an unbanded female. The newly formed pair investigated several natural cavities in the wooded section of their territory, yet once again, with this new female, the final choice was the same exposed sign post in the parking lot.

The sign post was situated so that it received no shade from the south or west; therefore it was unprotected from the afternoon sun. Since the nest was started so late, the female's incubation lasted well into July. On sunny afternoons the temperature within the black metal post must have been extremely high; at least five times per hour the female would come to the entrance of the nest and sit with her mouth open, in an apparent effort to cool off (fig. 1). As mentioned above, the nest site had minimal protection from rain; the one egg that was laid did hatch, but the nestling died unfledged 18 days later in a torrential storm.

The new female, who had been banded near the nest, deserted O/O immediately after post-breeding molt and joined a neighboring flock whose dominant male (Y) had just lost his mate. As of April 1973, she and Y were clearly mates, while O/O had yet another mate. Such desertion when both members of a pair are alive is rare in this species (see for example Odum, Bird-Banding 13:155, 1942; Bent, U.S. Natl. Mus. Bull. 191:1, 1946). It is interesting that it followed an unsuccessful nesting attempt in such an unusual nest site.

Bent (op. cit.) includes no statement concerning which sex selects the nest site for any North American species of *Parus*. S. Smith (Publ. Nuttall Ornithol. Club, No. 11, 1972) reported what was ". . . probably a nest site showing display . . ." (p. 19) seen in three males of the Carolina Chickadee (*P. carolinensis*). However, the only published report that I have found regarding this question in *P. atricapillus* is Odum's (op. cit.) statement suggesting that the female makes the final decision.

There are several reasons why the selection of the sign post for a nest site was unusual. First, the territory contained 8 acres of woodland, including many natural nest cavities; second, the sign post was in one corner of the territory, within 25 ft of a three-way boundary with two other nesting pairs of chickadees, whereas the wooded part of the territory was edged by fields unoccupied by territorial chickadees; and finally, it was in a very exposed position, unprotected from both afternoon sun and rain, and located in a well-used parking lot that was brightly lighted at night. The fact that the same male nested in such a peculiar site for two successive years with two different females strongly suggests that at least occasionally the male plays a significant role in nest-site selection in this species.

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TELEMETRY OF ELECTROCARDIOGRAMS FROM FREE-LIVING BIRDS: A METHOD OF ELECTRODE PLACEMENT

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Monitoring the heart rate of a bird in the wild requires an electrode placement that is not easily accessible to the bird's mandibles and feet, and that can remain functional for several weeks to months. In addition, electrode placement must give a discernible ECG signal while the bird is at rest as well as during flight when strong electromyogram (EMG) potentials from the active pectoral muscles are present. We experimented with several electrode placements in the American Kestrel (*Falco sparverius*) and found the following one to be superior.

METHOD

Briefly, two electrodes were anchored into the keel of the sternum near the heart from inside the body cavity. The electrode leads were brought through an incision in the abdominal muscle wall and threaded under the skin from the abdominal incision to the bird's back. They then passed through the skin and terminated at a position that is not readily accessible to the bird.

This procedure will now be described in detail. An incision about 6 mm long was made just posterior to the sternum through the midline of the abdominal wall of an anesthetized bird. An electrode, consisting of a No Knot Eyelet (available at sporting goods stores) silver-soldered to 8 cm of very flexible, multistrand, teflon-coated, stainless steel wire (available from Narco Bio-Systems, Inc., Houston, Texas), was grasped firmly with a hemostat and inserted through the incision. It was slipped carefully along the dorsal surface of the sternum (parallel to the keel) to a position near the apex of the heart. (It is helpful to practice on a dead bird before attempting a live implant.) The point of the No Knot Eyelet was then thrust into the keel while the breast of the bird was braced anteriorally with the other hand. The second electrode was anchored similarly in the midline of the sternum 1–2 cm posterior to the first (fig. 1A and B). The muscle of the abdominal wall was then stitched closed around the electrodes with triple zero chromic sutures; one or two stitches were usually sufficient.

The two electrode leads were then threaded under the skin to the bird's back through a curved 15-gauge hypodermic needle. The needle was inserted under the skin on the bird's side, just anterior to the femur, and was guided through the subcutaneous tissue to the incision. The wires were then threaded into the tip and through the bore of the needle. The needle was withdrawn leaving the wires under the skin (fig. 1C). The abdominal incision in the skin now can be sutured closed. This same procedure was repeated, starting from a point in the middle of the bird's back and going to the lead wires which protrude from the skin on the side (fig. 1D).

Connectors compatible with those on the transmitter were soldered to the lead wires protruding through the skin on the back. A harness was used to secure the ECG transmitter to the bird (fig. 1E and 2). We used a Narco Bio-Systems, Inc. Model E-3 ECG transmitter, weight—7 g. When the transmitter was not in place on the harness, the exposed electrode leads were taped to the harness to protect them from the bird's mandibles.

Figures 3A and B are X-rays of a kestrel with electrodes and harness (without a transmitter) in in place. The accompanying sketch (fig. 3C) is included to clarify the X-ray.

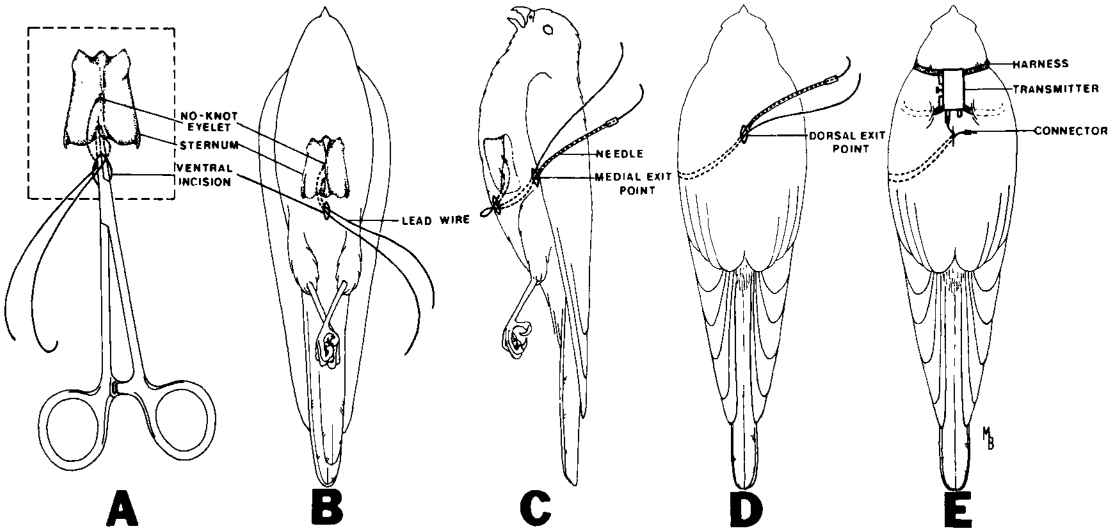

FIGURE 1. A and B (ventral view) is a diagram showing a small incision made through the abdominal wall and the two electrodes (No-Knot Eyelets) pushed into the keel of the sternum. C (lateral view), a curved, 15-gauge hypodermic needle is inserted under the skin medially and anterior to the femur and guided through the subcutaneous tissue to the abdominal incision. (Both lead wires are threaded through the needle, then the needle is withdrawn.) D (dorsal view), the step illustrated in 1C is repeated, threading the wires from their exit point in C to the middle of the back. E, the harness and transmitter are shown in place. The exit point of the wires should be under the transmitter for maximum protection from the bird's mandibles.

DISCUSSION

This method of electrode placement has several features which are superior to the fastening of electrodes onto the skin of the bird's dorsal surface or onto its pectoral region with suture thread or a safety pin. First, the electrode leads are subcutaneous and inaccessible to the bird's mandibles or feet except for a short piece (about 2 cm) that protrudes

FIGURE 2. An ECG transmitter mounted on a harness fitted for a kestrel (posterior end to right).

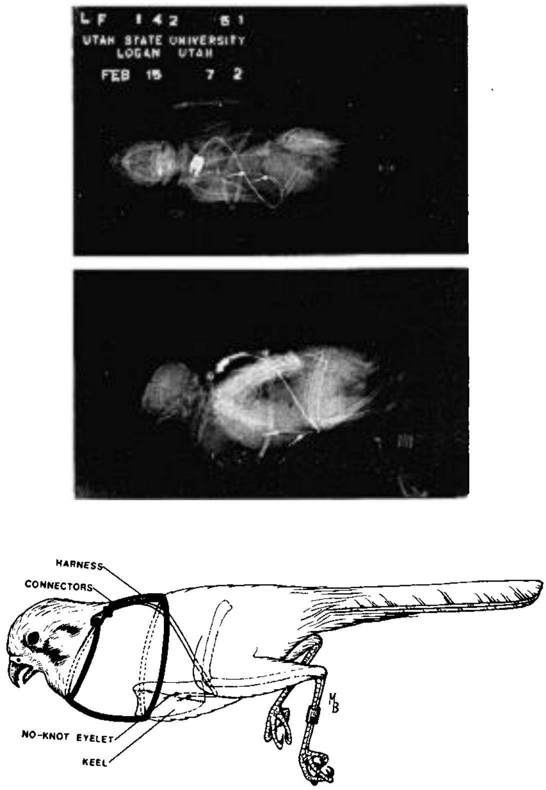

FIGURE 3. An X-ray of a kestrel with two electrodes in its keel and lead wires extending to connectors on its dorsal surface. The bird is wearing a harness. A, the bird's dorsal surface is facing the radiation source; B, the bird's left side is facing the radiation source; C, a lateral view sketch of the kestrel to clarify A and B.

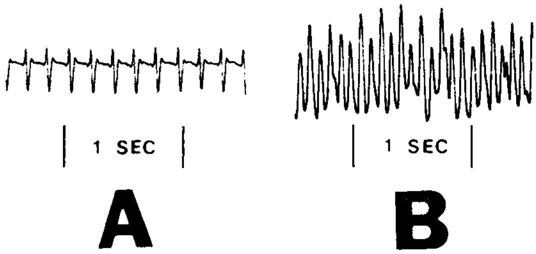

FIGURE 4. Two samples of ECG's from a kestrel, recorded from electrodes placed in its keel. A, ECG of a resting bird; B, ECG of a flying bird.

from the skin and connects to the dorsally mounted transmitter. Second, electrocardiograms recorded from the keel-anchored electrodes during flight have much less EMG interference than those recorded by surface electrodes (fig. 4). The reduced interference may be due to multiple factors. One possible reason may be that the sternum bone shields the keel electrodes from the EMG potentials more effectively than subcutaneous tissue shields surface electrodes. Another is that since the EMG potentials along the keel are determined by the electrical activity in both pectoral muscles, the EMG's from the pectorals may tend to cancel out along the keel which separates these two muscles. Third, the electrodes are anchored into the bird's skeleton, thus rigidly fixing the distance between them even though the bird is in flight. Fourth, the electrodes will remain in the same position for months in a free-living bird.

With this method we have telemetered ECG's from birds in the field for 2–3 week periods. One kestrel was implanted and released into the field in June 1971. Nine months later it was retrapped and the electrodes were still functional.

Two problems were encountered in using this method. One, the bird must be anesthetized to implant the electrodes. A few kestrels died when sodium pentabarbital was used as the anesthetic. Its effect varies among individual birds and with the age of the pentabarbital. We do not recommend its use on birds. Ketamine hydrochloride has been recommended by Kittle (Mod. Vet. Prac. 52:40, 1971) and Mattingly (Raptor Res. 6:51, 1972) as an anesthetic for birds of prey. The second problem, a small percentage (about 10%) of the kestrels and two of three Snowy Owls (*Nyctea scandiaca*) studied at the Naval Arctic Research Laboratory in January 1973 were able to reach the short electrode leads between the skin and transmitter. These birds pulled on the leads with their beaks, causing them to break away from the No Knot Eyelets at the soldered connections. Birds then usually continued to pull at a lead wire until it was pulled free of the body. The Snowy Owls could turn their heads more easily and get at the transmitter leads better than the kestrels.

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THE INCUBATION PATCHES OF CASSIN'S AUKLET

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During the beginning of the breeding season, certain areas of the ventral thoracic and abdominal skin of most birds undergo morphological and physiological changes that result in the formation of bare regions called incubation or brood patches. These changes include defeathering, hypervascularization, edema, and hyperplasia (Bailey 1952). An extensive review of the incubation patches of birds is given by Jones (1971).

This paper discusses the morphology and ecological significance of the brood patches of Cassin's Auklet (*Ptychoramphus aleuticus*). It is based on research conducted during 1969–71 on Southeast Farallon Island, California, 27 miles offshore from San Francisco. Cassin's Auklet is a small alcid that breeds on islands from southern Alaska to south-central Baja California. It is a nekton-feeder and is nocturnal with respect to its activities on the island. The nests are located in burrows or rock crevices, usually in colonies, and the normal clutch is a single egg. Both parents share the activities of incubation and nestling care.

Bailey (1952) separated birds into two major groups based on the distribution of the brood patches. Most birds belong to the group having a single large median patch corresponding roughly to the large median apterium. The other group develops a large patch from two large lateral apteria and a small median apterium. Most of the Charadriiformes follow this pattern but several species, including Cassin's Auklet, Crested Auklet (*Aethia cristatella*), Least Auklet (*A. pusilla*), Parakeet Auklet (*Cychlorrhynchus psittacula*), and the Rhinoceros Auklet (*Cerorhinca monocerata*), have no ventral median apterium but instead have two separate and distinct brood patches, one beneath each wing on the lateral ventral apterium (this study; Sealey 1968). All of these species lay just a single egg and it is placed beneath the wing on one side or the other of the abdomen.

Although Cassin's Auklets have been reported to lack brood patches (Payne 1966), intensive study of the birds through all seasons reveals that auklets incubating clutches early in the nesting season do have patches, but those nesting later often do not. I examined patches of birds that were either incubating or brooding and of those captured by a large net (see Ralph and Sibley 1970) during morning departure flights. I preserved brood-patch tissue samples in 10% formalin and stained sample slices (10) with eosin and hematoxylin for study. I classified brood patches of Cassin's Auklet in the following manner.

MORPHOLOGICAL CHARACTERISTICS

Type 3. Well-developed Brood Patch

The outstanding characteristics include the large amount of epidermal folding and increased vascularization (figs. 1 and 2). No feathers or down are present on the deep-pink surface contact area, but feather papillae can be found in subepidermal tissue. Edema appears to be moderate.

Type 2. Regressing Brood Patch

This is similar to Type 3 but folding is decreased and there is little or no edema. The patch surface

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