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Migratory movements and mortality of Danish Avocets *Recurvirostra avosetta*

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Recoveries of 440 Avocets ringed in Denmark were analysed to describe the migration pattern of the Danish population throughout the year. The overall recovery rate is 3.4%, with the recovery rate for birds ringed as adults being larger than the recovery rate for birds ringed as chicks (23.9% vs. 3.1%). The mortality of the Danish population reached 57.8% during the first year of life and 32% for older birds. Danish Avocets are truly migratory; the first birds leave Denmark in August and most birds have left the country by October. Most recoveries are from France (60%), Spain (12%) and Portugal (16%), especially at coastal wetlands along the Atlantic seaboard. No difference was found between young and old birds with respect to winter quarters. The return migration to the Danish breeding grounds occurs in March. Adult birds showed a higher rate of return to their ringing area (70%) than birds ringed as chicks (38%).

Denmark is situated on the outermost periphery of the breeding range for the north-west European Avocet *Recurvirostra avosetta* population. Only a few thousand birds pass through Denmark to more northerly breeding grounds in Sweden and Estonia, while Denmark supports a large proportion of the north-west European Avocet population during the breeding season. The Danish breeding population, which has been increasing during recent decades, is estimated to number 4,000 - 4,500 pairs (Olsen 1992) out of a total breeding population in north-western Europe of 20,000 pairs (Blomert *et al.* 1990). The present winter population in Europe and Africa has been estimated at 50,000 - 67,000 individuals (Smit & Piersma 1989, Blomert *et al.* 1990), which means that the non-breeding population consists of 10,000 - 27,000 birds.

In connection with studies of the breeding biology of the Danish Avocet carried out during 1987-88 (Salvig 1990), analyses of the migration pattern of the Danish population were performed. Earlier the migration of ringed Avocets breeding in Denmark has been treated by Rosendahl and Skovgaard (1970) and by Salomonsen (1972). The present study deals with the yearly movements of the Avocets as deduced by recoveries of Avocets ringed in Denmark.

The objectives are to determine migration routes, range extent, annual survival rates, differences in use of winter quarters between young and old birds, and the proportion of birds returning to their natal area. The yearly ranges of bird species deserve study, since events outside the breeding season and the breeding area are of great importance in understanding the factors regulating the population dynamics (Hill 1988).

MATERIAL AND METHODS

In Denmark, Avocets have been ringed since 1918, and the number ringed amounts to 11,358 birds up to 1988. Recoveries of 440 Avocets ringed in Denmark are available for analysis. The recovery rate, collected under three ringing schemes, is 3.4%.

Recoveries of Avocets ringed by one of the ringing schemes (Zoological Museum, Copenhagen) allows a further sub-division into two categories: (i) Avocets ringed as pulli, recovery rate: 3.1% (134 recoveries); (ii) Avocets ringed as adults, recovery rate: 23.9% (86 recoveries). The latter category includes birds of unknown age at the time of ringing.

Avocets ringed in Denmark have been recovered in 13 countries with most recoveries from summer and winter (Table 1a). The majority of the recoveries (85%) concerns individuals that have been "recaptured", "shot" or "found dead" (Table 1b). Hunting ("shot") is the most common cause of recovery in France, Spain and Portugal, while "recaptures" and "found dead" are the dominant causes of recovery in Denmark. Although this means the data are heterogenous as the total number of recoveries is quite low, all recoveries of whatever cause are included in the analyses.

In order to investigate if there was any difference between young and adults in the number of birds recovered as "shot", the amount is listed below. Two categories are used to distinguish between young and adult birds:

Juveniles: birds ringed as chicks, and recovered before 1 August of the year following the hatching year.

Adults:birds ringed as chicks, and recovered after 1 August of the year following the hatching year.

Juvenile birds recovered as "shot" consisted of 47% ($n = 65$, non-fledged birds have been left out).

Table 1a. The monthly number and geographical distribution of recoveries of Avocets ringed in Denmark.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Sweden							1	1					2
Denmark			1	16	26	68	36	39	13	4	3		206
Germany					1		1	1	2	2		1	8
The Netherlands	1		1	2	1	1					2		8
Belgium	2	1						1	1	1	1	3	10
France	22	18	15	8	4	2		3	3	9	20	37	141
Spain	6	5	3	1				1		2	5	3	26
Portugal	7	6	3						1	1	6	6	30
Morocco		3		1									4
Senegal										1			1
Italy									1			1	2
Algeria								1					1
Great Britain	1												1
Total	39	33	23	28	32	71	38	47	21	20	37	51	440

Table 1b. Survey of recoveries of Avocets ringed in Denmark. The total number of recoveries for each country.

	Hunting	*Recaptures*	*Found dead*	*Old dead*	*No information*	*Other*	*Total*
Sweden	1		1				2
Denmark	10	67	109	9	7	4	206
Germany	2		4	1		1	8
The Netherlands	1		4		1	2	8
Belgium	5		1		3	1	10
France	85	3	28	2	21	2	141
Spain	17	2	2	1	4		26
Portugal	21	1	1	1	5	1	30
Morocco	1	1	2				4
Senegal	1						1
Italy	2						2
Algeria	1						1
Great Britain	1						1
Total	148	74	152	14	41	11	440

Adults recovered as "shot" consisted of 42% (n = 51). This difference was not statistically significant.

The mortality rate is calculated by use of the Lack-Haldane model (Haldane 1955). Since the data set has a particular lack of information on numbers ringed and the total outline of the ringing scheme, the choice of statistical tool is limited to this model (Noer 1990).

RESULTS

Mortality

The age distribution of recoveries of birds ringed as chicks suggests a marked difference in mortality between the first and later years of life (Fig. 1). The data include a bird recovered at the age of 24 years and 7 months, the oldest known Avocet reported so far in Europe. Attention should be paid toward the fact that Fig. 1 underestimates the recoveries of older age classes, since recently ringed birds being still alive, are included in the analysis. First-year mortality was calculated from 209 recoveries made between 1 August and 1 April of birds in their first year of life. Recoveries made prior to 1 August in the year of ringing were excluded while recoveries from this period are mainly non-fledgings, which are believed to have a different set of recovery probabilities. Of the 209 recoveries 121 juvenile birds were recorded, corresponding to 57.9%.

The mortality rate was calculated for adults to amount 32.0 % ± 2.9%. The method of Haldane assumes that the mean annual mortality for adults is the same for all age-classes. A χ^2-test revealed that this assumption does not hold for the present material, which is based upon 85 recoveries ($\chi^2 = 29.373$, N.S.). A larger sample might support the assumption.

Geographical and temporary distribution of recoveries

From August to October, 88 recoveries were reported, of which 56 were from Denmark, and 32 from abroad (Fig. 2). Of the 56 birds recorded in Denmark, 39 were from August, 13 from September and 4 from October. The first juvenile recovered outside Denmark was from Belgium on 1 August. The first adult was recovered on 15 August in Germany.

From November to February, 160 Avocets were recovered. Of these, 96 were recovered in France, 45 in the Iberian peninsula, and 19 scattered among 7 countries (Fig. 3). The proportion of Danish ringed Avocets recorded in France (60%) and at the Iberian peninsula (28%) showed good correspondence with birds ringed in four other countries (Table 2). Most recoveries represent "juvenile" birds with 76 individuals for the four months. The category "adults" represented 44 individuals. The remaining 40 recoveries consisted of birds either ringed as adults or birds of which age was unknown, no age determination having been given at the time of ringing. There is no significant age-related difference in mean migration distances between the two age categories "juveniles" and "adults" from November to February. However, this does not mean that there are no differences between these two groups, but the result may be due to the limited size of the recovery material.

From March there were 23 recoveries, including one in Denmark (Fig. 4). The first Danish recovery in spring was recorded on 29 March, but not until April were higher numbers recorded. These late recoveries are primarily due to the fact that the Danish recoveries are primarily "recaptures" by ringers on the breeding grounds. Out of 17 recoveries from March and April, 13 were "recaptures".

There were 110 recoveries from April to July (excluding non-fledgings). The 12 recoveries of "juveniles" consisted of 42% from Denmark and 58% from abroad, while the 25 recoveries of "adults" consisted of 60% from Denmark and 40% from abroad. The remaining 73 recoveries consisted of 92% from Denmark and 8% from abroad (Fig. 5).

In order to determine the faithfulness to the breeding area, the distances of the migratory movements are calculated during the breeding season, based on a threshold distance of 30 km from the ringing site to define "emigrators" (which have found themselves a new breeding area) and birds which return to the area where they were hatched. From April to July, 37 Avocets were recovered which were ringed in Denmark as chicks. Of these, 14 were recovered within 30 km of their original ringing site.

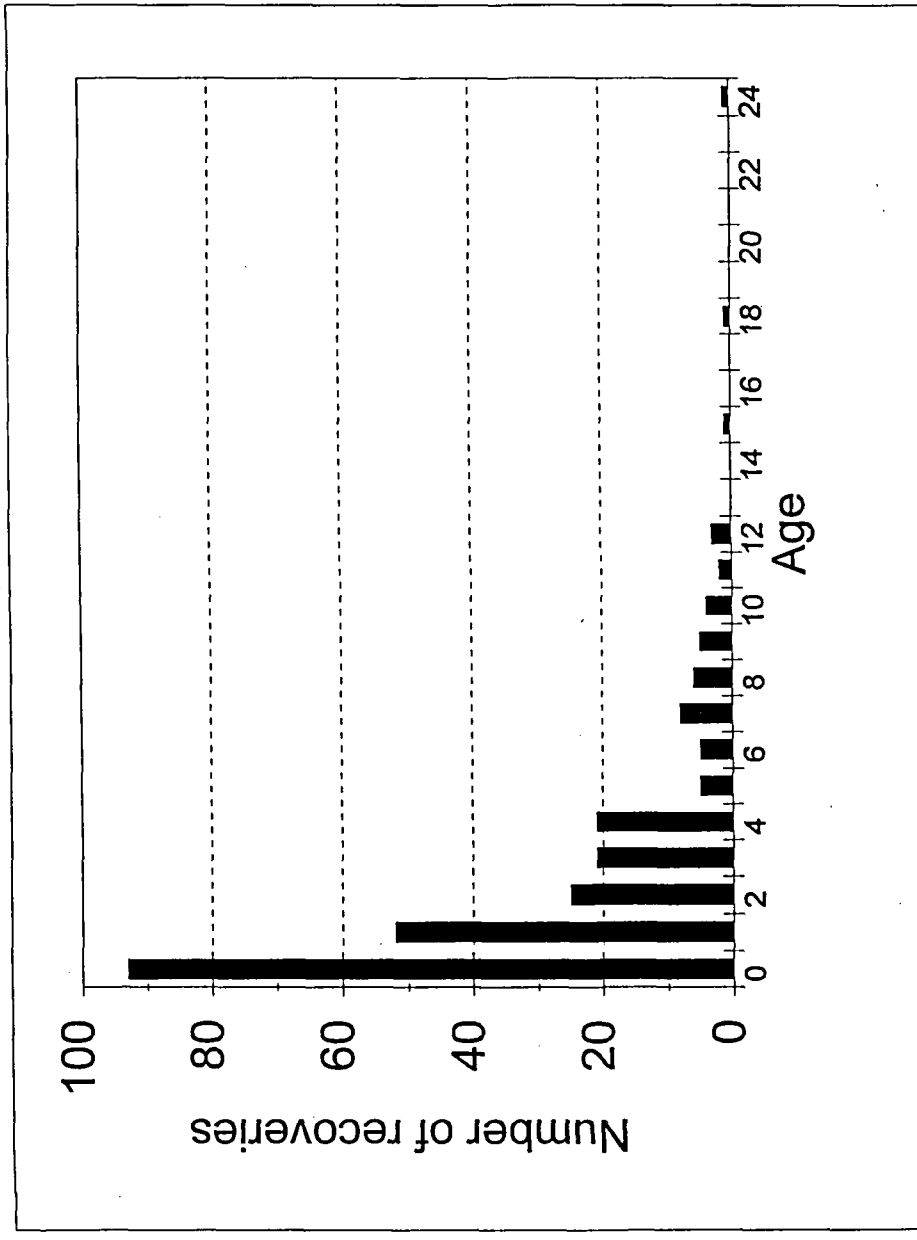

Figure 1. Recoveries of Avocets ringed as chicks in Denmark distributed on age groups. Year 0 = year of hatching. N = 253.

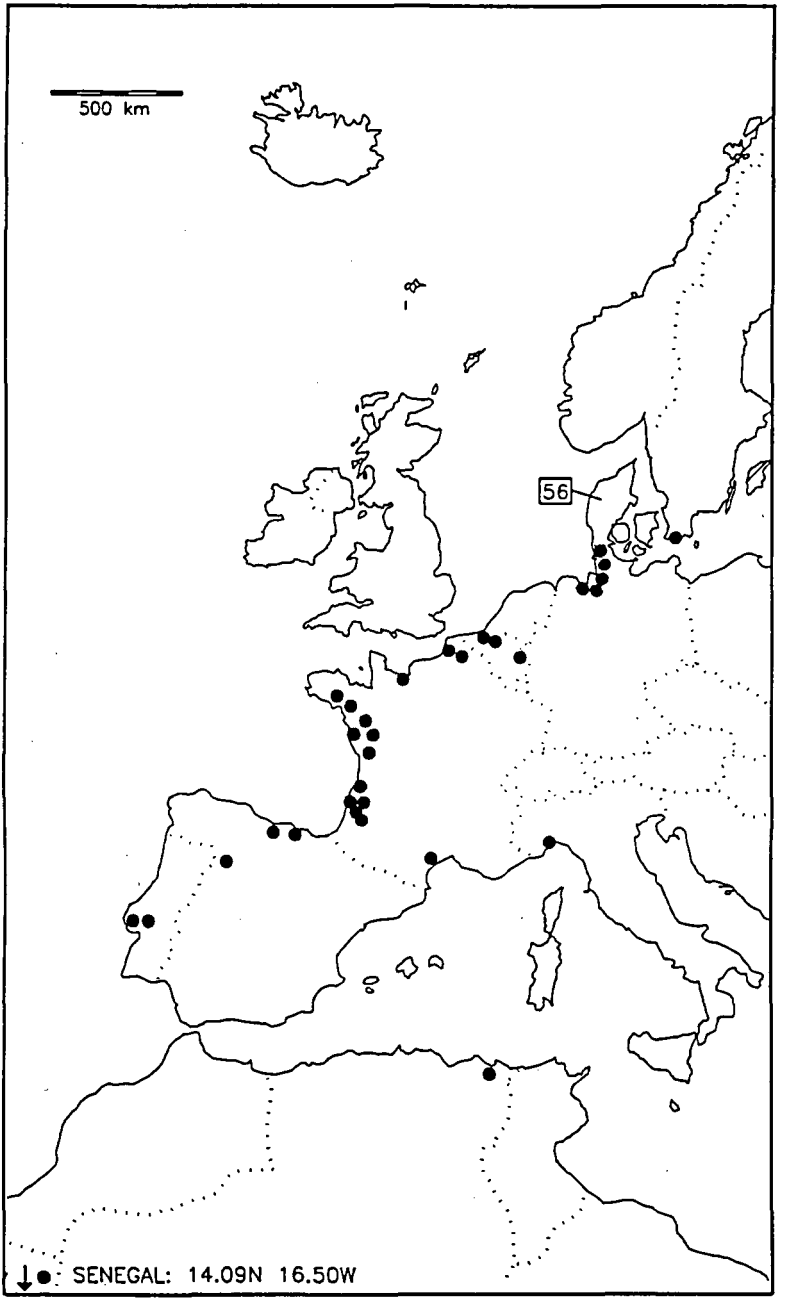

Figure 2. The geographical distribution of recoveries of Danish ringed Avocets. Autumn migration, N: 88.

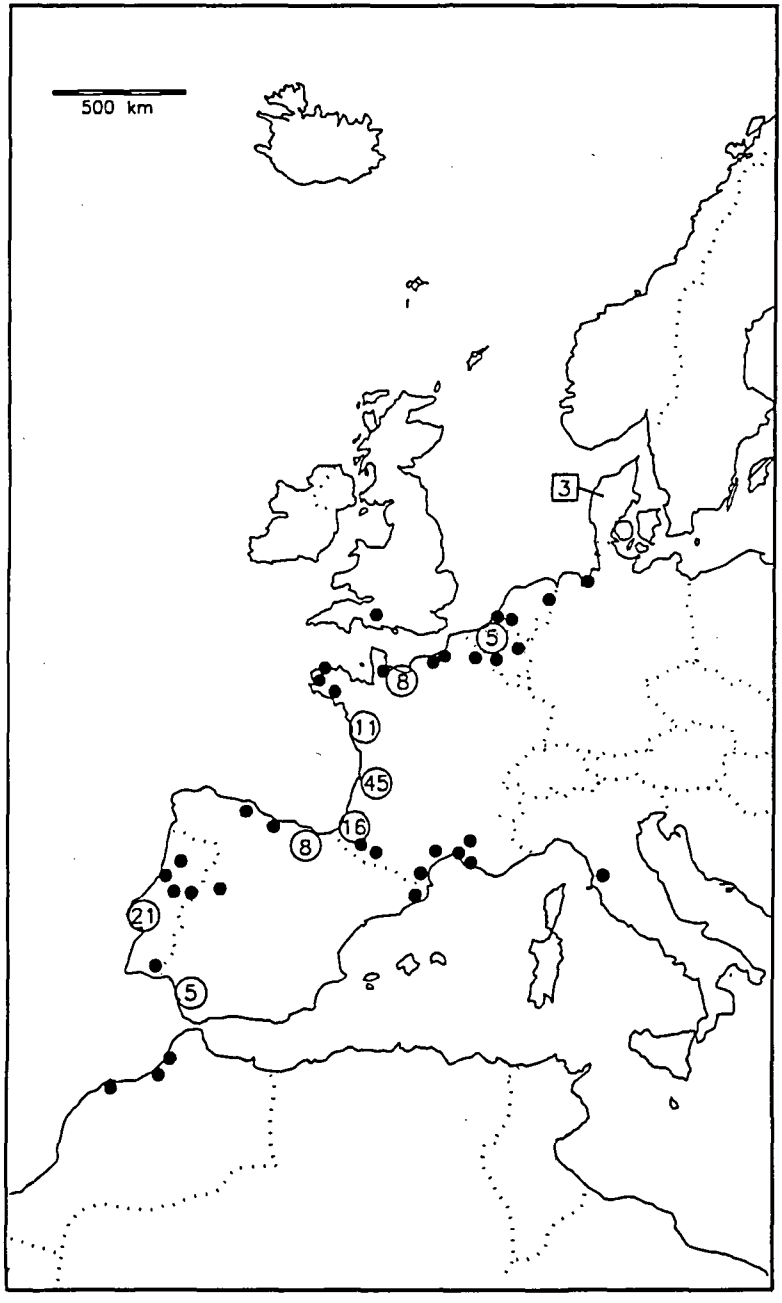

Figure 3. The geographical distribution of recoveries of Danish ringed Avocets. Winter quarters, N: 160. Solid circles = single records, figures in circles = multiple records at sites.

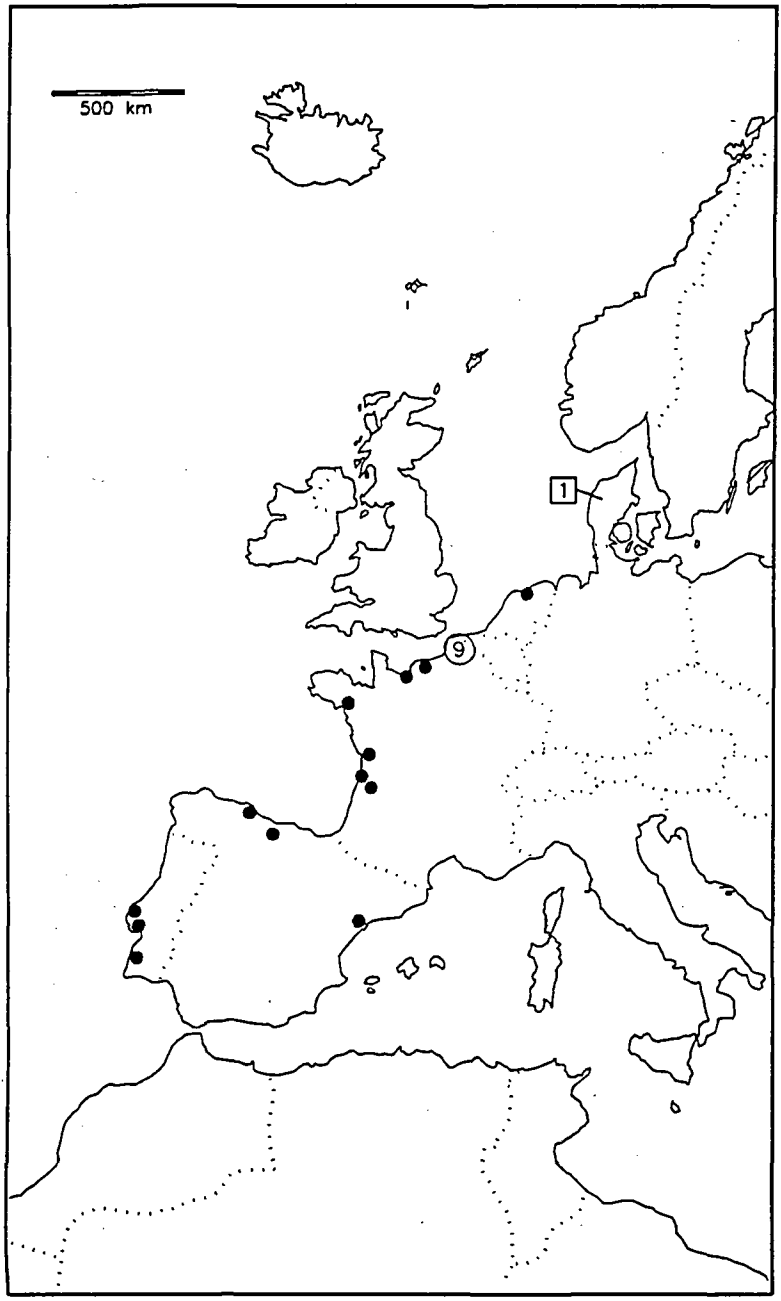

Figure 4. The geographical distribution of recoveries of Danish ringed Avocets. Spring migration, N: 23.

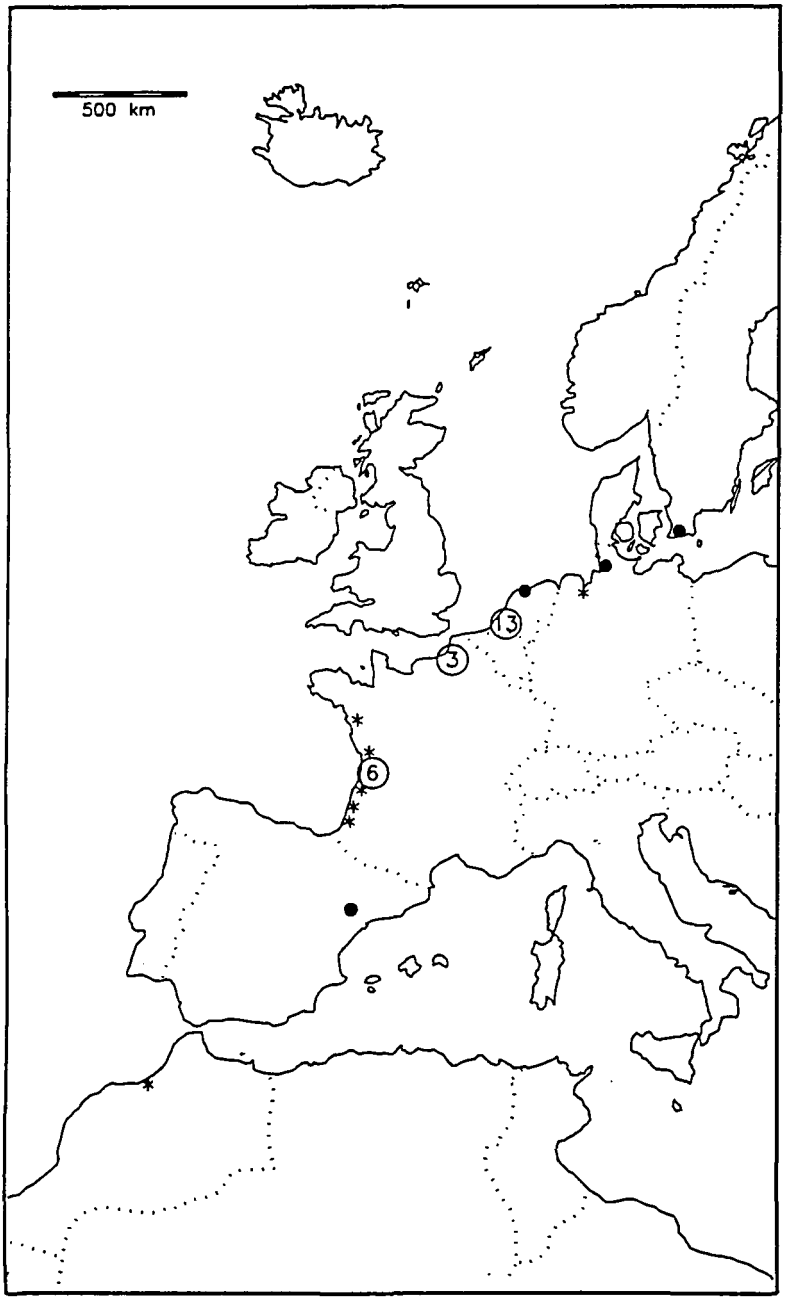

Figure 5. The geographical distribution of recoveries of Danish ringed Avocets. Breeding season, N: 23. *: juveniles, ·: adults.

Table 2. Spatial distribution in percentage of Avocets ringed in 5 countries and recovered in France and at the Iberian peninsula (Edelstam 1971, Ruitenbeek 1985, Glutz *et al.* 1975, Van Impe 1991, this study).

	Sweden	*Denmark*	*Germany*	*The Netherlands*	*Belgium*
France	55 %	60 %	56 %	46 %	56 %
The Iberian peninsula	30 %	28 %	28 %	36 %	31 %

DISCUSSION AND CONCLUSION

Danish Avocets are truly migratory, since no birds have been recorded during winter in the Danish wetlands. Amelioration of the winter and spring climate in north-western Europe has lead to an earlier arrival of the Avocets at the Danish breeding grounds than in the 1930s (Meltofte 1987, Salvig 1990). Continued amelioration of the climate in coming decades may lead to Avocets wintering in Denmark.

The overall recovery rate of Avocets ringed in Denmark (3.4%) is very similar to what has been recorded in Sweden, where Edelstam (1971) found a recovery rate of 3.5% (72 recovered birds out of 2,060 ringed). The majority of the recovered birds were ringed as chicks, which reflects that the fact that mortality amongst birds in their first year is much higher than for older birds, which can also be seen from Fig. 1. The mortality rates of the Danish population are comparable to other authors. Cadbury and Olney (1978) found that the mortality amongst birds in their first year of life was 60%, compared with 10% for older birds. The mortality of the Belgian population reached only 43% during the first year of life and 22-26% during the three subsequent years (Van Impe 1991).

Autumn migration

Departure from the Danish breeding grounds takes place from mid July (Meltofte 1980), thereafter the Avocets aggregate in large flocks in huge undisturbed areas, where the adults moult. Meltofte (1993) suggested that older birds move earlier from the breeding areas to the moulting sites than younger birds, as the ratio of young/adult increases dramatically in breeding areas in eastern Denmark in July. The main moulting sites in Denmark are all situated in south-western Jutland with most birds at the Rømø Barrage in the Danish Wadden Sea. Normally about 7,000 - 8,000 birds are recorded at the Rømø Barrage with maximum numbers of 11,400 (Laursen *et al.* subm.). Most of the moulting birds are probably Danish nesting birds, but breeding birds from Sweden, Norway and Estonia may also be present. Since extensive movements of Avocets have been recorded throughout the entire Wadden Sea area after the breeding season, German birds are also present (Dietrich and Hötker 1991). Up to 50,000 Avocets moult in the entire Wadden Sea area. When the Avocets have finished moulting they continue the migration towards their wintering quarters. The first Danish Avocets leave Denmark in August. On the evidence of the recovery material the young Avocets migrate before the adults, which has also been proposed by Cramp and Simmons (1983). Recoveries of Avocets ringed in Sweden show that adults and young set out on migration at approximately the same time (Edelstam 1971).

Most Danish Avocets have left the country by October, but a few birds may still be present in November. Three birds have been recovered in November in Denmark, two young-ones and one adult, but these were recovered as "old dead" and "found dead".

The majority of the recoveries from the migration period are from the Atlantic coast, which is due to this species' preference for coastal habitats. But the migration of Danish Avocets is not solely restricted to coastal areas as will be discussed later.

Winter quarters

Most winter recoveries of Danish ringed Avocets are from France, Spain and Portugal, where around 90% of the Danish recoveries were recorded. The majority of the recoveries in France is from the Atlantic coast: in the northern France near the mouths of the rivers

Somme and Seine, along most of the coast of Vendée and at the mouths of the rivers Loire and Gironde in mid and southern France, and also at the coastal lagoons of Les Landes in southern France. From the Iberian peninsula, most recoveries are from the great river estuaries at the mouths of Tejo and Sado in Portugal, the north-eastern coast of Spain and also at Las Marismas, the delta of the river Coria in southern Spain.

Avocets are on average 150 to 200 km further north in November and December than during January and February, which indicates that the Avocets move southwards as the winter gets harder. From the recovery material it can be seen that young and old birds move the same distances away from the ringing sites in winter. The same was recorded for the Swedish birds (Edelstam 1971). No difference in winter distribution was evident between juveniles and older birds on the basis of the recovery material.

All Avocets breeding in Denmark and further north are migratory, whereas some Avocets might stay in countries south of Denmark during mild winters. The wintering areas for the Danish Avocets correspond very well to the wintering areas for other north-west European Avocet populations, although variations in the general pattern do exist. The difference between the Danish and the Dutch Avocets is due to a larger fraction (11%) of the winter recoveries from the Netherlands and Germany in the Dutch recovery material. These wintering birds were mainly recorded in the Dutch Delta. Ruitenbeek (1985) also states that some hundreds of birds stay in the Netherlands during mild winters. The Danish birds seem to overfly these wintering areas.

English Avocets were found to stay in England during mild winters, but as for the other populations the main part migrate to France and the Iberian peninsula to winter (Cadbury & Olney 1978).

Even though most winter recoveries of Avocets come from France it is doubtful whether the ringing recoveries truly reflect the winter distribution. Hötker (pers. comm.) suggests that the high percentages of recoveries from France compared to that from all other countries are partly a result of the activities of French hunters. Attention should also be drawn to the African recoveries, 6 from Denmark and 24 from other countries (Edelstam 1971, Glutz *et al.* 1977, Ruitenbeek 1985, Van Impe 1991, this study). These recoveries could be indications of a much larger number of Avocets wintering in Africa than can be concluded from the recovery material. This is caused by the fact that the likelihood of receiving reports of findings from these countries is very low. Today, several observations and counts from the wintering areas exist which clarify the African c[illegible]es as important wintering areas (Table 3). Dornert *et al.* (1990) estimate that about 35% of the West European population winters south of the Sahara, and due to the timing of the migration, they suggest that most birds wintering in Africa originate from North West Europe. By way of comparison the number of wintering Avocets along the European Atlantic coast has been estimated to number 34,500 birds with largest concentrations in southwestern France (16,000) and Portugal (12,600) (Smit and Piersma 1989).

Spring migration

The spring migration can be described only to a lesser extent from the recovery material. The recovery material indicates that the Avocets rest several times during their migration, e.g. in northern France and in The Netherlands. Perhaps also some of the birds passing through Denmark in spring stop their migration to rest in Danish wetlands, as suggested by Meltofte (1993).

Hence, the first recoveries in spring from Denmark reflect merely the start of the breeding season than the time of the birds arrival at the breeding areas. Most birds arrive at the breeding areas late in March/early April. The breeding season in Denmark starts in late April/early May (Salvig 1990). The birds are present on the breeding grounds 1-2 months, before they actually start breeding, depending on the harshness of the winter, expressed by the temperature in February (Salvig 1990).

Breeding season

In total, 38% of the Avocets ringed as chicks in Denmark have returned to the area where

Table 3. Numbers of wintering Avocets along the coast of Africa (Smit & Piersma 1989).

Country	*Numbers*
Algeria	1,800
Tunisia	9,200
Morocco	2,900
Mauritania	2,500
Senegal	12,500
Guinea-Bissau	300
Gambia	100
West African coast	7,100
Total	36,400

they hatched. The proportion of birds which has been recovered in their ringing areas is higher for birds ringed as adults (70%). This suggests, that having chosen a breeding area, adult Avocets tend to be faithful towards it, as proposed by Cadbury and Olney (1978). Presumably the Avocets' breeding areas are determined by the populations with which the young Avocets interfere/mix in the winter quarters, and with which they later follow on the return migration to the breeding areas. The lower proportion of juveniles is due to the fact, that only around 7% of the birds return to the hatching area in their first summer after fledging (Cadbury and Olney 1978). Furthermore, juveniles arrive later and depart earlier than mature birds. This is probably due to the fact that sexual maturity is reached in the second year (Cramp and Simmons 1983, Engelmoer and Blomert pers. obs., Salvig pers. obs.).

Excluding 7 recoveries of juveniles, which did not reach the age of sexual maturity, 16 between-summer recoveries indicate that these birds may have changed breeding area, and had moved to other populations. This may not necessarily mean that all 16 birds have emigrated, since migratory movements during the breeding months are hard to distinguish from true emigration. These birds had mainly moved to new breeding areas in France and in the Netherlands. In addition, 6 Avocets were recovered in Denmark more than 30 km away from the ringing site.

The Danish Avocets follow a very narrow migration corridor, since almost all recoveries are entirely restricted to the Atlantic shores of Europe. The main winter quarters of Danish Avocets lie in northwestern and western France and at the Iberian peninsula mainly at near-shore areas of the European Atlantic coast, while the role of coastal areas in Africa as winter quarters has been more difficult to evaluate. The migration of the Danish Avocet is not solely restricted to the coast, as inland recoveries in France and Spain have been reported. Likewise, there have been recoveries from Italy, Southeastern France and Algeria, which show that these Avocets must have crossed land during their migration. Swedish, German and Dutch recoveries have also been reported from south-eastern France, Italy and Tunesia. These recoveries show that it is not unusual for Avocets of the north-western population to show overland passage to a limited extent. Lévêque (1971) confirms that Avocets frequently fly overland since Avocets are common visitors in Switzerland.

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