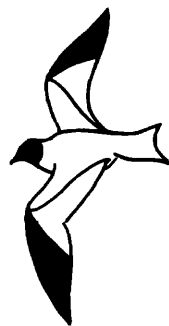


# WESTERN BIRDS



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## AGE, SEX, MOLT AND MIGRATION OF DUNLINS AT BOLINAS LAGOON

GARY PAGE, Point Reyes Bird Observatory, Box 321, Bolinas, California 94924

Various aspects of the winter biology of Dunlins (*Calidris alpina*) have been studied in California by Storer (1951), Recher (1966), Holmes (1966a, b, 1971), Gerstenberg (1972) and Jurek (1973). Recent studies at Bolinas Lagoon provide information that supplements and in certain details, contradicts previously published accounts. This paper reports on age and sex ratios, molt and migration of Dunlins at Bolinas Lagoon.

### STUDY AREA AND METHODS

Bolinas Lagoon is a 570-hectare estuary at the southern edge of the Point Reyes peninsula on the central California coast. It is shallow with extensive sand and mud flats on which large numbers of shorebirds can be found during most of the year.

To estimate the number of shorebirds on the estuary, six censuses per month were taken from June 1971 through May 1972, and usually three but occasionally six censuses per month from June 1972 through May 1974. On each census the estuary was divided into three areas and the birds in each area were counted or estimated simultaneously by three observers. Some censuses included numbers of small sandpipers that could not be separately identified as Dunlin, Least Sandpiper (*Calidris minutilla*) or Western Sandpiper (*Calidris mauri*), but in no census did such observations exceed 20% of the total number. These birds were incorporated into a census total as Dunlins, Least Sandpipers and Western Sandpipers according to the relative abundance of firm identifications of these species in the census. Most censuses were taken on flood or ebb tides 1.1 m to 1.7 m above mean low water.

## DUNLINS AT BOLINAS LAGOON

Between October 1971 and April 1972, Dunlins were trapped after dusk in mist nets set across channels and pools in salt marsh where the birds roosted. Trapped birds were weighed to the nearest gram on Pesola spring balances. The culmen (length from the tip to where the feathers meet the center of the upper mandible) was measured to 0.1 mm with dial calipers. Each bird was banded with a numbered aluminum band on the tarso-metatarsus and a blank aluminum band on the tibiotarsus. Both bands were covered with colored plastic tape to indicate the location and the season of banding and the age of the bird. Birds were considered immature if they had buffy edges on their innermost tertial or inner middle wing coverts, and adult if these feathers were white- or grey-tipped. Molt was recorded for six body regions (crown, upper back, rump, throat, breast and abdomen). The number of growing feathers was estimated in each body area and the molt was scored from 0 to 3 as described in Page (1974, Table 1). The molt score for the entire body is the sum of the different body regions. The flight feathers of the wing were grouped into 10 primaries, 10 secondaries and 5 tertials, including as a tertial the small innermost feather that Holmes (1966a) apparently did not consider a tertial in the Dunlins he examined. Each flight feather was recorded as growing or not growing.

In this paper, "season" as used under the heading "Return Rate" refers to the period from June to May of the following year.

### SEASONAL ABUNDANCE

Although the pattern of Dunlin occurrence varied during the study (Figure 1), the birds consistently arrived in late September and were present in the greatest numbers in November. During the period of peak abundance Dunlins were about twice as numerous in 1971 as in 1972 and 1973. During January and February of 1972 and 1974, the Dunlin population ranged from 1000 to 1600 individuals. In January 1973 the Dunlin population decreased from approximately 1000 at the beginning of the month to 300 at the end, probably because of very heavy rains (15 inches in 14 days). During periods of heavy rain, Dunlins and other shorebirds leave the lagoon at moderate and high tides and feed or roost in nearby pastures. In January 1973 heavy rains apparently drove most Dunlins out of the area entirely.

Spring migratory waves of Dunlins were apparent in April 1973 and 1974 although not in April 1972 (Figure 1). The magnitude of these waves was small in comparison to those in other species such as the dowitchers (*Limnodromus* spp) and the Western Sandpiper (Page, Fearis and Jurek 1972).

DUNLINS AT BOLINAS LAGOON

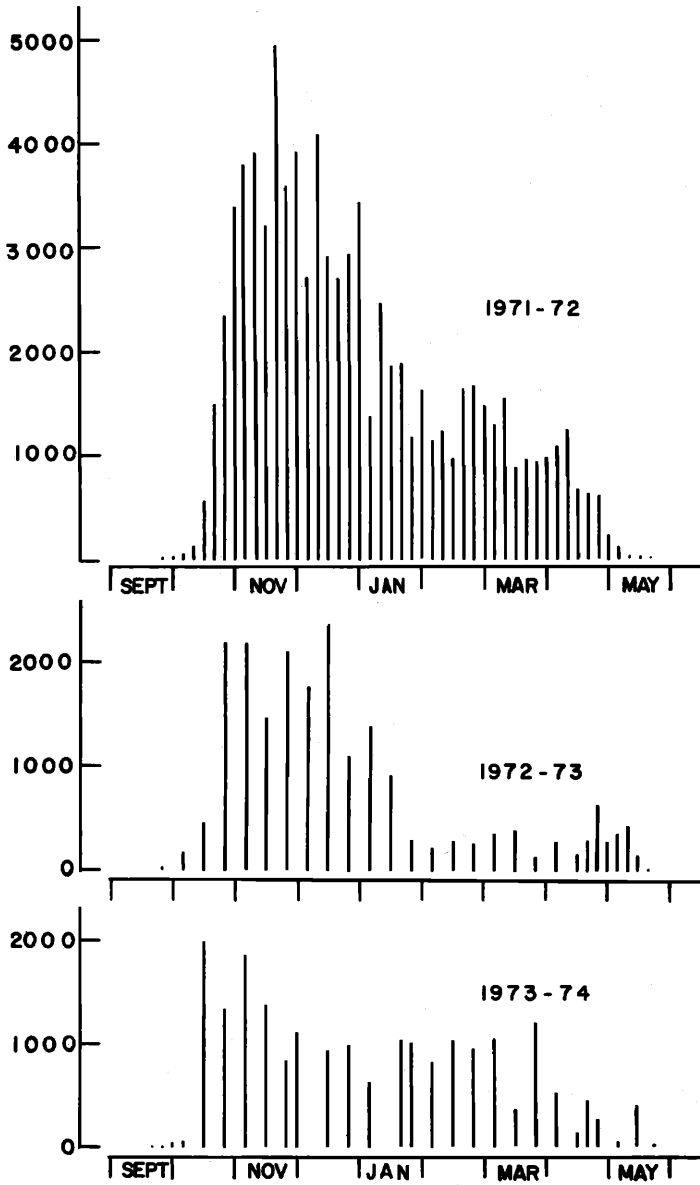


Figure 1. Numbers of Dunlins at Bolinas Lagoon from September 1971 to May 1974. Dunlins are absent from late May until late September.

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### DETERMINING THE SEX FROM THE BILL MEASUREMENT

MacLean and Holmes (1971) found a culmen range of 34.0 mm to 41.0 mm with a mean of 37.2 mm for male Dunlins, and a range of 34.5 mm to 45.0 mm with a mean of 40.5 mm for female Dunlins wintering in western North America. I measured Dunlin specimens in breeding plumage from California at the Museum of Vertebrate Zoology, Berkeley, and the California Academy of Sciences and obtained similar results. Bill lengths of 87 males were in the range of 33.1 mm to 41.3 mm with a mean of 36.9 mm (S.D.=1.7 mm) and those of 82 females in the range of 35.7 mm to 44.6 mm with a mean of 40.5 mm (S.D.=1.6 mm). Most if not all of these 169 specimens must also have been used by MacLean and Holmes. From these statistics the normal distributions of male and female bill lengths were determined (see Page and Fearis 1971). I found that 70% of the male and 4% of the female Dunlins had a bill length  $\leq 37.7$  mm and 67% of the females and 4% of the males had a bill length  $\geq 39.8$  mm. Twenty-five percent of the males and 28% of the females had a bill length between 37.8 mm and 39.7 mm. If Dunlins with culmens  $\leq 37.7$  mm are considered males and those  $\geq 39.8$  mm females, in a normally distributed sample with a 1:1 sex ratio the result would be 35% of the birds sexed correctly as males, 34% correctly as females, 2% incorrectly as males, and 2% incorrectly as females. Twenty-seven percent of the birds in the sample would be unsexed, of which 13% are expected to be males and 14% females. In the birds trapped from October 1971 to April 1972 the culmens of 24% of the adults and 23% of the immatures were between 37.8 mm and 39.7 mm. As my data suggest that approximately the same number of males and females will remain unsexed if Dunlins with bill lengths  $\leq 37.7$  mm are considered males and  $\geq 39.8$  mm females, I have used these divisions to separate the sexes in this paper.

### AGE AND SEX COMPOSITION

Adult Least Sandpipers and Western Sandpipers leave the breeding grounds before they begin the bulk of their prebasic molt and arrive in California well before the immatures. In contrast, Dunlins undergo most of the prebasic molt on the breeding grounds and the adult and immature Dunlins arrive together in California. Holmes (1966b) states that adult and immature Dunlins arrive in about equal numbers in California. This was based on the occurrence of approximately equal numbers of Dunlins of both age classes in museum collections (Holmes pers. comm.). But in birds trapped at Bolinas Lagoon in October 1971, im-

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matures markedly outnumbered adults (Figure 2). Adults made up 17% of the birds trapped from October to December 1971, 40% from January to February 1972, and 45% from March to April 1972. A possible explanation is that immatures are more easily trapped early in the season and are less wary of nets than adults. Later in the season adults and young may perhaps be trapped with similar ease. Differential mortality rates or movements of the two age classes could also affect the observed age ratio change in the Dunlin population between the spring and fall.

Male and female Dunlins arrived simultaneously at Bolinas Lagoon in October but males outnumbered females (Figure 2). Of birds trapped and sexed between October and December 1971, only 37% of the adults and 34% of the immatures were females; between January and February 1972, 25% of the adults and 18% of the immatures were females; and between March and April 1972, 46% of adults and 32% of immatures were females. Assuming that there is not an unequal sex ratio in the *C. alpina pacifica* population as a whole, the uneven sex ratios at Bolinas may indicate geographic or ecological segregation by sex of Dunlins on the wintering grounds. I was unable to trap enough birds to determine when males and females left the lagoon in the spring.

## MOLT

The Dunlin lingers on or near the breeding grounds and molts into its basic plumage (Holmes 1971) whereas the Western Sandpiper (Holmes 1972) and Least Sandpiper (Page 1974) migrate south before molting. Holmes (1971) reported that Dunlins leave the breeding grounds before the prebasic molt is complete but, except for a few early birds, have completed molt on arrival in California. I found some Dunlins in light molt at Bolinas Lagoon in October 1971 but body molt was most intense between late October and the third week of November (Figure 3). Growing feathers were apparent in many birds in most or all body areas I examined. Evidently body molt is not complete by the time many Dunlins arrive in California.

Molt of flight feathers differed in one respect between Least and Western Sandpipers and Dunlins. None of the 258 immature Dunlins captured between October and December 1971 had new or growing tertials or rectrices. Between 28 September and 6 November, during the height of the first prebasic molt of Least and Western Sandpipers at Bolinas, 8.2% of 61 Western Sandpipers trapped had new or growing tertials and 3.3% had new or growing tail feathers, as compared to 78.3% and 30.0% respectively for 217 Least Sandpipers. During the prealter-

PERCENT TRAPPED BIRDS

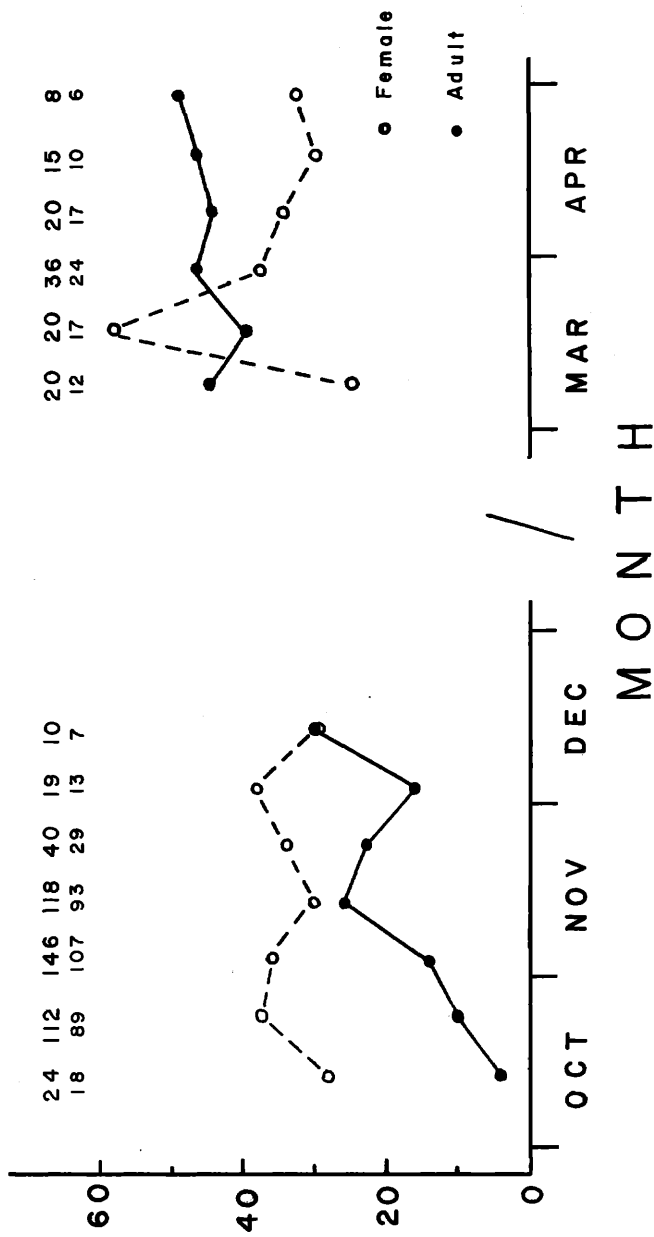
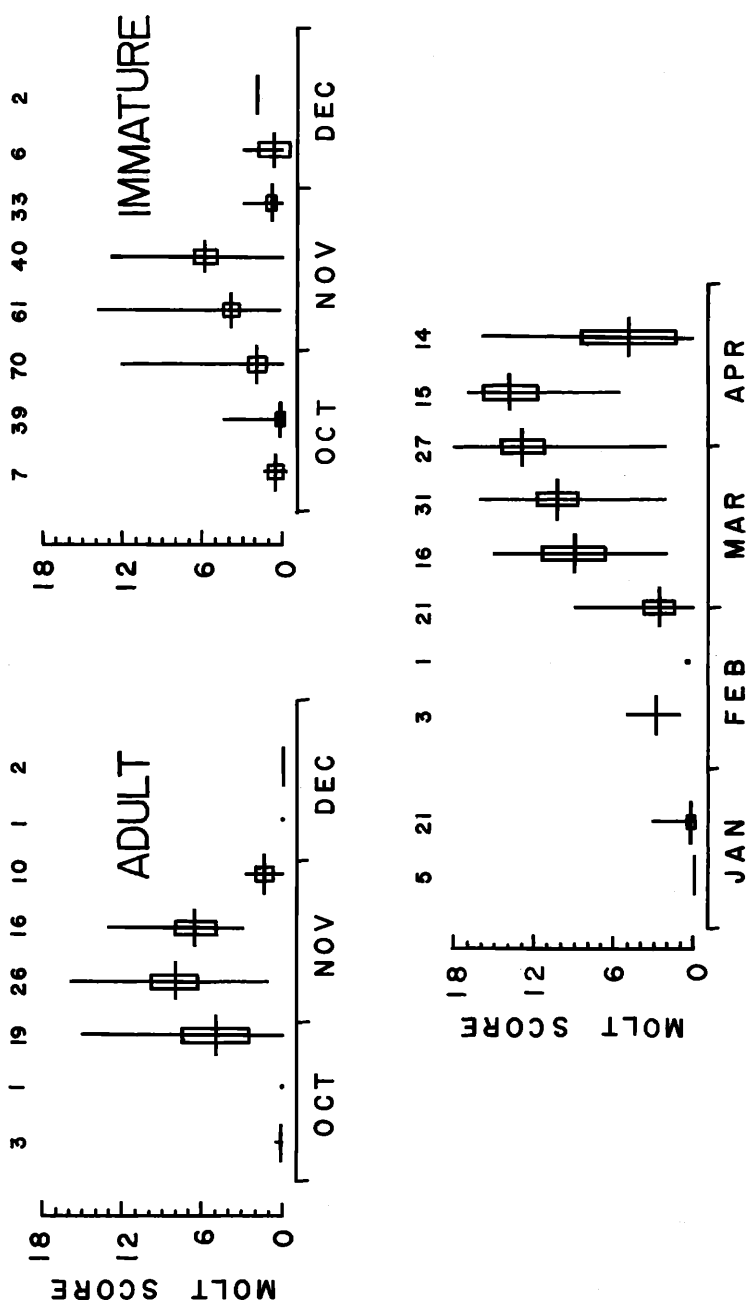


Figure 2. Age and sex ratios of Dunlins trapped at Bolinas Lagoon between October 1971 and April 1972. Sample sizes at the top of the figure include birds of known and unknown sex (upper) and birds of known sex (lower). Age ratios are based on all birds; sex ratios are based only on birds of known sex.



7 Figure 3. Intensity of body molt in Dunlins at Bolinas Lagoon, autumn 1971 and spring 1972. Vertical line is range, horizontal line is mean and rectangle is 95% confidence interval of mean. Sample sizes are at the top of figure.

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nate molt in March and April 1972, 1.8% of 55 adult Dunlins and 4.7% of 64 immature Dunlins had new or growing tertials. None had new or growing rectrices. More than 85% of 104 Western Sandpipers trapped in April had some new or growing tertials and 35% had replaced some rectrices. More than 80% of 110 Least Sandpipers trapped in March and April were replacing tertials and at least 37% of the adults and 20% of the immatures were replacing rectrices. The first prebasic molt and the prealternate molt includes more of the flight feathers in the Least Sandpiper and Western Sandpiper than in the Dunlin.

### RETURN RATE

The number of Dunlins on Bolinas Lagoon between 23 October and 6 December 1972 that had been marked between October 1971 and April 1972 was estimated by multiplying the mean proportion of marked birds by the maximum estimated Dunlin population (2100 birds) on the estuary between 23 October and 6 December 1972. I determined that 32% of the adult and 15% of the immature Dunlins banded in the 1971-72 season returned the following autumn. During autumn 1972, 26% of the adult and 22% of the immature Least Sandpipers (Page 1974) but only 1% of the adult and immature Western Sandpipers banded the previous season returned to Bolinas Lagoon. Western Sandpipers are primarily transients at Bolinas (Page, Fearis and Jurek 1972), whereas many Least Sandpipers (Page 1974) and Dunlins are winter residents. Given sufficient habitat to choose from, as in the Point Reyes-San Francisco Bay area, individual sandpipers seem more likely to return to particular molting and wintering areas year after year than to particular migratory stopover places. The return rates given for the three sandpipers are minimal as in the calculations I used the mean rather than the maximum number of marked birds on the estuary during the period that each species was most abundant. The fact that Western Sandpipers are more transitory at Bolinas than Dunlins or Least Sandpipers may have pulled the calculated return rate for the Western Sandpiper down proportionately more than those for the other species.

### MIGRATION

Holmes (1966b) reported that Dunlin populations at several locations in central California did not increase during spring migration. He suggested that the entire Dunlin population probably shifted northward gradually in an early, slow-moving spring migration, so that a spring



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Table 1. Weight in grams of Dunlins trapped at Bolinas Lagoon, Marin Co., California between November 1971 and April 1972. A is adult, I is immature.

	NOV (A)	NOV (I)	JAN-FEB	APR
Range	42-62	41-67	42-58	45-66
Mean	50.9	50.3	47.8	53.5
Standard deviation	4.1	4.1	3.6	4.9
Coefficient of variation	8.0	8.1	7.5	9.5
Sample size	52	172	34	41

build-up in numbers could not be observed. He thought that the birds moved primarily along the coast, although in the spring there was some shift inland. However, spring migrational peaks of Dunlins have been observed along the coast in some locations in some years. At Humboldt Bay Gerstenberg (1972) reported an increase in April 1969, and at Bolinas Lagoon spring migration waves of small magnitude were apparent in two of the three years of this study (Figure 1). Dunlins at Bolinas Lagoon were heavier during April than in January and February (Table 1), suggesting that April birds had fat deposits for migratory flights. These observations neither refute nor substantiate Holmes' suggestions.

In Oregon and Washington there are conspicuous waves of Dunlins during migration along the coast in April and May (Gabrielson and Jewett 1940; Jewett et al. 1953) and there are spring movements of Dunlins in the interior of Oregon (Strauch 1967). To probe more into the situation in California, I have summarized data from Jurek (1973) that provide an index of the relative abundance of Dunlins between the coast and the interior (Table 2). During fall migration the ratio of Dunlins on the coast compared to the interior was 3.2:1, in winter 8.2:1, but during spring migration only 0.4:1. Thus there appears to be a substantial shift of birds from a coastal to an inland migration route in California between fall and spring.

Dunlins may shift directly from coastal areas such as Bolinas Lagoon to the interior of California in late winter and spring. At a small marsh in the Willamette Valley in the interior of Oregon, Strauch (1967) regularly found a few hundred Dunlins in spring. Although Strauch indicates that this species does not normally winter in the interior of Oregon, in January and February 1965 they occurred in his study area in substantial numbers. Their appearance coincided with the beginning of heavy flooding on the coast which Strauch thought may have driven the birds inland. During this study, the disappearance of a large proportion of the Dunlin population from Bolinas Lagoon in January was correlated with heavy rainfall in the area. Therefore in some instances, a shift of Dunlins directly from the coast to the interior may be affected by the amount of rainfall on the coast, and very heavy rainfall in some years

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Table 2. Seasonal numbers of Dunlins at census sites in different parts of California. Data are from Jurek (1973), and for Point Reyes, from unpublished data of Point Reyes Bird Observatory. Number of census sites in each area is in parentheses. Maximum census figure for period of time under consideration has been used in all instances.

LOCATION	SEP-NOV	JAN-FEB	APR-MAY
Interior:			
N. E. California (4)	3238	0	4180
Central Valley (9)	3668	1813	9917
Coastal:			
S. California coast (10)	2248	1337	248
San Francisco Bay (7)	10946	5876	3704
Point Reyes area (5)	9193	7693	1348
Total of all areas	29293	16719	19397

may cause some birds to move inland considerably earlier than in years of more moderate rainfall. Another possibility suggested by Jehl (pers. comm.) is that inland birds come from southern wintering grounds and are following the most direct northern route from the Gulf of California and the Salton Sea. The nature of the Dunlin spring migration clearly needs further investigation.

The number of Dunlins that Jurek (1973) reported at all sites was lower in spring than in fall (Table 2). At Bolinas Lagoon between October 1972 and February 1973, Page and Whitacre (1975) estimated that raptors ate at least 21% of the wintering Dunlins and heavy mortality was observed throughout the study. Heavy predation here and elsewhere may substantially reduce winter populations and may account for some of the decline in winter on the California coast.

## SUMMARY

Dunlins were studied at Bolinas Lagoon from June 1971 to May 1974. They arrived in late September and were present in peak numbers between mid-October and late December. After December numbers declined until April and May, when small influxes sometimes occurred.

The sex of Dunlins was inferred from culmen measurements: birds with culmen  $\leq 37.7$  mm were considered males and  $\geq 39.8$  mm females. During much of the 1971-72 season males outnumbered females about 2:1. Immatures were much more abundant than adults from October to December; but in March and April adults and immatures were almost equally abundant. In autumn 1972 at least 32% of the adults and 15% of the immatures banded the previous season returned to Bolinas Lagoon.

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In autumn, birds of both age classes underwent some body molt after arriving at Bolinas Lagoon. Adults and immatures underwent a partial prenuptial molt in spring in which very few birds replaced any flight feathers.

Evidence suggesting migration is much more pronounced in the interior of California in spring than in fall conflicts with the previously held view and points out the need for further studies of Dunlin migration in California.

### ACKNOWLEDGMENTS

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