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ADVERSE EFFECTS OF RADIO TRANSMITTERS ON THE BEHAVIOR OF NESTING LEAST TERNS[1]

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Key words: Least Tern; radiotelemetry; foraging; nest desertion; behavior.

Radiotelemetry was used on California Least Terns (*Sterna antillarum browni*) in 1986 and 1987 in an effort to learn more about foraging behavior. This technique has been used successfully to obtain information on movements and activities of several species of seabirds (Morris and Black 1980, Croll et al. 1986, Trivelpiece et al. 1986), and appeared to be the method of choice for following wide-ranging, ocean-foraging birds such as terns. Previous foraging studies on terns have been based on counts of fishing birds made from fixed stations (Erwin 1975, Atwood and Minsky 1983), a method that shows the comparative use of selected areas under observation. Radiotelemetry offered a means of following individuals through their daily foraging routines. We knew from many years of experience with California Least Terns that they were not amenable to more than minimal handling, and intrusive techniques such as patagial tags have caused high desertion rates (Brubeck et al. 1981). Common (*S. hirundo*) and Roseate terns (*S. dougallii*) are more tolerant of handling but have also deserted their nests (although temporarily) if trapped when the eggs were pipping (Nisbet 1981, Spendelow 1982). Thus we took all care to minimize the trauma that might be associated with the technique.

In 1986 a preliminary study was done at the Terminal Island nesting colony in the Port of Los Angeles to test the method. Our trapping experience had shown that males were less trap-shy than females, and older birds less likely to desert nests than 2- or 3-year-olds breeding for the first time. Desertion was also minimized by trapping in the third and final week of incubation (Massey and Atwood 1981). At the Terminal Island colony there were many individually color-banded birds with nesting histories of several years, and we were able to select four males aged 6 years or older for telemetry. At two of the nests both birds were banded, and had been paired for several years. To establish normal incubation behavior, we observed the nests from a blind the day before trapping.

The study was initiated within 5 days of the expected hatching date. A wire-mesh trap was propped over the nest; the birds walked onto their eggs immediately and were easily caught. After a bird was weighed we glued a transmitter to the skin of the dorsum between the

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scapulae with Superglue. The bird was released immediately after the glue hardened; the time of handling was under 5 min. The transmitters (AVM Electronics, Livermore, California) weighed 1.8 g, approximately 3% of body weight; the components were encased in dental acrylic and the package was a small cylinder about 10 by 22 mm with a 20-cm wire antenna.

Previous studies have shown that the incubation stint (time between nest exchanges) was about 45 to 55 min, the maximum 190 min (Keane 1987). Nest watches the day before telemetry showed that pairs were exchanging in this time frame. After radio-tagging, none of the four terns was back on the nest in less than 4 hr, and one was not seen or heard for 5 days. (His mate, however, continued to incubate during his absence and when he returned he resumed nest duties.)

All four clutches hatched within the expected time range of 21 to 25 days (Massey 1974) and the chicks were fed and tended normally (Keane 1987). The behavioral changes we observed in the radio-tagged birds were temporary and did not influence the outcome of the nests.

Several major problems surfaced during the study. One was loss of the transmitters, which stayed on for only 8–12 days. Another was the limited range of the transmitter (2.8 km), which coupled with the fleetness of the bird caused great difficulty in tracking. During the incubation period the radio-tagged terns usually flew directly out to sea to forage and we were often frustrated in our efforts to follow them. However, after their chicks hatched they foraged more often in the shallow waters adjacent to the colony, within radio range. Despite the problems, the preliminary study was considered promising enough to plan an extended study for 1987.

The 1987 season began badly for the terns with a band of American Crows (*Corvus brachyrhynchos*) foraging through the nesting area every day and harassing pairs attempting to court and lay eggs. One pair nested, but the eggs were immediately taken by crows. After 2 weeks we succeeded in bringing the crow problem temporarily under control and nesting began again. By then, many of the terns that have habitually returned to Terminal Island had gone to another colony to nest, including the four males that had been radio-tagged in 1986. Others laid eggs about 0.3 km away from the usual nesting locale on recently deposited loose dirt. By late May, however, there were 20 nests and we were able to proceed with the study. Predators continued to plague the colony; during the next month three American Kestrels (*Falco sparverius*), several feral cats, and a Peregrine Falcon (*F. peregrinus*) created varying degrees of havoc. Late in the season crows returned and destroyed the remaining nests.

Criteria for selection of candidates for telemetry were the same as in 1986. Three banded, known-age males with at least two seasons of breeding experience were trapped and radio-tagged in June. All behaved abnormally from the time they were released, in both breeding and foraging activities. Prior to telemetry they had all shared incubation duties with their mates, exchanging at intervals of 15 to 120 min. After the transmitters were attached one bird deserted the nest for 12 days, returning only after the transmitter had come off; the second never came back to the nest; the third returned to incubate intermittently after the second day, but did not resume regular incubation stints until the sixth day, after his transmitter had come off.

During this period the females continued to incubate the eggs. At the first nest, hatching was on schedule and the raising of the one chick proceeded normally, with both parents in attendance. At the second nest the female was unable to provide food for herself and two chicks without her mate. The second chick, obviously hungry on the second day, wandered to the next nest where a 1-day-old chick was being attended along with an unhatched egg. Although initially rebuffed by the male there, the chick persisted and after several hours the male allowed it to be brooded, then flew off and returned shortly with a fish for it. This successful adoption continued for 2 days, but on the second night both chicks, the egg, and the female on the nest were eaten by a feral cat. At the third nest the eggs were attended by the female for 10 days; on the 10th night, she was eaten by a feral cat. (Hatching of this egg was by then 3 to 7 days overdue and it proved to be addled.) Other nests in the vicinity were attended normally and hatched on schedule, although we do not know how the chicks fared subsequently.

Foraging behavior was also abnormal from the time the transmitters were attached. Terns from the Terminal Island colony have always fished in Los Angeles and Long Beach harbors during the period of active nesting (Massey and Atwood 1981); in July, after the chicks fledge, parents and fledglings have often gone to Harbor Lake, a freshwater pond about 7 km from the nest site, to fish (Atwood and Minsky 1983). In 1986 the four males in the telemetry study followed this pattern. But in 1987, from the time they were radio-tagged the three males went directly to Harbor Lake every morning and stayed there for most of the day, returning to the colony only to roost at night. Only once did one bird fish briefly in the harbor waters off the colony before leaving for Harbor Lake for the day.

Harbor Lake has rarely been used by Least Terns prior to the fledgling phase of the breeding cycle (Atwood and Minsky 1983). However, in 1987 an unusual situation occurred at the end of May, when a flock of courting 2-year-olds (identified by an annual banding code) established a daily pattern of roosting in the Terminal Island colony at night and flying to Harbor Lake each morning to spend the day feeding and courting. Two-year-old Least Terns regularly arrive in the breeding range about a month after their older counterparts, and court and eventually nest in one of the established colonies (Massey and Atwood 1981). Their foraging behavior is presumably that of the older terns; in previous years those on Terminal Island have not been observed fishing at Harbor Lake until after their chicks have hatched. In 1987 the three radio-tagged males joined this flock of 2-year-olds in their unusual daily routine. We did not see other breeding terns from Terminal Island or other colonies at Harbor Lake until July.

We had planned to radio-tag six Least Terns in 1987, but terminated the project after three attempts resulted in abnormal behavior. There appeared to be little prospect for gathering data on normal foraging patterns. It was clear by then that the colony was under continuing severe stress from predators, and the addition of te-

lemetry was apparently more disturbance than the birds could handle.

The Least Tern is at best a marginal subject for telemetry because of its small size, adverse reactions to all but minimal handling, and need for streamlined flight. Common Terns, which are larger and more amenable to handling, should be better suited to the method. However, a pilot study on the Common Tern in Massachusetts in 1987 encountered similar problems. Transmitters were glued to the rectrices of five pairs of breeding birds, following which two pairs deserted their nests. The method of attachment was unsuccessful; all terns lost the transmitters within a few days (J. L. Atwood, pers. comm.).

Our experiences in 1987 have caused us to abandon radiotelemetry on the Least Tern. Further miniaturization of transmitters and internalization of antennas may in future make the method more useful, but at present caution is in order. For Least Terns the only marking technique that has proven tolerable is leg bands.

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FIRST DESCRIPTION OF THE NEST AND EGGS OF THE MOSS-BACKED TANAGER (*BUTHRAUPIS [BANGSIA] EDWARDSI*)[1]

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Key words: Buthraupis edwardsi; *nest; eggs; Ecuador.*

While making an avifaunal survey in wet, foothill forest at El Placer, Prov. Esmeraldas, Ecuador (0°52′N, 78°33′W), we discovered a nest with two eggs of the Moss-backed Tanager (*Buthraupis [Bangsia] edwardsi*). This apparently represents the first published description of the nest and eggs of this species, since a recently published book summarizing tanager biology (Isler and Isler, *The Tanagers: natural history, distribution, and identification.* Smithsonian Institution Press, Washington, DC, 1987) gives no information on its breeding biology.

The nest was discovered on 30 July 1987, along the crest of a ridge in wet, relatively undisturbed foothill forest at ca. 670 m. However, the contents and the identity of the owner were not positively established

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