DIFFERENTIAL AUTUMN MIGRATION OF CURLEW SANDPIPER *(CALIDRIS FERRUGINEA)* THROUGH THE EBRO DELTA, NORTHEAST SPAIN

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SUMMARY.—*Differential autumn migration of Curlew Sandpiper* (Calidris ferruginea) *through the Ebro Delta, Northeast Spain.* The sexual differences in the timing of autumn migration in the Curlew Sandpiper *(Calidris ferruginea)* have never been accurately studied. We surveyed the autumn migration of this species in the Ebro Delta (Northeast Spain) in the autumns of 1992 and 1993. Numbers present in the study area were assessed by means of visual counts. The proportion of young and adult males and females was determined from the composition of the samples trapped for ringing. Migration phenology was different in both years. In 1992 few young birds were detected, probably due to the low breeding success in 1992. In the Ebro Delta, adult males migrate ahead of females and peak 10 days before adult females. The early departure of adult males from the breeding grounds seems to be the cause of differential autumn migration in the Curlew Sandpiper.

Key words: autumn migration, Mediterranean, phenology, sexual differences, staging areas, waders.

RESUMEN.—*Migración otoñal diferencial en el Correlimos Zarapitín* (Calidris ferruginea) *en el Delta del Ebro, Nordeste de España.* La migración postnupcial del Correlimos Zarapitín *(Calidris ferruginea)* se estudió en 1992 y 1993 en el Delta del Ebro (Nordeste de España). El número de individuos presentes se determinó mediante censos periódicos. Las variaciones en el número de jóvenes y adultos machos y hembras capturados para su anillamiento se utilizó para determinar las diferencias en la migración de cada grupo. La fenología de la migración fue diferente en los dos años, siendo muy escasa la presencia de jóvenes durante 1992. Esta menor presencia de juveniles parece ser debida al bajo exito reproductor en 1992. En el Delta del Ebro, los machos adultos precedieron a las hembras en los dos años, dándose el período de migración máxima diez días antes que el de las hembras adultas. El hecho de que los machos adultos abandonen las zonas de nidificación antes que las hembras parece ser la causa de las diferencias sexuales en la migración de esta especie.

Palabras clave: diferencias sexuales, fenología, limícolas, Mediterráneo, migración otoñal, zonas de reposo.

INTRODUCCIÓN

Differential migration occurs when males and females of the same species differ in the timing of passage through the staging areas on their migratory routes (Terrill & Able, 1988). This temporal separation of male and female migration appears when one of the sexes starts migration before or migrates faster than the other. In species where sexes winter in different localities, the latitudinal segregation of the sexes in winter can also account for the differences in timing of passage (Chandler & Mulvihill, 1990). However, this factor does not affect the autumn migration since both sexes depart from breeding grounds. Differences in date of passage can also occur between young and adults, and can be accounted for by the same factors as the differential migration of sexes.

The migration system of the Curlew Sandpiper (*Calidris ferruginea*) has been well studied (Elliott *et al.*, 1976; Wilson *et al.*, 1980), although less attention has been paid to the study of its differential migration. The differences in timing of passage of young and adult Curlew Sandpipers are well documented (Wilson *et al.*, 1980; Gromadzka, 1987). Nevertheless, detailed data on the timing of passage of the sexes through staging areas is almost non-existent. We have studied the autumn migration of waders through the

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Ebro Delta, combining the results of visual counts and data from captured birds. Here, we present the data from a two-year study of the Curlew Sandpiper.

MATERIAL AND METHODS

Wader passage was studied at Les Salines de la Trinitat (40.37N 00.35E, NE Spain). The study area was in a saltpan. Water levels were nearly constant during the study period, the greatest variations being produced by changes in wind force and direction, or when salt extraction was in progress. Birds were censused from 27 July to 12 October 1992 and from 27 July to 24 September 1993 along a transect of 2.2 km within 44 ha of non-tidal mud and sandflats. Data were grouped in five-day periods from 27 July onwards. The configuration of the study plot, with no area hidden from view, makes us confident that the census gave a good estimate of the number of birds actually present in the study plot.

In the same period in 1992 and from 25 July to 24 September 1993, birds were trapped at night with mist-nets and by day with walk-in-traps. Captured birds were colour ringed and wing, bill and tarsus lengths of most birds were measured. Ageing criteria follow Prater *et al.* (1977). Sex of adult birds (more than one-year-old birds) was determined from wing and bill length using the discriminant formula of Wymenga *et al.* (1990).

The proportion of young, adult males and adult females among the captured sample were used to estimate, from census data, the number of birds of each group present in the area. We calculated the ratio between the birds of each category and the total number of birds trapped on each five days period, these ratios were then multiplied by the maximum number of birds censused in each period, obtaining an estimate of the number of young, adult males and adult females present in the study plot.

On some days during 1992 the high number of birds trapped prevented us from measuring all birds, and some adults were released after only ringing and ageing, without measuring wing and bill lengths. These birds could not be sexed and have been excluded from calculations. This fact has not affected the estimations of relative abundance of young and adult males and females because no young birds were present in the area at that moment, and unmeasured birds were a random sample of all the birds trapped on these nights. With this approach we can obtain good estimates of numbers in the area if the probability of capture of young versus adults and males versus females is the same.

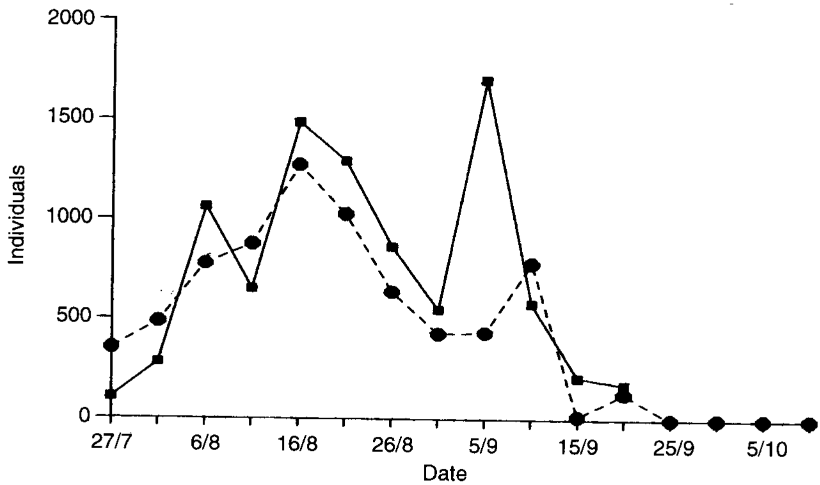

FIG. 1.—Maximum number of birds censused in each five-day period in 1992 (–●–) and 1993 (–■–).
[Número máximo de individuos censados en cada período de cinco días en 1992 (–●–) y 1993 (–■–).]

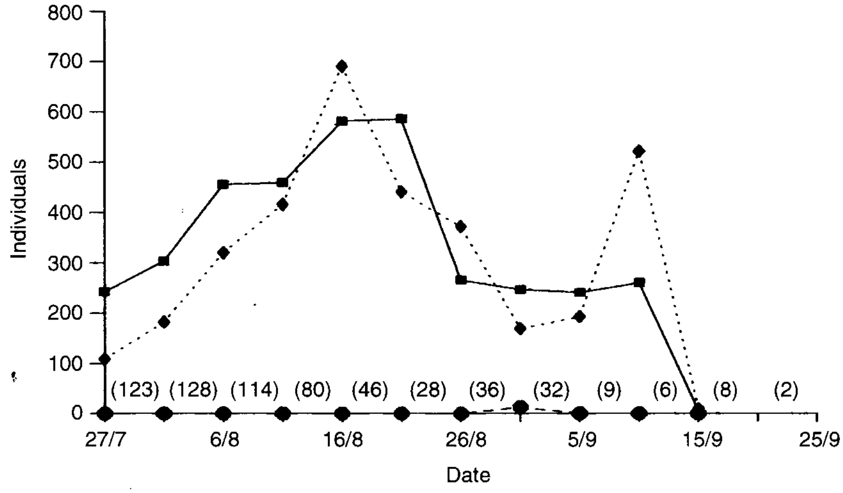

FIG. 2.—Estimated numbers of adult males and females and young present in the study area in 1992. Numbers trapped in each period are presented in brackets. –■– males; –♦– females; –●– youngs. *[Número estimado de machos y hembras adultas e individuos jóvenes presentes en la zona de estudio en 1992. El número de individuos capturados en cada período se presenta entre paréntesis. –■– machos; –♦– hembras; –●– jóvenes.]*

However, young individuals were captured in mistnets more frequently than adults (Pienkowski & Dick, 1976) and we may have slightly overestimated the number of young present in the area.

RESULTS

A small number of individuals of Curlew Sandpiper was present in the study area at the start of the study periods. Bird numbers increased through late July and early August. In 1992 there were two main peaks of migration (Fig. 1). The first peak in mid August, produced an increase in the number of adult males and females present in the area (Fig. 2). The second peak occurred in early September, and was produced by an influx of females in the area. The presence of young birds was very low, with only one young bird captured out of 675 adult birds. In 1993, the migration phenology of the Curlew Sandpiper was different from 1992. Migration lasted approximately the same period of time, although three migration peaks were detected (Fig. 3). These three maxima in the number of censused birds were produced by the arrival of different groups of birds. An increase in the number of males in early August produced the first migratory peak. Female migration occurred slightly later, with a peak in females occurring ten days later than in males. The passage of juveniles did not start until mid-August and peaked by the beginning of September. In 1993 the presence of juveniles in the study area may have been a 100 times greater than in 1992. In both years males migrated significantly earlier through the area than females (Table 1).

DISCUSSION

Overall passage of Curlew Sandpiper through the Ebro Delta extends from mid-July to late September. This period corresponds to those described previously (Ferrer *et al.*, 1986). However, the numbers present were twice as high as had ever been recorded for the Ebro Delta (Ferrer *et al.*, 1986). The census data presented here refer to a small portion of the suitable habitat for this species in the Ebro Delta, and so the total number of birds should be much higher than it is currently assumed to be.

Migration through the mouth of the River Vistula (2000 km from the Ebro Delta) in

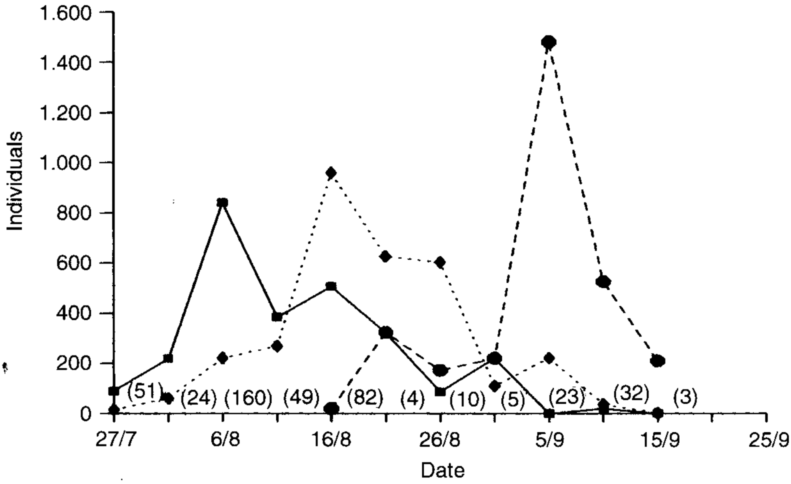

FIG. 3.—Estimated numbers of adult males and females and young present in the study area in 1993. Numbers trapped in each period are presented in brackets. —■— males; —◆— females; —●— youngs. *[Número estimado de machos y hembras adultas e individuos jóvenes presentes en la zona de estudio en 1993. El número de individuos capturados en cada período se presenta entre paréntesis. —■— machos; —◆— hembras; —●— jóvenes.]*

1992 occurred 16 days before the birds passed through our study area (Gromadzka, 1994). In the same year, the passage through the German Waddensee (1700 km from the Ebro Delta) occurred 11 days before our study (Zeiske, 1992). Some colour-ringed birds in the Waddensee or in the Ebro Delta were observed in the other area in the same or subsequent years (Zeiske and authors unpubl. data), suggesting a direct link between the Waddensee and the Ebro Delta, with at least some birds accumulating reserves in the Waddensee before flying to our study area. These figures suggest an average migration speed of 125 and 155 km/day respectively, estimates higher than the 108 km/day reported for Curlew Sandpipers in autumn (Hildén & Saurola, 1982). The reasons for these diffe-

TABLE 1

Mean and standard error of capture dates of adult males and females in 1992 and 1993. Dates are expressed as days from 1st July. Differences in date of capture between sexes were tested by Mann-Whitney U-Test.
[Media y error estándar de la fecha de captura de los machos y hembras adultos en 1992 y 1993. La fecha de captura se expresa como días a partir del 1 de julio. Las diferencias en la fecha de captura de los sexos se comprobaron mediante el test de la U de Mann-Whitney.]

	Males *[Machos]*			Females *[Hembras]*				
	Mean	S.E.	*n*	Mean	S.E.	*n*	*Z*	*P*
1992	41.20	0.60	350	45.01	0.79	252	−3.96	<0.001
1993	38.56	0.56	237	44.62	0.64	181	−6.93	<0.001

rences are still unclear. These estimates have been calculated with different methods. Hildén & Saurola (1982) used recoveries of birds ringed in Finland to estimate migration speed, but our estimates were derived from comparisons of arrival dates at different stopover sites. Ellegren (1990) compared the performance of both methods and obtained similar figures of migration speed for the Bluethroat (*Luscinia svecica*) in autumn. However, Hildén & Saurola (1982) used recoveries of birds ringed in different years, and consequently estimated migration speed averaged over several years. However, our estimates do not represent average migration speed because they were obtained using data only from 1992. Consequently, the higher migration speeds reported in our study could suggest that birds found good conditions for migration in 1992 (e.g. high density of prey at the staging areas, or tail-winds during migratory flight). However, migration speed of some Passerines increase with the distance travelled (Hedenström & Pettersson, 1987; Ellegren 1990), and a higher migration speed of the Curlew Sandpiper in southern than in northern Europe is also consistent with this hypothesis.

Differences in migration patterns

Two different migration patterns in the Curlew Sandpiper have occurred in the two study years. The greatest differences occurred in the number of juvenile birds using the area. Preliminary ringing data from the same site suggest that a important number of juveniles occurred in the study area in the autumns of 1990 and 1991 (Figuerola *et al.*, 1993). As a result we consider that something must have affected the 1992 autumn passage. Three main causes may explain the absence of juveniles in the area: the characteristics of the study area could have changed in 1992, birds could have been displaced from their usual migration route, or the number of migrating juvenile curlew sandpipers was extremely low.

The study area was located in a Natural Reserve where no transformation in the habitat has occurred in the last ten years. In addition, water levels did not differ between the two years since they are regulated artificially with regular variations and so changes in habitat characteristics were not likely to have affected the migration of these birds.

Displacement from the usual migratory routes is common and the young of this species may take more westerly migration routes when persistent low-pressure weather systems occur over northern Europe (Stanley & Minton, 1972). Zeiske (1992) reported a small displacement in the autumn 1992 of the Curlew Sandpiper from its usual refueling area in the German Waddensea to an area 200 km away in Denmark. However no other displacements from traditional areas were reported in the 1992 migration in northern Europe (Nightingale & Allsopp, 1993) nor in southern Europe (personal enquiries to the participants of the *I Encuentro Ibérico de Trabajo Sobre Aves Limícolas*, Huelva [Spain], April 1993).

The third possible cause of low juvenile numbers in 1992 may be the high annual variation in the breeding success of the waders in the Arctic (Underhill *et al.*, 1993). In 1992 the breeding success of curlew sandpipers at Taimyr peninsula was very low due to the intensive nest predation by Arctic foxes (*Alopex lagopus*) (Underhill *et al.*, 1993). In addition, very low numbers of young Curlew Sandpipers were registered at the mouth of the River Vistula (Poland), where regular wader ringing takes place each autumn (Gromadzka, 1987, 1994). This suggests that the differences registered in the number of young present in our study area were related to a low breeding success in 1992.

Differential migration of males and females

In both study years males migrated ahead of females. The difference probably reflects the earlier departure of males from the breeding grounds (Portenko, 1959). Male Curlew Sandpiper leave females to incubate and tend the young and depart from breeding grounds three to four weeks before females (Portenko, 1959; Holmes & Pitelka, 1964). In the low production year (1992) many females and males arrived at the same time on the first migration 'wave', probably because females leave early too when they have failed breeding, whereas in 1993 there was a first clear peak of males, probably because many more females stayed behind to attend young. These data suggests that breeding success affects not only the proportion young/adults but also the passage of different sex adults. Chandler & Mulvihill (1990) proposed that differences in timing of passage could also be produced by sexual differences in the speed of migration. We have examined this issue in the Curlew Sandpiper. Both sexes accumulate comparable levels of reserves and do not differ in their estimated flight ranges (Figuerola & Bertolero, 1995). However, females showed shorter staging times than males (pers. obs.), suggesting that females accumulate the reserves necessary to migrate faster than males. Since males depart from the breeding grounds three to four weeks before females (Portenko, 1959; Holmes & Pitelka, 1964), this difference in migration speed would actually result in a reduction of the differences in the timing of migration. Indeed, the differences detected by us between maximum male and female passage are much smaller (around 10 days in 1993; Fig. 3). However, definitive conclusions can not yet be drawn since estimates of differential departure were derived 30 years ago, but mainly because the Ebro Delta estimate is based upon a very small number of years.

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