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MIGRATION AND WINTERING OF WESTERN SANDPIPERS ON THE PACIFIC COAST OF COLOMBIA

LUIS G. NARANJO
Departamento de Biología
Universidad del Valle
A. A. 25360, Cali, Colombia

REBECA FRANKE
Parque Nacional Natural Isla Gorgona
A.A. 3039, Cali, Colombia

WILLIAM BELTRÁN
Sociedad Vallecaucana de Ornitología
A. A. 26538, Cali, Colombia

Abstract.—The population structure, monthly variation in body mass and sequence of molt of Western Sandpipers (*Calidris mauri*) on the Buenaventura Bay, Pacific Coast of Colombia, are described based on banding and specimen data of 223 individuals caught between 1982 and 1985. The proportion of adults and juveniles in the sample did not follow a regular pattern, suggesting that first-year birds migrate to a different area. In every month, adult females outnumbered the males, indicating partial spatial segregation of the sexes. Analysis of variance of body mass demonstrates the presence of two groups of migrants in the area. Birds arriving in August use the Bay as a stopover site until late November, when a second wave arrives for the rest of the boreal winter.

MIGRACIÓN E INVERNADA DE *CALIDRIS MAURI* EN EL LITORAL PACÍFICO DE COLOMBIA

Sinopsis.—Analizamos datos de 223 individuos de *Calidris mauri* colectados o anillados entre 1982 y 1985 para describir la estructura poblacional, variación mensual de masa corporal y secuencia de muda en la Bahía de Buenaventura, costa Pacífica de Colombia. La proporción de adultos y juveniles en la muestra no siguió ningún patrón definido, indicando que los animales de menos de un año migran hacia un área diferente. Para cada mes, las hembras adultas superaron numéricamente a los machos, lo que sugiere una segregación espacial de los sexos. Un análisis de varianza de la masa corporal demostró la presencia de dos grupos migratorios en el área. El primero llega en agosto y usa la Bahía como un sitio de descanso hasta finales de noviembre, cuando arriba la segunda oleada de migrantes. Esta última permanece en la localidad hasta el final del invierno boreal.

Since the initiation of the Pan-American Shorebird Program (PASP) in the early 1980s, a great deal of interest has been generated about the role of shorebirds in Neotropical ecosystems and, consequently, about the necessity of including these animals among the priorities of conservation strategies. The challenge faced by conservation biologists in the process of making decisions related to migrant shorebirds, however, is perhaps greater than, or at least equal to, that of preserving exclusively neotropical organisms. Our current knowledge of the most basic aspects of the ecology of these migratory species is meager.

For example, migration of Western Sandpipers (*Calidris mauri*), a common winter resident of the Pacific coast from Mexico to northern Peru (Blake 1977), is poorly known outside the United States. The lack

of information from south of the U.S. is particularly striking when compared with papers dealing with the biology of the species in North America (e.g., Holmes 1971, 1972; Page et al. 1972). Several papers on communities of shorebirds wintering in the neotropics (e.g., Beltrán 1986; Franke 1986, 1987; McNeil 1968, 1969, 1970a,b) provide an adequate framework for comparison of its migration.

In this study, we compiled data from our banding program on the Pacific Coast of Colombia. Western Sandpipers are one of the four most common species of shorebirds along the coast (along with *Actitis macularia, Charadrius wilsonius,* and *C. semipalmatus*; Franke 1986, Naranjo et al. 1987, Naranjo and Mauna in press), occurring locally as a winter resident. The aims of our study were (1) to confirm the migratory status of the population, (2) to document the sex and age ratios during the boreal winter, (3) to describe the chronological changes in mass and (4) to describe molt of the flight feathers. Along with other projects dealing with shorebirds on the Pacific coast of Colombia, this study will help improve our basic understanding of Western Sandpipers' migration, contributing to the necessary basis for design conservation strategies of coastal wetlands in the region.

STUDY AREA AND METHODS

Field work was carried out at two sites: a mudflat of approximately 4 ha located within the Buenaventura City limits (03°54′N, 77°05′W), and a roost used by several shorebird species on the Punta Soldado Island (03°48′N, 77°10′W). This island is located at the northwestern end of the Buenaventura Bay, and is separated from the mainland by a network of channels and mudflats partially covered by mangroves. Its outer shore, where the root was located, is mostly a continuous sandy beach. At both sites tide fluctuations are wide (up to 4 m).

Most of our data were obtained during the 1984–1985 winter migration, but our analysis also includes birds captured between 1982 and 1984; a total of 223 birds was captured. During the 1984–1985 winter migration, we captured birds monthly, using three mist nets set at a roost during the night, whenever the oncoming tide allowed (3–5 nights per month). For most birds, we recorded all of the basic data of the PASP banding schedule (mass, sex, measurements, molt and plumage), but because particular data for some birds were not recorded, for each analysis we specify the corresponding sample size.

Birds were measured to the nearest 0.5 mm with a dial caliper, and weighed to the nearest 0.29 g with a Pesola spring balance. We determined sex using the method of Page and Fearis (1971); individuals with a culmen length less than 24.6 mm were considered to be males, whereas those with a culmen longer than 24.9 mm were considered females. Those with intermediate measurements were ignored in the analysis of sex ratios.

Age was estimated on the basis of presence-absence of buffy edges on the wing coverts and tertials (Page et al. 1972, Prater et al. 1977), and thus the birds were classified either as juveniles or adults (older than 1

TABLE 1. Population structure of the Western Sandpiper at the Buenaventura Bay during 1984–1985.

Month	n	Adults			Juveniles		
		Males	Females	M:F	Males	Females	M:F
September	25	3	11	1:4	7	4	1:1.6
October	19	6	12	1:2	1	0	1:0
November	16	3	8	1:2.7	2	3	1:1.5
December	49	12	21	1:1.8	4	12	1:3
January	23	6	14	1:2.3	0	3	0:3
February	24	6	17	1:2.8	0	1	0:1
April	12	0	0	—	2	10	1:5

yr). For the study of molt, we took into account only primaries, secondaries and rectrices, following the conventions of the PASP banding scheme (Myers et al. 1983); each feather was classified from class 0 (old, wearing variable) to class 5 (new, fully grown). We combined the stage of molt for each category of feather into a single figure for the analyses.

The data were analyzed using EPISTAT version 3.0 (Gustafson 1984). Each particular analysis is described in the text.

RESULTS

Chronology of migration.—Our observations in the Buenaventura Bay indicate that Western Sandpipers can be found at any month of the year. The number of individuals increases by mid-August, reaches a definite peak in December, and then decreases steadily until the end of March (Franke 1986, 1987). Mist-net capture rates, however, did not follow this pattern; the proportions of monthly captures did not have the same distribution as that of monthly censuses ($\chi^2 = 131.7$, 11 df, $P < 0.05$) and thus cannot be used as an indication of the schedule followed by the birds during their migration.

Age and sex.—The population structure of Western Sandpipers in the Buenaventura Bay during the 1984–1985 migration is presented in Table 1. The adult sex ratio is female-biased in all months. This bias seems to be a consistent phenomenon not only from month to month, but also from year to year. Our data from November 1985 and from 1984 confirm the female-biased sex ratio.

The numbers of juveniles captured were variable from month to month and did not follow a definite pattern. Females outnumbered males in five of the seven months sampled, although the sex bias was not as consistent as that of the adults. For the last sampled month (April), when only first year birds were captured, the sex ratio showed more bias, the females outnumbering the males (5:1).

Body mass and flight capacity.—A total of 71 adult birds banded during the 1984–1985 migration were used to analyze body mass variation during winter. Birds were very lean upon arrival, but mass increased from

TABLE 2. Comparisons of body mass of adult Western Sandpipers wintering at the Buenaventura Bay during 1984–1985. Means of samples with different letters at the bottom are significantly different ($P \leq 0.05$).

	September	November	December	January	February
Mean (g)	22.57	24.63	22.84	24.5	25.9
Variance	6.88	3.05	3.31	5.73	2.74
n	14	6	27	10	14
	A	B	A	B	C

September to November. Surprisingly, the average mass of birds from December was close to that of the beginning of the fall migration. During January and February mass increased at a rate similar to the September–November rate. Analysis of variance of the mass data (Fisher's least square difference) showed statistically significant differences between consecutive months (Table 2). Average body mass of birds captured in December did not differ significantly from that of sandpipers banded in September.

Flight-feather molt.—We carried out the analysis of plumage based only on banding data of 116 adults, because most of the samples of juveniles were too small for comparative purposes. Western Sandpipers arrive at Buenaventura Bay while undergoing prebasic molt; except for a few body feathers, all adults were in basic (=winter) body plumage. The replacement of flight feathers, which had begun prior to arrival, continued from September to January, following a definite pattern (Fig. 1). In September, more than 90% of the sampled individuals had completed the molt of the secondaries, whereas only 41% had completed the primary molt, and less than 10% had completed the rectrix molt.

By the end of October, all secondary molt was complete; primary molt continued until November. The tail feathers were the last to be replaced by most individuals; not all birds were finished until January.

DISCUSSION

Franke's (1986, 1987) data of monthly censuses made during 1984–1985 show that numbers of Western Sandpipers at Buenaventura increased during August, and then stabilized for 3 mo. Then the numbers increased again in December to a peak of about 3000 individuals before declining to level off at about 500 individuals at the beginning of spring migration.

The increase in numbers of Western Sandpipers 3 mo after the first fall migrants reached the area, coupled with our analysis of monthly variation in body mass, suggest that two groups of Western Sandpipers use the mudflats of Buenaventura Bay. The first group would reach the area in August, increase in mass through November, and then be replaced by a second wave of migrants. These lean birds, arriving in December, would remain in the area until spring migration. The presence of only one body-mass class in December, significantly lower than the average

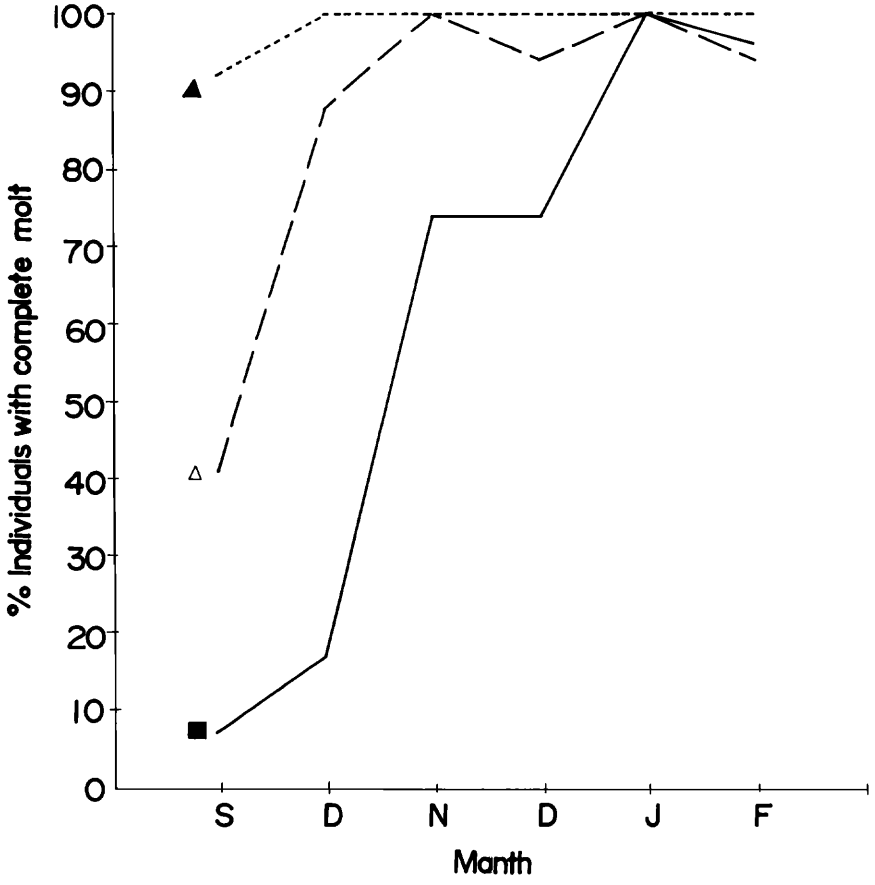

FIGURE 1. Molt of flight feathers of Western Sandpipers wintering at the Buenaventura Bay. Upper line (solid triangle): Secondaries; Middle line (open triangle): Primaries; Lower line (solid rectangle): Rectrices.

mass of birds caught in November, supports this interpretation, unless it can be explained as a sudden mass loss of birds that had been fattening during the preceding 3 mo.

Using the average body mass for each month we calculated flight-range capacity (FRC; McNeil 1969, 1970a,b). Our data indicate that sandpipers arriving in August can only move short distances (approx. 470 km), but after 3 mo are potentially capable of continuing their southbound migration ($\bar{x}$ FRC = 660 km, a distance close to that from Buenaventura to the mudflats near the border with Ecuador). The steady mass gain by birds arriving in December, coupled with the completion of the molt of the flight feathers indicates that by mid-February Western Sandpipers are ready to leave their wintering grounds on the Pacific coast of Colombia, having a FRC that may enable them to go from Buenaventura to Panama

Bay in a non-stop flight ($\bar{x}$ FRC = 800 km, which is roughly equivalent to one half of the Colombian Pacific Coast length). This analysis, however, might be biased if, as Castro and Myers (1990) demonstrated for the Sanderling (*C. alba*), equations to estimate body fat for the Western Sandpiper cannot be extrapolated among different localities.

The continued but slow gain in body mass can be explained either as a consequence of low food availability, or by its coincidence with the completion of the molt of flight feathers that, according to Holmes (1966), in some shorebirds is mutually exclusive with fat deposition. In any event, Western Sandpipers wintering at Buenaventura Bay must surely use a stopover area during the spring migration before reaching their breeding grounds.

The pattern of variation in numbers of Western Sandpipers seems to be consistent throughout the Pacific coast of Colombia south of the San Juan River. Our observations during the last 4 yr indicate that despite the permanence of small flocks of wanderers throughout the year, the species can be considered to be a winter resident concentrating from middle August to early March.

The female-biased sex ratio of Western Sandpipers wintering at our study site, confirms the hypothesis of Page et al. (1972) that the females of this species winter farther south than males. This evidence may reveal a potential danger for the species in part of its wintering grounds. At Buenaventura, the birds are restricted to a few feeding and roosting areas (Franke 1986, 1987; Naranjo and Mauna, in press) and some of these are being reduced and transformed at an alarming rate by human activities (pers. obs.). If these threats are also present at major wintering areas, such as the Panama Bay where more than 10,000 Western Sandpipers are winter residents (F. Delgado, pers. comm.), during a single winter a significant number of females may fail to complete their migration.

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LITERATURE CITED

BELTRÁN, J. W. 1986. Ecología alimentaria de las aves playeras (Scolopacidae-Charadriidae) en la Bahía de Buenaventura. Tesis de Grado. Universidad del Valle, Cali, Colombia. 86 pp.

BLAKE, E. R. 1977. Manual of Neotropical birds, vol. 1. Univ. Chicago Press, Chicago, Illinois. 674 pp.

CASTRO, G., AND J. P. MYERS. 1990. Validity of predictive equations for total body fat in Sanderlings from different nonbreeding areas. Condor 92:205–209.

FRANKE, R. 1986. Distribución cronológica y uso habitacional de los chorlos (Aves: Scolopacidae-Charadriidae) en la Bahía de Buenaventura. Tesis de Grado. Universidad del Valle, Cali, Colombia. 92 pp.

———. 1987. Distribución cronológica de los chorlos (Scolopacidae y Charadriidae) en

la Bahía de Buenaventura. Pp. 105–109, *en* H. Alvarez-L, G. Kattan, y C. Murcia, eds. Memorias III Congreso de Ornitología Neotropical, Cali, Colombia.

GUSTAFSON, T. L. 1984. Epistat, statistical package for the IBM personal computer.

HOLMES, R. T. 1966. Molt cycle of the Red-backed Sandpiper (*Calidris alpina*) in Western North America. Auk 83:517–533.

———. 1971. Density, habitat, and the mating system of the western sandpiper (*Calidris mauri*). Oecologia 7:191–208.

———. 1972. Ecological factors influencing the breeding season schedule of western sandpipers (*Calidris mauri*) in subarctic Alaska. Am. Midl. Nat. 87:472–491.

MCNEIL, R. 1968. Hivernage et estivage d'oiseaux aquatiques nord-americaines dans le Nord-Est du Vénézuéla, en rapport avec la mue et l'accumulation de graisse. Thèse de Doctorat en Biologie (Ph.D.), Dépt. Sciences Biologiques, Université de Montréal, Montréal, Quebec, Canada.

———. 1969. La détermination du contenu lipidique et de la capacité de vol chez quelques espèces d'oiseaux de rivage (Charadriidae et Scolopacidae). Can. J. Zool. 47:525–536.

———. 1970a. Estudios de la veranada de aves acuaticas norteamericanas en el nordeste de Venezuela, con relación a la muda y la acumulación de grasa. Act. IV Congr. Latin. Zool. 2:785–810.

———. 1970b. Hivernage et estivage d'oiseaux aquatiques Nord-Americains dans le Nord-Est du Vénézuéla (mue, accumulation de graisse, capacite de vol et routes de migration). L'Oiseau et la R.F.O. 40:185–302.

MYERS, J. P., J. L. MARON, E. ORTIZ, G. CASTRO, M. A. HOWE, R. I. G. MORRISON, AND B. A. HARRINGTON. 1983. Rationale and suggestions for a hemispheric colour-marking scheme for shorebirds: a way to avoid chaos. Wader Study Group Bull. 38:30–32.

NARANJO, L. G., J. W. BELTRÁN, R. FRANKE, L. PELÁEZ, Y A. SÁNCHEZ. 1987. Notas preliminares sobre aves de la Bahía de Buenaventura. Boletín Ecotrópica 17:25–39.

———, AND J. E. MAUNA. In press. Segregation of roosting habitat in migratory shorebirds on the Pacific Coast of Colombia. Wader Study Group Bull.

PAGE, G., AND B. FEARIS. 1971. Sexing Western Sandpipers by bill length. Bird-Banding 42:297–298.

———, B. FEARIS, AND R. M. JUREK. 1972. Age and sex composition of Western Sandpipers on Bolinas Lagoon. Calif. Birds 3:79–86.

PRATER, A. J., A. J. MARCHANT, AND J. VUORINEN. 1977. Guide to the identification and ageing of Holarctic Waders. British Trust for Ornithology Field Guide 17. 168 pp.

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