

Autumn migration of the Broad-billed Sandpiper *Limicola falcinellus* on the southern Baltic Coast

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Broad-billed Sandpipers *Limicola falcinellus* were counted and trapped in Puck Bay on the southern Baltic coast in autumn. The number of arriving birds varied greatly between years. The observed pattern was not completely convergent with data gathered at Ottenby, Sweden, 220 km north of Puck Bay. It seems that within years these two stop-over sites might be used by different groups of migrants with the majority of birds that stopped in southern Sweden being able to fly over the Polish coast, making their next stop somewhere closer to the wintering grounds. Adult Broad-billed Sandpipers migrated in the second half of July, and juveniles in August and the first half of September. There were no significant differences in biometrics between adults and juveniles. Morphometric variables were not correlated with date in either age group. Hence, the assumption of earlier departure of females from the breeding grounds was not supported. On average, Broad-billed Sandpipers gained 1.6 g/day in body weight, with a maximum value of 4.0 g/day (from 29 g to 33 g after one day). The theoretical flight range of Broad-billed Sandpipers departing from the Puck Bay region ranged between 1,300 and 1,400 km. Thus, it seems that the majority of Broad-billed Sandpipers are able to reach the northern Black Sea coast, which is one of the most important stop-over sites, in one flight.

The Broad-billed Sandpiper *Limicola falcinellus* breeds in northern Scandinavia and northern Russia. The main wintering grounds of the western subspecies *L f falcinellus* spreads between the Red Sea and Sri Lanka, while the eastern subspecies *L f sibirica* winters in southeast Asia and Australia (Glutz von Blotzheim *et al* 1975, Cramp & Simmons 1983). Little is known about the migration routes or strategies of this species. In general, the western subspecies migrates south to southeast overland from its north European breeding grounds. The most important stop-over sites are the mudflats and saltmarshes of the northern Black Sea coasts at the base of the Crimea Peninsula (Sivash), where up to 6,000-7,500 birds have been recorded in spring and up to 2,700 in autumn (Chernichko *et al* 2001).

The Broad-billed Sandpiper rarely occurs west of the Baltic basin (Glutz von Blotzheim *et al* 1975). Unlike most other small wader species, which often occur in flocks of hundreds of individuals, the Broad-billed Sandpiper in autumn is almost exclusively found in groups of less than 10, although in slightly larger groups

in spring (Glutz von Blotzheim *et al* 1975, Tomialojc & Stawarczyk 2003). Only in Hungary is the Broad-billed Sandpiper recorded regularly in moderate numbers (Beretz & Sterbetz 1970). In Germany between 1960 and 1995 there were only 11 records of flocks of 10 or more birds (Dierschke 1997). In Poland the largest number was recorded in 1986 in southern Poland, where 96 birds were seen (Stawarczyk *et al* 1996), but this is an exception. Thus, collecting sufficient data on migration dynamics and biometry takes many years and is feasible only in the case of long-term fieldwork (eg Dierschke 1997, Waldenström & Lindström 2001) or at the few sites where this species concentrates in higher numbers (eg Gavrilov *et al* 1995, de Nobel *et al* 2001).

This study aims to present data on the biometrics and phenology of migration of Broad-billed Sandpipers migrating in autumn through the Puck Bay region. Special emphasis was placed on assessing the ability of birds to reach the main autumn stopover area on the northern Black Sea coast.

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METHODS

The study was conducted on the Puck Bay coast (54°45'N, 18°30'E) at three sites: in Jastarnia, at Rewa and in the surroundings of the Reda river mouth. These areas are important stopover sites for waterfowl and waders (Górski *et al* 1993, unpublished data). In the Reda river mouth, fieldwork took place on narrow sandy beaches and on temporary emerging sandy islets. The study area in Jastarnia consisted of a complex of wet and dry meadows, a communal sewage plant and a narrow strip of sandy beach. In Rewa research was conducted on a sandy peninsula approximately 1 km long. A more detailed description of the study area is given in Meissner & Remisiewicz (1998).

Daily counts of all waders were made in the Reda mouth at about midday, from 10 July to 29 September, in all seasons between 1996 and 2000. In 1993-1995 birds in this area were counted at least twice in each five-day period. To show migration dynamics the number of birds seen in a given day was expressed as the percent of the total number of birds counted each year. This made it possible to compare years more effectively. In all sites, waders were caught in walk-in traps (Meissner 1998a). During this study, 27 adult and 96 juvenile Broad-billed Sandpipers were ringed, and data were combined from the three ringing sites. Birds were aged according to criteria in Prater *et al* (1977). Wing length (maximum chord, Evans 1986), total head length (Green 1980), bill length (Prater *et al* 1977) and tarsus length (Svensson 1992) were measured. All measurements were taken to the nearest 0.1 mm with callipers, except wing length which was measured with accuracy of 1 mm using a stopped rule. Birds were also weighed to the nearest 1 g. Ringers were checked every year with respect to comparability of their measuring accuracy, according to the procedure described by Busse (2000).

To enable comparison with the results of Waldenström & Lindström (2001), the average lean body mass of the Broad-billed Sandpiper is assumed to be 30 g, and the rate of fuel deposition is described as a proportion of lean body mass. To assess the theoretical flight ranges, I used the equation given by Pennycuik (1975), assuming still air conditions. For this analysis, the body mass on the departure was taken as 42 g (median body mass of retraps at the last capture, $N = 22$, interquartile range = 6) and 46 g (mean body mass of the heaviest 10% of birds in the sample, $N = 21$, $SD = 1.7$). The body mass after arrival to the next destination was assumed to be 30 g.

RESULTS

Variation in numbers and migration dynamics

The number of Broad-billed Sandpipers stopping at Reda mouth varied greatly between years. Between 1996 and 2000, when daily counts were conducted, the highest daily mean was in 1995, but the highest numbers of birds were trapped in 1996 (Fig 1). In other seasons, less than 40 Broad-billed Sandpipers were counted and less than 20 were trapped. The numbers of trapped and counted birds in the Reda mouth were highly correlated (Spearman Rank Correlation Coefficient $r_s = 0.97$, $N = 5$, $P = 0.005$).

The earliest record was of three birds seen on 13 July 1998 and the latest was another three birds noted on 28 September 1995. Such late occurrence was, however, rather an exception because in other seasons there were no records after mid-September. Daily count data revealed two waves of migrants (Fig 2). Adults dominated within the first wave in the second half of July (Fig 3). The latest adult was caught on 22 August, although the median date of the latest record of an adult was 2 August ($N = 8$). Juveniles migrated in the second wave (Fig 3). The first juvenile was caught on 8 August, with an overall median date of 12 August, $N = 7$).

Biometrics

There were no statistical differences in linear measurements between adults and juveniles. The mean body mass at the first capture was almost the same in both age classes (Table 1). Total head length, bill length and wing length all showed bimodal distributions, while tarsus length and body mass at the first capture were unimodal (Fig 4). Linear biometric variables were not correlated with capture date for either age class (in both cases: $r < 0.20$, $p > 0.40$). The body mass of juveniles at first capture increased during the season ($r = 0.30$, $N = 94$, $P = 0.004$).

Length of stay, body mass change and theoretical flight range

During all years, four adult (15%) and 43 juvenile (45%) Broad-billed Sandpipers were caught more than once within a season. The time interval between the first and last captures varied between one and 17 days, with a median of five days.

Nearly all retrapped birds showed a body mass increase between the first and last captures. The one exception was a bird which maintained low mass for two weeks. On average, Broad-billed Sandpipers gained 1.6 g per day ($SD = 0.88$, $N = 40$) with a maximum gain of 4.0 g per day (from 29 g to 33 g after one day). Twelve out of

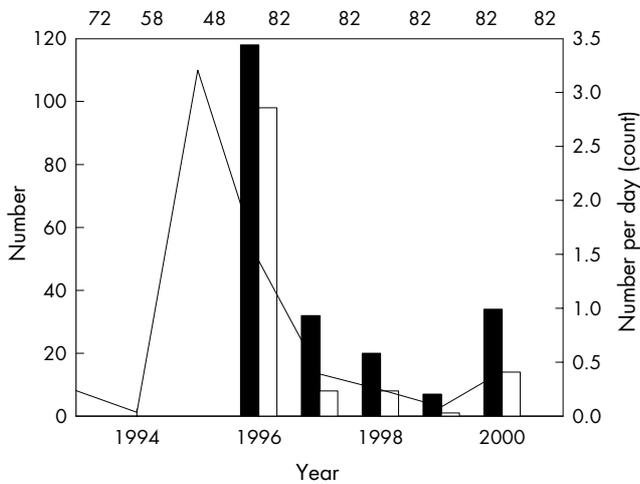


Figure 1. The total number of Broad-billed Sandpipers trapped (black bars, including retraps) and counted (open bars) at the mouth of the Reda river (RM) each season (10 Jul to 29 Sep). The line shows the mean daily number of birds counted between 1993 and 2000. Number of counts in each autumn are given above.

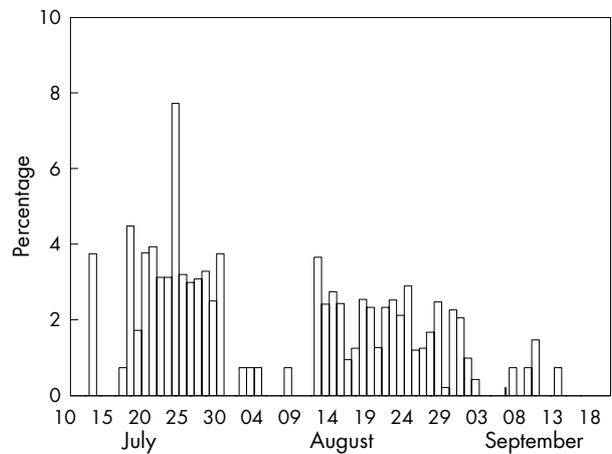


Figure 2. The pattern of daily migration of Broad-billed Sandpipers, expressed as the average percentage of the total number counted throughout the season, at the mouth of the Reda River in 1996-2000 (but excluding 1997).

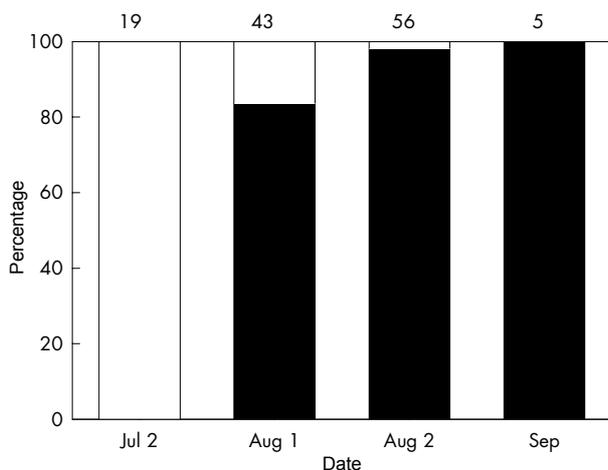


Figure 3. Percentage of adult (open bars) and juvenile (filled bars) birds among Broad-billed Sandpipers caught in the Puck Bay region in half-month periods and the whole of September. Sample sizes are shown above the bars.

Table 1. Comparison of mean measurements (mm) and body mass (g) at the first capture of juvenile and adult Broad-billed Sandpipers. The t-test compares the age classes.

Measurement	Adults			Juveniles			t-test	
	Mean	SD	N	Mean	SD	N	t	p
Total head length	52.24	2.04	16	52.45	2.15	61	-0.34	0.73
Bill length	30.64	1.80	16	31.03	1.92	61	-0.75	0.46
Tarsus length	22.36	0.74	8	22.01	0.80	55	not tested	
Wing length	108.1	3.95	20	108.1	3.06	94	-0.08	0.93
Body mass	33.7	4.62	27	33.9	5.61	94	0.16	0.87

23 retraps (52%) weighed more than 40 g on their last capture. Mean daily mass change was smaller on the first two days after initial capture, but on the third day it increased up to 5.4% of lean body mass (Fig 5). The highest recorded body mass increase was 13 g in 3 days, which corresponded to a mean gain of 4.3 g per day (14.4% of lean body mass).

The theoretical flight range of Broad-billed Sandpipers departing from the Puck Bay region ranged between 1,300 km and 1,400 km, depending on presumed body mass at take-off. This is equal to the distance between the Puck Bay and the northern coasts of the Black Sea.

DISCUSSION

The number of Broad-billed Sandpipers observed and ringed each autumn varied greatly. However, the observed pattern is not completely convergent with data gathered at Ottenby, Sweden, which is 220 km north of Puck Bay. In both sites, bird numbers were higher

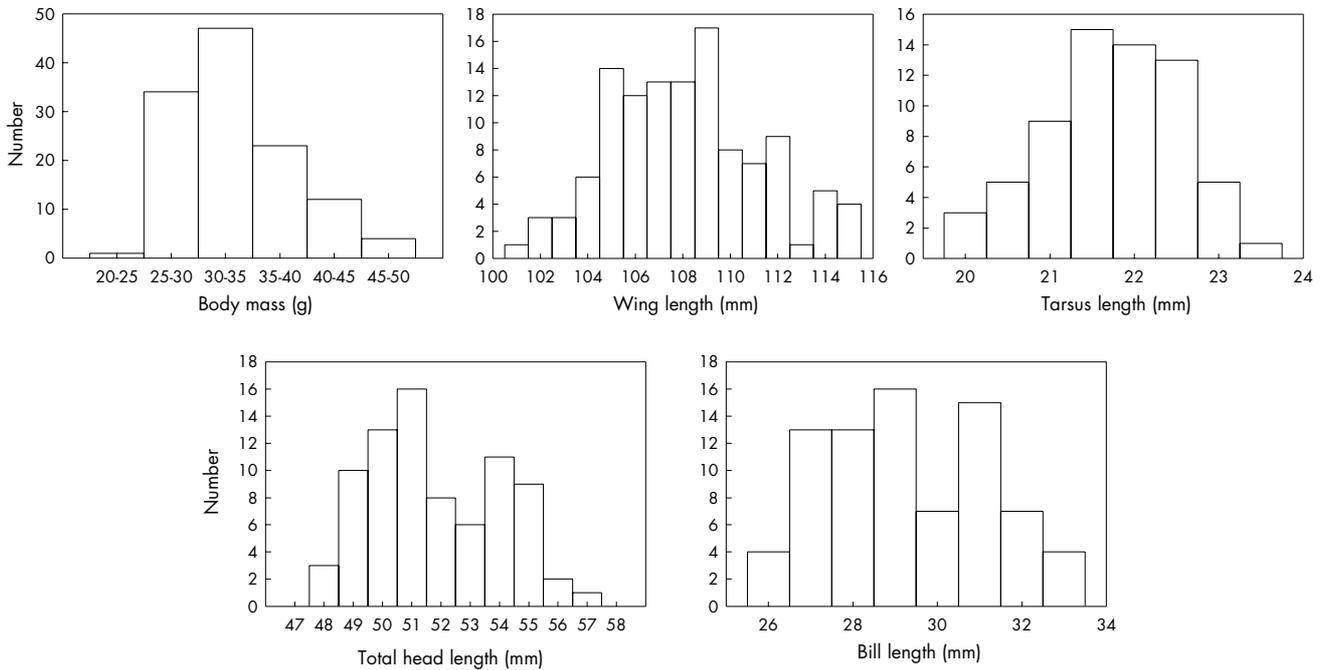


Figure 4. Frequency distributions of five measurements of body size of Broad-billed Sandpipers at the first capture in Puck Bay. Age classes were combined.

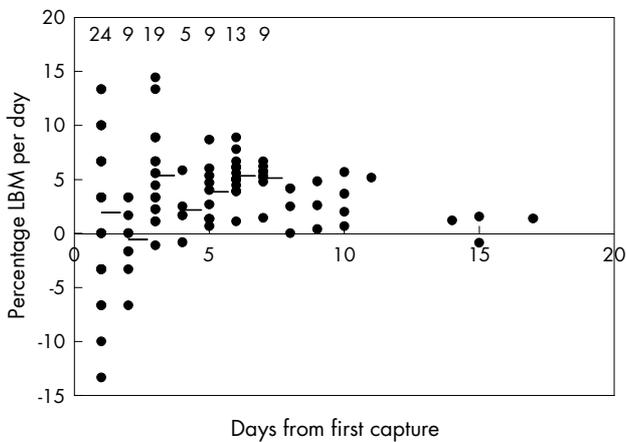


Figure 5. Changes in body mass (percentage of estimated lean body mass of 30 g) of retrapped Broad-billed Sandpipers. Horizontal lines indicate mean values for the first seven days following capture. Sample sizes are shown.

than usual in 1996, but a conspicuous peak in numbers observed in 2000 at Ottenby was not seen in Puck Bay. It is possible that within years, the two stopover sites might be used by different individual Broad-billed Sandpipers. The majority of birds that stopped in southern Sweden would have been able to continue their migration by flying over the Polish coast and not stopping until arrival near the wintering grounds.

Broad-billed Sandpipers arrived at the Reda mouth in two waves. Adults migrated in the second half of

July and juveniles in August and the first half of September. The same pattern was found in southern Finland (Lilja 1964), southern Sweden (Waldenström & Lindström 2001), in different parts of Germany (Dierschke 1997) and in Kazakhstan (Gavrilov *et al* 1995). This species migrates through northern and central Europe in the same brief period (Glutz von Blozheim *et al* 1975, Winkler & Herzig-Straschil 1981), which suggests a rapid migration.

Some published sources presented biometrical data obtained from museum specimens (Dementiev & Gladkov 1951, Kozlova 1962, Glutz von Blozheim *et al* 1975, Cramp & Simmons 1983), which suffer from the problem of skin shrinkage. Comparison of mean measurements of Broad-billed Sandpipers taken from live birds is given in Table 2. Data are inconsistent, despite the fact that the declared method of measuring was the same in all of these studies. Adults caught in southern Sweden were the largest, but mean measurements of juveniles from this site are surprisingly low. Differences in mean measurements of adults might be a result of a sex-biased sample, as in the case of the northern Black Sea coast, where mainly males were caught (de Nobel *et al* 2001). Thus, the mean wing length obtained in this site is low, but in the other sites the trapping period encompassed the whole migration duration and the samples should not be sex-biased. Low mean measurements of Broad-billed Sandpipers caught in Kazakhstan may suggest that there

Table 2. Comparison of mean measurements of Broad-billed Sandpipers caught during autumn migration in different regions of Europe and in Kazakhstan. Means obtained from sample sizes less than 30 birds are marked with asterisks.

Region	Adults		Juveniles		Reference
	Total head length	Wing length	Total head length	Wing length	
Kazakhstan		106.8		106.8	Gavrilov <i>et al</i> (1995)
Northern Black Sea	52.0	106.1	53.2	108.6	de Nobel <i>et al</i> (2001)
Gulf of Gdansk	52.2*	108.1*	52.5	108.1	This study
Southern Sweden	53.1	110.3	52.2	107.3	Waldenström & Lindström (2001)

is size variation within the breeding range of the nominate subspecies. On the other hand, the measuring method in this study is described as “maximum wing length” and might be different to maximum chord used in the other ringing sites.

In the eastern subspecies *L f sibirica* the female leaves the brood during chick rearing and only the male takes care of the chicks (Glutz von Blotzheim *et al* 1975, Cramp & Simmons 1983), but there are some doubts about the roles of the sexes in brood rearing in *L f falcinellus* which migrates through Europe. Brood patches were found in both sexes, thus both parents probably take part in incubation, although often only one parent is involved in chick care (Glutz von Blotzheim *et al* 1975, Cramp & Simmons 1983). Adult Broad-billed Sandpipers caught in Kazakhstan showed a slightly declining mean wing length with date, over the period of autumn migration (Gavrilov *et al* 1995), suggesting that females, being larger than males (Glutz von Blotzheim *et al* 1975), migrated earlier. However, similar to results obtained in southern Sweden (Waldenström & Lindström 2001), morphological variables in Puck Bay did not change significantly with the season. Hence, the assumption of earlier departure of females from breeding grounds was not supported, although future work could usefully explore the issue of sex-biased sampling at ringing sites, which is suggested in Table 2.

Body mass at the first capture was about 3-5 g lower than for birds at sites in southern Sweden (Waldenström & Lindström 2001), Finland (Glutz von Blotzheim *et al* 1975) and on the northern Black Sea coast (de Nobel *et al* 2001). Only juveniles caught in Kazakhstan had a similar average body mass to birds from Puck Bay. However, the mean body mass increase recorded in Puck Bay was greater than at other sites. In seven of 38 retraps (18%), the average daily mass increase exceeded the theoretical maximum gain (7.2%) calculated by Lindström (1991) for waders of this size. It indicates a very rapid fat accumulation in Broad-billed Sandpipers; higher than in the majority of wader species feeding

on Puck Bay at the same time (Meissner & Koziróg 2001, Krupa & Krupa 2002, Meissner 2003, WRG KULING unpublished data).

A decrease of body mass during the first days of stay is common in waders on passage (Mascher 1966, Meissner 1998b, Meissner & Koziróg 2001) and has been noted previously in the Broad-billed Sandpiper (Gavrilov *et al* 1995, Waldenström & Lindström 2001). It is likely that this phenomenon is due to the physiological transition between metabolising fat for energy on migration and depositing fat in preparation for the next section of the journey (Meissner 1998b, Meissner & Koziróg 2001).

The proportion of birds that were trapped more than once in Puck Bay was considerably greater for Broad-billed Sandpipers than for other wader species caught during the same period. Also, the median length of stay of birds which stopped for more than one day was slightly longer than in other species (Meissner 1997, Meissner 1998b, Meissner & W odarczak 1999, Meissner & Koziróg 2001). These facts, together with the high rate of fat gain, suggest that the majority of Broad-billed Sandpipers were able to make longer flights than other waders departing from the Puck Bay region. The calculated theoretical flight range should be treated as a minimum possible distance, because the formula used did not take into account the improved body-drag coefficient, which would increase the distance that a bird can fly with certain energetic reserves (Pennycuik *et al* 1996). Thus, it seems that the majority of Broad-billed Sandpipers are able to reach the northern Black Sea in one flight.

ACKNOWLEDGEMENTS

I am grateful to all colleagues from the Waterbird Research Group KULING, who helped during fieldwork. Special thanks to Norbert Pokorski and Darek Górecki for their enthusiastic effort in the trapping of Broad-billed Sandpipers in Reda mouth. This is contribution number 110 from WRG KULING.

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(MS received 30 August 2004; MS accepted 15 January 2005)