements from other warbler species could be related to the fact that, aside from the Lucy's Warbler, no other parulid warbler except the Prothonotary is a cavity nester. If the Prothonotary Warbler does indeed have very specific roost-site requirements which only certain trees provide, association between yearling and adult birds during day-time periods may be essential to the transfer of locational information and the continued survival of populations. Du Plessis and Williams (1994) have made similar arguments concerning the social behavior of Green Woodhoopoes (*Phoeniculus purpureus*). They suggested that a shortage of suitable cavity roosts (in conjunction with an apparent physiological intolerance for even moderately low nighttime temperatures; Ligon and Ligon 1978) has led to the evolution of conspicuous group living among Green Woodhoopoes.

Typically, the Prothonotary Warblers seen moving to and from roosting areas flew rapidly from perch to perch, using frequently repeated "seep" calls as if to maintain contact with group members. This behavior was similar to that reported for migrants moving to roosts in Puerto Rico by Staicer (1992). During our observations, we also noted that Prothonotary Warblers began to tail fan more frequently while perched, as light levels decreased near dusk. Fanning the tail feathers exposes white patches on the inner webs of the outer rectrices; these patches are more prominent in adult than yearling birds (Pyle et al. 1987). Some individuals held the tail feathers open for periods up to 10 sec, perhaps using the behavior as an additional signal to maintain contact with other members of the flock while moving to a roost.

Within the two field seasons completed in Costa Rica, eight (of 60) color-banded individuals (that had been marked at hillside trapping stations as much as four weeks prior to roosting observations) were seen moving between the hillside and mangrove on up to three occasions per individual. One Prothonotary trapped in 1990–1991 on the hillside was seen moving into the mangrove at dusk the following season. Although limited in number, these observations suggest consistent use of the same pathway between roosting and foraging sites for at least part of the non-breeding season and possibly between years. Similar observations of large numbers of Prothonotary Warblers moving together at dusk have been recorded for Playa Honda, Panama (letter from Horace Loftin to Alexander Wetmore dated 21 December 1966).

Prothonotary Warblers forage solitarily, in pairs, as well as in mixed- and single-species flocks (Morton 1980; Warkentin, unpubl. data). Of 502 foraging Prothonotary Warblers encountered over two seasons (dates listed above) in Costa Rica, only 14% (69 individuals) were seen foraging alone. The remainder of these birds were either in mixed- (191 birds in 50 groups) or single-species (242 birds in 55 groups) flocks, with a mean of 2.8 and 3.4 other conspecifics in the flock, respectively. The use of communal roosts may have implications for the development of sociality in this species. If suitable roosting sites for this species are rare in the habitat, joining flocks during the day which contain other Prothonotary Warblers may be a means of discovering the location of scarce, suitable roost sites. The majority of individuals seen foraging alone were adults; yearlings, which were at least

initially unfamiliar with their wintering habitat, tended to be found only in association with other Prothonotary Warblers throughout the winter (Morton 1980; Warkentin, unpubl. data). Information on, and quantitative measures of, actual sites used for roosts by Prothonotary Warblers are essential to furthering our understanding of this behavior.

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