## California Sparrows Return from Displacement to Maryland

Abstract. *Twenty-two migratory sparrows* (Zonotrichia) *which had returned to their winter home at San Jose, California (1962–63), after being displaced 2900 kilometers to Baton Rouge, Louisiana, in the winter of 1961–62, were then displaced the 3860 kilometers to Laurel, Maryland, during the winter of 1962–63. Six of the 22 birds returned across the continent to San Jose to be recaptured during the winter of 1963–64.*

The return of migratory birds year after year to nest in the same place is well known. Many species have been shown to home to their nests after being artificially displaced a few kilometers, or even thousands of kilometers in the case of certain oceanic birds (*1*). Banded birds of several migratory species have been shown to return year after year to the same few acres to spend the winter season (*2, 3*). Less well known is the ability of some species to return to their winter home, remote from their nesting home, after displacement (*4*).

Reported here are the results of displacing golden-crowned sparrows, *Zonotrichia atricapilla*, and white-crowned sparrows of two races, *Z. leucophrys gambelii* and *Z. l. pugetensis*. All three taxa winter regularly in the San Jose area. The *Z. l. pugetensis* breed in Washington and British Columbia in the vicinity of Puget Sound (Fig. 1). Both *Z. l. gambelii* and *Z. atricapilla* breed in Canada (probably northwestern) and Alaska. All three taxa migrate annually during September and October (southward) and April and May (northward). Once a wintering area is established, individual *Zonotrichia* return with great fidelity to it each October (*3, 5*).

In an earlier study (*6*), 411 *Zonotrichia* were displaced by aircraft the 2900 km from San Jose, California, to Baton Rouge, Louisiana, in the winter of 1961–62. Twenty-six returned to traps at the San Jose banding station during the 1962–63 winter season. The birds were from a well-studied population in the eastern suburbs of San Jose. The number of birds returning to the San Jose station was 21 percent of the 123 which would normally have been expected to survive and return to traps if no artificial displacement had been made. Those returning included a greater percentage of the adults expected to return than of the immature birds expected, and a greater proportion of the long-distance migrants, *Z. l. gambelii* and *Z. atricapilla*, than of the short-distance migrant, *Z. l. pugetensis* (*6*).

During the period from October 1962 to April 1963, 660 birds, all marked with colored bands in addition to their numbered service bands, were transported the 3860 km from San Jose to Laurel by jet aircraft (Table 1). They included not only established winter residents but also many birds which infiltrated the trapping station from the surrounding area in response to the removal of birds for displacement (*3*). Releases were made at the Migratory Bird Populations Station of the U.S. Fish and Wildlife Service at Laurel, Maryland (*7*). A trapping and retrapping program in the release area at Laurel revealed that adults tended to disappear from the release area, while many of the birds less than a year old remained in the release area until spring. One *Z. l. pugetensis*, released at Laurel on 30 October 1962 when about 4 months old, was recaptured at Laurel in apparent good health on 24 November 1963. Where this bird spent the intervening summer months is not known.

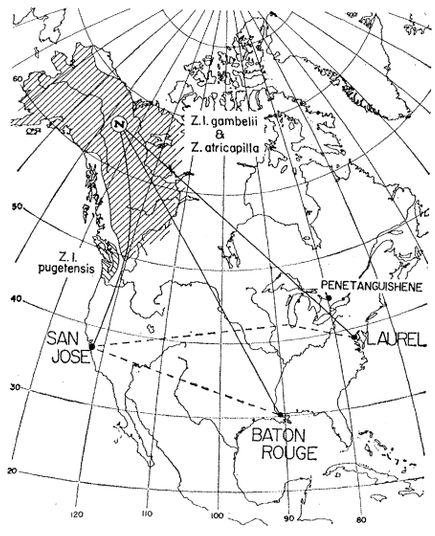


Fig. 1. Probable nesting limits of *Zonotrichia leucophrys gambelii, Z. atricapilla,* and *Z. l. pugetensis* which winter at San Jose, California, are represented by the diagonally ruled areas. Broken lines represent approximate aircraft displacement routes from San Jose to Baton Rouge, Louisiana (1961–62), and to Laurel, Maryland (1962–63). Solid lines between each of Baton Rouge and Laurel and the nesting grounds (*N* in the circle) represent the probable approximate routes taken from the displacement stations to the nesting area for *Z. l. gambelii* and *Z. atricapilla*. The solid line between nesting grounds and San Jose traces the probable migratory route for far northern birds. A *Z. atricapilla* released at Laurel on 21 March 1963 was found injured 13 May 1963 at Penetanguishene, Ontario.

Table 1. Numbers of golden and white crowned sparrows returning to San Jose, California, during 1963–64 after displacement to Laurel, Maryland, during 1962–63. Approximately 30 percent of all *Zonotrichia* returned 1955–61. Approximately 50 percent of established adult *Zonotrichia* returned 1956–61.

| Displaced | Expected to return | Returned |
|---|---|---|
| | *Z. l. pugetensis* | |
| 287 | 86 | 0 |
| | *Z. l. gambelii* | |
| 231 | 69 | 6* |
| | *Z. atricapilla* | |
| 142 | 43 | 9* |
| Previously returned from Baton Rouge | | |
| | *Z. l. pugetensis* | |
| 7 | 3 | 0 |
| | *Z. l. gambelii* | |
| 8 | 4 | 4 |
| | *Z. atricapilla* | |
| 7 | 4 | 2 |

* One *Z. l. gambelii* and one *Z. atricapilla* were seen but not captured.

Of the 660 birds displaced to Laurel, 15 are known to have returned to San Jose during the 1963–64 winter season. They included six *Z. l. gambelii* and nine *Z. atricapilla*. No *Z. l. pugetensis* are known to have returned to San Jose from Laurel. After 13 birds had been captured and their color bands removed, two more birds were identified. These, one *Z. l. gambelii* and one *Z. atricapilla*, were not captured but were recognized by their color bands in the vicinity of the banding station.

Of greatest significance was the return of 6 of 22 birds displaced to Laurel after they had already returned from Baton Rouge. These re-displaced birds included eight *Z. l. gambelii*, seven *Z. l. pugetensis*, and seven *Z. atricapilla*. Those returning included four *Z. l. gambelii* (two males and two females) and two *Z. atricapilla* (one male and one female). No more than 11 (50 percent) of the 22 would normally be expected to return to San Jose without artificial displacement. Thus the six birds which returned comprised more than 50 percent of those expected to return. This is in spite of the increased hazards involved in crossing the continent prior to reaching

ancestral and familiar territory. Of the 15 long-distance migrants (*Z. l. gambelii* and *Z. atricapilla*) no more than eight would normally be expected to return without displacement. Although the six of these two races which did return are from a small sample, the fact that any returned seems indeed remarkable. It should be noted that none of the seven *Z. l. pugetensis* which had already returned to San Jose from Louisiana returned from displacement to Laurel.

Of the 638 birds displaced for the first time we would normally have expected 30 percent, or about 198, to return. The nine which returned (seven *Z. atricapilla* and two *Z. l. gambelii*) comprise only about 4 percent of those normally expected to return to traps at San Jose after a summer on the breeding grounds. Most of these 638 birds were from populations peripheral to the banding station (*3*), and the presence of returned birds in the surrounding suburbs would not have been detected. One of the birds which returned was captured about a kilometer from the banding station.

Because these birds returned the following winter (none in the same winter), it is presumed that they found their way first to their ancestral nesting ground (Fig. 1) and then returned to San Jose in normal migration. The return to the nesting ground was probably accomplished for the most part in spring during the normal period of migration. This hypothesis is supported by the chance recovery of one *Z. atricapilla* on 13 May 1963 at Penetanguishene, Ontario (Fig. 1). This recovery was nearly on the direct line from the release area at Laurel (21 March 1963) to the presumed nesting grounds in northwestern North America.

These data support the hypothesis that small passerines of the genus *Zonotrichia* have an innate ability to home, probably by means other than chance, from artificial displacements as far as across the continent of North America. The returns observed must be accounted for by a mechanism which includes an ability to home from a geographical area beyond their experience. The ability to home is better demonstrated in long-distance migrants than in short-distance migrants (*Z. l. gambelii* and *Z. atricapilla* in contrast to *Z. l. pugetensis*) and is better developed in adults than in immature birds. These findings further suggest that experience in homing, such as return to San Jose from displacement to Baton Rouge, improves homing performance from another remote location such as return to San Jose from displacement to Laurel.

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**References and Notes**

1. G. V. T. Matthews, *Bird Navigation* (Cambridge Univ. Press, London, 1955); K. W. Kenyon and D. W. Rice, *Condor* **60**, 3 (1958).
2. W. P. Wharton, *Bird-Banding* **12**, 137 (1941).
3. L. R. Mewaldt, *ibid.* **35**, 184 (1964).
4. A. C. Perdeck, *Ardea* **46**, 1 (1958); R. Roadcap, *Western Bird Bander* **37**, 55 (1962).
5. J. M. Linsdale, *Condor* **51**, 88 (1949).
6. L. R. Mewaldt, *Western Bird Bander* **38**, 1 (1963); L. R. Mewaldt and R. J. Newman, in preparation.
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## Collagenolytic Activity of Intact and Necrotic Connective Tissue

Abstract. *Isotonic saline extracts of both intact and necrotic skin of the rat were capable of releasing over 50 percent of the hydroxyproline content of soluble collagen as dialyzable, peptide-bound amino acid only after prior, limited proteolytic activation of trypsin. These "activated" extracts could also solubilize insoluble collagen to release dialyzable hydroxyproline containing peptides. This collagenolytic activity was maximal at* p*H 5.5 and was not inhibited by soybean trypsin inhibitor, ethylenediaminetetraacetic acid, or heavy metal salt. The "activated" extracts showed no general proteolytic activity toward denatured hemoglobin. The collagenolytic activity was destroyed both by heat and by extensive tryptic proteolysis.*

Results of studies (*1*) in which radioisotope has been incorporated into collagen indicate that most dermal collagen is relatively inert metabolically, with 50 percent of the labeled insoluble collagen remaining in the tissue for as long as 300 days. Despite this, the collagen content of rat skin is markedly reduced within 24 hours after onset of necrosis or stress (*2*). This catabolism of collagen, it has been suggested (*3*), proceeds by disaggregation of isotonic collagen into soluble precursors which are then denatured thermally into gelatins. These gelatins could then be attacked by cathepsins. However, this thermal denaturation of dermal collagen has recently been shown to be unlikely (*4*). An alternative mechanism to explain the rapid catabolism of collagen would be that a specific collagenase degrades insoluble collagens into diffusable breakdown products; this explanation has also been considered unlikely since various investigators (*5*) could not demonstrate any collagenolytic activity in necrotic tissue.

To learn more of the mechanism of collagen catabolism, we have studied the capacity of extracts of the connective tissue to release dialyzable, peptide-bound hydroxyproline from solutions of purified soluble collagen and from suspensions of purified insoluble collagen. Neutral soluble collagen was prepared from dilute acid extracts of calf skin (*6*) and purified by repeated successive precipitations with salt at acid and neutral *p*H (*7*). This presentation had an intrinsic viscosity of 14 dl/g and an optical rotation of −350 deg. The acid-insoluble residue after preparation of soluble collagen was washed exhaustively with dilute acid and water and it served as an insoluble collagen substrate.

Soluble collagen (1.25 mg/ml) was dissolved in cold 0.1*M* acetate buffer (*p*H 5.5) containing 0.5*M* $CaCl_2$ (*8*). Four milliliters of this solution were incubated for 16 hours at 12°C with 1.0-ml samples of various tissue extracts, and the hydroxyproline concentration of these solutions before and after 48 hours of dialysis at 4°C against 500 volumes of buffer was determined (*9*). The low temperature prevented thermal denaturation of the substrate, since no change in either viscosity or optical rotation was noted under these conditions when buffer was substituted for the tissue extracts. The *p*H used is optimal for a mammalian collagenolytic activity (*8*).

Isotonic saline extracts of necrotic wounds 48 hours after they had been induced by croton oil (*2*) and of intact uninjured skin from 24 injured male Sprague-Dawley rats (250 to 270 g) were prepared (*10*) from three pools representing eight animals each. After dialysis and lyophilization, solutions of these extracts were diluted in acetate