

The migration through Europe and wintering in West Africa of Curlew Sandpipers

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Introduction

Curlew Sandpipers *Calidris ferruginea* breed along the arctic coastal regions of Siberia, and occasionally to Alaska. They winter in Africa south of the Sahara, around the Indian Ocean and in S.E. Asia and Australasia. The moult, weight and migration patterns of Curlew Sandpipers wintering in the southern hemisphere were reported by Thomas & Dartnall (1971) for Tasmania, by Elliott *et al.* (1976) for South Africa and by Pearson *et al.* (1970) and Pearson (1974) for those in E. Africa.

Results of ringing in N.W. Europe, which is on the edge of the species' migration routes, were summarized by Nørrevang (1959) and Stanley & Minton (1972); the latter also analysed weights during a weather-displaced migration through Britain in autumn 1969. Moult and migration in Morocco were considered by Pienkowski (1976) Pienkowski *et al.* (1976) and Pienkowski & Knight (1977), and weights in north-west Africa by Dick & Pienkowski (1979). The present paper develops the studies of these western Curlew Sandpipers and extends them to its wintering grounds, thus putting the irregular movements in W. Europe into perspective and allowing comparison with the southern hemisphere studies.

Materials and methods

The data come from 367 post-juveniles and 120 juveniles caught in Morocco, 370 post-juveniles and 355 juveniles in Mauritania, and 1,069 post-juveniles, 748 juveniles and 3,328 birds of unknown age in Tunisia. 'Juvenile' refers to birds hatched in the year of study and 'post-juvenile' to all other birds. Juveniles can be distinguished from post-juveniles by plumage characters when captured or observed closely in the field (Prater *et al.* 1977).

Birds were caught in August and September 1971, 1972 and 1973 in Morocco at Sidi Moussa (33° 00'N, 8° 44'W) and at Puerto Cansado (28° 02'N, 12° 15'W), and from September to November 1973 on the Banc d'Arguin, Mauritania, lying be-

tween 20° 32'N, 16° 31'W and 19° 22'N, 16° 30'W. These areas are described by Pienkowski (1972, 1975) and Dick (1976). Birds, caught by mist nets at night and cannon nets by day, were weighed to the nearest gram using a 'Pesola' spring balance. Bill lengths (from tip to the base of the feathers) were measured to the nearest millimetre. The moult of each of the ten primaries of one wing (ignoring the much reduced outer eleventh primary) was scored from 0 (old) to 5 (new, fully grown). The primary moult score obtained as the sum of feather scores thus ranges from 0 (moult not started) to 50 (moult complete). In Tunisia between 1968 and 1976 birds were caught at the Lagune de Tunis at Radès (36° 52'N, 10° 18'E). Traps were permanently installed here and were operated at day and night. Measurements and details of moult were taken only occasionally.

Curlew Sandpipers show sexual dimorphism in bill lengths, so that the sexual composition of a flock and the mean bill length for each sex can be estimated by probability graph paper methods (see Griffiths 1968).

Migration through Europe and North Africa

Ringing recoveries (Figure 1) occur along two main bands: along the western European seaboard and overland via the Black Sea and Tunisia. Stanley & Minton (1972) suggested that in some years many birds may have been displaced westwards by persistent cyclonic weather systems centred over the Baltic and north Russia and that, in normal years, they subsequently migrate along a more easterly line. Since their analysis, a more complete picture of the migration system has developed. Thus, it is now clear there is a significantly greater chance ($\chi^2 = 5.74$, $P < 0.05$) of birds ringed as juveniles in N.W. Europe being recovered on an easterly route in later autumns than for those ringed as post juveniles (Table 1). Of Curlew Sandpipers ringed in N.W. Europe 30% of recoveries in later autumns occur in south and east

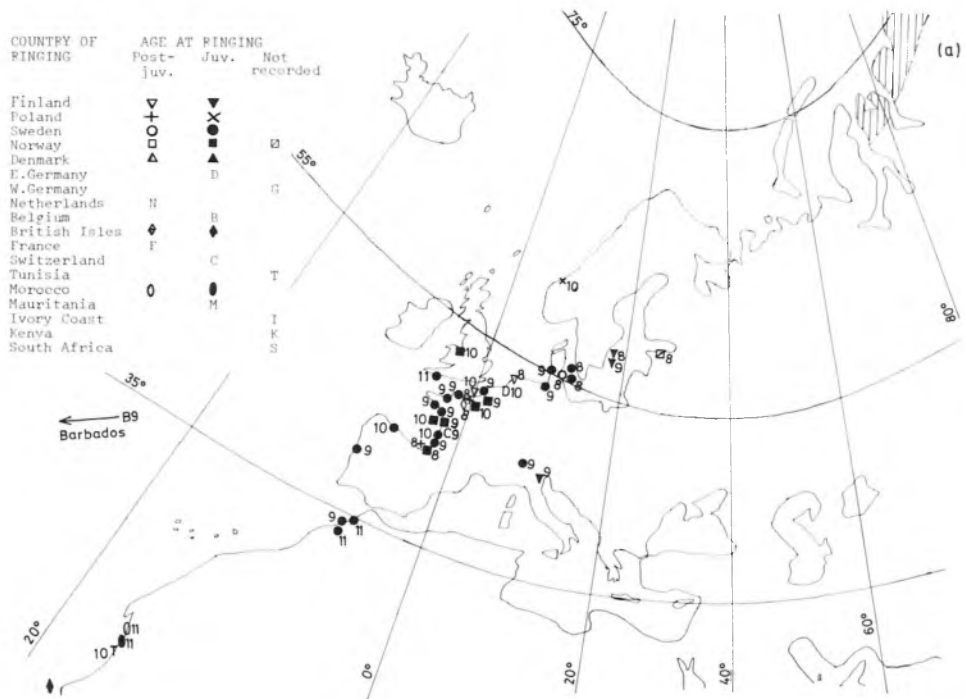




Figure 1. International movements of Curlew Sandpipers ringed in Europe and north and west Africa. (a) recovered in the same autumn as ringing; (b) recovered in later autumns; (c) recovered in winter and spring, also showing all recoveries of birds ringed in southern Africa regardless of season. Ringing in Europe and N.W. Africa took place in autumn, Ivory Coast in spring, and Tunisia in autumn and spring. Symbols relate to country of ringing (see key in (a)) and the number beside each to the month of recovery. For four movements to the south coast within southern Africa the site and month of ringing rather than of recovery are shown. The projection is gnomonic on which the shortest route between any two points (a great-circle) is a straight line. Sources: Ash (1977); M. A. Czajkowski (unpub.); Dick (1976, 1978); Elliott *et al.* (1976); Glutz *et al.* (1975); M. & J. Gromadzki (in litt.); Holgersen (1974, 1976); Lachaux (1974); Pienkowski (1975, 1978); Schifferli & Imboden (1972); Spencer & Hudson (1974–77); Stanley & Minton (1972); Thévenot (1970, 1972).

Table 1. Recoveries of Curlew Sandpipers ringed in autumn in north and west Europe. N & W Europe divided from S & E Europe by a line from Gibraltar to Moscow.

	Ringed as		Total
	juvenile	adult	
(i) Recovered in same autumn			
N & W Europe	24	6	30
S & E Europe	2	0	2
Total	26	6	32
(ii) Recovered in later autumns			
N & W Europe	6	14	20
S & E Europe and Mediterranean	7	2	9
Total	13	16	29
(iii) Recovered in spring			
N & W Europe	3	2	5
S & E Europe and Mediterranean	3	3	6
Total	6	5	11

Europe and Tunisia, but there are no signs of a reverse exchange. The 5,145 Curlew Sandpipers ringed in Tunisia by 1976 had, by 1978, given 13 recoveries in USSR, 1 in Poland, 2 in S. France, 1 in Spain, 1 in Morocco, 1 in Mauritania, 1 in Senegal, 1 in South Africa, but none on more westerly routes (Lachaux 1974; M. A. Czajkowski unpub.).

Within the autumn of ringing, juveniles were recovered much more frequently than post-juveniles (Table 1), probably because of a greater tendency by juveniles to make intermediate stops during migration. This occurs in several species of waders, e.g. Knot *Calidris canutus* (Dick *et al.* 1976).

The two lines of recoveries may merely reflect the presence of more suitable resting areas or more intensive shooting. Migrant Curlew Sandpipers are commonly recorded in Central Europe away from these 'routes', as indicated by counts in Switzerland, Brandenburg (E. Germany) and, nearer the coast, Munster (W. Germany) (Figure 2) but the numbers landing in Switzerland are small. There does, however, appear to be a real divergence of routes as no Curlew Sandpipers have been recovered in Italy where shooting pressure is undoubtedly high, producing most of the recoveries of Dunlins *Calidris alpina* ringed in Tunisia (M. A. Czajkowski, unpub.).

Sightings are far less numerous in spring than in autumn in Finland, Norway, Britain, Germany, Switzerland, Dombes and the Camargue, France (for sources, see Figure 2, plus Haftorn 1971). However, the birds are commoner in spring in Algeria, Tunisia, Libya and Malta (François 1975; Smart 1975; Bundy 1976; Sultana *et al.* 1976; M. A. Czajkowski, unpub.).

Since retraps of ringed birds indicate that individuals stay in Tunisia for a shorter period in spring than in autumn (see below), the difference is greater than indicated by counts alone. The birds may behave differently and be more likely to be seen in autumn than in spring; or the routes used may be different at the two seasons, as suggested by Nørrevang (1959) and Stanley & Minton (1972). The latter suggestion is supported by the more even distribution of recoveries across Europe in spring than in autumn of birds ringed in N.W. Europe in autumn (Table 1).

Age and sex differences in the timing of autumn migration

Autumn migration of post-juveniles starts in early July and is rapid, only a few days separating the first appearances in Finland, Sweden, Germany, Denmark, Switzerland, S. France, Morocco and Tunisia (Figure 2). The first juveniles do not appear in Finland until mid-August and their passage produces a second peak in numbers. It also is very rapid; many reach Tunisia and Morocco in August.

Further recoveries have confirmed the rapid passages remarked on by Stanley & Minton (1972), e.g. Finnmark, Norway, to Estonia in 13 days; Sandblåstvägen, Norway to Calais, France in 8 days; Kent, England, to Calvados, France, in 1 day; Ottenby, Sweden, to Sidi Moussa, Morocco, in 13 days; and Radès, Tunisia, to Cap Timiris, Mauritania, in 15 days (Holgersen 1974, 1976; Spencer & Hudson 1974; Pienkowski 1975; Dick 1976). During the influx into Britain in 1969, Stanley & Min-

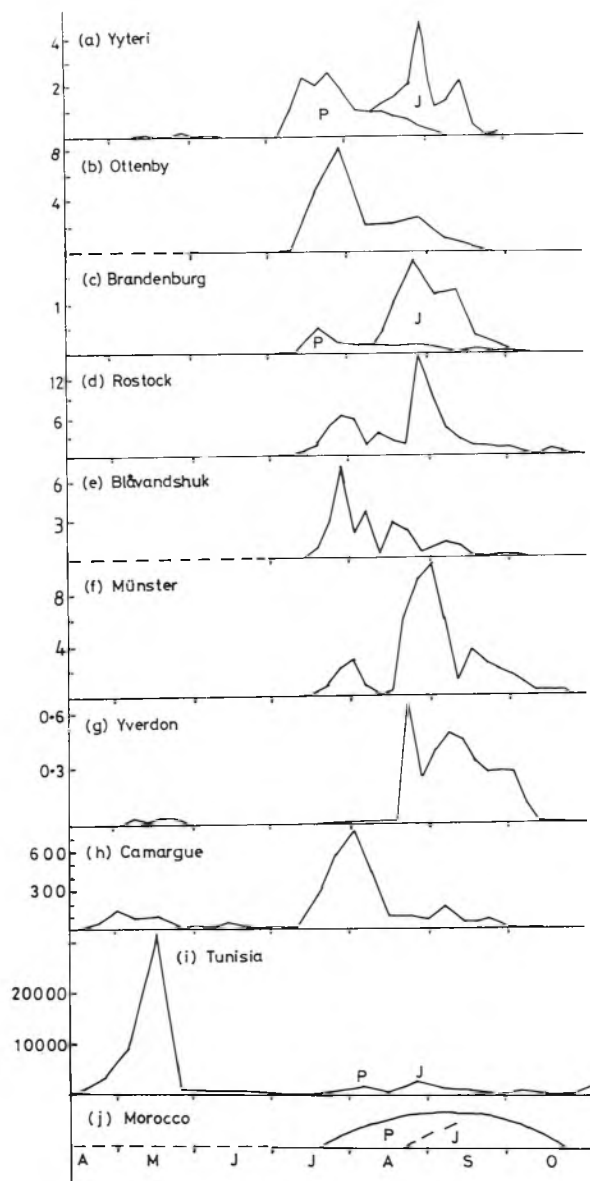


Figure 2. Timing of migration of Curlew Sandpipers at various localities. Different methods of counting and recording were used so that totals are not directly comparable:

- (a) Birds per day, averaged over 5-day periods, in 1961–69 (Kaukola & Lilja 1972);
- (b) Birds per day, averaged over 10-day periods, in 1947–1956 (Edelstam 1972);
- (c) Birds per day, averaged over weekly periods, in 1963–1973 (Dittberner & Dittberner 1976);
- (d) Birds per day, averaged over 5-day periods, in 1972–1974 (Plath 1976);
- (e) Birds per 10 hours, averaged over 5-day periods, in 1963–1971 (Meltøfte *et al.* 1972);
- (f) Birds per day, averaged over 5-day periods, in 1962–1971 (Harengerd *et al.* 1973);
- (g) Birds per day, averaged over 5-day periods, in 1948–1972 (Baula & Sermet 1975);
- (h) Weekly counts in 1972 (Johnson 1974);
- (i) Total birds grouped in 10-day periods in 1963–1978 (M. Smart & M. A. Czajkowski, unpub.);
- (j) Schematic indication of presence (Pienkowski & Knight 1977).

P = post-juvenile; J = juvenile.

ton (1972) concluded that birds stayed between one and three weeks while depositing fat reserves prior to onward migration. In Tunisia, 74 retrapping intervals in autumn averaged 4.9 days (S.D. 6.6), and there were even shorter stays in spring, 25 retraps averaging 1.8 days (S.D. 1.2) (Lachaux 1974; M. A. Czajkowski, unpub.). In Morocco also, juveniles and pre-moulting post-juveniles probably stayed for short periods, (6 retraps averaging 3.2 days, S.D. 1.9), but two post-juveniles staying to moult were retrapped after 15 and 39 days (Pienkowski & Knight 1977). The tendency for juveniles (which do not have a complete moult in their first autumn) to move on while post-juveniles remained to moult appeared to be more pronounced in Mauritania. There, the percentage of juveniles in catches fell from 60% in late September and early October to 30%–40% in mid November (Dick 1976).

In Europe, for many sites, the total numbers passing, age ratio and dates of peak numbers differ greatly from year to year (see, e.g. references in Figure 2). This factor is probably insufficient, however, to account for the great differences in the proportion of juveniles between sites. Different habitats may be preferred by the two age groups; or post-juveniles may exclude juveniles from preferred sites, or post-juveniles may utilize previous experience. Juveniles seem to be more numerous at inland sites. Separation between age groups during feeding and roosting was noted in Morocco and Mauritania (Dick 1976).

Male Curlew Sandpipers leave females to incubate and tend the young (Portenko 1959; Holmes & Pitelka 1964), quitting breeding grounds in the Soviet Union in mid-July; the females follow in the first half of August.

Males precede females in autumn migration at Ottenby in the Baltic (Edelstam 1972) and arrive in Morocco from late July onwards, 2–3 weeks before females (Pienkowski *et al.* 1976). In some years the numbers of adults passing through Tunisia suggested two peaks, in early and late August, and these could be due to males and females respectively.

Moult

In Morocco, male Curlew Sandpipers moulted earlier than females, few of the

latter having begun by mid-September (Pienkowski *et al.* 1976). For Mauritania, the moult scores of the Curlew Sandpipers which could be sexed by bill-length are shown in Figure 3. Thus, in Mauritania also, males were generally more advanced in moult than females, the difference in median scores remaining about 10 points until near the completion of moult. Some males had completed moult by early October and some females by late October. The median score for males reached 50 in mid November. If it is assumed that males arrive in late July and early August and females from mid-August, and that both start moult shortly afterwards, the moult in first arrivals of both sexes can be estimated to last about 60 days. It is possible that moult duration increases later in the season. Pienkowski *et al.* (1976) suggested a primary moulting period of as little as 40 days for some Curlew Sandpipers in Morocco with most probably moulting in less than 60 days.

Few post-juveniles caught at Sidi Moussa were moulting (16% or 174), whereas at Puerto Cansado, further to the south, most were (80% of 92). The proportion of moulting birds caught is affected by the catching method (Pienkowski & Dick 1976), but if cannon-netted catches alone were compared the difference was still significant (33% vs. 70%, $\chi^2 = 10.47$, $P < 0.01$). Thus it is possible that some parts of the Moroccan coast are more important as moulting areas, and it may be relevant that the highest proportion of moulters were found in the south, nearest to the wintering area. Moult in Morocco is completed from mid-September onwards, and presumably birds then move quickly south, as the last birds leave in October. In Mauritania only six birds, in October, had not yet started moult. A bird caught with completed moult on 19 November 1973 had been ringed 98 days earlier at Sidi Moussa when its moult score was 9.

Some individuals in Morocco and Mauritania were recorded in arrested moult, all primary feathers being fully grown but some new and others old. Arrested moult seems to show some increase later in the season. Six birds out of 367 (1.6%) were in arrested moult in Morocco in August and September, 4 out of 222 (1.8%) in October and early November in Mauritania, and 7 of 132 (5.3%) in late November.

At least some birds arrested their moult later in the season in Mauritania. For example, one bird with moult score 9 (in-

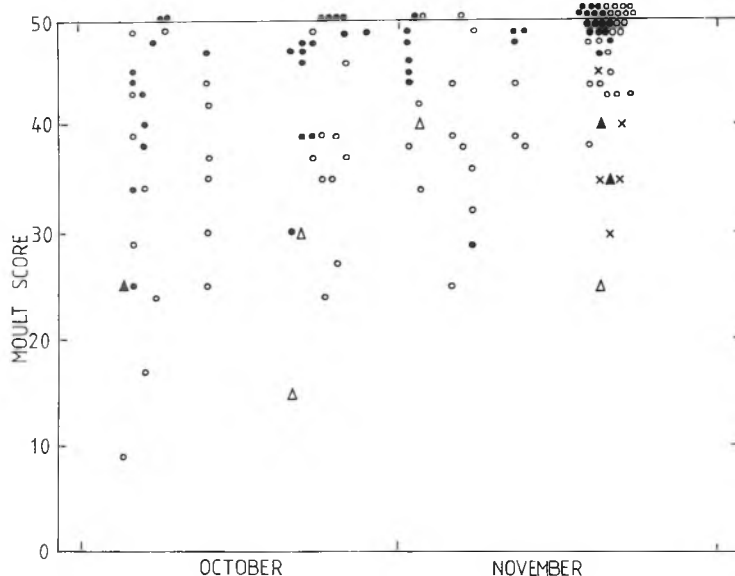


Figure 3. Primary moult scores of selected Curlew Sandpipers caught in Mauritania. ○ all birds with bill-lengths ≥ 42 mm (these include 29% of females and only 1.1% of males); ● all birds with bill-lengths ≤ 36 mm (these included 31% of males and only 1.3% of females). (This separation was calculated by probability graph paper analysis—see Methods.) ▲, △, × probable males, probable females and birds with intermediate bill lengths showing arrested moult.

ner three feathers at score 3, remainder old) on 4 October 1973 was retrapped in arrested moult on 20 October (score 15, 3 fully-grown new feathers, remainder still old).

In the main, the Curlew Sandpipers passing through Tunisia in autumn do not stay to moult but use the area to accumulate fat for further migration.

Weights

General aspects of the weights of Curlew Sandpipers in north-west Africa have been considered by Dick & Pienkowski (1979). Winter weights (Figure 4) were similar to those in East and South Africa and Tasmania during the northern winter and fat levels were probably only about 5 g or less.

Juveniles

The mean weight of juveniles in Morocco fell in September and remained low early in October in Mauritania. Some of the lowest weights probably represented re-

cent arrivals: a bird weighing 33 g on 23 October 1973 in Mauritania had been ringed 15 days earlier in Tunisia. Subsequently the mean weight rose, but six retraps maintained constant at about 45 g while five others increased to about 60 g at a mean rate of 0.3 g/day. This is less than the rate of pre-migratory weight increase in spring in South Africa (Elliott *et al.* 1976) and far less than the 2–4 g/day in autumn in Britain (Stanley & Minton 1972). The highest weights were also far less than the pre-migratory ones in those two areas and it seems unlikely that the north-west African birds were about to perform very long non-stop migrations. Shorter movements within West Africa seem more likely for the birds increasing weight. Assuming the weight increases to be due to deposited fat, the potential range of flight would be 1,000–2,000 km, depending whether the assumptions of McNeil & Cadieux (1972) or Greenewalt (1975) or Pennycuik (1975) are followed. The distance from the Banc d'Arguin to the Niger Inundation Zone is about 1,500 km and to the coast of Ghana 2,500 km.

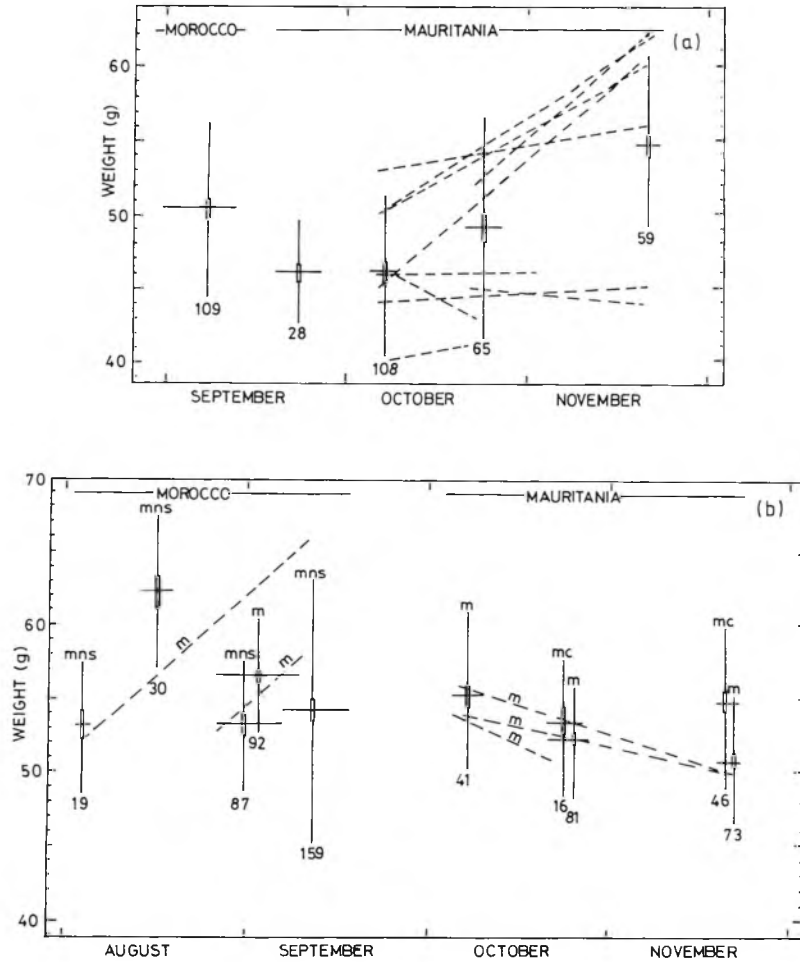


Figure 4. Weights of (a) juvenile and (b) post-juvenile Curlew Sandpipers in Morocco and Mauritania. Horizontal line shows mean weight over period indicated; box shows one standard error, vertical line one standard deviation either side of mean. Number indicates sample size. mns = moult not started; m = moulting; mc = moult complete. Dashed lines join weights for re-trapped individuals.

Post-juveniles

The weights of pre-moulting birds in Morocco were more variable than those of moulting birds (variances 34.2 and 21.9, $F = 1.56$, $P < 0.05$). The former probably included new arrivals, birds about to moult, and others moving on before moulting. Weight data from Morocco are consistent with passage birds some of which stop to moult. The onward movement is probably to Mauritania. There the mean weights of moulting birds all declined during October and November. In late

November the mean weight of birds which had completed moult was slightly higher.

Status in North and West Africa

Moreau (1972) stated 'though mainly coastal in winter the Curlew Sandpiper occurs sporadically across the northern tropics, the northeast Congo, throughout East Africa and the interior of South Africa.' Only at the southern tip of the continent are the numbers well documented; Summers *et al.* (1977) reported 55,000 Curlew

Sandpipers along 1,090 km of the coast of south-western Cape Province, South Africa in November 1975 to February 1976. Underhill & Whitelaw (1977) found a further 19,000 along 236 km of the coast of Namibia. Some non-breeders, mainly one-year-old birds, remain in South Africa in the breeding season.

Libya

Curlew Sandpipers are virtually absent in summer and winter and rare even at migration times, spring sightings being more frequent than autumn ones. Most records are from the western area, Tripolitania and Fezzan (Bundy 1976).

Tunisia

At most only a few hundred Curlew Sandpipers summer at Lac de Tunis and Sebkha Kelbia. Autumn migration begins in mid-July and ends in mid-October for adults and November for juveniles (see Figure 2). Several hundred winter regularly at Golfe de Petite Syrte and Sebkha Kelbia when it holds water, and similar numbers may winter at other sites not investigated. Spring migration builds up rapidly in mid-April, increasing to several thousand birds in mid-May, and finishes sharply at the end of May or beginning of June (M. Smart, M. A. Czajkowski, unpub.; Johnson & Hafner 1972).

Algeria

A few dozen birds may winter (Johnson *et al.* 1975).

Morocco

A few summer. In autumn, they are abundant passage migrants, concentrations of several hundreds being recorded (Pienkowski 1975; Pienkowski & Knight 1977). None or a very few winter.

Mauritania

Several hundred summer at the Banc d'Arguin, where they are abundant passage migrants and winter visitors, 36,500 being estimated in October and November 1973

(Knight & Dick 1975). Daily numbers at Cap Timiris, part of the Banc d'Arguin, varied considerably in September and early October 1973, suggesting waves of migrants. This is supported by a decrease from September to October (Dick 1976).

Tropical West Africa

Morel & Roux (1973) recorded Curlew Sandpipers as regular winter visitors in groups of several dozen at the mouth of the Sénégal river. In Gambia flocks of up to 80 have been recorded between November and March.

B. Lamarche (in litt.) has supplied a summary of their status in Mali. They can be found in any period of the year but are most numerous in the winter. In October the migrants arrive at the Niger and small groups (25–30) are seen by the large lakes and Sahelian ponds in the north of the country. Three birds found dead give evidence of Sahara crossings; one near Bidon 5, just inside Algeria, north of Tessalit; one near Taganet Keina, 180 km N. of Timbuktu, at the tree limit; and one near Assouarirt, 40 km north of Lake Faquibine which lies 120 km west of Timbuktu. It seems to be much more numerous in the Sahelian zone than in all the other ones, except the sea-shore in Ghana, etc. In Mali, for instance, it stays nearly exclusively in the Sahel and is really rare in the Bamako latitude.

Observations are not available from the northern parts of Niger, Tchad and Sudan. Further south, Hall (1977a, b) found Curlew Sandpipers only in the early dry season, September to November at Maiduguri and the area S.W. of Lake Chad in N.E. Nigeria, and reports (in litt.) that they do not winter to any extent in N. Nigeria, only passing through in large numbers in spring and autumn. Lévêque (1969) reported the first record, in February, of Curlew Sandpipers on the east side of Lake Chad.

The species is apparently absent, but other wader species are present, from areas such as Mole National Park, Ghana (Greg-Smith 1976), Yankari Game Reserve, Nigeria (Dyer & Gartshore 1975) and Waza National Park, Cameroun (Pet-tet 1976). Birds may occur in this zone at migration times and Brown (*in* Maclaren 1953) noted a large flock moving north-westward up the Niger at Pategi in April.

In the coastal region, records are lacking from Guinea Bissau to Liberia. On the

Ivory Coast, Brunel & Thiolley (1969) recorded the species as an isolated winterer in the Abidjan region. In Ghana, Dr L. Grimes (in litt.) states that 'Curlew Sandpipers are very common passage migrants to the shore line, lagoons, fresh water dams and especially the saltpans near Accra. Birds remain at the saltpans in May, June and July. A large influx of birds in partial breeding dress takes place in late July and early August (c. 800 on 2 August 1968 and 200+ on 12 August 1970). Frequently 100 to 150 in northern winter months.' In December 1976, I. R. Taylor (unpub.) found 255 Curlew Sandpipers along 48 km of coast, making it the fifth commonest wader. The species is clearly localized as few were recorded 150 km to the West near Cape Coast, and then mainly in April and late June to August (Macdonald 1978).

In coastal Nigeria, earlier reports indicated that Curlew Sandpipers were mainly passage migrants, but a few wintered. There were also some indications of summering flocks of immatures in July and a heavy coastal movement in autumn, some birds arriving in full summer plumage (Maclaren 1953; Elgood *et al.* 1966). More recent systematic coverage has indicated larger numbers wintering. Gee & Heigham (1977) report them to be common in the Lagos area between September and April. Heigham (1976) classed them as 'occasional' in coastal areas of Mid-West State between November and February, and Smith (1966) found a roost of 1,000 in August and 2,000 in September at the mouth of the Bonny River and flocks of c 100 in January in the Mid-West Region.

Moreau (1967) summarized that 'all across Africa on the southern edge of the Sahara it seems that this bird appears almost wholly on passage, in northern Nigeria, August and September and also in March and April, and nowhere in large numbers.' The further information now available makes it clear that Curlew Sandpipers are numerous in winter and at migration times in the Sahel zone and locally on the coast. However, our knowledge of their distribution in West Africa between Mauritania and Namibia, a distance of more than 5,000 km, is very sketchy. There is a virtual absence of records between Sénégal and Ivory Coast and between Nigeria and Namibia, and information is lacking from large parts of the Sahel zone. In East Africa, Curlew Sandpipers occur commonly on migration

and in winter, and evidence of return by ringed birds to the same site in later years is accumulating (Pearson *et al.* 1970; Moreau 1972; Pearson 1974; d'Huart 1977).

Discussion and conclusions

Annual differences in numbers seen

The migration of Curlew Sandpipers in north-west Europe is notable for its variability in annual intensity, in timing, and between autumn and spring. Stanley & Minton (1972), while attributing the large influxes into Britain in 1969 and in previous years to meteorological conditions during migration, also considered that a good breeding season might lead to large numbers of juveniles.

Numbers of Curlew Sandpipers counted or caught at a range of sites in Europe, north Africa, South Africa and the Indian Ocean tend to run parallel (Table 2). In those areas where birds were caught and aged, the percentages of juveniles tended to fluctuate with the annual variations in the totals present. Thus differences in breeding success would appear largely to account for the annual variation in numbers. It would seem that 1969, 1970, 1972, and 1973 were good breeding years, and 1967, 1968, 1971 and 1974 poor ones.

Weather during migration is unlikely to cause parallel variations in numbers over such a wide geographical area, especially as these include wintering grounds as well as passage areas. The years of fairly high numbers of Curlew Sandpipers in Britain (e.g. 1967, 1969, 1970, 1971, 1972) do, however, coincide with the occurrence of cyclonic weather systems over north-eastern Europe similar (though not necessarily so extreme) as those described by Stanley & Minton (1972).

It seems likely that both high breeding success and appropriate weather patterns are involved in determining the numbers of Curlew Sandpipers seen in north-west Europe, the relative importance of the latter factor increasing towards the extremities of the migration range, in Britain. When the two factors are additive, notably in 1969, large influxes may occur.

Seasonal differences in numbers seen

The differences in numbers reported in European or N. African sites between

Table 2. Counts and age composition of Curlew Sandpipers at various localities in different years.

Country and locality	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	Notes
Netherlands											
Vlieland	—	—	—	—	—	19% 37	31% 35	0% 32	—	—	a a
Germany											
Münster	5	0	30	30	5	—	—	—	—	—	b
Spulfeld	—	—	—	—	—	220	20	0	—	—	c
Radelsee	—	—	—	—	—	220	20	0	—	—	c
Brandenburg	35	33	210	294	77	281	125	—	—	—	d
	20%	36%	85%	71%	22%	87%	92%	—	—	—	d
Morocco											
Sidi Moussa											
salt pans	—	—	—	—	10	180	—	—	—	—	e
					100	200					
lagoons	—	—	—	—	3	100	—	—	—	—	e
					10	250					
	—	—	—	—	1%	21%	11%	—	—	—	f
	—	—	—	—	8%	37%	21%	—	—	—	f
	—	—	—	—	12	387	92	—	—	—	f
Tunisia											
Rades	—	160	990	272	179	602	472	238	—	11	g
	—	17%	63%	88%	41%	33%	59%	1%	—	—	g
South Africa											
Langebaan	—	—	—	—	—	21%	35%	0%	8%	3%	h
Kommetjie	—	—	—	—	10%	—	—	—	—	27%	i
	—	—	—	—	30	—	—	—	—	142	i
Seychelles											
Mahe	—	—	—	—	200	367	600	—	—	—	j

All records refer to autumn unless otherwise stated.

(a) Percent 1st yr birds in catch and total catch (Boere 1974). (b) Peak count (Harengerd *et al.* 1973). (c) Peak count (Plath 1976). (d) Numbers counted and percent juveniles (Dittberner & Dittberner 1976). (e) Range in daily counts (Pienkowski 1972, 1975 and unpub.). (f) Percent in wader catch, percent of 1st yr birds, and total (Pienkowski 1972, 1975 and unpub.). (g) Numbers ringed and juveniles as percent of those aged (Lachaux 1974; M. A. Czajkowski, unpub.). (h) Numbers of non-breeding 1-yr-olds remaining in following year as percent of peak numbers in non-breeding season (Pringle & Cooper 1977). (i) Percent of 1st yr birds in winter and catch total (Pringle & Cooper 1977). (j) Peak numbers in non-breeding season (Feare & High 1977).

spring and autumn can be accounted for in two ways; either passage birds are more likely to stop at intermediate sites, and are therefore seen more often in autumn, or routes are different at the two seasons. Juvenile waders are more likely to stop at intermediate sites (e.g. Dick *et al.* 1976). However, at Ytyeri, Rostock, Münster and the Camargue, the number of autumn sightings of post-juveniles alone greatly exceeded those in spring. It may be that over-flying post-juveniles are less likely to land on spring migration except following a long non-stop flight, such as over the Sahara Desert, thus accounting for the anomalous observations in Tunisia and

adjacent areas (cf. Moreau 1972). However, along the Atlantic coast of Europe the migration is less in spring than in autumn; if large numbers were passing, feeding stops would be likely at a few sites at least.

The alternative explanation, favoured by Stanley & Minton (1972), that birds following a western route in autumn may be displaced westwards by weather conditions, is supported by ringing recoveries for juveniles, but less so for post-juveniles (Table 1).

It is possible that two groups of Curlew Sandpipers occur in north-west Europe: one which regularly migrates through

north-west Europe in autumn but tends to follow a more easterly route in spring; and an occasional and irregular passage mainly of juveniles displaced westwards by weather conditions from a more easterly route to which they adhere in later years.

In view of the 'loop' migration suggested for the first group, why are there no recoveries in N.W. Europe of Curlew Sandpipers ringed in spring in Tunisia or in autumn where the routes converge on the west coast of north Africa? This is probably because, as counts of migrants and the pattern of winter distribution indicate, the Curlew Sandpipers passing regularly through north-west Europe form only a small proportion of those wintering in West Africa and passing northwards through the Mediterranean in spring.

Patterns of movement in the non-breeding season

The wintering areas of the Curlew Sandpipers passing through Europe and north-west Africa have been known only in very general terms until recently and many large gaps in knowledge remain. Few normally winter in Morocco, but the Banc d'Arguin in Mauritania is an important wintering site for this and other wader species. However, many Curlew Sandpipers move further south. It seems likely that Curlew Sandpipers are widely dispersed in West African wetlands in the coastal and Sahel zones in the non-breeding season. The evidence suggests a south-eastward movement by many birds after moulting. Although birds probably arrive in tropical west Africa both from the N.N.E. and via north-west Africa, radar evidence in Ghana indicates departure mainly on a direct great-circle route to the N.N.E. towards the breeding grounds (Grimes 1974), and the more intensive use of Tunisia in spring probably relates to this also.

Present knowledge of the migration patterns of Curlew Sandpipers in Europe and Africa are summarized in Figure 5. The movement in both directions on a great circle line between breeding grounds and southern Africa via the Black and Caspian Seas and east African wetlands has been documented by Elliott *et al.* (1976). Birds also use fairly direct routes to West Africa, in autumn either via the Baltic and west European coasts or via the Black Sea and Tunisia. The second group are probably heading for the lands north of the Gulf of

Guinea but there is also some ringing evidence for movement from Tunisia to Mauritania. There is probably some eastward movement during the winter so that, in the spring, the more easterly migration route is more frequented. Consequently, Tunisia and the north Black Sea coasts are of particular importance to this species. The Moroccan and Mauritanian coasts are clearly important as moulting areas and the Banc d'Arguin also as a wintering site. The reasons for the onward movement of many birds from these areas are unknown.

Some Curlew Sandpipers arriving early in north-west Africa apparently moult more quickly than later arrivals and the latest, and possibly slowest, moults are the most likely to arrest moult. Males tend to migrate southwards earlier than females, thus leading to a difference in moulting schedules between the sexes. A comparable difference occurs in Ruff *Philomachus pugnax*, a species in which the sexes tend to winter at different latitudes (Pienkowski *et al.* 1976). The two species have similarities in their polygamous mating systems which are related to the early departures of males (see Pitelka *et al.* 1974). Further work in West Africa would be required to establish whether there is also a difference in wintering areas between the sexes in Curlew Sandpipers.

The status of the species between Nigeria and Namibia remains only vaguely known, as does the extent of movement between western and southern Africa. Any large degree of onward movement over this distance by post-juveniles seems unlikely as these birds moult in autumn in west Africa but Curlew Sandpipers arrive in South Africa unmoulted and moult more slowly over the northern winter. The adaptive significance of this has been discussed by Pienkowski *et al.* (1976) and Elliott *et al.* (1976). This difference does not of course apply to juveniles which in neither area moult in their first calendar year. Age ratios and counts in Mauritania and the October to November increase in weights of many juveniles suggest a greater tendency by juveniles to move further south. Some of the juveniles passing through north Africa may belong to the southern African population but have been displaced during migration in a manner similar to that resulting in the 'invasions' into Britain. The recovery of a bird ringed in Tunisia in August a year later in South Africa indicates some movement between north-west and southern Africa.

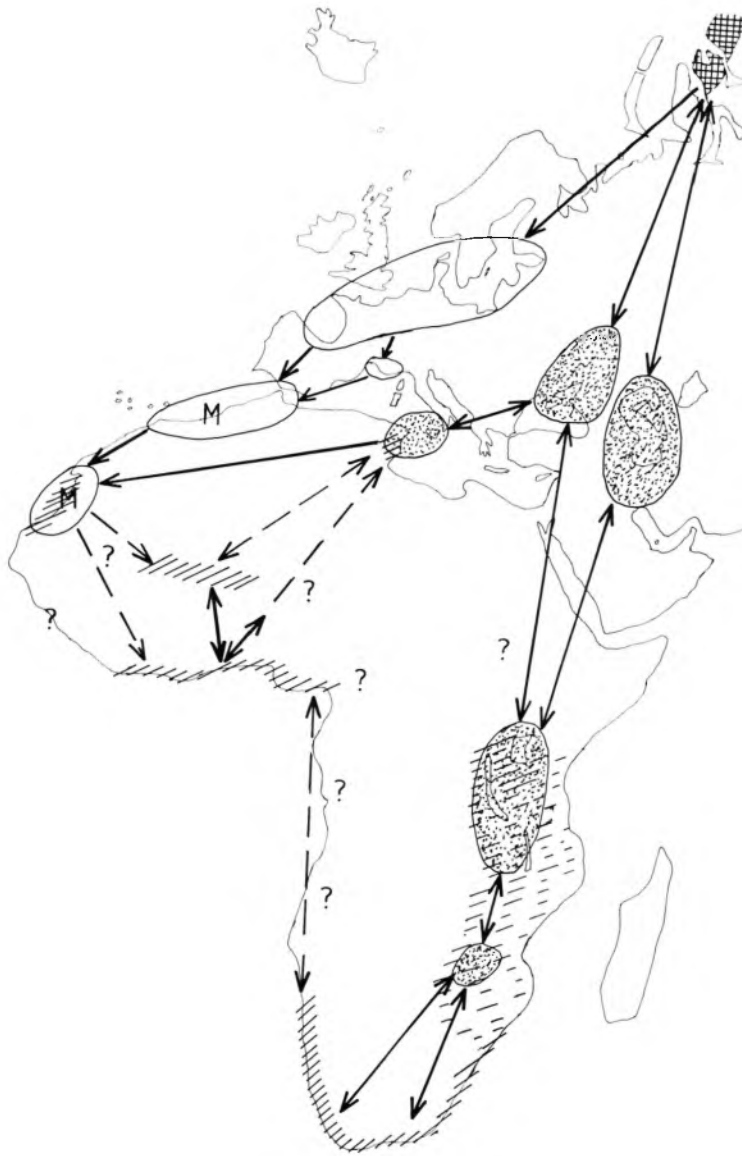


Figure 5. Schematic summary of the migration system of Curlew Sandpipers in Europe and Africa.

▨ Breeding area, /// principal wintering areas, M known moulting areas, ⊗ known major staging areas on both spring and autumn migration, ○ known major staging areas on autumn migration only, ? area where status unknown, → presumed main migration routes (supported by evidence from ringing, radar or visible migration), ----→ other probable migration routes.

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Summary

The migration of Curlew Sandpipers *Calidris*

ferruginea in Europe and north-west Africa is reviewed by bringing together sightings of visible migration, counts at resting sites, and ringing recoveries to put into perspective the occasional influxes of this species into north-west Europe. Data on counts, catching, weights and moult obtained in north-west Africa are presented and the species' wintering status in west Africa is reviewed.

Most Curlew Sandpipers occurring in these regions appear to migrate between northern USSR and West Africa via European Russia and the Black and Mediterranean seas. There is a smaller regular autumn passage through N.W. Europe but these birds tend to join the majority in the more easterly route in spring. In years of high breeding success and certain weather patterns over northern Europe large numbers of juveniles are displaced westwards resulting in the occasional large influxes into Western Europe. Unlike the regular N.W. European component, these birds use a more easterly course in later autumns.

The early departure of males from the breeding grounds results in different migration and moult schedules between the sexes but it is not known if wintering grounds are also different. More work is required in west and central Africa to clarify the winter distribution of this species.

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