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The Condor 97:585-587
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OBSERVATIONS ON THE NESTING AND BREEDING BEHAVIOR OF THE ROCK WREN¹

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Key words: *Salpinctes obsoletus*; Rock Wren; nest construction; breeding biology; stone-carrying; incubation; territory takeover; extra-pair copulation.

The Rock Wren *Salpinctes obsoletus* is a common bird in the rocky, arid habitats which characterize its range in western North and Central America from Canada to Costa Rica (AOU 1983). Rock Wrens generally nest in holes or crevices in boulders, rocky slopes or cliffs. They are known for their curious habit of constructing a foundation of small, flat stones upon which the nest is built; often a "pavement" or collection of stones is placed at the entrance to the nest as well (Bailey 1904, Ray 1904, Smith 1904, Bent 1948). Other than descriptions of completed nests, however, relatively little is known of the basic breeding biology of this species (e.g., Harrison 1979, Ehrlich et al. 1988, Terres 1991). The one exception is a study of nest temperature and parental feeding rates by Wolf et al. (1985).

I observed the nesting and breeding behavior of six pairs of color-banded Rock Wrens in Rinconada Canyon just west of Albuquerque, New Mexico, from March through August, 1992. The sloping walls of the canyon are covered by large volcanic rocks; the grassland floor at 1,558 m rises 88 m to the top of the mesa. Birds were captured with mist nets, fitted with a U.S. Fish and Wildlife Service aluminum band on the right leg

and a unique combination of plastic color bands (A. C. Hughes) on the left leg for individual identification. Birds were sexed by the presence of a brood patch or cloacal protuberance; these determinations were later confirmed through behavioral observations (e.g., copulations).

Mated pairs were well established on their territories by the first of March, and Rock Wrens were seen carrying nesting material as early as 6 March. Mated pairs remained together throughout the breeding season; two pairs remained on the site for the duration of the study, each producing three broods. One of these pairs remained on their territory following a nest predation event and subsequently raised their third brood. Of the four other banded pairs, predation on nests by either snakes or mammalian predators resulted in either one of both members of the pair abandoning the territory.

Over the course of the study, I made observations of nine active Rock Wren nests. I followed two broods of two different pairs of Rock Wrens from egg-laying through fledging. In both cases the clutch consisted of five eggs which were laid at the rate of one per day. Incubation was by the female only. Incubation was measured as starting from the first time the female was observed incubating until the hatching of the first egg. In both cases the female was first observed incubating early in the morning with a complete clutch of eggs; whether the female may have begun incubating the night before the final egg was laid or just that morning is not known. Incubation time was 12 days in one case, 14 days in the other. The male occasionally fed the

¹ Received 30 June 1994. Accepted 19 October 1994.

female on the nest while she was incubating, but this was observed only sporadically; the female also left the nest for short periods of time, presumably to forage. In one instance I observed a male feed a female during courtship. The female responded to the appearance of the male carrying food by exhibiting behaviors similar to that of a begging fledgling: lowering the body, rapidly flicking the wings, and vocalizing loudly. Both parents assisted in the feeding of the young; the relative contributions of each parent were not recorded. The young Rock Wrens fledged between 14 and 16 days after hatching. In one case, within 24 hr of the first brood leaving the nest, the female moved to a new nest on the territory and began to lay a new clutch of eggs. The male continued to feed and care for the fledglings from the first brood for approximately another week. Once independent, the fledglings remained on their parents' territory for approximately four more weeks, after which time they disappeared.

In four cases I observed the process of nest construction. Both the male and the female participate in nest building; occasionally the female remained inside the nest cavity, with the male bringing pieces of nesting material to the entrance and passing them in to her. Eight of the nine nests had both the stone foundations and trails reported by earlier researchers (Bailey 1904, Ray 1904, Smith 1904, Bent 1948); the remaining nest had a foundation of stones beneath it, but there was no collection of stones before the nest entrance. In this case it appeared that the placement of the nest precluded the building of such a trail. The stone foundation was always in place before nest building commenced. The actual construction of the stone foundation was observed in only one instance. This pair had already fledged one brood and still had one nestling from their second brood. On 2 July 1992, I observed the female carrying small, flat stones to a new nest site. From 07:10 to 09:20 she averaged one stone per minute. The male perched on a nearby rock and sang while the female was carrying stones to the nest site; the male was never observed assisting in the construction of the stone foundation. Although the pair remained on the territory, no nest was built following the completion of the stone foundation and the pair did not attempt to raise another brood this season.

Measurements of the stone foundation of one completed nest showed that it was composed of 778 individual stones with an average weight of 2.85 g each (range 0.7–6.1 g) (also see Bent 1948). These stones were flat and varied in length from approximately 12 to 50 mm. The construction of such a foundation must pose a great energetic cost for these birds. For example, the female Rock Wren that I observed weighed 18 g. A stone weighing 2.85 g represents 15.6% of the bird's body weight. At the upper end of the weight range of stones used (6.1 g), construction would require the bird to carry the equivalent of 33% of its body weight. This seems especially heavy, since the placement of this nest, in a lava bubble in the vertical face of a rock 1.2 m above the ground, would require the bird to fly with the stone. Although it is possible that the stones may have reached the nest by some other means, the physical placement of the nest makes it difficult to envision any alternative means of transport.

This nest was most likely not the result of only one season's effort. The Rock Wrens nested two or three times during the breeding season within the same territory, but always in a new location. However, old nest sites may be re-used in subsequent years. The wrens may continue adding rocks to the foundation and/or trail each year that the site is used, resulting in a large accumulation of stones. I checked several of the nest sites that I first found in 1992 again in both 1993 and 1994; some sites had a new nest built upon the old stone foundation, and were again being used by a resident pair of birds. Two of the sites were again being used by banded males which had occupied the same territory the year before, but in three cases old nest sites were being used by unbanded birds.

The functional significance of the Rock Wren's stone nest foundation and pathway is not known. The Black Wheatear *Oenanthe leucura*, which also resides in arid, rocky landscapes, is known to construct a stone nest foundation strikingly similar to that of the Rock Wren (Richardson 1965). In this species, it is predominantly the male which carries stones to the nest site. After testing several alternative hypotheses on the function of this behavior, Moreno and colleagues (Moreno et al. 1994) conclude that stone-carrying in the Black Wheatear serves as a sexual display by the male, providing the female with the opportunity to assess the quality of her mate and adjust investment in the offspring accordingly. Females were occasionally observed to carry stones as well. Further investigation is needed to determine whether stone-carrying in Rock Wrens may serve a similar function. In view of my limited observation, I cannot say whether only the female Rock Wren typically constructs the stone foundation. Additional theories advanced propose that the Rock Wren's stone foundation may function to deter predators (Bailey 1904), to help the birds locate their nests (Bailey 1904), to keep the nests free from dampness (Ray 1904), and to keep the nestlings from falling out (Smith 1904). The Rock Wren's investment of much time and energy in the construction of the stone nest foundation suggests some selective advantage to the behavior; what that advantage may be remains to be tested.

An additional observation of interest concerns possible evidence for territory takeovers and/or extra-pair copulations in Rock Wrens. Male Rock Wrens defend their territories primarily through countersinging (Kroodsma 1975). Males in my observations were vigilant in the defense of both their territories and their mates; paired females were frequently chased by paired males from neighboring territories. I observed two pairs of banded Rock Wrens on adjacent territories: male O/LB and female P/LB comprised one pair, and male Y/P and female B/R the other. Both females were incubating at the time of observation. Male Y/P disappeared while his mate B/R was still incubating. On one occasion following the disappearance of Y/P, I observed male O/LB from the adjacent territory feeding B/R on her nest. Territorial expansion through the bigamous pairing of males with neighboring females whose mates have disappeared, though uncommon, is documented in wrens (e.g., Johnson and Kermott 1990); however, in such cases it is more common for the

replacement male to destroy the existing eggs or fledglings (Freed 1986). The fact that the bigamous replacement male in this case assisted the female while she was incubating the clutch of the previous male may indicate some possibility of paternity by the replacement male. It would have been of great interest to know whether this male might also have assisted with parental care of the chicks, but unfortunately this nest was lost to a predator and the female disappeared. The replacement male was not the cause of nest failure in this instance, as the nest, placed very low to the ground, had clearly been dug up and scattered by a mammalian predator. Extra-pair copulations with the resident female appear to be the primary function of territorial intrusions by neighboring males in the House Wren *Troglodytes aedon* (Johnson and Kermott 1989). The vigilant defense of paired females by their mates and the behavior of male O/LB in my observation suggests that extra-pair copulations may possibly serve as the goal of territorial intrusions in the socially monogamous Rock Wren as well.

At the time of this study my education was supported by a Graduate Fellowship Act Award from the University of New Mexico. My research was aided by grants from the Student Research Allocations Committee of the Graduate Student Association, the Vice President's Graduate Research Fund, and the Graduate Research Allocations Committee, Department of Biology, all of the University of New Mexico. Many thanks to N. Cox and D. Salceies for their assistance, and to G. H. Farley, J. D. Ligon and two anonymous reviewers for providing valuable comments on the manuscript.

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