Migration of Curlew Sandpiper *Calidris ferruginea* through the Azov–Black Sea region, Ukraine

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The Sivash, the largest system of non-tidal lagoons in Europe, is a shallow bay of the Azov–Black Sea region, Ukraine. The total number of Curlew Sandpipers using the area on northward migration is estimated at 66,000 birds, and on southward migration possibly by as many as 160,000 birds. Peak northward migration was in the middle decade of May; from bill-length dynamics, it is clear that the passage of males was earlier than that of females. Although second calendar year birds are thought to remain in their non-breeding areas, substantial numbers were mistnetted on northward migration; from their bill lengths, most of these were males. Based on body mass, it seemed unlikely that Curlew Sandpipers departing the Sivash in May could reach the breeding grounds in the Taimyr Peninsula in one flight. Also, the interval between departure and arrival was about 20 days; it therefore seems likely that birds have an intermediate staging area. On southward migration, males arrived from mid-July, with mostly females from mid-August onwards. Juvenile passage started in the last decade of August, and continued through September. There are 78 ring recoveries either to or from the Ukraine. Birds on passage through the Ukraine are headed both to West Africa and to southern Africa. Some birds appeared to perform a loop migration, travelling south through the Black Sea region and north along the western coast of Europe.

INTRODUCTION

The Ukraine, and especially the Azov–Black Sea region, is of great importance for migrating Curlew Sandpipers *Calidris ferruginea* during both northward and southward passage (Kozlova 1962, Chernichko *et al.* 1991, 1992, Korzukov 1991, van der Hawe *et al.* 1993). They utilize the wetland habitats of the Azov–Black Sea coast, primarily the shallow and non-tidal *liman*s in estuarine zones, and also the mud-flats in the saline lagoons of the Sivash which are rich in macrozoobentos and Brine Shrimps *Artemia salina* (Verkuil *et al.* 1993, Chernichko & Kirikova 1999). These wetlands attract several hundred thousand Curlew Sandpipers twice a year; they provide a stopover, fattening and partial moult area.

The general migration patterns, biometrics and moult characteristics of this species are well studied in some parts of its range (e.g. Thomas & Dartnall 1971, Elliott *et al.* 1976, Wilson *et al.* 1980, Cramp & Simmons 1983, Gromadzka 1985, Wymenga *et al.* 1990). In contrast, little information is available for many parts of the range, including Ukraine. The Azov–Black Sea region is 4,000–5,000 km distant from the breeding grounds on the Taimyr Peninsula, and is thought to be one of the final stepping stones for many Curlew Sandpipers, from where they start their final non-stop flight north to the breeding grounds (Piersma *et al.* 1987). On southward migration, a larger proportion of juveniles is believed to pass through this area than western Europe and the East Atlantic Flyway (Wilson *et al.* 1980).

Annual wader catching and counts were carried out between 1974 and 1998 by the staff of the Azov–Black Sea Ornithological Station and the Odessa University, at first on the *liman*s of the Black and Azov Sea coast and later in the Sivash in Crimea. These studies enabled us to describe not only numbers and distribution, but also sex and age composition, body mass dynamics and moult patterns of Curlew Sandpipers migrating through this area. Together with the analysis of ringing recoveries, we now have an improved understanding of the role of this region in the flyway system of Curlew Sandpipers in relation to Europe, Africa and Asia.

STUDY AREA

Most of the data were collected in the Sivash area situated in the north-eastern part of Crimean Peninsula and the south of the Kherson region of Ukraine. This shallow bay of the Azov Sea was discovered to be one of the most important for migratory waders of all Ukrainian wetlands. Some catching activities were performed also in the estuarine zones (locally called *limans*) of Molochnaia River and Tiligul River. The first is situated in the north-western part of the Azov Sea coast (46°20'N, 35°20'E) and the second is on the north-western part of the Black Sea coast (46°50'N, 31°00'E). Incidental counts provided data for most of the *limans* from the Danube Delta eastwards along the coast to the mouth of River Berda (46°50'N, 36°45'E).

The Sivash is the largest system of non-tidal lagoons in Europe (160 km east-west and 115 km north-south) with a highly indented coastline and locally varying salinity of water. It appeared as a result of a rising water level in the Azov and Black Seas (Fig. 1). Its western part has always been most isolated from the Sea of Azov and thus has the highest water salinity. It is characterized by the low diversity and abundance of benthos and plankton fauna. The central part of the Sivash evolved from a typical bay of the Azov Sea to an almost isolated waterbody, when the accumulating spit of Arabat cut off a part of the Azov Sea, thus creating the eastern part of the current Sivash. Because evaporation is double the combined river inflow and precipitation, most water enters the Sivash through the Genicheski Strait in its north-eastern corner (Babkov 1954). Until water from the Dnieper

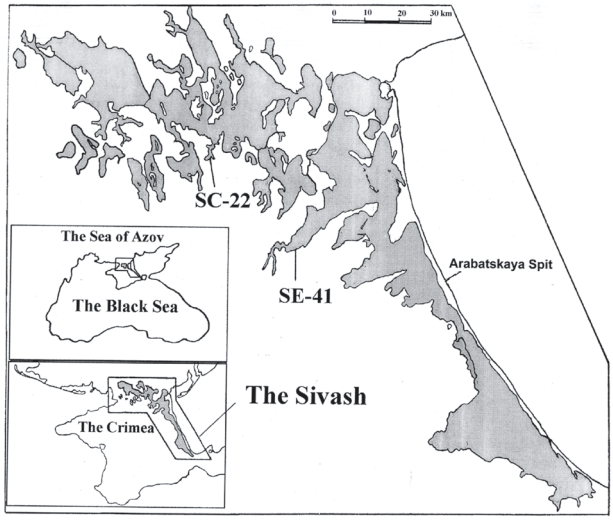

Fig. 1. Map of study area in the Sivash, Black Sea, Ukraine. Codes SE-41 and SC-22 indicate the most frequent ringing locations in the eastern and central Sivash respectively.

River was brought to the Crimea by the North Crimean Canal, this had been the only source of relatively fresher water for the Sivash. During the 1960s, discharge of irrigation water from Crimea resulted in a number of bays in the central and eastern parts of the Sivash becoming partly or completely fresh water. The effect of freshening was especially apparent in the eastern Sivash. As a result, the gradient of water salinity currently decreases from the western to the eastern Sivash and from the south to the north in its eastern part. Eventually, the lagoons of "eastern" and "central" type differed sharply in the food supply available to waders (Verkuil *et al*. 1993); this strongly influences the distribution of migratory waders within the whole Sivash system (S. Khomenko in prep.).

The *liman*s along the Azov–Black Sea coast are the second most important set of areas where Curlew Sandpipers were recorded or captured during migration. Although not subject to tidal fluctuations of water level, they are of importance for the species, mostly on southward migration, when a combination of wind and low water level sometimes results in large mudflats becoming exposed.

MATERIALS AND METHODS

All available published information on the numbers and phenology of migration of Curlew Sandpipers, both in the inland and the coastal areas of Ukraine, were summarised. Unpublished data were extracted from the database of the Azov–Black Sea Ornithological Station. These included totals of birds counted at the wetlands along the Azov–Black Sea coast which were visited occasionally in 1986–1998, results of both regular and irregular counts in the Sivash area (1988–1998), catching data (1990–1998) and ring recoveries. Data on numbers and phenology of migration in the Danube-Dniester area were provided by the Danube Biosphere Reserve. Recovery data were obtained from the Moscow Ringing Centre and from our own ringing activities, which started at the field station of the Odessa State University under the leadership of Joseph Chernichko in 1986 and have been continued in the Sivash by collaborators of the Azov–Black Sea Ornithological Station.

Counts

The indented coast line (3,185 km) of the Sivash, and its huge area (2,640 km^2 including periodically flooded areas) make it difficult to carry out regular counts of birds. Most lagoons become available for waders only under favourable wind conditions. Winds in certain directions temporarily expose mudflats in different parts of the bay; this results in irregular redistribution of birds within it. Moreover, water levels determine the abundance and distribution patterns of birds. Therefore, two major sites which were the least impacted by these variables were selected for regular surveys of Curlew Sandpipers in May and August–September 1996, on every fourth day of the study period. They are a part of the coastline adjacent to the freshened bay near the town Dzhankoy in the eastern part of the Sivash (45°47'N, 34°31'E) and a peninsula near the village Tzelinnoe in the central part of the Sivash (46°01'N, 34°15'E). These areas comprise 15% of the total Sivash area and held the largest numbers of birds ever recorded in the area. The effect of the wind is opposite at these two sites, so counting the birds at them simultaneously, as was done in 1996, is likely to provide data reflecting migration patterns of the species correctly and avoid the redistribution effects in general. In August 1998, wader counts were carried out in every three-day period along the standard counting route in the Dzhankoi Bay area. Irregular counts, carried in 1988–98 in different parts of the Sivash, provided data on the relative importance of each area, but are of little help when attempts are made to estimate total number on passage through the Sivash. In the last decade of May 1992, during the Ukrainian–Dutch WIWO expedition, half of the total area was covered during a single survey (van der Winden *et al*. 1993), but this was too late to give an adequate estimate of the highest numbers (see Phenology). A survey carried between 8–16 August 1998 by the "Sivash '98" WIWO expedition was the first attempt to survey the entire area of the Sivash simultaneously.

Catching activities

A total of 408 Curlew Sandpipers was captured and ringed in the north-western part of the Black Sea region (Tiligul *liman*, 46°38'N, 31°11'E) in 1974–1989 (Korzukov 1991) resulting in eight foreign recoveries (2%). In 1986, Joseph Chernichko and collaborators in the Chongar Peninsula of the Sivash (45°58'N, 34°34'E) started catching sandpipers using walk-in traps; since 1990 this was continued with the help of mist-nets at the two main monitoring sites of the Sivash and

Table 1. Numbers of Curlew Sandpipers captured in the Sivash on northward migration. An additional 26 birds were caught before the 26th pentade.

Year	Catching periods (pentades)				
	26	**27**	**28**	**29**	**30**
1991	–	–	497	–	–
1992	–	–	–	48	173
1993	–	1,153	374	–	–
1994	–	314	424	–	–
1995	–	–	–	89	60
1996	–	32	23	–	–
1997	72	33	–	–	–

at irregular points in the Sivash, the north-western Black Sea coast and the Zaporozhie region. In total, more than 6,000 Curlew Sandpipers were ringed in the south of Ukraine by the Azov–Black Sea Ornithological Station during 1986–98 and 38 long-distance foreign recoveries (0.6%) were obtained. Currently, the Sivash is the only area in Ukraine where large scale ringing of Curlew Sandpipers takes place. Only 17 Curlew Sandpipers were ringed between 1995–97 in the Lviv region of the Western Ukraine according to Information of the Working Group on Waders of the former USSR. Because it is only since 1990 that representative samples per pentades have been obtained, the earlier data were not involved in biometric analysis.

A total of 3,313 Curlew Sandpipers was caught on northward migration during 1991–97 in the different areas of the Sivash (Table 1). Timing of catching activities and sample size varied between years, ranging from small samples in April and early May to large ones from the first decade of the month and onwards till the end of May. This complicates comparisons of data between years and that of overall seasonal patterns in the morphometrics, sex and age composition, etc. The available data were divided into samples of at least 20 individuals per year and number of Bertold's pentades (Table 1). In some samples, the number of birds differs from the number of measurements because catches were sometimes too large to take measurements on all birds.

We caught 1,414 adult Curlew Sandpipers on southward migration in 1990–98. Timing of the catching activities varied between years, the earliest being in 40th and 41st pentades (15–24 July) and from 43rd to 54th pentades (30 July–27 September) (Table 2). The few birds captured in 55th to 58th pentades (28 September–17 October) were not included in biometric analyses. In 1990–98, 401 juvenile Curlew Sandpipers were captured, mostly in the period from 47th to 54th pentade (19 August–27 September).

Birds were aged according to plumage criteria (Prater *et al*. 1977). On northward migration, age classes distinguished were second calendar year birds (2cy, age code 5), adult birds (>2cy, code 6), and birds to which neither age codes 5 or 6 could be assigned (code 4). This group comprised up to 50% of the sample in some years. On southward migration, juveniles (1cy, code 3) and adults (>1cy, code 4) were distinguished.

Standard measurements (wing length, bill length, total head length and tarsus-with-toe length) were taken in accordance with Schekkerman (1990). Birds were weighed using Pesola balances to 0.5 g.

The extent of breeding plumage was scored following Schekkerman (1990): 1 = nonbreeding plumage, 2 = trace of breeding plumage, 3 = one-quarter breeding plumage, 4 = 50% breeding plumage, 5 = three-quarters breeding plumage, 6 = trace of nonbreeding plumage, 7 = breeding plumage. An index of intensity of body feather moult was used: 0 in non-moulting birds, 1 if single feathers were in moult, 2 if 10–20% of feathers were in moult, 3 if 20–50% of feathers were in moult, and 4 if more than 50% of feathers were in moult. An index of primary moult was calculated as a sum of 10 primary feather scores using the standard 0–5 system (Ginn & Melville 1983). In both cases the proportion of non-moulting birds was estimated.

Wing to bill ratio as an indicator of predominant sex in the sample was chosen to describe sexual composition by

Table 2. Age composition of Curlew Sandpipers (percentage of juveniles) captured during southward migration in the Azov–Black Sea region.

Year	Catching periods (pentades)													
	40	**41**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**
1990	0 *n* = 21	0 *n* = 74	–	0 *n* = 27	–	–	–	–	–	–	–	48.6 *n* = 35	50.9 *n* = 116	61.9 *n* = 21
1991	0 *n* = 62	0 *n* = 99	–	–	0 *n* = 57	–	–	–	–	–	87.2 *n* = 141	–	–	–
1993	–	–	–	–	–	–	–	–	–	–	– *n* = 29	86.2	–	–
1994	–	–	–	0 *n* = 256	0 *n* = 219	–	–	–	–	–	73.1 *n* = 26	–	–	–
1995	–	–	–	–	–	–	34.3 *n* = 35	40.5 *n* = 74	71.4 *n* = 14	66.6 *n* = 24	–	–	–	–
1996	–	–	–	–	–	0 *n* = 55	–	–	–	–	48.1 *n* = 108	75.5 *n* = 49	–	–
1997	–	–	–	0 *n* = 183	0 *n* = 60	–	–	–	–	–	–	–	–	78.9 *n* = 19
1998	–	–	8.3 *n* = 12	–	0 *n* = 26	–	2.7 *n* = 37	4.5 4.5	–	–	–	45.8 *n* = 48	–	

pentades during northward migration (see Discussion). If the ratio tended towards 3.6, males predominated in the sample; if 3.4, females predominated. On southward migration, these ratios for the pentades were used to determine relative abundance of males and females.

The maximum flight distance (MFD, km) was calculated according to the formula of Gavrilov (1992):

$$MFD = 95.447V(T^{0.302}–M^{0.302})$$

where V is flight speed (km/h), T is initial mass (g) and M is arrival mass (g).

RESULTS

Numbers and distribution

As elsewhere in the former USSR, Curlew Sandpipers were more numerous during southward migration than on northward passage. They migrated northward faster and with shorter stopover periods than on southward migration which continued for more than three months (Kozlova 1962). In Ukraine, really intensive northward migration with concentrations as large as tens of thousands of birds in one staging area occurred only for the Sivash. About 40–50% of its area was covered by wader counts in 1992 (van der Winden *et al*. 1993) and the census area covered about 15% of the total in 1996 (see "Methods"). The maximum total numbers of Curlew Sandpipers recorded during these most complete counts were 9,000 in the last decade of May in 1992 and 28,568 in the first decade of the same month in 1996. A similar total was obtained on 12–14 May 1990, when 28,833 Curlew Sandpipers were found in the Sivash, but it is not clear whether the coverage of the area was adequate. However, all three parts of the Sivash were mentioned in the report (van der Have 1990). We have summarized maximum totals ever recorded for all counting units of the Sivash on northward migration to estimate its real maximum capacity without taking into account turnover rate (Fig. 2). Our estimate was 32,664 birds, which may be considered the upper limit of the numbers passing through the area simultaneously.

Maximum numbers during southward migration were counted in the first decade of August 1998, when an almost complete simultaneous count was carried out in the whole Sivash area. The total number of Curlew Sandpipers observed was 72,410. If maximum numbers in all counting areas are summed without respect to date (Fig. 3), a total of 113,298 Curlew Sandpipers is obtained. The central part of the Sivash was the most important area for this species both on northward and southward migration. For example, 94.6% of Curlew Sandpipers were counted in the Central Sivash in May 1996. Though in the first decade of August 1998 proportions of Curlew Sandpipers in the central and eastern Sivash were about equal, regular counts during the whole August in 1996 also showed that the most (93.5%) occurred in the central Sivash. The hypersaline western Sivash was of a little importance for migrating Curlew Sandpipers and the maximum number observed here was 3,500 birds in August 1992.

The *limans* of the Black and Azov Seas were also important staging sites for Curlew Sandpipers, although numbers were never as high as in the Sivash. On northwards migration, data were scanty due to short staging periods and irregular counts. On the whole, wader counts outside the Sivash were quite accidental and insufficient in most areas, so we used all results to show relative numbers in other coastal wetlands of Ukraine. The extensive wetlands of the Danube-Dniester area, first of all *limans* of Tuzlovskaya group and water reservoir Sasyk were used by Curlew Sandpipers migrating both northwards and southwards. In the second decade of May (1994) 135 Curlew Sandpipers were observed at Lake Sasyk and in Dzhensheyskiy *liman* (about 210 birds). The number of Curlew Sandpipers counted in 18–20 May 1994 in Danube-Dniester area was 465 individuals, but taking into account incompleteness of investigation in such an extensive area, we reckon that 700 birds were simultaneously present here in May–June (M. Zmud pers. comm.). The Dniester delta and adjacent *liman* were rarely used as staging sites during migration and were not important for Curlew Sandpipers. The Ukrainian part of the Danube delta was not visited on northward migration due to high water levels in this period. By the time of southward migration, water level in the Danube River delta is lower and small spits or islands make suitable staging sites for Curlew Sandpipers, but they were never numerous. From 5–45 birds were observed on a fixed counting route (9 km long) in Kiliya delta of Danube River in September. About 180 Curlew Sandpipers were observed in the upper part of Alibey *liman* on 21 July 1995 though they had never been counted in this period here before (M. Zmud pers. comm.).

Curlew Sandpiper was among the numerous migrants (500–1,000 birds annually) in Tiligul and Kuyalnik *limans* (north-western Black Sea coast), more frequently found during southward migration (Chernichko *et al*. 1992). Flocks up to 106 birds were observed in Tiligul *liman* (the Nikolaev region) from the first half of April and the average number of birds per counting route (12 km) was 60 in April and 100–175 in August–September (Chernichko *et al*. 1992). The maximum number on southward migration was 3,250 birds in the second decade of August 1994 (J. Chernichko unpubl. data).

Curlew Sandpiper was estimated to be a numerous migrant (more than 50 records annually) in the Black Sea Reserve (Kotenko *et al*. 1996) though it was not noted as migrant in Tendra Bay between April–October 1994 (Rudenko *et al*. 1996) nor on Kinburnskaya Spit in 1987–1990 (Pirogov 1996).

Maximum number of 1,478 Curlew Sandpipers was observed in the last decade of May 1993 on the Kerch Peninsula (eastern Crimea, sea coast near Opuk mount). Only single birds were observed in October on Sakskoe Lake, Crimea. Curlew Sandpipers were rare on migration in the Mys Martyan Reserve (southern Crimea, Black Sea coast) (Beskaravainyi 1995).

Small numbers of Curlew Sandpipers were counted during northward passage in the *liman*s of the Azov Sea coast and most data related to southward migration. Totals of 2,000–3,000 Curlew Sandpipers were counted in one of the *limans* of Berdyansk spit (Zaporozhie region, Azov Sea coast) between 20–30 September in different years (Ogulchanski 1973). In the Molochniy *liman* (Zaporozhie region, Azov Sea coast) only tens of Curlew Sandpipers were observed in the first half of May and a maximum of 1,080 birds was found in the middle of the month in this region. Up to 370 birds were recorded during one count in August and up to 180 in September. At the mouth zone of Taschenak River (right tributary of Molochniy *liman*), 60 Curlew Sandpipers were observed in the beginning of October. Only single birds were counted during northward migration and up to 150 individuals per count in August at the mouth zone of Korsak River (a small river in Zaporozhie region). Up to 970 Curlew Sandpipers were counted simultaneously in late May and about 150 in August in the Utlyuk *liman* area. A maximum of 520 Curlew Sandpipers was counted on Biryuchiy Island

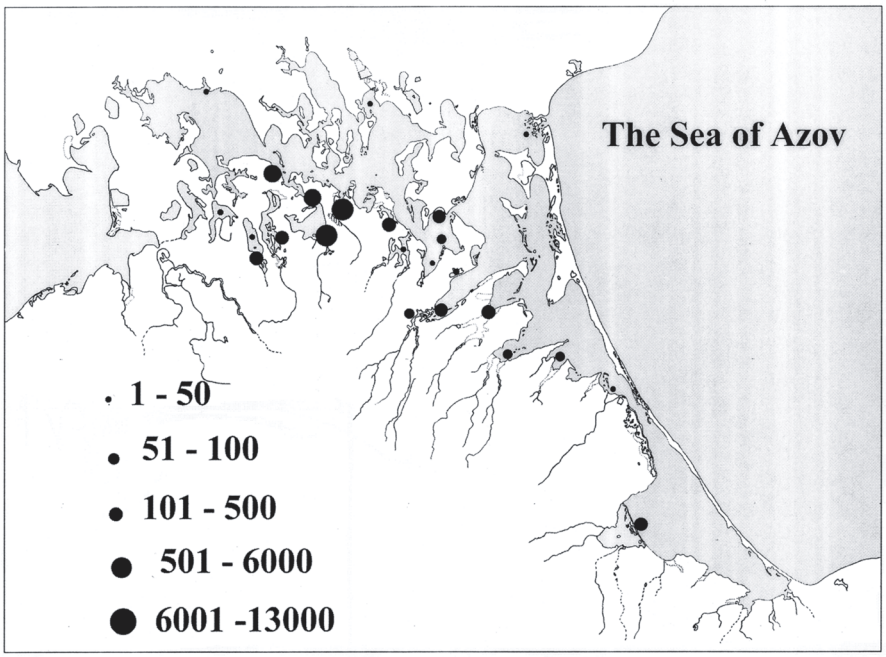

Fig. 2.
Numbers and distribution of Curlew Sandpipers on northward migration in the Sivash. Maximum totals recorded from 1988–98.

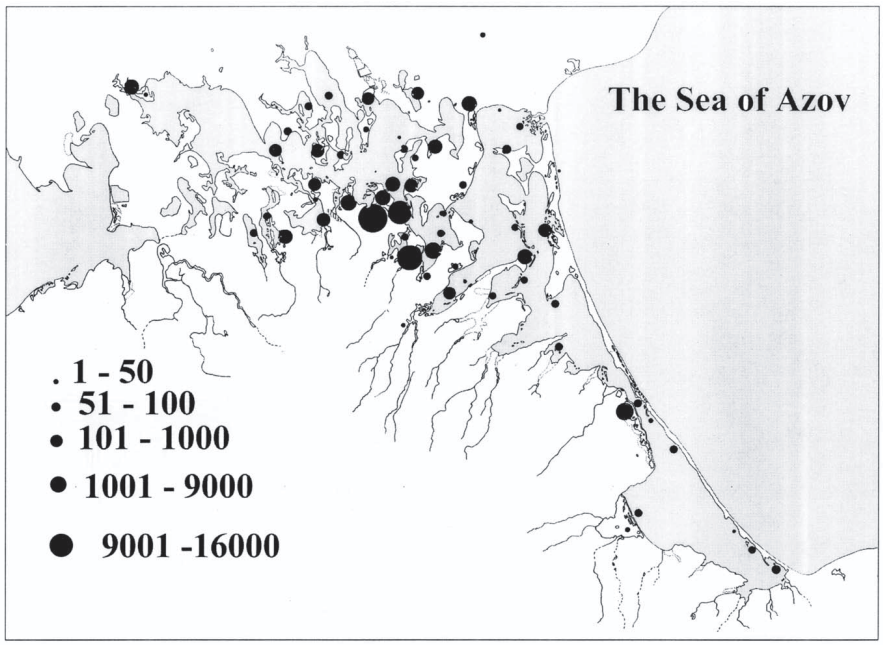

Fig. 3.
Numbers and distribution of Curlew Sandpipers on southward migration in the Sivash. Maximum totals recorded from 1988–98.

(Zaporozhie region, Azov Sea coast). In total, at least 4,500–5,000 Curlew Sandpipers occurred simultaneously in August–September in *liman* areas of the Zaporozhie region and *c.*2,100–3,000 were present on northward migration.

There was no good quantitative data concerning inland areas of Ukraine. Curlew Sandpiper was noted as a common and sometimes numerous migrant during both migration periods in western Ukraine (Tatarinov 1973) but in other publications it was listed as rare (Zinoviev 1980). It was noted on migration in Khmelnitskiy region (Novak & Novak 1998) and Ivano-Frankovsk region (Guzi 1996b). Short stops on northward and more often on southward migration were recorded along the rivers of Zakarpatskiy region (Hrabar 1997). In Lvov region, the Curlew Sandpiper was listed as a rare (Guzi 1996a) and irregular visitor to some areas (Shidlovsky *et al*. 1998).

It was regarded as a rare species in the forest and forest-steppe zones of Ukraine, occurring mainly on Dnieper water reservoirs during northward migration (Klestov *et al*. 1996). Only single observations were made during northward migration in the Sumy area (Lebed *et al*. 1992) and in Dnieper forest-steppe area (Lebed 1995b), where it makes up only 0.5% of southward migrating waders (Lebed 1995a). Seven Curlew Sandpipers were observed on northward and 174 on southward migration during long-term observations in the 1980s–1990s at a fish-pond near the town of Sumy (Lebed *et al*. 1992). Artificial water reservoirs on big rivers (e.g. Dnieper) play a limited role in Curlew Sandpiper migration. It was not numerous on Kanev Reservoir (Cherkassy region) and was observed only on southward migration (Sabinevski *et al*. 1988). Curlew Sandpiper occurred at the Dneprodzerzhinsk Reservoir near the end of April and in the middle of September (Bulakhov 1973). It was noted that numbers of migrating Curlew Sandpipers decreased along the Dnieper River migration route soon after the construction of artificial water reservoirs which destroyed many flood plain lakes (Kistyakovski & Melnichuk 1975). For example, Curlew Sandpipers had been common on migration in the Dniepropetrovsk region before 1984 and became rare in the 1990s (Bulakhov & Gubkin 1996).

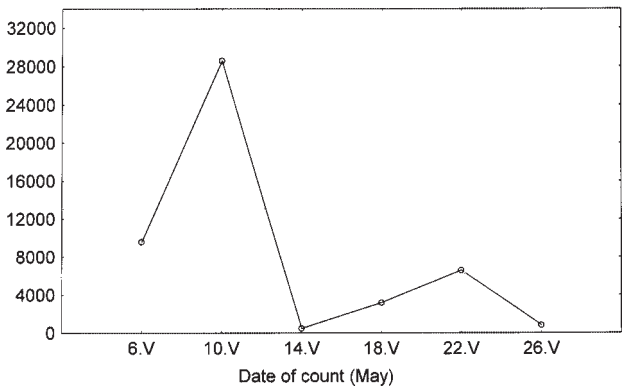

Fig. 4. Migration pattern of Curlew Sandpipers in May 1996. The most important concentration sites making a total of 15% of the Sivash area were counted regularly.

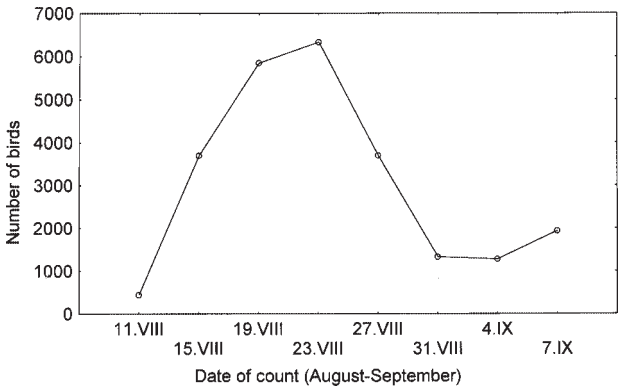

Fig. 5. Migration pattern of Curlew Sandpiper in August–September 1996. The most important concentration sites making a total of 15% of the Sivash area were counted regularly.

Mass southward migration was noted in Poltava and Kharkov regions in the second half of September (Kozlova 1962). A flock of 40 Curlew Sandpipers was observed on Krasnooskolskoe Reservoir in Donetsk region in August 1990 (Shaparenko 1994).

Phenology and dynamics of migration

Curlew Sandpipers occurred in the Ukrainian section of Azov–Black Sea region during both migration periods. Small numbers were also regularly present during the breeding season. There were very few records during the nonbreeding season; e.g. on 25 February in Askania-Nova (Kozlova 1962). The Sivash was the only place in Ukraine where mass concentration and intensive northward migration of this species occurred (Kozlova 1962). In other areas it migrated in small numbers and within short periods. The earliest Curlew Sandpipers were observed in the 21st to 23rd pentades (11–25 April) in the eastern Sivash: 20 April 1988 (flock of 80 birds), 14 April 1992, 22 April 1995, 19 April 1996, 21 April 1997 (single first birds). In the central Sivash first records were on 24 April 1992 (single birds) and 30 April 1993 (flock of 2,200 birds).

Kozlova (1962) recorded first arrivals on 24 April in Kharkov region and after 1 April in Askania-Nova, by the end of April or even in March in the Black Sea Reserve area, and on 26 April on Belosarayskaya Spit of the Azov Sea coast (Kotenko *et al*. 1996). Northward migration took place from 17 April to 7 June in the north-eastern part the Black Sea area (Karkinitski Bay, Lebyazhyi Islands) (Tarine *et al*. 1999). On 30 April they were recorded in the South Crimea, in Mys Martyan Reserve (Beskaravainyi 1995). The start of migration in the north-western part of the Azov Sea coast occurred in the second half of April (Lysenko 1992, own data) and in Tiligul *liman* of the Black Sea coast in early April, e.g. 6 April 1976 (Chernichko *et al*. 1992). Northward migration was intensive, and by the end of April first Curlew Sandpipers appeared in the northernmost parts of Ukraine, e.g. for Chernigov region the arrival dates were 28 April 1966, 29 April 1968 (Marisova *et al*. 1992). A March record in Kiev region is questionable (Dementiev *et al*. 1951).

In the Sivash the peak numbers on northward migration were *c*.30,000 (11–15 May 1996) and 14,000 (16–20 May 1992). Most Curlew Sandpipers were observed in 27th and 28th pentades (11–20 May). The maximum numbers ever recorded at each counting area of the Sivash during northward migration were summarised by pentades using the most complete census data collected in 1992, 1994, 1996. In 29th and 30th pentades (21–30 May), numbers decreased sharply (about 1,400 birds were counted in 1992, about 800 in 1996). A similar timing of migration was obtained from the analysis of regular census data at standard counting locations. In May 1992, numbers peaked on 16 May and, to a lesser extent on the 26 May. On 28 May 1992 large numbers of Curlew Sandpipers left the Sivash area in a north-easterly direction (van der Winden *et al*. 1993). In 1996, the main peak of northward migration was on 10 May, and a smaller one on 22 May (Fig. 4).

Maximum numbers in Danube-Dniester region (465 individuals) were observed between 18–20 May 1994 (M. Zmud unpubl. data). In the *liman*s in north-western part of the Black Sea coast peak numbers were noted earlier; in April, Curlew Sandpipers were still common in the first half of May and usually absent by the end of the month (Chernichko *et al*. 1992).

In the first half of June (4–15 June), 30–120 birds were

Table 3. Biometrics (mm) and body mass (g) of 2nd calendar year (2cy) and adult (>2cy) Curlew Sandpipers captured in April–May 1991–1998 in the Sivash.

Measurement	Means			*t*-test		*n*		SD	
	2cy	>2cy	*t*	df	*P*	2cy	>2cy	2cy	>2cy
Wing	133.7	133.0	1.8	2,098	0.07	69	2,031	2.59	3.10
Tarsus+toe	52.6	53.3	1.5	879	0.14	24	857	3.00	2.32
Bill	37.6	38.4	2.5	2,100	0.01	70	2,032	2.66	2.66
Total head	62.1	62.0	0.24	777	0.8	25	754	2.86	2.68
Mass	53.3	55.6	2.7	2,073	0.00	70	2,005	6.08	6.98

Table 4. Biometrics (mm) of 23 Curlew Sandpipers sexed after dissection, on northwards migration in the Sivash.

Measurement	Males				Females			
	n	Mean	Range	SD	*n*	Mean	Range	SD
Wing	11	136.1	131.0–141.0	3.3	12	133.2	130.0–138.0	2.3
Tarsus+toe	9	54.3	52.0–56.0	1.5	12	53.6	52.0–60.0	2.3
Bill	11	40.3	36.9–44.5	2.0	12	37.4	34.3–40.1	1.8
Total head	11	64.5	61.0–69.7	2.4	12	61.0	58.2–62.9	1.5

observed in the Sivash and on the Azov Sea coast; these were most likely the last migrants as well as nonbreeding individuals which did not reach the breeding areas. Curlew Sandpipers were also quite common during whole of June in the Danube-Dniester area. It occurred during the breeding season in Karkinitski Bay (Tarina *et al*. 1999).

Southward migration in the northern Ukraine started in the first half of July: Chernigov and Kiev regions, 12 July 1946 (Smogorzhevsky 1992); the Sumy region, 14 July 1987, with mass migration observed in August (58% of total migrating birds in the Sumy region) and some birds occurred to mid October–early November (Lebed *et al*. 1992). Last records in the Chernigov and Kiev regions were on 12 October 1946 (Smogorzhevsky 1992), in the Sumy region, 29 September 1991 (Lebed *et al*. 1992, Knysh 1994) and the beginning of November (Matvienko 1978).

In the Danube-Dniester area significant numbers of Curlew Sandpipers were observed in some years in the second half of July, in other years they were completely absent until end July–early August. The maximum number was recorded on 2 September 1993 in Kilija delta of Danube river, 45 birds on 9 km of fixed counting route; they occurred regularly until 23 September and the last observation was made on 6 October. On the north-western Black Sea coast (Tiligul *liman*) southward migration began in the second decade of July (first record, 11 July 1988) and continued to the end of October (last record, 28 October 1979); peak numbers on the monitoring count route were observed in August (Chernicko *et al*. 1992). Southward migration in the Black Sea Reserve took place from August–October (Kotenko *et al*. 1996), in Karkinitski Bay (Lebyazhyi Islands) from 23 July–21 November (Tarina *et al*. 1999). The timing is similar on the north-western coast of the Azov Sea (14 July 1993, 27 July 1987 at Molochniy *liman*), continuing to the end of October, sometimes mid November (Lysenko 1992). Generally, southward migration in the Azov–Black Sea region was more prolonged than northward (Chernichko 1992, own data). The earliest Curlew Sandpipers arriving in the Sivash from the breeding areas were birds trapped in the 40th pentade (15–19 July); in the first decade of August (4–8 August 1998, 44th pentade) maximum numbers of 68,800 were observed. Southward migration from the Sivash seemed to end in November, because totals in 60th pentade (24–26 October 1994), the last in which observations were made, were as large as 3,840 birds. Kostin (1983) noted that the latest record in the Crimea was on 21 November 1959.

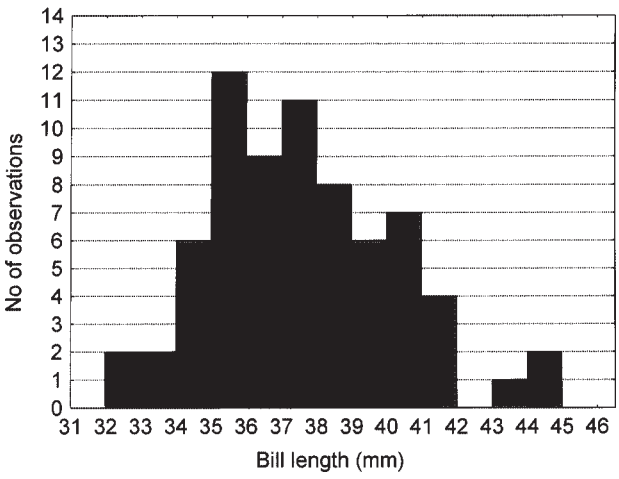

Fig. 6. Distribution of bill length of second calendar year (2cy) Curlew Sandpipers captured during northward migration 1991–98 in the Sivash.

Because the Sivash is too large for regular complete counts, the phenology of migration was observed along 15% of its coastline between 11 August and 7 September 1996. Also counts were made every three day in 31 July–23 August 1998 in the monitoring area of eastern Sivash. In 1996, numbers peaked on 19 August (Fig. 5) and a smaller peak was recorded on 7 September. In 1992 the main peak was on 8 August and a smaller one on 23 August. Thus, apparently two waves of migrants passed through the area in August.

One juvenile bird was captured in the 43rd pentade (30 July–3 August) but no more until the 47th (19–23 August) (Table 2). Apart from the single juvenile, only adults migrated in 40th–46th pentades (15 July–18 August). Later on in the season, the percentage of juveniles varied between years clearly reflecting breeding success. The proportions were high in 1991, 1993, 1997, all of which were good breeding years in Arctic (Tomkovich 1992, 1994, 1998). Overall proportions of juveniles were large compared with coastal Europe. Wilson *et al*. (1980) recorded large proportions of juveniles during southward migration at inland sites; similarly juveniles were predominant in the Black Sea *liman*s (Chernichko 1992).

Morphometrics

Although juveniles are reported to remain in their nonbreeding areas in Africa when adults commence the northward migration in about April, some of them (aged 2cy, second calendar year) clearly did take part in this migration. Size variation between adults (>2cy) and 2cy birds was significant only for bill length (Table 3); the adults had bills averaging 0.8 mm longer than the 2cy birds, suggesting that the latter were predominantly males (Fig. 6). The 2cy Curlew Sandpipers were also on average 2.3 g lighter than adults; this could be attributed to the small proportion of females in the sample and differences in catching time; most juveniles were caught in the first decade of May.

Twenty three individuals which died during trapping on northward migration were sexed after dissection. Their biometrics are summarized in Table 4.

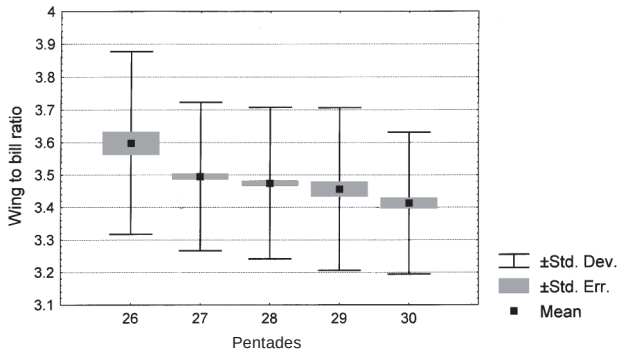

Fig. 7. Mean wing to bill ratio of adult Curlew Sandpipers captured in the Azov–Black Sea area during northward migration by pentades.

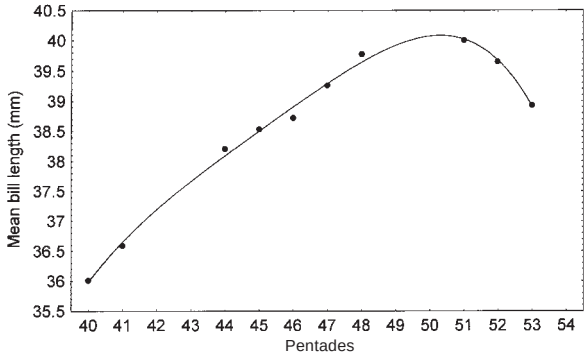

Fig. 8. Mean bill length of adult Curlew Sandpipers captured in the Azov–Black Sea area during southward migration by pentades.

To analyse occurrence of sexes during northward migration we combined data for all years and calculated means of wing to bill ratio by pentades. Of all body dimensions bill length is most sexually divergent, but its variation is partly related to the size of birds. To avoid this complication we divided wing length by bill length for each bird. In the sexed sample of birds (Table 4) these ratios were 3.4 for females and 3.6 for males. The same figures were obtained when the bill to wing ratio was calculated for the "male period" of southward migration (second half of July) and the "female period" from the mid-August onwards. The variation in wing to bill ratio was mostly related to the variations of bill length (r = 0.94, n = 2,314, P < 0.001) rather than to the variation in wing length (r = 0.3, n.s.). Samples in the Sivash at the beginning of May contained a larger proportion of males and the ratio gradually increased during the month indicating an increasing proportion of females on passage (Fig. 7). Differences in the mean bill length by pentades were not significant in the period from 10–25 May (27–29th pentades), whereas in the first decade of May bill length was significantly shorter than later in the month. Birds captured between 26–30 May (30th pentade) were significantly longer billed than those caught earlier.

In both 1993 and 1994 large numbers of Curlew Sandpipers were caught in the second decade of May (n = 738 and 632 respectively); this enabled comparison between years. Mean bill length did not differ between years (38.3 and 38.5 mm), but the birds were 1.9 g heavier in 1993 (means = 55.6 and 53.5 g, t = 5.9, df = 1,343, P < 0.001). In May 1993 strong winds did not permit departure, thus increasing the catch of heavier birds.

Adult birds captured on southward migration were almost identical in size (means=132.8, 53.6, 38.2 and 62.1 mm for wing, tarsus + toe, bill and total head respectively, n = 1,395) as those captured on northward migration (Table 3) but averaged 16.6 g heavier (mean mass 72.2 g, SD = 11.3, range 35–102 g, n = 1,397) than those on northward migration (mean mass 55.6 g).

Juveniles captured on southward migration were similar in size to adults in three measurements: tarsus + toe (53.8 mm, SD = 2.1, n = 212), bill (38.4 mm, SD = 2.6, n = 401) and total head (62.1 mm, SD = 3.0, n = 257) (cf. Table 3 and paragraph above). Mean wing length was *c*.1 mm shorter than adults (131.9 mm, SD = 2.9, n = 399) and mean mass was 4.7 g less than that of adults on southward migration (67.5 g, SD = 10.6, range = 35–98 g, n = 397).

Early in the southward migration period (40th–41st pentade, 15–24 July), the mean bill length was short (36.4 mm, SD = 2.0, range 31.1–46.0 mm, n = 254) indicating that mostly males passed through the area. The mean bill length increased steadily to maximum in the 51st pentade (8–12 September) (Fig. 8) indicating that the proportion of females increased during the course of the southward migration period and that few males were captured from 50th pentade onwards. This pattern is confirmed by the pattern of means of the wing to bill ratio (Fig. 9)

Weight increase and flight range

Twenty six birds were captured before 5 May, in the 22nd–25th pentades; all had mass below 60 g, but increased steadily to the 26th pentade (Fig. 10). In the next pentade, 10–15 May,

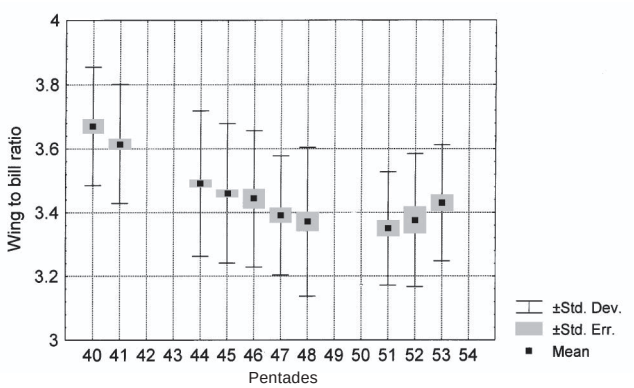

Fig. 9. Mean wing to bill ratio of adult Curlew Sandpipers captured in the Azov–Black Sea area during southward migration by pentades. A polynomial regression was fitted.

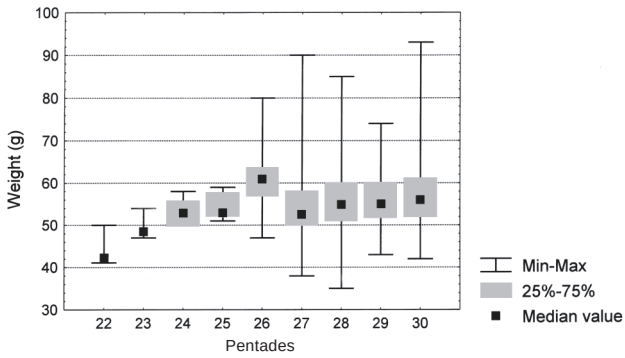

Fig. 10. Median body mass of adult Curlew Sandpipers captured in the Azov–Black Sea area during northward migration by pentades.

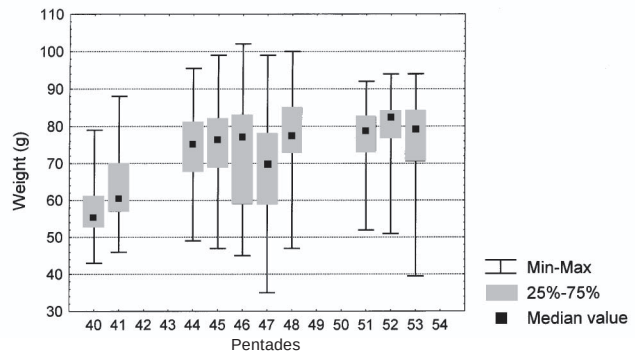

Fig. 11. Median body mass of adult Curlew Sandpipers captured in the Azov–Black Sea area during southward migration by pentades.

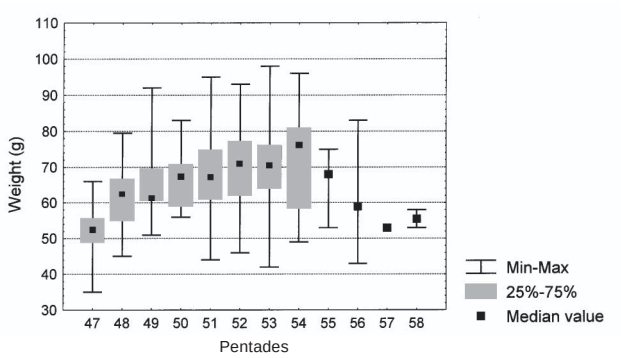

Fig. 12. Median body mass of juvenile Curlew Sandpipers captured in the Azov–Black Sea area during southward migration by pentades.

the mean weight decreased, related to large scale arrival of lean Curlew Sandpipers. During northward migration, the mean weight of captured Curlew Sandpipers was low (55.6 g), and probably largely reflects mass upon arrival in the Sivash and not final departure mass (see Discussion). Birds with weights up to 90 g occurred up to mid May and then both maximum and minimum weights decreased, suggesting the departure of heavy birds and the arrival of new ones. In the second half of May, minimum weights increased showing that there were fewer new arrivals. By the end of May the heaviest birds reached 80–94 g. Gavrilov's (1992) formula (with arrival mass 52 g and flight speed 65 km/h; Zwarts *et al*. 1999) suggested that these heaviest birds would be able to cover 2,800–4,000 km, insufficient to reach the breeding grounds in the Taimyr Peninsula.

Body mass of adult Curlew Sandpipers in the Sivash on southward migration varied between 35–103 g (Fig. 11). In the 40th pentade (15–19 July) median body mass of adults was 56 g (range 43–79 g). In the next pentade (20–24 July), the median increased to 61 g (range 56–89 g). Later pentades were irregularly represented in the Sivash catches in different years (Table 5). But the overall tendency was a gradual increase in mean body mass from pentade to pentade despite between year variations (Table 5, Fig. 11). Birds appear to leave the Sivash staging area at body masses above 80 g; the maximum recorded mass was 103 g. Masses of Curlew Sandpipers captured on southward migration appeared to represent population dynamics more correctly, suggesting a longer stopover period than on northward migration.

The median mass of the first juveniles to arrive, in 47th pentade (19–23 August) was 53 g; the median steadily increased to the 54th pentade (23–27 September); the wide ranges in most pentades indicated the arrival of light birds and the departure of heavy birds (Fig. 12). The rates of arrival and departure are likely to balance from the last decade of August till the end of the second decade of September.

Moult and plumage

Most Curlew Sandpipers are thought to start moult of the primary feathers after arrival in their nonbreeding areas and only occasionally moult during southward migration (Cramp & Simmons 1983). However, we regularly observed adults with moulting primaries in the Sivash area. The percentages of captured birds with all primaries old varied between 84% and 95% in 44th–51st pentades (4 August–12 September) and with active primary moult varied between 4.8% and 14.3% (Table 6). By the 51st pentade (8–12 September), the average moult score of the four adults in moult was 36.4. Three birds showed interrupted primary moult, and 11 birds

Table 5. The means (SDs) of body mass (g) of adult Curlew Sandpipers captured on the Azov–Black Sea coast during southward migration by years and pentades.

Year	Pentades									
	40	**41**	**44**	**45**	**46**	**47**	**48**	**51**	**52**	**53**
1990	62.0 (7.3) *n* = 21	67.5 (10.7) *n* = 73	82.9 (7.2) *n* = 27	–	–	–	–	–	–	76.7 (11.5) *n* = 56
1991	55.7 (5.7) *n* = 61	60.5 (6.0) *n* = 98	– –	73.7 (10.2) *n* = 57	–	–	–	–	–	–
1994	–	–	74.0 (9.6) *n* = 254	74.6 (9.31) *n* = 218	–	–	–	–	–	–
1995	–	–	–	–	–	63.3 (12.0) *n* = 35	77.2 (10.7) *n* = 43	–	–	–
1996	–	–	–	–	72.6 (15.1) *n* = 54	– –	– –	77.2 (7.7) *n* = 56	–	–
1997	–	–	72.7 (8.0) *n* = 176	76.3 (10.9) *n* = 60	–	–	–	–	–	–
1998	–	–	–	76.7 (12.0) *n* = 25	–	75.8 (11.8) *n* = 36	79.2 (10.4) *n* = 21	–	81.0 (8.4) *n* = 25	–

were recorded as having new primaries.

The proportion of adult Curlew Sandpipers in breeding plumage during southward migration decreased from 89% in the 40th pentade (15–19 July) to 11% in 53rd pentade (18–22 September) (Table 7). No birds in non-breeding plumage were captured in 40th–41st pentades (15–24 July). The proportion in almost complete non-breeding plumage tended to increase; the fluctuations probably occur because birds in non-breeding plumage leave the staging area.

The mean value of the body moult index increased during southward migration from 1.3 to 2.0, and then decreased to 0.9 in the 52nd pentade when the most birds had already acquired nonbreeding plumage (Table 7). The percentage of Curlew Sandpipers without body moult was 26% in 40th pentade, peaked at 46.2% in 52nd pentade. In 40th–41st pentades all birds without body moult had mainly breeding plumage (score >4). The discontinuities in several measures in Table 7 at pentade 46 are probably due to the departure of males in nonbreeding plumage and the arrival of female in full and partial breeding plumage.

Migratory connections

In total 78 long distance foreign recoveries of Curlew Sandpipers connected with the Ukraine are known; 63 of these are of birds ringed abroad and recovered in the Ukraine and 15 are of birds ringed in the Ukraine and recovered abroad (Table 8, Fig. 13).

Only one direct recovery from Siberian breeding grounds is known: a breeding female Curlew Sandpiper was ringed on 30 June in the northern Taimyr Peninsula and was recovered on 4 August in the same year on the north-western Black Sea coast in the Tiligul *liman* (P.S. Tomkovich, J. Chernichko pers. comms). This recovery directly links the breeding population of the Taimyr Peninsula with the Black Sea coast.

Five recoveries were obtained during the year of ringing; only one was a bird ringed and recovered in the same season. This Curlew Sandpiper was ringed in the Sivash on 12 August 1991 and recovered in Spain on 7 September 1991, and demonstrates a direct westward linkage between the Azov–Black Sea region across the Mediterranean Basin to the Atlantic coast and later perhaps southwards to West Africa. There were two other recoveries of birds ringed in the Sivash on northward migration and recovered in Spain on southward migration in the same year. Taken together, these might indicate that some Curlew Sandpipers cross the Mediterranean Basin–Azov–Black Sea route in both directions or indicate that birds use a loop migration pattern: northwards along the Atlantic Ocean coast and southwards across the largely overland Azov–Black Sea route.

Birds ringed on southward migration in Scandinavia, Poland, England and Germany were recovered in the Azov–Black Sea region, both on northwards and southwards migration (Table 8). There were no recoveries on northward migration in western Europe north of France of birds ringed in the Ukraine. This suggests that most Curlew Sandpipers migrate northward overland through the Azov–Black Sea region, but follow the Atlantic Ocean coastline southwards (loop migration). It is possible that some birds reach the Ukraine region on southward migration from some point in Scandinavia, the Baltic and North Seas; this is suggested by a number of recoveries on southward migration in the Azov–Black Sea region of birds ringed in these regions.

Recoveries of birds ringed or found in the nonbreeding season were distributed across Africa: in Tunisia and Morocco in the north, in Senegal, Mali and Chad in the west, and in southern Africa. This suggests that two migration routes cross the Azov–Black Sea region. The first initially runs westward across the Mediterranean Basin and then south-west to western Africa and the second runs directly southward to southern Africa. Most birds ringed in Tunisia were recovered in the Azov–Black Sea region on southward migration so this country may provide a key stopover site along the route to the western Africa. Birds ringed in Italy and Greece on northward migration were recovered in the Azov–Black Sea region and these may indicate that northward migration of considerable part of the population from African nonbreeding grounds is via these countries to Ukraine and then overland to the Siberian breeding grounds.

DISCUSSION

Population sizes

In the inland areas of Ukraine, no reports suggest large numbers of Curlew Sandpipers. The status here is described as “common, not numerous” but more often “rare” on the passage; no quantitative estimates exist to make any comparisons. There is an indication of a decrease on southward migration in the 1980s–1990s since the Dnieper River was regulated by dam construction (Bulakhov & Gubkin 1996). It is possible that, in addition to the large numbers stopping in the Azov–Black Sea area, a proportion flies on a broad range across the continent from and to their staging

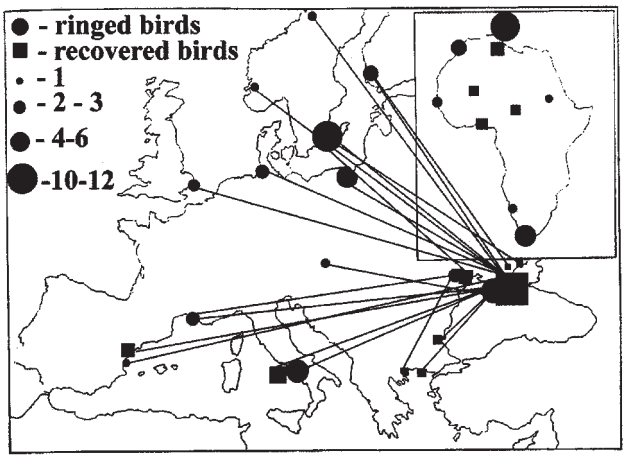

Fig. 13. Long distance ringing recoveries of Curlew Sandpipers either ringed or recovered in Ukraine.

Table 6. Percentages of Curlew Sandpipers on southward migration through Sivash with old and moulting primaries, and average primary moult score, per pentade.

Pentades	44	45	46	47	48	51
Old primaries	95	84.4	93.8	85.0	90	90.8
Moulting primaries	4.8	14.3	6.2	7.5	10	5.3
n	251	224	65	67	50	76
Mean index of PM moult for I > 0	14.5 s.d. = 8.4	18.4 s.d. = 12.9	7.25 s.d. = 3.8	31.7 s.d. = 19.5	23.0 s.d. = 3.1	36.4 s.d. = 16.7

Table 7. Percentages of adult Curlew Sandpipers with extent of breeding plumage in three categories and mean intensities of body moult score by pentades, for birds captured on the Azov–Black Sea coast during southward migration.

Pentades	40	41	44	45	46	47	48	51	52	53
Score <4	0	0	8.2	17.5	1.8	19.3	12.7	16.1	73.1	63.6
Score 4–5	11.1	24.6	40.7	40.4	85.2	61.4	58.7	71.4	15.4	25.5
Score 6–7	88.9	75.4	51.1	42.1	13.0	19.3	28.6	12.5	11.5	10.9
n	81	171	462	361	54	57	63	56	26	55
Mean moult score	1.3	1.4	1.7	1.3	1.9	1.5	1.7	2.0	0.9	–
Percentage birds not moulting	26.1	22.9	25.4	37.0	22.2	40.0	37.5	21.4	46.2	–
n	23	35	433	319	54	70	64	56	26	–

Table 8. Numbers of Curlew Sandpiper ringing recoveries for countries and seasons: *n* = total numbers of recoveries per country, S–S = birds both ringed and recovered during southward migration, S–N = birds ringed during southward migration and recovered during northward migration, N–S = ringed during northward migration and recovered during southward migration; N–N = birds both ringed and recovered during northward migration, N–nba = birds ringed during northward migration and recovered in nonbreeding areas, S–nba = ringed during southward migration and recovered in nonbreeding areas, nba–S = ringed in nonbreeding areas and recovered during southward migration, X = ringing date not known.

Country of ringing–country of recovery	*n*	Ringing season–recovery season							
		S–S	S–N	N–S	N–N	N–nba	S–nba	nba–S	X
Russia–Ukraine	1	–	–	1	–	–	–	–	–
Norway–Ukraine	4	–	2	–	–	–	–	–	2
Finland–Ukraine	3	1	2	–	–	–	–	–	–
Sweden–Ukraine	11	7	3	–	–	–	–	–	1
Poland–Ukraine	4	1	1	–	–	–	–	–	2
Germany–Ukraine	3	2	1	–	–	–	–	–	–
England–Ukraine	3	3	–	–	–	–	–	–	–
France–Ukraine	3	–	–	1	–	–	–	–	2
Spain–Ukraine	1	–	1	–	–	–	–	–	–
Ukraine–Spain	3	1	–	2	–	–	–	–	–
Hungary–Ukraine	2	–	–	–	–	–	–	–	2
Italy–Ukraine	6	–	–	2	4	–	–	–	–
Ukraine–Italy	4	–	1	–	3	–	–	–	–
Ukraine–Bulgaria	1	–	–	1	–	–	–	–	–
Ukraine–Greece	2	–	1	–	1	–	–	–	–
Tunisia–Ukraine	12	5	–	6	–	–	–	–	1
Ukraine–Tunisia	2	–	–	–	1	1	–	–	–
Morocco–Ukraine	3	3	–	–	–	–	–	–	–
Senegal–Ukraine	1	–	1	–	–	–	–	–	–
Ukraine–Benin	1	1	–	–	–	–	–	–	–
Ukraine–Mali	1	–	–	–	–	1	–	–	–
Sudan–Ukraine	1	–	–	–	–	–	–	1	–
Ukraine–Chad	1	–	–	–	–	–	1	–	–
Namibia–Ukraine	1	1	–	–	–	–	–	–	–
South Africa–Ukraine	4	1	–	–	–	–	–	3	–
Total	**78**	**26**	**13**	**13**	**9**	**2**	**1**	**4**	**10**
%		**33.3**	**16.6**	**16.6**	**11.5**	**2.6**	**1.3**	**5.1**	**12.8**

Table 9. Estimated total numbers of Curlew Sandpipers in the Azov–Black Sea area during northward and southward migrations.

Area	Max. counted totals on northward migration	Estimated totals on northward migration	Max. counted totals on southward migration	Estimated totals on southward migration
Danube–Dniester region	465	700*	180	?
Tiligul *liman*	106	500	3,250	3,000–4,000
Sivash	28,833	33,000*–66,000	72,410	130,000–160,000
Kerch peninsula	1,478	1,500–2,000*	?	?
limans in the Zaporozhie region	2,050	2,100–3,100*	4,250	4,500–5,000*

* simultaneously present birds, without estimation of turnover rate
? representative counts are not available for the whole area

areas in the Mediterranean Sea, avoiding the sea coast on both migrations, and using river valleys and water reservoirs. Similar timing of migration at inland and coastal sites supports this idea.

The Sivash is the major stronghold of migratory Curlew Sandpipers through Ukraine. The surveys suggested a minimum estimate of *c.*33,000 birds simultaneously present in the area on northward migration (Table 9). Taking into account that this corresponds to the first peak of migration, the high turnover rate and insufficient coverage of some Sivash wetlands, the total number of Curlew Sandpipers using the area in May can be doubled (66,000 birds). This fits well with the earlier estimate of Chernichko *et al*. (1991). Up to 95% of these concentrate on the saline lagoons of the central Sivash, where flocks of up to 13,000 birds occurred.

A simultaneous count in mid August 1998 produced 72,500 birds; calculations based on 10 years' observations suggested that a maximum of 113,300 birds which potentially can be simultaneously present in the area. Taking turnover into account, and considering the timing of male and female migration, there are an estimated 110,000–130,000 adults on southward migration. Because most juvenile Curlew Sandpipers migrate later, in the second half of August and September, we can add at least 20,000–30,000 birds based on irregular count data available for this period. Although a wide range of the Sivash wetlands were used by Curlew Sandpipers on southward migration, the largest numbers were in central Sivish.

Maximum totals obtained on northward migration at other coastal wetlands of the Azov–Black Sea coast add only 6,000–7,000 birds to the estimate for the Sivash area. Everywhere along this coast Curlew Sandpipers are more numerous during southward migration when water levels are lower and at least 10,000 birds occur in the *liman*s and bays of the area. The largest concentrations were found in Tiligul *liman* (3,250 birds) and some Azov *liman*s (up to 5,000). Unfortunately, some *liman*s of the Black Sea coast, especially in its north-eastern part, were not surveyed.

Migration patterns

On northward migration, males pass the Sivash earlier than females. This pattern was also found in Tunisia and may be related to the fact that the nonbreeding areas of females are farther south in Africa than that of males (Spiekman 1993, Wymenga 1990) and that females therefore reach the Azov–Black Sea area later. First arrivals in April are likely to be mostly males (unfortunately no representative catches were obtained for this period) and males form the bulk of the first wave of migration peaking in first decade of May. Most depart by mid May. From this time onwards females predominate in the catches and make up the second wave of migrants in the second part of May.

On southward migration, the first arrivals were usually recorded during second decade of July, at the same time both in continental and coastal Ukraine. Birds captured in the last decade of July in Tiligul *liman* were predominantly males. The proportion of females increased from the beginning of August; most females arrived in mid-August. Most females had departed by early September. The first juvenile birds were captured in early August in some years; by mid August, the proportion of juveniles in catches remained below 10% and increased steadily thereafter; from mid September onwards mostly juvenile birds were captured.

Weight and flight range

The average mass of Curlew Sandpipers during northward migration was low. This might be a bias in the catching method; for example, birds mistnetted in Egypt during northward migration were significantly lighter than those shot by a hunter; heavier birds were possibly less mobile thus less likely to be captured (Meininger & Schekkerman 1994). Another explanation for low masses might be a rapid turnover rate in the Sivash and few ready-to-go birds are caught. Both reasons might be operating. Curlew Sandpipers stopover in the Sivash in May for only five to six days (Khomenko in press); by the end of the stopover period they decrease nighttime feeding activity and return to the night-roosts before sunset. Because most birds were mistnetted on the way to the roost in darkness, we trapped mostly light birds, which foraged intensively until they could no longer see food items (Brine Shrimps).

The Black Sea area is thought to be the last refuelling station of the birds starting their migration from the West Africa or continuing after a stopover period in Mediterranean (Wymenga 1990). Our data suggest that most cannot reach the breeding grounds in one flight. The next possible staging area within the flight range seems to be the Caspian Sea region. Most Curlew Sandpipers have departed from the Sivash before mid May and do not arrive in the breeding grounds for a month (Tomkovich 1994a, Tomkovich & Soloviev 2006, pers. obs), but these birds seem to be as heavy (or rather as light) as those departing during the last decade of May and having about 20 days before arrival on the tundra. We infer that Curlew Sandpipers are likely to "hop" rather than "jump" (Piersma 1988), at least on the way between the Sivash and the breeding grounds.

A different strategy is used during southward migration. We infer, from the mass dynamics and moult, that males increase their body mass steadily to a departure mass above 80 g, and leave near the end of August. Their stopover is probably about one month. Most females arrive near the end of July, but in better condition than males, and increase body

mass above 80 g in about 15–20 days. Juvenile Curlew Sandpipers arrive in better condition as their arrival period progresses; the fluctuations of their maximum and median masses suggest that they stopover for about 10–15 days.

Moult and plumage

Most birds captured in May were in full breeding plumage. Only males in the end of the first decade of May showed more or less intensive moult of body feathers. They were also more advanced in plumage, because the largest percentage of birds in breeding plumage was observed in the end of the first decade of May. Females captured in the middle of May fell behind males in the development of breeding plumage (69.7% in breeding plumage), but at the beginning of the last decade of May 84.6% of them already have full breeding plumage. Females in the area at the end of May were less advanced in moult (60% were in breeding plumage and 25% were in transitional plumage). These are likely to be individuals that did not migrate to the breeding grounds.

Most Curlew Sandpipers (89%) were in breeding plumage at the beginning of southward migration. These proportions decreased steadily whereas body moult score increased. Most birds reached mainly nonbreeding plumage by mid September, after which body moult score decreased and the percentage of nonmoulting birds was largest (46%). Most birds (*c.*86%) left the Sivash staging area without intensive moult.

During southward migration a large proportion of male Curlew Sandpipers moulted from full breeding or transitional plumage into nonbreeding plumage during the last decade of July and the first decade of August. About 15% of them started primary moult in 44th pentade, whereas females, arriving in mid August mostly in transitional plumage, started primary moult later.

Ringing recoveries and migration routes

The available ringing recoveries suggest that Curlew Sandpipers staging in the Azov–Black Sea region may come from various sectors of the breeding range. Taking into account the relatively small numbers of Curlew Sandpipers counted along the Atlantic coast of Europe (Gromadzka 1985) and a small proportion of recoveries from South Africa, most birds on passage through this area are likely to migrate across the Mediterranean Sea to western Africa (Fig. 13).

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