The northern and western Black Sea region - the Wadden Sea of the Mediterranean Flyway for wader populations

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This review summarises some of the available information, up to 1993, about wader populations using the Mediterranean flyway with special references to the northern and western Black Sea region, which have not been included in previous reviews. The paper presents data on the number and distribution of coastal breeding waders in south-east Europe and the pattern of their migration and winter distribution. For numerous migrant species their population size and migration habits are discussed. Further data on the numerical status of other migrants at the northern and western Black Sea coast were added to demonstrate the important role of this region as the main staging area of the Mediterranean flyway. Ringing results demonstrate the complicated overlaps between various flyway systems around the Black Sea. Data for other migrants, although rather incomplete, are included. The ecological differences of the Mediterranean flyway compared with other flyways of the western Palaearctic are discussed. The dramatic rate of wetland losses in the Mediterranean region has greatly reduced the number of stop-over sites and wintering areas available for waders and wildfowl. There is a clear need for reviews of the current state of knowledge, because only following this can focused research and conservation programmes be planned.

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В обзоре обобщена часть имеющихся данных, до 1993 года, о популяциях куликов, использующих Средиземноморский пролетный путь, при этом особое внимание уделяется Северному и Западному Причерноморью, которое не было включено в предыдущие обзоры. В настоящем сообщении представлены данные о численности и распространении прибрежных гнездящихся куликов в юго-восточной Европе и о характере их миграций и распределения зимовок. Для многочисленных перелетных видов приведено обсуждение о численности их популяций и о статусе их миграций. Были добавлены также данные о количественном статусе других перелетных птиц на северном и западном Черноморском побережье с целью продемонстрировать важную роль этого региона как главного места остановок на Средиземноморском пролетном пути. Возвратами окольцованных птиц показаны сложные частичные перекрытия между разными системами пролетных путей вокруг Черного моря. Включены данные для других перелетных птиц, несмотря на то, что они сравнительно неполны. Обсуждены экологические различия Средиземноморского пролетного пути по сравнению с другими путями Западной Палеарктики. Драматическая скорость потерь водно-болотных угодий в Средиземноморском регионе значительно сократила число мест остановок и зимовок, доступных куликам и водоплавающим. Очевидно, нужны обзоры современного состояния сведений, в следствии того, что только после этого можно будет планировать конкретные исследования и программы по охране природы.

Introduction

The Mediterranean Flyway, part of the wader flyway for the western Palaearctic, comprises the annual migration route of wader and wildfowl populations between their breeding quarters and the wintering grounds in the Mediterranean Basin and Africa, including all stop-over sites in between (Smit & Piersma 1989; Summers *et al.* 1987). Waders using the Mediterranean Flyway breed in the arctic and subarctic region of northern Europe and Siberia, in the temperate region and also along the Black and Mediterranean Seas.

A dramatic rate of wetland loss in the Mediterranean region has greatly reduced the number of stop-over sites and wintering areas available for waders and wildfowl. Van Vessem *et al.* (1992) showed an overall decline of 54% during the last 20 years for the most important waterfowl, calculated for the Mediterranean as a whole. The Mediterranean Flyway also has the highest percentage of endangered species of all the Palaearctic migration systems, indicating that flyway conservation plans should be prepared immediately. There is a clear need for reviews of the current state of knowledge, because only following this we can start to plan research and conservation programmes (Davidson *et al.* 1998).

In recent years, political changes in Eastern Europe have lead to better opportunities for internationally co-ordinated field work and an exchange of data and literature between East and West Europe. Hopefully, this co-operation will also encourage conservation initiatives for wetlands in south-east Europe. Therefore, our review will concentrate on the Black Sea region and its role in the Mediterranean Flyway system. For migrating waders we will define their numerical status at important resting sites of the northern and western Black Sea region and discuss their directions of migration. For the best known migrants we also give details of their winter distribution and for Mediterranean coastal breeders we present data on their breeding population size. In this way we hope to show how the pieces of the Mediterranean Flyway puzzle fit together between breeding and wintering grounds, and to identify the main gaps in our present knowledge.

The present level of knowledge

The present level of knowledge about population sizes and migration patterns of the Mediterranean Flyway is far less complete than that of the East Atlantic Flyway. The review by Smit (1986) was the first attempt to estimate the size of wintering wader populations in the Mediterranean. Further data on the winter wader distributions were given by Van Dijk *et al.* (1986) and Summers *et al.* (1987). Details of the size of breeding populations have been summarised by Tucker & Heath (1992) and Hagemeijer & Blair (1997). The rôle and the importance of stop-over sites has never been reviewed.

Since Smit's review (1986) a lot of research projects have yielded new information:

- data on the number of mediterranean breeding waders (*e.g.* Tinarelli & Baccetti 1989; Nankinov 1989; Korzyukov *et al.* 1991; Siochin *et al.* 1988);
- results of winter censuses in the Mediterranean Van Dijk *et al.* 1986; Dijksen & Blomert 1989; Baccetti *et al.* 1992);
- studies on the spring migration system (Meininger 1990; Van der Have *et al.* 1988);
- studies on spring and autumn migration in the northern and western Black Sea region (*e.g.* Uhlig 1984, 1989, 1991; Brehme *et al.* 1992);
- analysis of ringing results (*e.g.* Viksne & Mihelson 1985; Gromadzka 1989; Mullie *et al.* 1989).

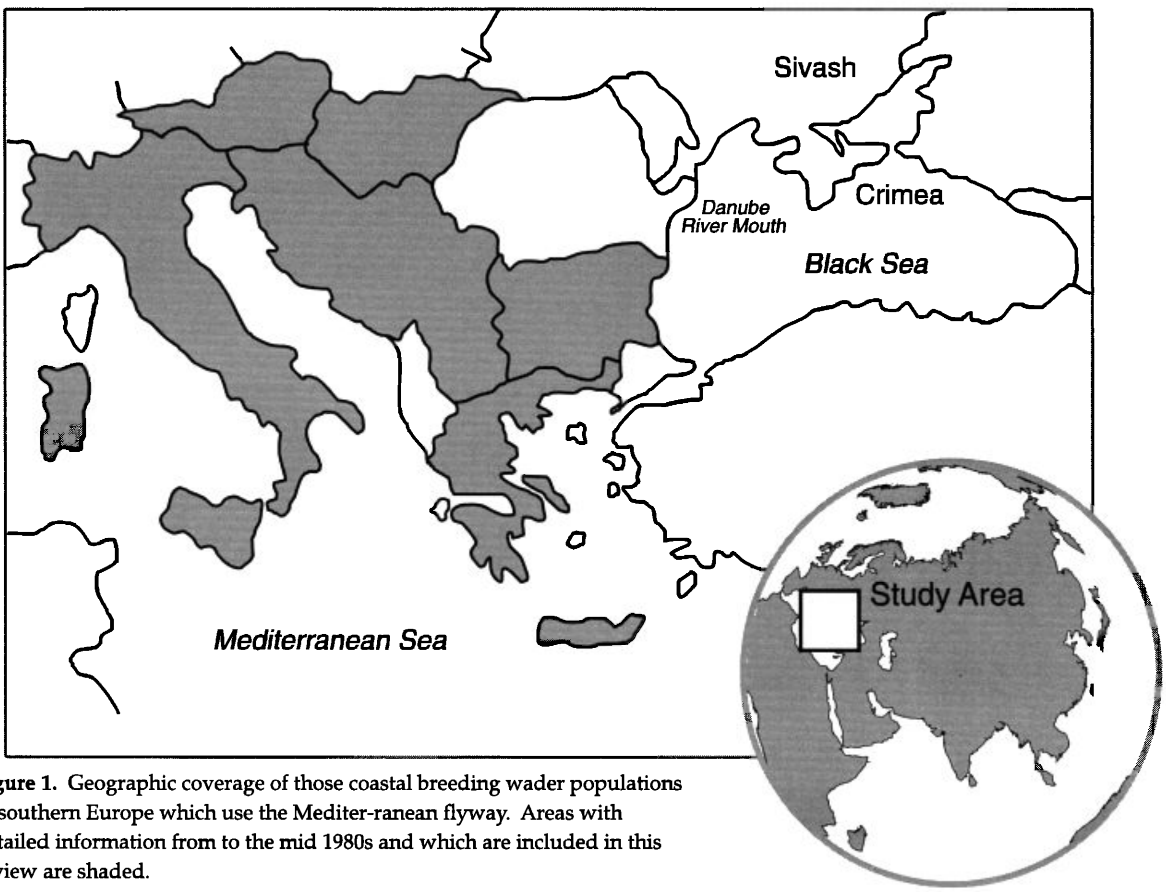


Figure 1. Geographic coverage of those coastal breeding wader populations in southern Europe which use the Mediter-ranean flyway. Areas with detailed information from to the mid 1980s and which are included in this review are shaded.

The amount of available data differs considerably between species. The best-known waders are the Mediterranean coastal breeding species, Redshank *Tringa totanus* and Black-tailed Godwit *Limosa limosa* as temperate breeders, which use the northern and western Black Sea region for their postnuptial moult. Dunlin *Calidris alpina* and Ruff *Philomachus pugnax* are the most numerous migrants, breeding in arctic and subarctic Siberia.

The northern and western Black Sea region as a habitat for migrating waders

The northern and western Black Sea region is one of the most important staging areas along the Mediterranean Flyway. More than one million waders stopover during spring and autumn each year. Of these, more than half use the huge lagoon systems of the Crimean Peninsula. The others are to be found at various sites on the western Black Sea coast.

The salinity of the Black Sea varies between 15-25 parts per thousand. Because of its small size tides do not occur in the Black Sea. Since there are no tidal mudflats, stop-over habitats for wader migrants are coastal lakes, salines, brackish lagoons and estuaries. The extent of shallow waters changes periodically. These changes are effected mostly by changes in wind direction, but also by rainfall and evaporation. Coastal shallow water areas of this type are called wind-tidal flats.

These wind-tidal flats mainly harbour typical marine invertebrates. Their number and species composition depend on the salinity, as does the mean body size of the polychaetes, molluscs and crustaceans (Remane & Schlieper 1958).

A census at the most important resting sites along the Black Sea coast represents nearly the total current stock of waders. The birds can be counted throughout the whole day rather than at only short periods of suitable tidal state in large intertidal areas. The accuracy of counts will, however, be affected by flock movements in between large lagoon systems, induced by changes in wind direction or speed.

Population size, winter distribution and timing of moult and migration of Mediterranean coastal breeding waders

Oystercatcher *Haematopus ostralegus*

Oystercatchers breeding in south-east Europe belong to the subspecies *H. o. longipes*. Italian breeders are possibly part of the nominate race *H. o. ostralegus* (Glutz von Blotzheim 1976; P. Meininger pers. comm.). Both subspecies of Oystercatchers breed inland in Belorussia (Nikiforov 1998). The number of coastal breeding Oystercatchers in the Ukraine represents only a small part of the *H. o. longipes* population using the Mediterranean Flyway: most of them breed inland. The few existing ringing recoveries suggest a breeding range from the upper Volga River onwards (Viksne & Mihelson 1985). The population size can be estimated at between 6,000 - 7,000 birds (Table 1, Figure 2). There is close correspondence between the estimate of the wintering population in the Mediterranean and the number of birds on spring passage on the Black Sea coast (Tables 2 and 5, Figures 3 and 4).

Oystercatchers leave their wintering grounds in Tunisia in late March. When they arrive at the

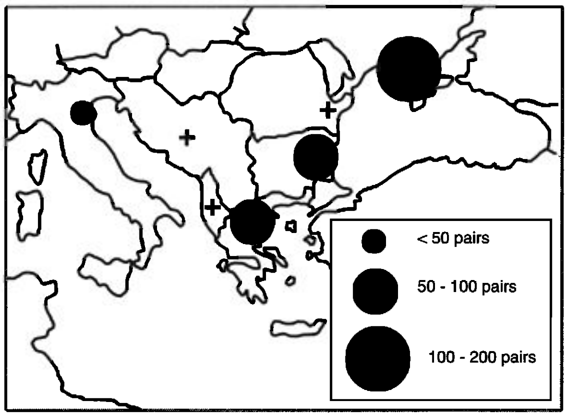


Figure 2. Breeding distribution of Oystercatchers *Haematopus ostralegus* in south-east Europe (total number of pairs 300-450).

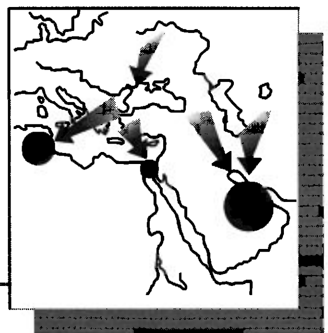


Figure 3 *(right)*. Autumn migration and winter distribution of Oystercatchers *Haematopus ostralegus longipes* between eastern Mediterranean (Tunisia: 5,000, Egypt: 500-1,000) and the Persian Gulf (10,000-15,000).

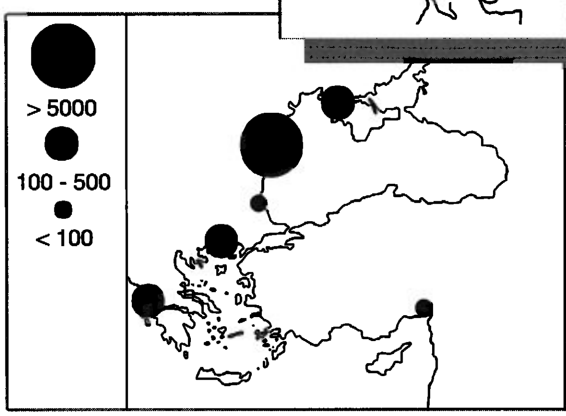


Figure 4. Distribution of Oystercatchers *Haematopus ostralegus longipes* during spring migration in late March/ early April in south-east Europe.

Danube mouth, they seem to stop for only a few days. The shoreline of the Danube mouth is probably the most important stop-over site for East European Oystercatchers between their breeding and wintering quarters. Large concentrations of several hundred birds have also been observed on the islands of the Black Sea reserve in early April (Rudenko 1998; Ardamatskaya pers. comm.). There are no observations of visible migration along the coastline of the Black Sea. Thus, a direct passage across the Balkan Peninsula seems to be likely (*e.g.* Nankinov 1989).

Up to 500 Oystercatchers occur at the Danube Mouth in mid-August (Brehme *et al.* 1992). However, nearly the total flyway population was observed there in early spring 1991. This variation between years is probably a result of differences in the available food supply between the seasons. In autumn Oystercatchers, together with thousands of Mediterranean *Larus melanocephalus* and Black-headed Gulls *Larus ridibundus*, were seen using a flush of large gammarids. On spring passage they had fed on large amounts of dead bivalves (*Mytilus galloprovincialis, Mya arenaria*) on the beach (Kube unpublished). Important sublittoral bivalve beds of both these species occur only in the flat north-western part of the Black Sea (see Caspers 1951 for details of benthos distribution and main current directions in the Black Sea).

Avocet *Recurvirostra avosetta*

Avocets breed on the coast of the Mediterranean and the Black Sea as well as inland in Romania, Bulgaria, Austria and Hungary. After a big increase in the mid 1970s the population has decreased slightly in recent years. The number of breeding pairs is about 6,700-10,000 pairs (Table 1, Figure 5). Another 1,000-2,000 pairs may breed in Turkey (Cramp & Simmons 1983, Grimmett & Jones 1989). Taking into account that there must also be non-breeding birds, this figure corresponds rather well with that from the wintering grounds in the Mediterranean (Table 2, Figure 7).

The autumn migration of south-east European Avocets starts in late July. Three important moulting sites harbour nearly the whole Pannonian population (Table 5, Figure 6). More than 2,000 birds also moult in Italy, in two Adriatic wetlands (Comacchio-Cervia area and Margherita di Savoia saltplans, R. Tinarelli pers. comm.).

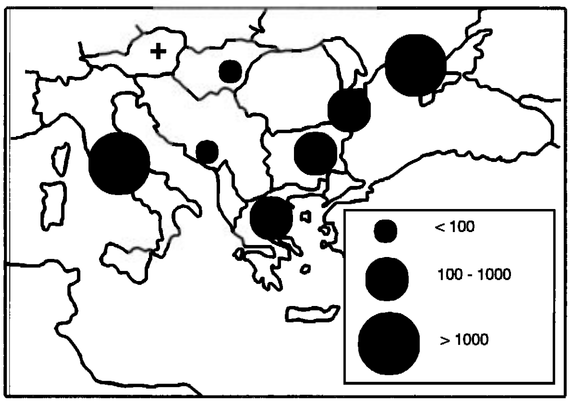
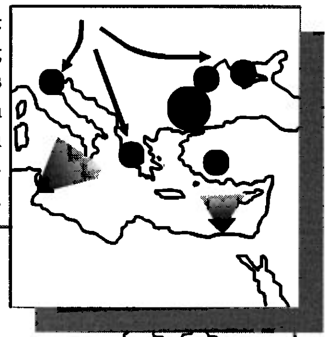


Figure 5. Breeding distribution of Avocets *Recurvirostra avosetta* in south-east Europe (total number of pairs 6,700-10,000).

Figure 6 ***(opposite).*** Moult migration and moulting sites of Avocets *Recurvirostra avosetta* in south-east Europe (small dots: > 1,000, large dot: > 10,000).



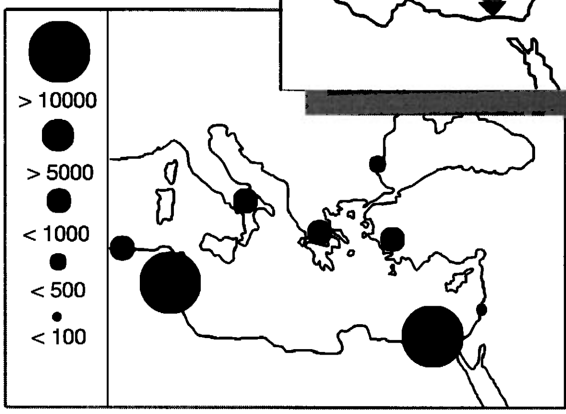


Figure 7. Winter distribution of Avocets *Recurvirostra avosetta* in the eastern Mediterranean (total number 35,000-45,000).

Later in the season the birds migrate southward along the coastline to concentrate in October in very large numbers at Lake Atanasov, where up to 47,500 were seen in the mid 1970s (Siochin *et al.* 1988; Nankinov 1989). Avocets from Turkey seem to moult inland (Grimmett & Jones 1989).

Most of the 35,000-45,000 birds winter on coastal wetlands and inland salt lakes in Tunisia and Egypt. Their winter numbers can vary markedly between years. Ringing recoveries indicate that the Italian and Tunisian winter quarters function as meeting points with the West European population (Glutz von Blotzheim 1977; Viksne & Mihelson 1985; Siochin *et al.* 1988).

Most Avocets probably migrate directly to their breeding colonies in spring, where they arrive in late March/early April. A lot of stop-over sites are known in south-east Europe, each holding 1,000-2,000 birds and larger concentrations are unusual. The enormous numbers at Lake Atanasov in April in some years might be a result of migration delay.

Black-winged Stilt *Himantopus himantopus*

The south-east European population of Black-winged Stilts consists of 3,500-4,700 pairs, breeding mainly at coastal wetlands with a few inland (Table 1, Figure 8). Their number has been decreasing over the last decade. The increasing destruction of natural habitats and disturbance at the breeding sites are considered to be the main causes of their disappearance. The increasing colonization of anthropogenic habitats (salines, rice fields, ponds) might compensate locally for habitat loss (Uhlig 1990; Kube & Grube 1992).

A minimum of another 2,000 pairs breed in Turkey and the southern Mediterrranean (Cramp & Simmons 1983).

The studies of Tinarelli (1990) suggest that the Black-winged Stilts breeding in Italy belong to the West European population. Their population dynamics are similar to those from France (showing a strong decrease in 1984 and then a rather stable situation in the following years). Tinarelli also demonstrated movements of breeding birds between the Adriatic coast of Italy and the Atlantic coast of France. Knowledge of the migration of the Black-winged Stilt is still quite poor. As for the East Atlantic Flyway, the estimates of the number of wintering birds in the eastern Mediterranean yield highly unreliable figures regarding population size. The total number found is about 2,000 birds (Table 2, Figure 10). Large concentrations winter at Lake Chad, the rivers Niger and Nile and in East Africa (Smit & Piersma 1989; Summers *et al.* 1987; Nikolaus 1987): these are possibly part of the Mediterranean Flyway population (Figure 9). New data of wintering counts were presented by Perennou (1991), OAG Münster (1991) and Tinarelli (1998), but no recoveries have been published that would prove this theory. Tinarelli (1990) presented a few winter recoveries for the East Atlantic Flyway population: these birds were found at the rivers Senegal and Niger and also in Tunisia.

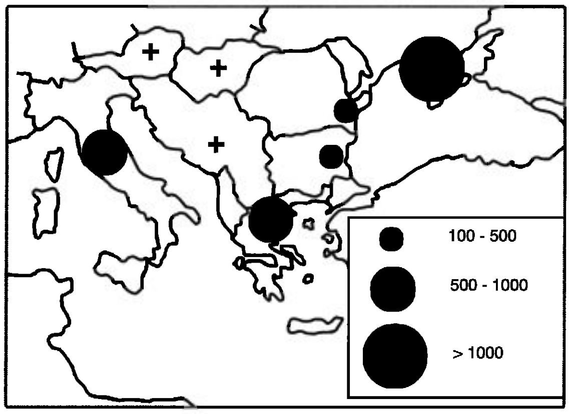


Figure 8. Breeding distribution of Black-winged Stilts *Himantopus himantopus* in south-east Europe (total number of pairs 3,500-4,700).

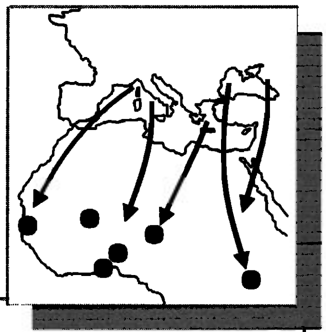


Figure 9. Possible scheme of autumn migration and winter distribution of south-east European Black-winged Stilts *Himantopus himantopus.*

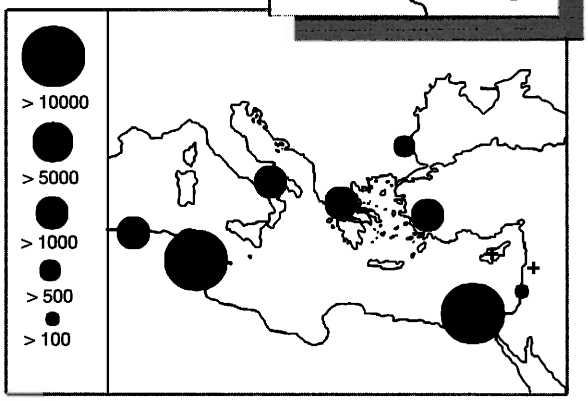


Figure 10. Winter distribution of Black-winged Stilts *Himantopus himantopus* in the eastern Mediterranean (total number 1,000-2,000).

During autumn migration, flocks of 100-500 birds are to be found at a lot of stop-over sites in Greece, Turkey and on the Black Sea coast. In comparison, the spring migration in April/May is much more inconspicuous (Grimmett & Jones 1989; Meininger 1990; Van der Have 1988).

Kentish Plover *Charadrius alexandrinus*

The number of breeding Kentish Plovers in south-east Europe can be estimated as between 5,500 - 7,500 pairs. Half of them breed in the Ukraine (Table 1, Figure 11). Little is known of the population size in Turkey and north Africa, which is rather large (*e.g.* Cramp & Simmons 1983). This might explain the discrepancy between the size of the south-east European population and the estimate of 60,000 - 80,000 birds present during winter in the Mediterranean Basin (Table 2, Figure 13). The frequency distribution of wing lengths of Kentish Plovers captured in Tunisia, which is double-peaked, suggests that two different populations winter there (Van Dijk *et al.* 1986).

Taking into account the foreign recoveries of Kentish Plovers captured during the breeding season on the Crimean Peninsula, the scheme of winter distribution becomes rather complicated (Figure 12). These recoveries describe a wintering range for south-east European birds from the Niger innudation zone southwards (Siochin *et al.* 1988). The small numbers that have been found in Nigeria and Chad perhaps belonging to this population (Cramp & Simmons 1983; Summers *et al.* 1987).

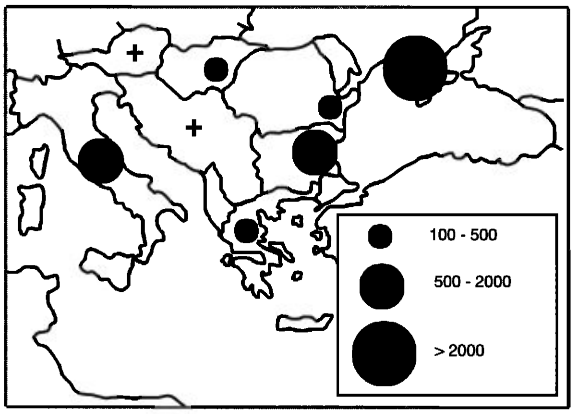


Figure 11. Breeding distribution of Kentish Plovers *Charadrius alexandrinus* in south-east Europe (total number of pairs 5,500-7,500).

Kentish Plovers from the northern and western Black Sea region start their autumn migration in late July/early August, forming moulting flocks of several hundred individuals at the main breeding grounds (Brehme *et al.* 1992; Siochin *et al.* 1988).

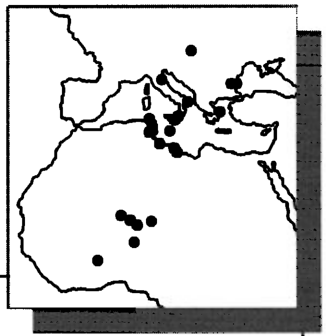


Figure 12. Ringing recoveries of Kentish Plovers *Charadrius alexandrinus* ringed on the Crimean Peninsula during the breeding season (from SIOCHIN *et al.* 1988).

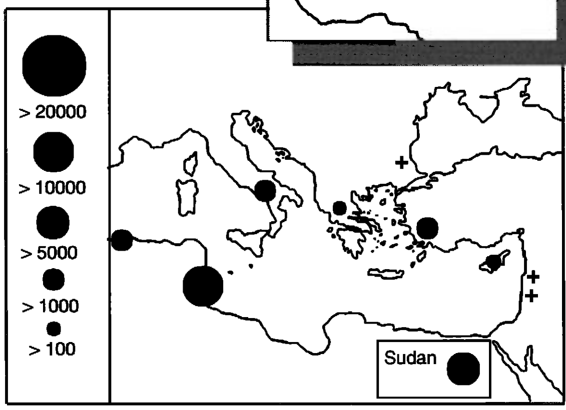


Figure 13. Winter distribution of Kentish Plovers *Charadrius alexandrinus* in the eastern Mediterranean (total number 60,000-80,000).

Moulting flocks of similar size are also found in Italy (R. Tinarelli pers. comm.), and they leave these areas in September/October (Roberts 1980).

The concentrations of migrants are even smaller during spring passage.

Collared Pratincole *Glareola pratincola*

The Collared Pratincole is one of the most endangered breeding species in south-east Europe. Recent estimates are of 1,650-2,700 pairs breeding in the area covered by this paper (with an additional several hundred pairs possibly breeding in Turkey (Table 1, Figure 14, Cramp & Simmons 1983; Grimmett & Jones 1989; Hagemeijer & Blair 1997). Large colonies occur in the Ukraine and in Greece. In other countries now only a few breeding sites are regularly occupied. The number of breeding pairs has decreased dramatically during this century, with the loss of steppe areas and salt marshes being the main reasons for this population decline (Uhlig 1989; Nadler 1990).

South-east European Pratincoles leave the breeding grounds after moult in late July and August. Small flocks of up to 100-200 individuals occur at various coastal wetlands at the Black Sea coast, although most birds migrate non-stop along the western coastline to the resting sites around the Aegean Sea (*e.g.* Nankinov 1989; Siochin *et al.* 1988). Two areas harbour more than a thousand birds: the Axios-Aliakmonas Delta in north-east Greece and the Amik-Goelue/Hatai in west Turkey (Glutz von Blotzheim 1977; Kube unpublished). They stay there until late September.

Because of its small population size, little is known about the winter distribution of eastern European

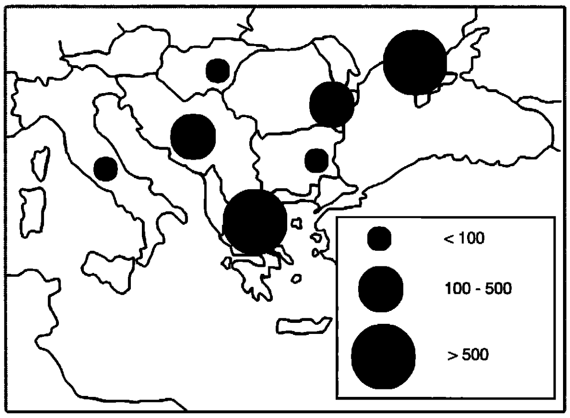


Figure 14. Breeding distribution of Collared Pratincoles *Glareola pratincola* in south-east Europe (total number of pairs 1,650-2,700).

Collared Pratincoles. In September, when they arrive at the wintering grounds, they are known to occur in mixed flocks with two other subspecies (*G. p. limbata, G. p. fuelleborni*), from which they cannot be distinguished in the field (Nikolaus 1987). Another part of this population may migrate via the Maghreb region, wintering at Lake Chad or in Mali and Nigeria (Glutz von Blotzheim 1977).

The spring passage starts in late March with maximum numbers in the second half of April in the Mediterranean (Van der Have 1988; Meininger 1990) and in early May in the Black Sea. Collared Pratincoles, like other Mediterranean coastal waders, mainly migrate directly to their breeding grounds (Siochin *et al.* 1988).

Population size and migration pattern of other waders

Dunlin *Calidris alpina alpina*

In contrast to the East Atlantic Flyway there is only one subspecies of Dunlin using the Mediterranean Flyway: *Calidris a. alpina*. However, the picture of migratory patterns is still far from clear, as more than one northern Dunlin population exists (Meltofte 1991). Recent publications and intensified ringing activities in the Baltic, Mediterranean and Black Sea have yielded much new information on this problem (*e.g.* Stiefel & Scheufler 1989).

It is not our main intention to describe differences in the breeding ranges of various migratory populations, but we hope to provoke a more detailed analysis of ringing results by suggesting different migratory populations wintering in the eastern Mediterranean (see Figures 15 and 16).

a) East Atlantic Flyway migration system

About 1.1-1.3 million *C. a. alpina* use the East Atlantic Flyway (Smit & Piersma 1989), while migrating via northern and southern Scandinavia to the Wadden Sea and the Wash, where they moult (*e.g.* Brenning 1989; Rösner 1990). After moult, the birds move to wintering grounds in western Europe. Most of them winter in the British Isles and France. A few also occur in the western part of the

Table 1. Number of breeding waders in south-east Europe.

species	Austria[1]	Hungary[2]	Italy[3]	former Yugoslavia[4]	Greece[5]	Bulgaria[6]	Romania[7]	Ukraine coastal)[8]
Haematopus ostralegus	-	-	20-25	6	(50-100)	60-90	+	150-200
Recurvirostra avosetta	50-80	200	1,200-1,300	25-40	300-500	760-2,200	100-200	4,000-5,000
Himantopus himantopus	+	25-30	933-1,091	50	700-1,000	100-200	100-200	1,500-2,000
Charadrius alexandrinus	10	60-80	1,520-2,000	44-71	(>>100)	200-400	200-300	3,000-4,000
Hoplopterus spinosus	-	-	-	-	10-30	-	-	-
Tringa totanus	85-100	400-500	390-720	67-82	(>>100)	50-150	50-100	1,000-2,000
Glareola pratincola	-	30-50	30-90	0-150	900-1,100	50-100	100-200	500-1,000
Glareola nordmanni	-	(+)	-	-	-	(+)	(+)	50-100

1 Piersma (1986)
2 Piersma (1986); Grimmett & Jones (1989); Szekely (1991)
3 Tinarelli & Baccetti (1989)
4 Bartovsky *et al.* (1987)
5 Glutz von Blotzheim (1975, 1977); Cramp & Simmons (1983); Scott (1980); Grimmett & Jones (1989); Meininger (1990); WIWO (1990)
6 Nankinov (1989); Uhlig (1989, 1990); Kube & Grube (1992)
7 Glutz von Blotzheim (1975, 1977); Weber & Szabo (1985); Brehme *et al.* (1992); Uhlig (1989, 1990a)
8 Siochin *et al.* (1988); Korzyukov *et al.* (1991); Chernichko *et al.* (1991)

Table 2. Number of wintering waders in the Eastern Mediterranean and the Red Sea. For Romania and the Ukraine no numbers available.

species	Algeria	Tunisia	Italy	Greece[4]	Bulgaria[3,1]	Turkey	Syria[1]	Israel[1]	Cyprus[1]	Egypt	Sudan
Haematopus ostralegus	+	5,000	10	120	-	30-40	-	-	-	500-1,000	10-100
Recurvirostra avosetta	1,800	10,000-15,000	2,000 (65162)	3,800	400-800	1,300	30	370	10	10,000-20,000	-
Himantopus himantopus	50-3008	900-1,300	10-608	-	-	-	-	610	-	20-100	?
Charadrius alexandrinus	1,600	21,300	2,300	250	10	1,000-1,500	40	20	300	26,000-43,000	3,000-8,000
Calidris alpina	2,900	150,000-200,000	16,000 (41,3862)	8,000-10,000	100-500	1,000-3,000	40	60	100	30,000-100,000	8,000-16,000
Tringa totanus	180	40,000	3,400	2,600	100-1,000	1,000-2,000	20	610	300	8,000-17,000	2,000-3,000
Limosa limosa	580	3,500	2,600	+	300	-	160	-	200	15,000-30,000	15,000-30,000

1 Van Dijk *et al.* (1986)
2 Baccetti *et al.* (1992) for Adriatic wetlands only
3 Nankinov (1989)
4 Roberts (1980)
5 Dijksen & Blomert (1989)
6 Summers *et al.* (1987)
7 Nikolaus (1987)
8 Tinarelli (1987) for the Maghreb region

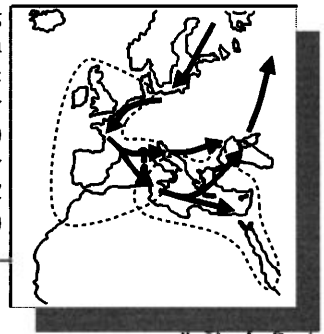
Mediterranean.

b) Mediterranean Flyway migration system
The total number of northern Dunlins migrating from west Siberia on an inland route to the Mediterranean via the Black Sea is a minimum of 0.2 million birds (data combined from Van Dijk *et al.* 1986 and Table 5). Their most important stopover site in both seasons is the Gulf of Sivash on the Crimean Peninsula (Chernichko *et al.* 1991). This area seems to function in a similar ecological manner to the Wadden Sea for west European Dunlins. Tunisia and Egypt are the main wintering grounds for this population (I. Chernichko & J. Gromadzka pers. comm., Table 3).

c) Loop migration system
A part of the northern Dunlin population seems to perform a loop migration. Similar migratory strategies have been described for other sandpipers

also, *e.g.* Curlew Sandpiper *Calidris ferruginea* (Wilson *et al.* 1980). Such birds migrate in autumn via the southern Baltic and inland to southern France and Italy. They winter in the eastern

Figure 15. Wintering grounds of Dunlin *Calidris a. alpina*:
A - East Atlantic flyway (1.1-1.3 m.)
B - Mediterranean flyway
C - loop migration (B+C 0.2-0.3 m.)



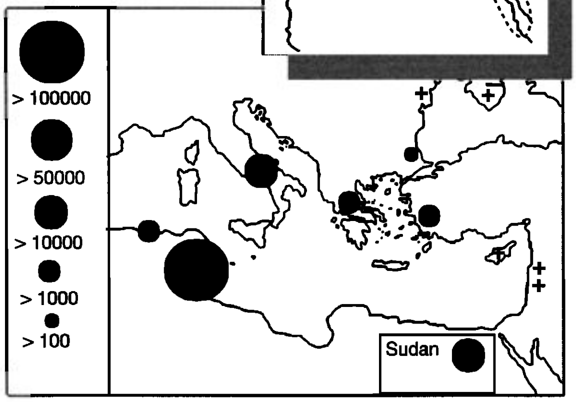


Figure 16. Winter distribution of Dunlin Calidris alpina in the eastern Mediterranean (total number 250,000-300,000).

Mediterranean and pass back to their breeding grounds via the Black Sea. Several lines of evidence suggest the existence of this loop migration scheme:

- there are more reports of Dunlins ringed or recovered during autumn in the southern Baltic and western (excluding north-western) Europe that have been also ringed or recaptured during spring in the Black Sea, than there are reports of ringed Dunlins occurring in the Black Sea in both spring and autumn (Gromadzka 1989 and pers. comm.).

- there are increasing numbers of Dunlin during the winter season at Mediterranean resting sites (*e.g.* Van Dijk *et al.* 1986).

- larger concentrations of Dunlin occur in the northern and western Black Sea region in spring than in autumn (see examples in Table 5).

d) East European Flyway migration system
An increasing number of direct recoveries between the Baltic and the Black Sea or Egypt in the same autumn suggests also an eastward migration of northern Dunlin (J. Gromadzka & P. Meininger pers. comm.). This suggests that a separate population exists which migrates directly to the south-east such as for Scandinavian wader populations (see below). Alternatively a small number of Dunlin could annually migrate together with wader species using an East European Flyway (Dittberner & Dittberner 1982).

e) Exchange between flyways
Recoveries of Dunlin ringed in their first autumn along the East Atlantic or the Mediterranean flyways and reported in later years in autumn on the other may be either overlap between the two flyways or an exchange of birds between the two flyways as a consequence of mixing on their winter quarters in the mid-Mediterranean (Viksne & Mihelson 1985; Gromadzka 1989).

Ruff *Philomachus pugnax*

Ruffs are the most abundant wader migrants in south-east Europe. More than 0.5 million birds rest during the peak of spring passage in mid-April, spread over the whole region. Whilst most birds rest and feed on flooded meadows and agricultural fields inland, small numbers can also be seen feeding on dead mussels on the beach (*e.g.* Meininger 1990; Kube unpublished). The steppe areas in Hungary, southern Ukraine and in the Dobrodgea (Romania) harbour the largest concentrations (Table 3, Figure 18). A maximum of only 20,000-30,000 Ruffs are seen at any one time on spring migration in Italy (Serra & Baccetti 1992). Insights into the origins of the huge number of birds in this region in spring come from an OAG Münster dye-marking project carried out during three winter periods in Senegal. Dye-marked Ruff were resighted in spring on average 4,366 km away from the ringing site. The distribution of sightings and negative records at other sites indicate that Ruff wintering in Senegal fly non-stop to west and central Europe (OAG Münster 1989).

If a 4,000 km Great Circle model for the first stop-over is useful as a general rule for birds from other important wintering sites in Africa in Mali, Nigeria, Chad and Sudan, a wide range of overlaps between these circles can be found in south-east Europe and should result in the occurence there of large numbers of passage Ruff (Figure 17). But the idea of long distance spring migration by Ruff does not fit well for birds using East African wintering sites, since these birds have low spring departure weights (Pearson 1981).

OAG Münster tried to demonstrate their model for the Mediterranean Flyway by colour-marking wintering Ruffs at Lake Chad and then undertaking a spring census at the western Black Sea coast. Out of 250,000-350,000 wintering Ruff in the northern Cameroon, 105 birds were dye-marked, but none were resighted elsewhere that spring (OAG Münster 1991).

So the spring migration system of Ruff along the Mediterranean Flyway is still somewhat obscure. Nothing is known about turnover rates in Tunisia and in south-east Europe. Actual figures of the number of Ruff wintering in North Africa, which are known to have strongly decreased in the last decades, are not available (although there are a few new data from Perennou (1991) and Tinarelli (1998)). The extent of movements between the main winter quarters is also obscure (*e.g.* Scheufler & Stiefel 1985; Nikolaus 1987).

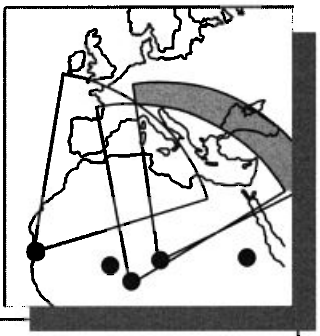


Figure 17. The 4,000 km circle as the range of first stop over for Ruffs *Philomachus pugnax* during spring migration from various important wintering grounds, See the overlap in south-east Europe (changed from OAG Münster 1989).

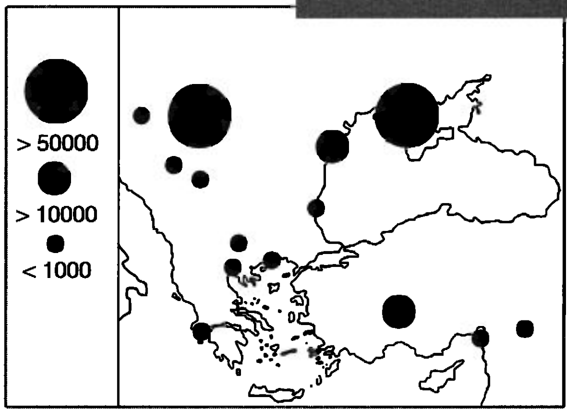


Figure 18. Distribution of Ruffs *Philomachus pugnax* during spring migration in April in south-east Europe (the dot for the Crimean Peninsula means 250,000-500,000 birds at two sites, the Black Sea Nature Reserve and the Sivash).

Table 3. Number of Ruffs during spring and autumn migration at some important resting sites in south-east Europe.

area	number in spring	number in autumn	source
Hortobagyi-Puszta	50,000-200,000	1,000-10,000	OAG Münster (1989), Van Impe (1989)
Gulf of Sivash	150,000-250,000	20,000-30,000	Chernichko *et al.* (1991)
Danube mouth and Dobrodgea	20,000- 30,000	10,000-20,000	Van Impe (1977), Brehme *et al.* (1992)

South-east Europe is also an important moulting area in late summer, but the numbers present during this period are even smaller.

Redshank *Tringa totanus*

The total of 2,500-4,000 pairs of Redshank breeding in the area covered by this paper in south-east Europe represents only a quarter of the estimate for the east European population of 60,000 - 70,000 birds (Table 2, Figures 1 and 21). The main part of the population breeds in mostly temperate inland habitats. The western border of its breeding range is located in the southern Baltic, where westward migrants also breed (Stiefel & Scheufler 1983). Redshanks breeding further north tend to use the East Atlantic Flyway, but a few birds from Scandinavia migrate in a southeast direction to the Arabian Peninsula (Hale 1973; Viksne & Mihelson 1985).

Redshanks also breed in Turkey and Tunisia but population sizes are unknown (Cramp & Simmons 1983; Grimmett & Jones 1989).

After the breeding season nearly all east European Redshanks moult on the northern and western Black Sea coast before migrating further south to the winter quarters between Tunisia and the Persian Gulf (Table 5, Figure 20). There are also important moulting sites on the Adriatic coast of Italy, but no estimates are available (Tinarelli pers. comm.).

Since the estimate of wintering Redshanks in the eastern Mediterranean is similar to the maximum estimate for just the moulting birds in south-east Europe in late July and August, a more realistic wintering estimate must be higher. The recent estimate does not, however, include the Redshanks wintering on the Arabian Peninsula and does not allow for any turnover at moulting sites.

The spring migration system of Redshanks shows further overlaps in the migration routes of different European populations. More than 100,000 birds had been observed in Tunisian intertidal areas at this time of the year (Van der Have pers. comm.). These Redshanks are perhaps north and central European breeders wintering in West Africa, which are migrating back on a trans-Saharan route via the mid-Mediterranean (Wymenga *et al.* 1990; Smit & Piersma 1989).

In the northern and western Black Sea region the concentrations of Redshank are smaller in spring than in autumn. Largest numbers were found during a census in spring 1991 at the Romanian Danube Delta (Brehme *et al.* 1992). A maximum of 10,000 birds was counted along the coastline, feeding, like Oystercatcher and Ruff, on dead mussels.

Black-tailed Godwit *Limosa limosa*

It is not known how many Black-tailed Godwits use

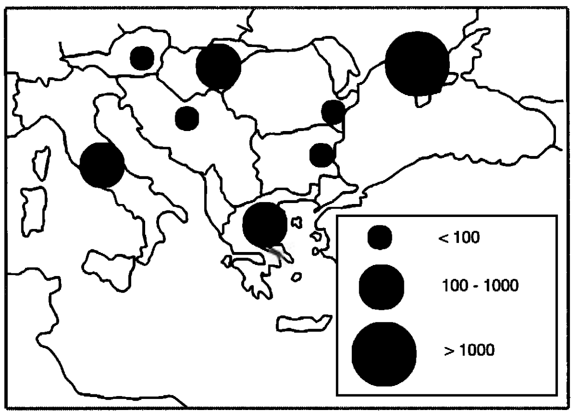


Figure 19. Breeding distribution of Redshank *Tringa totanus* in south-east Europe (total number of pairs 2,500-4,000).

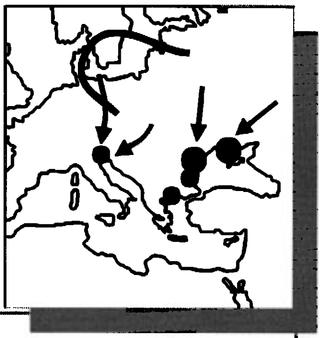


Figure 20. Moult migration and moulting site of east European Redshanks *Tringa totanus* using the Mediterranean flyway (the distribution range is illustrated by the thick line, small dots: 1,000-5,000, large dots: 10,000-30,000).

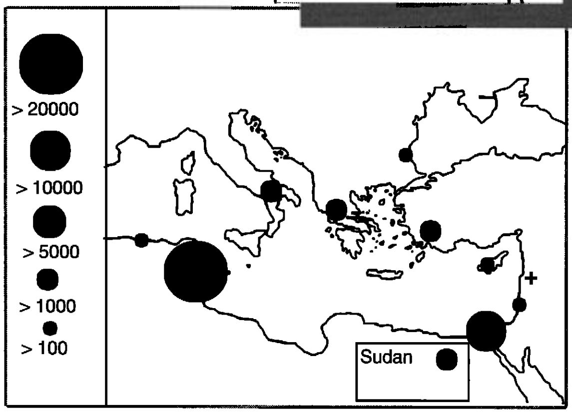


Figure 21. Winter distribution of Redshanks *Tringa totanus* in the eastern Mediterranean (total number 60,000-70,000).

the Mediterranean Flyway. This species breeds northwards from Hungary and southern Ukraine. Estimates for the number of breeding pairs in East Europe are not available nor are winter totals. A varying number of only 5,000-10,000 birds, depending on weather conditions, winter in the eastern Mediterranean (Table 2). The majority of east European Godwits winter in West African inland sites in the Niger innundation zone (more than 100,000 in the 1940s) and around Lake Chad (Glutz von Blotzheim 1977; Beintema & Drost 1986; Figure 22). No representative counts have been undertaken there recently, but some data are given by Perennou (1991), OAG Münster (1991) and Tinarelli (1998). Alternatively it may be possible that East European Godwits are also to be found among the 15,000-30,000 birds wintering in Sudan (Summers *et al.* 1987; Nikolaus 1987).
The maximum simultaneous count of Black-tailed Godwits on spring passage in south-east Europe, gives a minimum population size of about 50,000 birds. This figure does not include about 5,000 birds which rest in Italian wetlands on spring passage (Serra & Baccetti 1992). Black-tailed Godwit prefer to use the same resting sites as Ruff (Table 4, Figure 23). Perhaps they also migrate non-stop to these sites because there are no important stopovers known in the southern Mediterranean.

The northern and western Black Sea region is an important moulting site for Black-tailed Godwit in July and August. In contrast to the spring passage, the birds in autumn also rest in small flocks on inner mudflats in the Danube Delta, including around Lake Razelm-Sinoe (Brehme *et al.* 1992).

Which species use a Mediterranean flyway

The flyway concept can be adequately used to describe the movements of specific populations of a single species or to describe an amalgamation of migratory routes of a group of species. Thus the overall East Atlantic and the East African Flyway consist of a combination of the separate flyways of all wader populations that use routes along the shores and involve coastal species resting in tidal areas (Piersma *et al.* 1987; Summers *et al.* 1987). Waders migrating and wintering in freshwater habitats were often excluded from such reviews and integrations because of the large gaps in knowledge of their migration patterns (Smit & Piersma 1989).

In contrast, on the Mediterranean Flyway, which lies between these two coastal routes, birds use mainly non-tidal and freshwater wetlands. There is no species, however, which could be designated as either a typical coastal or a typical inland wader: most are to be found in both habitat types.

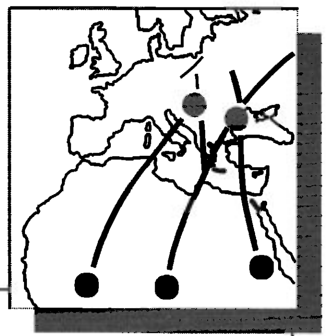


Figure 22. Moult and autumn migration of Black-tailed Godwits *Limosa limosa* using the Mediterranean flyway (shaded dots: main moulting sites, black dots: main wintering grounds (changed after Glutz von Blotzheim 1977; Beintema & Drost 1986).

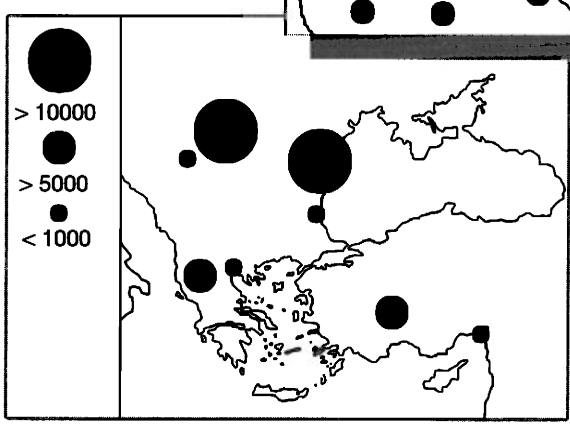


Figure 23. Distribution of Black-tailed Godwits *Limosa limosa* during spring migration in late March/early April in south-east Europe.

Therefore, we do not like to neglect any group of waders in our review. Numbers of each migrant species on spring and autumn passage in the most important resting sites of the three countries involved in the northern and western Black Sea region are given in Table 5.

There are some large differences in species composition between sites, probably as a result of differences in habitat composition. Whereas *Calidris* species prefer to use huge lagoon systems on the Crimean Peninsula, most *Tringa* species rest in the inner Danube Delta.
Differences are also a consequence of the wide range of overlap between the three western

Palaearctic flyway systems (Figure 24). The idea of an intermediate flyway between the East Atlantic and the East African Flyway is a useful concept for most of the temperate and Mediterranean breeding species discussed in this chapter and for Slender-billed Curlew *Numenius tenuirostris* which could be defined as the symbol of this flyway (Nankinov 1991; Gretton 1991). But it is difficult to apply to subarctic and arctic breeding waterfowl and waders because an intermediate third flyway often cannot be defined on the basis of present data (Creutz 1976).

Table 4. Number of Black-tailed Godwits during spring and autum migration at the most important resting sites in south-east Europe.

area	spring	autumn	source
Hortobagyi-Puszta	10,000-30,000	6,000-10,000	Grimmett & Jones (1989), Van Impe (1989)
Gulf of Sivash	(100-120)	1,800-2,000	Chernichko *et al.* (1991)
Danube Delta and Dobrodgea	10,000-15,000	10,000-15,000	Van Impe (1977), Brehme *et al.* (1992)
Burgas Bay	1,000-2,000	500-1,000	Nankinov (1989), Roberts (1980)

Some wader species, however, challenge the flyway concept by migrating almost perpendicular to the migration direction of most other species. Such an eastward migration is well known for various freshwater waders migrating inland and for Scandinavian Broad-billed Sandpipers *Limicola falcinellus* and Red-necked Phalaropes *Phalaropus lobatus*. Both winter around the Arabian Sea (*e.g.* Schiemann 1989). Analysis of the numbers of migrants at the most important resting sites along the northern and western Black Sea coast, compared with numbers of wintering waders in the Mediterranean and the Persian Gulf (Van Dijk *et al.* 1986; Behrouzi-Rad 1991; Zwarts [Figure 22, 23]. 1991; Summers *et al.* 1987) and ringing results, indicate a similar migration scheme for other coastal species migrating via the Black Sea, such as: Turnstone *Arenaria interpres*, Grey Plover *Pluvialis squatarola*, Bar-tailed Godwit *Limosa lapponica* and Whimbrel *Numenius phaeopus* (Uhlig 1990d).

For ten of the 24 wader species discussed, Viksne & Mihelson (1985) present ringing recoveries along a south-eastern migration route. The origin of the East European Flyway (Figure 24) is still obscure. Perhaps it was initiated by climatic and geological processes during previous glacial periods. It seems to be possible that Scandinavia and Taimyr were recolonized after this period by populations from various refuge areas with different migration routes (Ploeger 1968; McClure 1974). Such speculation can only be proved, however, by molecular genetic studies.

The northern and western Black Sea region - the Wadden Sea of the Mediterranean Flyway ?

The Wadden Sea is the hub of the East Atlantic Flyway. Almost all waders with Nearctic, Palaearctic or temperate breeding origins that use this migration route, stage one or two times per year in the Wadden Sea (*e.g.* Prokosch 1988). On spring passage they stop there for premigratory fattening before flying to their breeding grounds whilst a lot of species spend the period of moulting in this region during autumn migration (Piersma *et al.* 1987). The Wadden Sea is also the most important breeding area for temperate coastal waders along the East Atlantic Flyway (Piersma 1986).

All these features can be found also in the northern and western Black Sea region for waders using the Mediterranean Flyway. The only important difference is the kind of feeding habitat. Whereas in intertidal areas of the Wadden Sea, with its well defined tidal changes of water level, the available food supply will be limited mainly by cold temperatures during winter (Pienkowski 1983; Esselink & Zwarts 1989), the availability of prey in the lagoons of the Black Sea depends mainly on irregular water level changes caused by wind. Thus, tidal mudflats allow much higher densities of feeding waders per area than do windflats. This circumstance might be an important factor to explain the smaller size of wader populations using the Mediterranean Flyway in contrast to those using both flyways (Smit & Piersma 1989; Summers *et al.* 1987; Zwarts *et al.* 1991).

Gaps in knowledge

We have indicated some important gaps in present knowledge. These gaps are sometimes larger than those of the East Atlantic Flyway (Smit & Piersma 1989). If we wish to have a more detailed view of the wader migration system in the Eastern Mediterranean region, which is necessary for more successful conservation of the populations using it, we have to encourage research on the following topics :

- breeding range and population size of Siberian arctic waders using the Mediterranean Flyway;
- population size of coastal breeding waders in Turkey and in the Eastern Mediterranean;
- population size of breeding waders in East Europe;
- numbers of waders wintering in Libya and inland Africa;
- movements of waders between their wintering grounds in the Eastern Mediterranean and inland Africa;
- phenology, turnover and moult of waders in the northern and western Black Sea region;
- autumn and spring migration pattern of waders using the Mediterranean flyway in comparison to

Table 5. Number of resting waders at three of the most important wetlands in the northern and western Black Sea region. Median and maximum numbers (in brackets) for Burgas-Bay, for both other areas most of the data represent minimum numbers. Main sources for each area are given below, but a few of these data are unpublished).

species	Burgas-Bay (Bulgaria)[1]		Danube Mouth (Romania/ Ukraine)[2]		Sivash (Ukraine)[3]	
	spring	autumn	spring	autumn	spring	autumn
Haematopus ostralegus	5-20	20-30 (35)	6,000	500	?	?
Recurvirostra avosetta	2,000-4,000 (22,600)	10,000-20,000 (47,500)	1,000-2,000	1,000-3,000	?	?
Himantopus himantopus	100 (135)	100-200 (400)	?	?	?	?
Pluvialis squatarola	50-100	50-100 (421)	50-100	200-500	4,131-5,500	750-1,000
Pluvialis apricaria	50-100	?	?	50-100	1-15	2-10
Eudromias morinellus	5-10 (25)	5-10 (25)	10-20	?	5-10	?
Charadrius dubius	? (33)	? (94)	?	100-200	?	?
Charadrius alexandrinus	150-250	500-700 (1,000)	500	500	?	?
Charadrius hiaticula	10-20	20-30 (60)	50	100-300	370-500	45-60
Arenaria interpres	20-30	100-250	?	50-100	2,900-3,900	650-800
Philomachus pugnax	3,000-5,000 (9,940)	400-600	?	10,000-20,000	153,000-250,000	19,700-29,600
Calidris canutus	rare	rare	rare	rare	150-200	100-120
Calidris ferruginea	2,500-5,500	1,000 (2,300)	?	10,000-15,000	47,400-63,200	80,000-140,000
Calidris alpina	? (6,900)	1,000-3,000 (4,300)	10,000-20,000	1,000-2,000	170,000-254,000	100,000-160,000
Calidris minuta	? (5,176)	500-1,500 (3,080)	9,000	5,000	16,000-21,000	40,000-50,000
Calidris temminckii	10-20	100-200 (635)	50	50	1-5	5-10
Calidris alba	? (170)	?	400	50-100	1,300-1,700	?
Limicola falcinellus	5-10	50-100 (415)	10-20	400-600	4,000	800-1,000
Gallinago gallinago	200-300	200-300	1,000	?	2-5	5-7
Gallinago media	rare	rare	rare	rare	rare	rare
Lymnocryptes minimus	5-10	rare	rare	rare	rare	rare
Numenius arquata	? (2,000)	100-250	200-300	500	1,060-1,400	2,500-3,700
Numenius phaeopus	rare	rare (5)	600	?	700-1,000	450-500
Numenius tenuirostris	rare	rare	rare	rare	rare	rare
Limosa limosa	500-1,000 (6,000)	500-1,000	10,000-15,000	5,000-15,000	100-120	1,800-2,000
Limosa lapponica	rare	rare	rare	rare	1,000-1,200	100-130
Tringa erythropus	100-300	100-300	1,275	?	200-240	?
Tringa nebularia	? (910)	?	212	>1,000	10-30	70-90
Tringa stagnatilis	50-150	100-200 (500)	500-700	200-500	45-60	300-400
Tringa totanus	? (1,000)	1,000-2,000 (5,000)	10,000	15,000-25,000	4,100-6,000	28,000-32,000
Tringa ochropus	5-10	5-10	>>100	>>500	10-50	5-10
Tringa glareola	200	500-700 (1,000)	700	2,000-3,000	300-400	2,800-3,500
Actitis hypoleucos	10-20	10-20	?	>>500	5-10	20-50
Xenus cinereus	rare	rare	rare	rare	rare	rare
Glareola pratincola	?	100-200	50	100-200 (500)	?	?
Glareola nordmanni	rare	rare	rare	rare	?	?
Phalaropus lobatus	10-20 (21)	10-20	?	100-200	5,400-8,000	900-1,200
Burhinus oedicnemus	? (20)	? (20)	?	>50	?	?

1 Nankinov (1989, 1991); Roberts (1980); Uhlig (1984,1990b,1991a,b,c,d,e)
2 Brehme *et al.* (1992); Grimmett & Jones (1989); Harengerd *et al.* (1991); Kiss (1971, 1973); Nankinov (1991); Schiemann (1989); Van Impe (1970,1977); Weber & Szabo (1985); Zhmud (*in litt.*)
3 Chernichko *et al.* (1991)

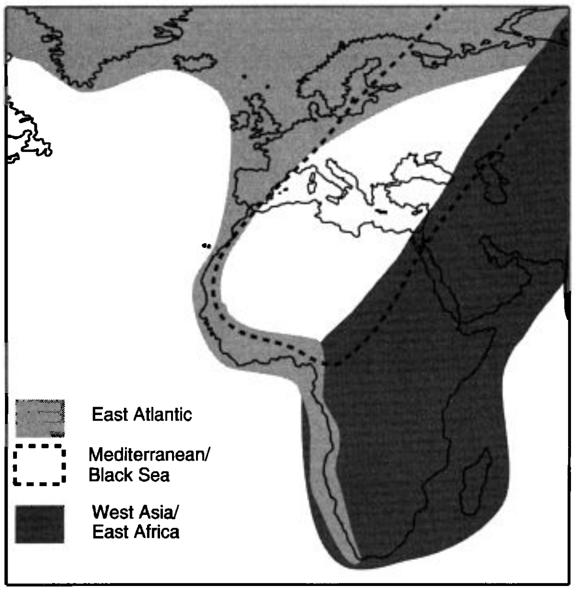


Figure 24. Flyways for waders in the Western Palaearctic

those using the East Atlantic flyway;
- feeding ecology of waders in non-tidal coastal wetlands; and
- connections and overlap between this flyway system and the East Atlantic and the East African flyway systems.

Acknowledgements

We thank all the people who are involved in wader studies along the Mediterranean Flyway, making this review possible by their intensive field work. Furthermore, we wish to thank T.B. Ardamadskaya, S. Brehme, G.C. Boere, I. Chernichko, J. Gromadzka, P. Meininger, G. Nikolaus, C. Smit, R. Uhlig, T. van der Have and M.E. Zhmud for further information or their advice and comments on an earlier draft of the manuscript.

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