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# The primary moult of Curlew Sandpiper in the Ebro Delta, North-East Spain

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*The primary moult of Curlew Sandpiper* Calidris ferruginea *was studied at a staging area in the south of Europe. The duration of primary moult was estimated as 73 days (9 August to 21 October), a shorter period than those reported in the wintering areas. Birds in moult showed a lower speed of fat accumulation than non moulters. An increase in the proportion of moulting birds was detected at the end of the migratory period, probably as a result of a longer staging time of moulting birds in the study area. The number and sex-ratio of birds in wing moult showed a great annual variation. The brooding system of this species, in which only females give parental care, and the great annual variation in breeding success could be two of the factors that explain the great yearly variation in the moult schedule of Curlew Sandpiper.*

Curlew Sandpiper *Calidris ferruginea* is a long distance migratory wader that starts primary moult during the postnuptial migration, or in the wintering grounds (Cramp & Simmons 1983). The primary moult of this species has been chiefly studied in their wintering areas (from Mauritania and South Africa to New Zealand and Australia), but the information related to the moult during the postnuptial migration is very scarce (Pienkowski *et al.* 1976 in Morocco and short references in Boere 1977, Zeiske 1992 and Meltofte *et al.* 1994 for the Waddensee). In this paper we describe the moult of Curlew Sandpiper in the Ebro Delta, a refuelling area in the south of Europe. We also discuss the relevance of several factors that could explain the great yearly variation found in the occurrence of wing moult within the birds resting in the study area.

## MATERIAL & METHODS

Field work was carried out in mud- and sandflats area, located in a commercial saltpan, Les Salines de la Trinitat (40.37'N, 00.35'E); see Maldonado *et al.* (1977) and Urmenetea *et al.* (1992) for a detailed description of the study area. Birds were captured with mist-nets at night and walk-in-traps in daylight, from August to October in 1991, July to October in 1992 and July to September in 1993. Moult stage of each primary on the right wing was scored according to Ashmole (1962), from 0 (old feather) to 5 (completely grown new feather). Moult scores were transformed in to moulted relative mass of primaries (see Underhill & Zucchini 1988, Underhill & Summers 1993). Moult duration was estimated from the linear regression of relative mass of primaries moulted on date (days from 1st July). From most of the birds trapped, we recorded body mass, bill and wing lengths. Sex of more than one year old birds (EURING code 4) was determined according to Wymenga *et al.* (1990), from the measurements of wing and bill length. Loss of body mass between capture and weight recording was corrected according to Zwarts *et al.* (1990). Daily mass gain was estimated from the changes in body mass of individuals retrapped in the same season. Captures were grouped on five days periods starting on 25 July, named onwards by the first day of each period. The relative annual importance of the juvenile passage in the study area was estimated from the proportion of juvenile to adult birds trapped between 19 August to 17 September. This period was sampled in each of the three years and included most of the juvenile passage through the study area (Figuerola *et al.*1993).

## RESULTS

The estimated duration of moult was of approx. 73 days ($y = 1.35x$-53.94, $n = 83$, $r = 0.65$), starting on average by 9 August and finishing by 21-22 October. The frequency of adults in active wing moult showed a great variation within each year, with a great occurence of wing moult between the last birds remaining in the area (Figure 1). In a same year the proportion of adults in moult could raise from 0% (as on 14 August and 19 August 1991 periods) to 100% nearly a month later (as in 18 September and 28 September periods), see Figure 1 and Table 1. The number of young and adults captured in each year was also variable, as well as the proportion of adult birds in active wing moult (Table 2), with more birds moulting in the year with lower juvenile passage. The occurrence of primary moult in males was higher than in females in 1991 and

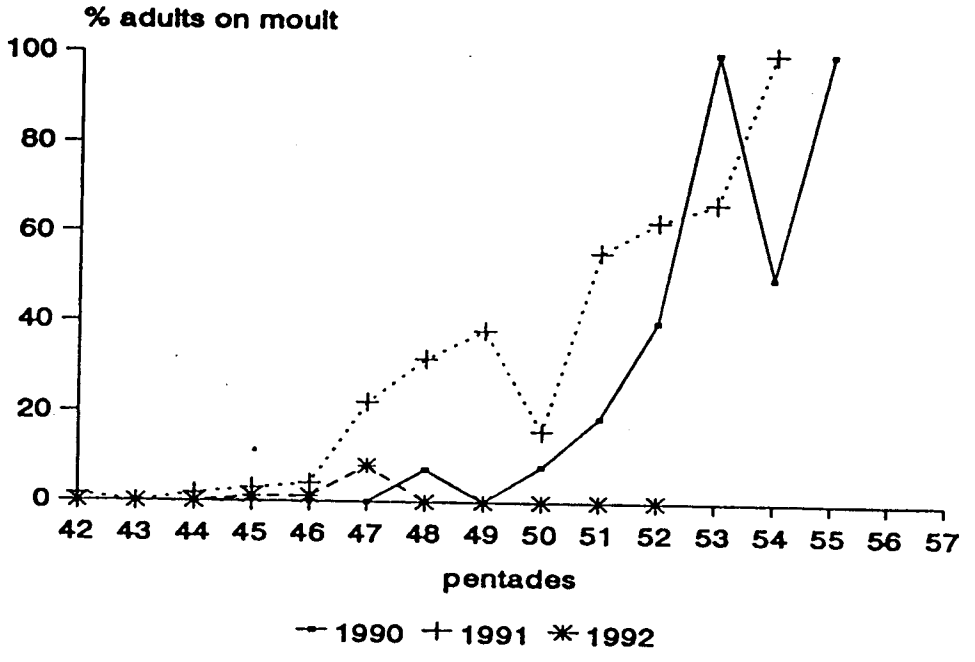


**Figure 1.** Evolution of the proportion of trapped adults in active wing moult during each autumn migration (1991-1993). First day of pentades 42 corresponds to 25 July.

Table 1. Number of adult Curlew Sandpiper trapped in each year on each five days period. Each period is refered by its first day.

| | July | | August | | | | | | September | | | | | | October | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25 | 30 | 4 | 9 | 14 | 19 | 24 | 29 | 3 | 8 | 13 | 18 | 23 | 28 | 3 | 8 |
| 1991 | - | - | - | - | 4 | 12 | 14 | 8 | 9 | 16 | 10 | 3 | 6 | 2 | - | - |
| 1992 | 61 | 170 | 111 | 99 | 74 | 54 | 22 | 42 | 19 | 9 | 8 | 3 | 3 | 0 | 0 | 0 |
| 1993 | 78 | 20 | 22 | 172 | 85 | 25 | 2 | 8 | 4 | 3 | 2 | 0 | - | - | - | - |

nearly significantly higher in 1993, but we failed to find any difference in 1992 (Table 2). Daily mass gain of non-moulting birds was higher than those which were moulting ($x$ = 1.7 g., S.D. = 2.56 , $n$ = 11 versus $x$ = 0.2 g., S.D. = 0.58, $n$ = 12; $t$ = 2.05, 21 d.f., $P$ = 0.05).

## DISCUSSION

The estimated duration of moult in the Ebro Delta (73 days) was similar to the estimate of 40 - 85 days reported in a refuelling area in Morocco (Pienkowski *et al.* 1976). However, some turnover of individuals in primary moult may have been occurred and consequently affected the accuracy of the estimates of moult duration at refueling areas. Nevertheless, moult was quicker than in the wintering areas, where the moult duration has been estimated to be 130-140 days (Thomas & Dartnall 1971, Elliot *et al.* 1976, Barter1986). At the refuelling areas, such as Morocco or the Ebro Delta, time could act as a constraining factor, and birds should leave these areas before the winter arrives, moulting at a higher speed than in southern areas. On the other hand, in the winter quarters the birds could moult over a more extended period until the start of the spring fattening, incurring in a lower stress during moult (Elliot *et al.* 1976, Pearson 1984).

A higher frequency of wing moult occurred at the end of the migratory period. This could be related to a longer staging time in the area

Table 2. Annual numbers of trapped adults; and percentage of adults in moult, number of adults, juveniles, and males and females non moulting and moulting in the period 19 August - 17 September. Sex differences in the composition of moulters and non moulters samples were tested using Fisher exact test.

| | | | *Non moulters* | | *Moulters* | | |
|---|---|---|---|---|---|---|---|
| *Year* | *Adults* | *% moulting* | *Adults* | *Juveniles* | | | *p* |
| 1991 | 84 | 15.9 | 69 | 126 | 10 | 46 | 5 | 4 | 0.02 |
| 1992 | 675 | 31.1 | 154 | 1 | 48 | 52 | 25 | 23 | 0.39 |
| 1993 | 421 | 4.5 | 44 | 58 | 11 | 31 | 2 | 0 | 0.08 |

of moulting birds, which have higher energetic requirements (Payne 1972, Lindstrom *et al.* 1993) and therefore didn't achieve the same speed of reserves accumulation (this study), thus staying for a longer time in the study area. By the end of the migration period, only the birds still in moult remained at the study area, while non moulting birds could have resumed their southward travel.

Although the Ebro Delta constitutes a moulting area used regularly by Curlew Sandpipers, the incidence of wing moult within captured birds was variable in each year. In the years with great juvenile passage, a smaller proportion of adults in active wing moult occurred and a major incidence of wing moult within males was detected. The 1992 breeding season was one of the worst ones ever recorded for the arctic waders (see Underhill *et al.* 1993), and only one juvenile was trapped in the study area. In this year, the proportion of adults in moult was higher, without any difference in the sex composition of moulters and non moulters. The occurrence of females in active wing moult in the Ebro Delta could be conditioned by the parental effort in the former breeding season, since only females incubate and take care of the young (Portenko 1959, Holmes &Pitelka 1964). In those seasons with a high breeding success, most females should delay their wing moult until they reach the wintering areas. A positive relationship between breeding effort and time of moult initiation has been detected in Pied Flycatcher *Ficedula hypoleuca* (Siikamäki *et al.* 1993). In other waders with uniparental care, the sex less involved in parental duties show earlier moult initiation dates (as in Dunlin *Calidris alpina*, Bar-tailed Godwit *Limosa lapponica*, Boere 1977; and Purple Sandpiper *Calidris maritima*, Morrison 1976). However, the data reported for the Curlew Sandpiper are contradictory. Pienkowski *et al.* 1976, Wilson et al. 1980 and Barter 1986 found sex related differences in the timing of primary moult, but Elliot *et al.* 1976 and Thomas & Dartnall 1971 failed to find any difference. However, the annual variation in the proportions of each sex in the moulting sample in the Ebro Delta suggests that this process has a great variation from year to year, and this could be the reason for the different results obtained by these authors. The analysis of longer data series as well as the study of the annual differences in moult development could confirm or refute the suggested sex-related effects in the time of Curlew Sandpiper primary moult.

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