

BIOMETRICS OF THE DUNLIN (*Calidris alpina*)
MIGRATING IN AUTUMN ALONG
THE POLISH BALTIC COAST

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ABSTRACT

Meissner W., Krupa R. 2009. *Biometrics of the Dunlin (Calidris alpina) migrating in autumn along the Polish Baltic coast*. Ring 31, 1: 3-13.

The aim of this study is to present the general biometrical characteristics of Dunlins passing the Polish Baltic coast during autumn migration. Data were collected between the first week of July and the end of September in 1991-2002. Comparison of the mean wing lengths of Dunlins from different regions revealed that birds migrating through the Puck Bay had on average shorter wings than those trapped in areas located more south-easterly and clearly longer than those from Mauritania. In adults, seasonal variation of mean bill and wing lengths showed sigmoid pattern with larger birds in July at the beginning of migration and in mid-September. Such pattern is typical for this species, because females, which are larger than males, migrate earlier. Similar pattern of seasonal changes of mean bill and wing lengths might be noted in second-year birds. Juveniles caught in July must have belonged to local population of *C. a. shinzii*, which is smaller than the nominative subspecies. The sample of juvenile birds trapped in the beginning of August probably consisted of individuals from both subspecies, which resulted in the lower mean values of wing and bill lengths. Changes in the size of juveniles from year to year might be caused by differences in food availability on the breeding grounds, *e.g.* due to weather conditions.

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Key words: Dunlin, autumn migration, biometrical analysis, Puck Bay

INTRODUCTION

The Dunlin is the most numerous wader species migrating in autumn along the Baltic coasts (Kube and Struwe 1994, Meissner and Sikora 1995). Geographical variation within its Palaearctic part of breeding range received much attention (Glutz

von Blotzheim *et al.* 1975, Greenwood 1984, Tomkovich 1986, Browning 1991, Wenerberg *et al.* 1999). It is known that at least two subspecies migrate through the Baltic area: *C. a. shinzii* from local breeding population and *C. a. alpina* inhabiting vast area between Scandinavia and North Central Siberia (Glutz von Blotzheim *et al.* 1975). The eastern border of the Dunlin population migrating through Europe remains poorly known, but there is evidence that some birds may originate from as far east as the Taimyr Peninsula from the breeding area of subspecies *C. a. centralis* (Gromadzka 1985a, 1989; Goede *et al.* 1990).

Despite thousands of individuals measured in Europe (*e.g.* Gromadzka 1998, Meissner and Remisiewicz 1998) biometrical data can be found only in a few publications from Sweden (Mascher and Marcström 1976), Germany (OAG Münster 1976, Onnen 1991), France (Fuchs 1973) and Poland (Zajac 1980). However, in the majority of them only mean values were given without more comprehensive analyses.

The aim of this study is to present the general biometrical characteristics of Dunlins passing the Polish Baltic coast during autumn migration. Particular emphasis was put on inter- and intraseasonal variability of mean measurements of juvenile, second year and adult birds.

MATERIAL AND METHODS

Birds were caught mainly in walk-in traps at two ringing sites at the Puck Bay – the westernmost part of the Gulf of Gdańsk (Fig. 1) in 1991-2002. More detailed description of the study area was given elsewhere (Meissner and Remisiewicz 1998). The fieldwork started about the first week of July and finished at the end of September, except for 2002, when Dunlins were caught only during two weeks of September. The results of regular counts showed that this period covered the whole migration of

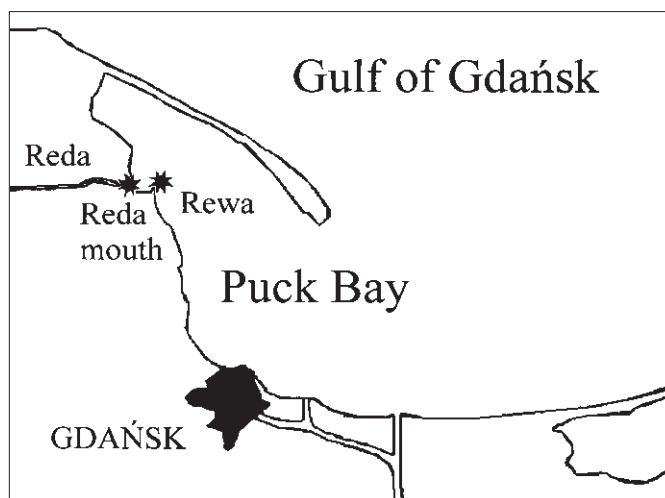


Fig. 1. The study area. Ringing sites are indicated by asterisks.

adults, while first-year birds were still present quite numerously in the study area in October (Meissner and Sikora 1995).

Each caught birds was aged according to Prater *et al.* (1977) and Gromadzka (1985b). Three age classes were distinguished: first-year, second-year and adult (older than 2 years) birds. Some late migrating second-year birds which finished moult of inner median coverts into winter plumage might have been included into category "adults". It is impossible to assess the number of such individuals, but probably this had no important influence on obtained results, because on average the second-year birds migrate earlier than adults (Meissner and Strzałkowska 2006). These two age categories were easily distinguishable up to the end of August, while in September the number of Dunlins older than 1 year was very low.

Lengths of bill, head with bill, and tarsus were measured with callipers with accuracy 0.1 mm, while wing and tarsus plus toe lengths were measured with a stopped rule to the nearest 1 mm (see Meissner 2000 for details). In adult and second-year birds the stage of primary moult was assessed according to Ashmole (1962). To show seasonal variability of mean measurements, the standard five-days period (pentade) scheme was used (Berthold 1973).

Every year the accuracy and repeatability of measurements taken by different ringers were checked as described by Busse (2000). Statistical analysis was done in STATISTICA 8.0 software (StatSoft 2007).

RESULTS

Among second-year and adult birds there were individuals with old worn and new freshly moulted outer primaries. Nevertheless, differences in the mean wing length between Dunlins with old and new flight feathers were insignificant both in second-year birds (t -test: $t = 0.57$, $p = 0.57$) and adults (Cochran-Cox test: $t' = 0.68$, $p = 0.50$). Thus birds with old and new outer primaries were treated jointly in all analyses.

Juveniles, second-years and adults differed significantly in the mean total head, bill, tarsus, tarsus plus toe and wing lengths (ANOVA, see Table 1 for details). However, only in the tarsus and wing lengths significant differences were found among all three age groups (Tuckey *post-hoc* test at $p < 0.05$). Juveniles had the shortest while adults the longest tarsus (Table 1). For the wing length the highest mean value was found in juveniles, intermediate in adults and the lowest in second-year birds (Table 1). Juveniles had shorter total head but longer tarsus plus toe length than adult and second-year birds and shorter bill length than second year birds (Table 1). There were no significant differences in means of these measurements between adult and second-year birds.

There was clear bimodality in distributions of wing length, total head length and bill length in adult and second-year birds (Fig. 2 and 3). Lengths of bill and total head of adults are clearly right-skewed (coefficient of skewness 0.20 and 0.16, respectively), while distributions of other measurements were almost symmetrical (coefficient of skewness < 0.10 in all cases). In juveniles, wing, bill and total head length distributions showed two peaks (Fig. 2 and 3).

Table 1

Comparison of mean measurements among juveniles, immatures (second-year birds) and adults of Dunlins caught at the Puck Bay during autumn migration. The mean, standard deviation (*SD*) and sample size (*N*) are given. Values in bold differ significantly from other(s) according to the *post-hoc* Tukey test at $p < 0.05$.

Measurement	Juveniles			Immatures			Adults			ANOVA
	Mean	<i>SD</i>	<i>N</i>	Mean	<i>SD</i>	<i>N</i>	Mean	<i>SD</i>	<i>N</i>	
Total head	56.89	2.76	9550	57.14	2.80	2178	57.06	2.67	4868	$F = 11.28$ $p < 0.0001$
Bill	33.10	2.53	9540	33.29	2.51	2175	33.14	2.43	4876	$F = 5.40$ $p = 0.0045$
Tarsus	25.17	0.98	8194	25.25	0.98	1689	25.37	0.97	3937	$F = 56.02$ $p < 0.0001$
Tarsus+toe	47.69	1.77	3147	47.35	1.80	657	47.44	1.77	1424	$F = 16.58$ $p < 0.0001$
Wing	121.0	2.96	9563	118.8	3.03	1465	119.3	3.10	4096	$F = 648.32$ $p < 0.0001$

There were significant differences among the means of all measurements in following five-day periods (pentades) (ANOVA: $p < 0.05$ in all cases). Data on the bill and wing lengths were chosen to show intraseasonal variation in size of Dunlins passing the study area. Bill length is known to be the best skeletal measurement for sexing the Dunlin (Brennan *et al.* 1984, Meissner 2005, Meissner and Pilacka 2008), while wing length in wader studies is often used as an indicator of birds' structural size (*e.g.* Hedenström 2004, Dale *et al.* 2007, Lehnen and Kremetz 2007). In adults, seasonal variation of the mean bill and wing lengths showed sigmoid pattern with larger birds in July at the beginning of migration and in mid-September (Fig. 4). The same pattern was found in second-year birds at least in July and August. Juveniles, which were caught in small numbers early in the season, had much shorter bill and wing lengths (Fig. 4). During the main migrating period (from mid August onwards) the variation in mean measurements in following five-day periods was rather small.

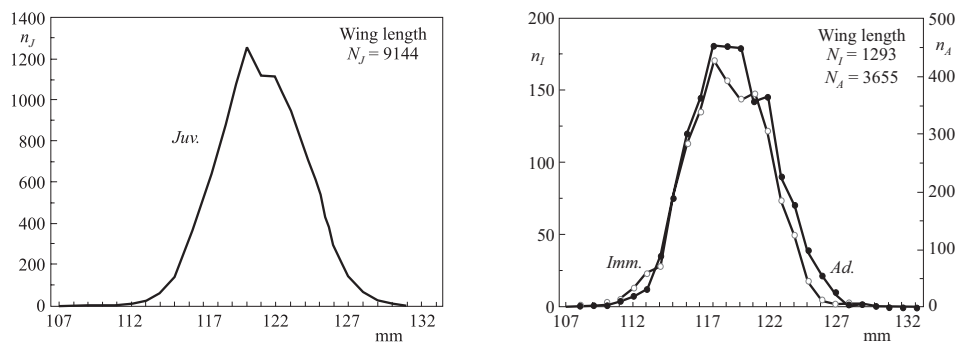


Fig. 2. Distribution of wing lengths of juvenile (*Juv.*), second year (*Imm.*) and adult (*Ad.*) Dunlins caught at the Puck Bay during autumn migration. Data smoothed by moving average.

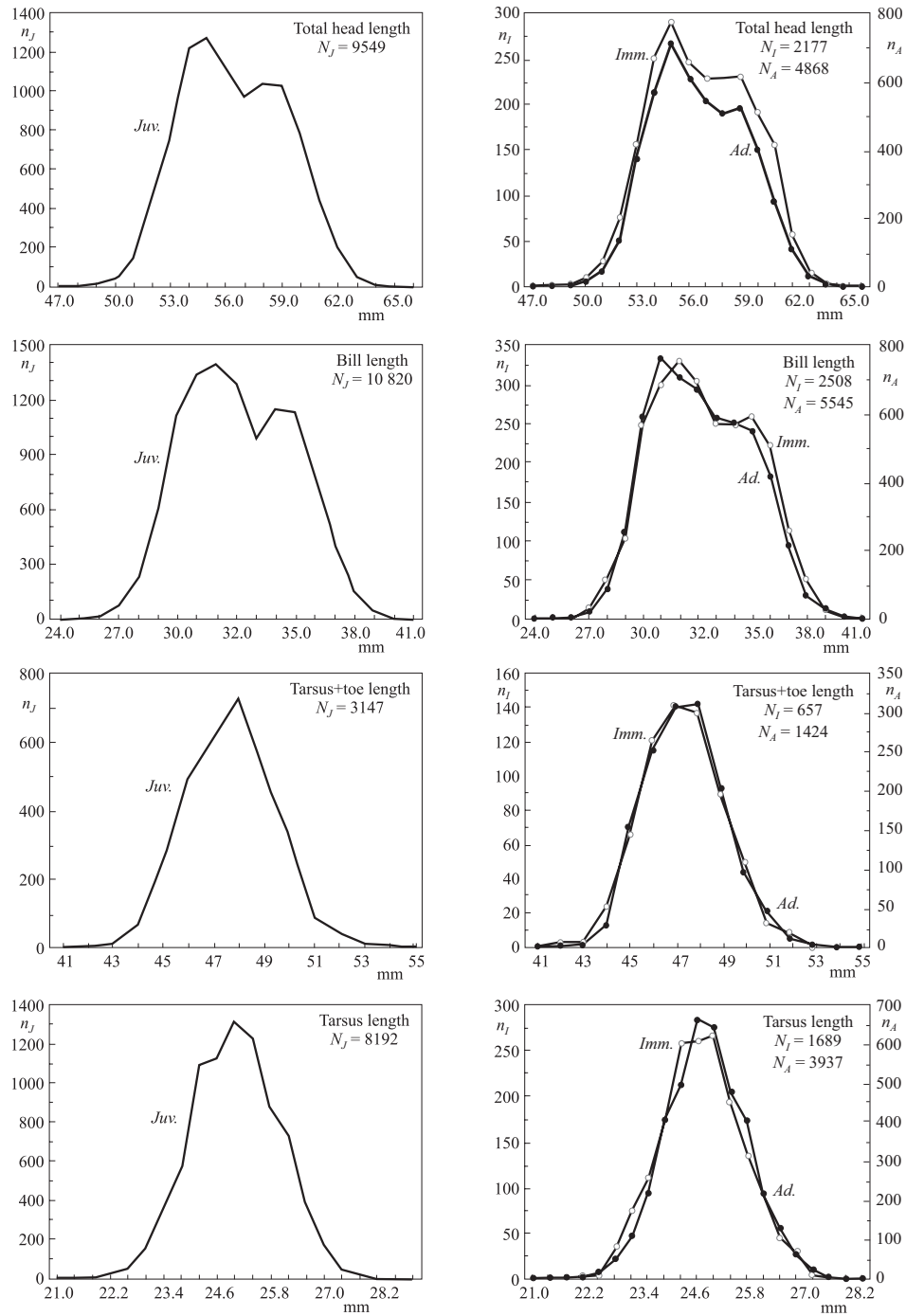


Fig. 3. Distribution of some measurements of juvenile (*Juv.*), second year (*Imm.*) and adult (*Ad.*) Dunlins caught at the Puck Bay during autumn migration. Data smoothed by moving average.

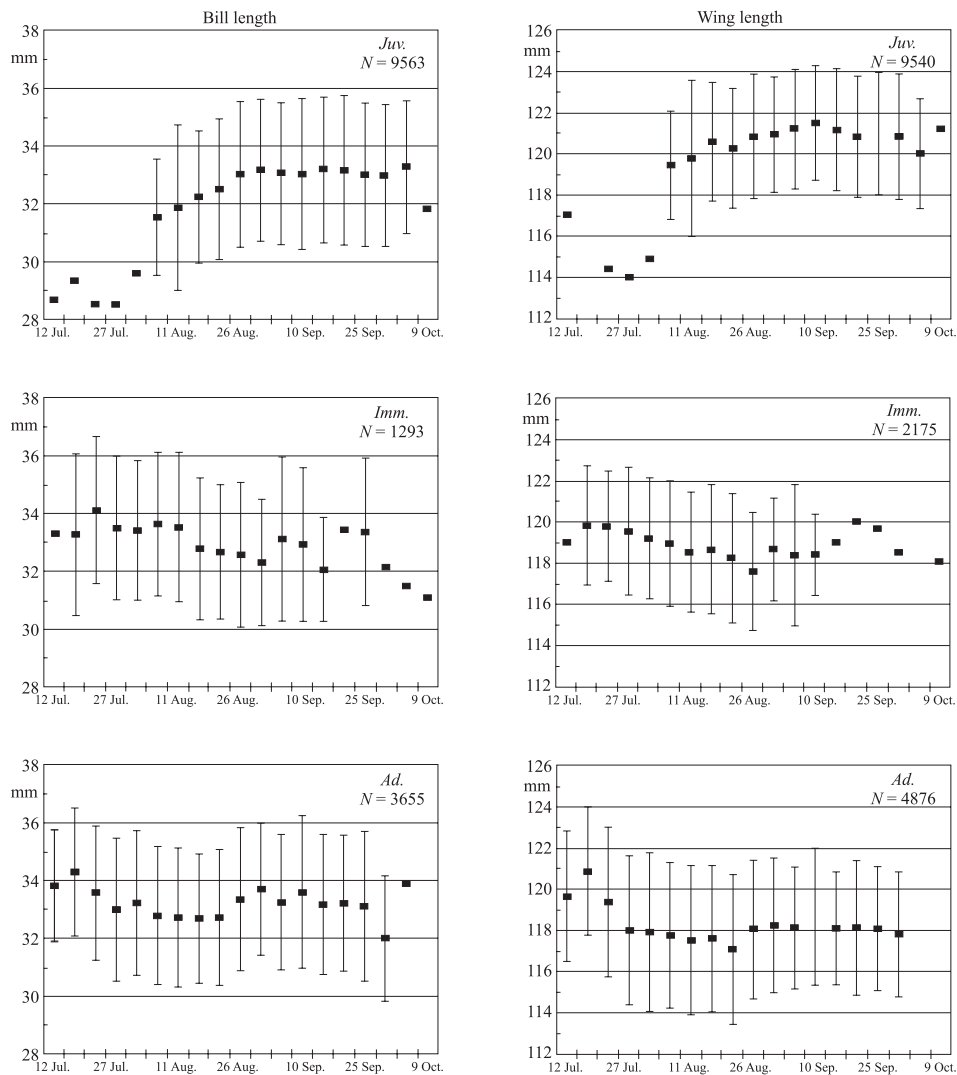


Fig. 4. Changes of mean bill and wing lengths in following five-day periods (pentades) of autumn migration in juvenile (*Juv.*), second-year (*Imm.*) and adult (*Ad.*) Dunlins. Markers – mean values, vertical lines – standard deviations (\pm SD). Total sample sizes are given. For subsample sizes less than 10 only mean values are given.

There is no indication that in this species juvenile males and females migrate separately, whereas in adult and second year birds males migrate on average later than females (Zajac 1980). Thus, the yearly mean measurements of adult birds might be biased due to differences in catching effort in different parts of the migration period. That is why the interseasonal variation in mean measurements of Dunlins was analysed only for juvenile birds. There was significant variation among seasons in the means of total head (ANOVA: $F_{11,9538} = 29.02, p < 0.001$), bill (ANOVA: $F_{11,9528} = 34.82,$

$p < 0.001$), tarsus (ANOVA: $F_{9,8184} = 42.88$, $p < 0.001$) and wing (ANOVA: $F_{9,9251} = 6.43$, $p < 0.001$) lengths in juvenile Dunlins. Interseasonal variability of the total head, bill and tarsus lengths had similar pattern with higher and lower mean values in the same seasons. Thus, there was strong correlation between the yearly means of total head and tarsus lengths ($r = 0.84$, $p = 0.004$, Fig. 5) as well as of bill and tarsus lengths ($r = 0.75$, $p = 0.02$). However, there was no relationship between the total head and wing lengths ($r = 0.59$, $p = 0.09$, Fig. 5), nor between bill and wing lengths ($r = 0.60$, $p = 0.09$).

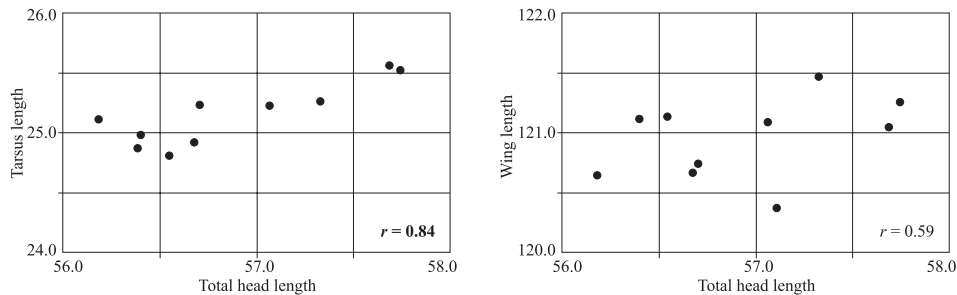


Fig. 5. Correlations between yearly mean measurements of juvenile Dunlins caught at the Puck Bay. Significant correlation coefficient in bold.

DISCUSSION

Comparison of mean wing lengths of Dunlins from different regions revealed that birds migrating through the Puck Bay had on average shorter wings than those trapped in areas located more south-easterly and clearly longer than those from Mauritania (Fig. 6). Although wintering grounds of different Dunlin populations considerably overlap in the Palaearctic, there is a clear tendency for birds from more western breeding sites to winter in more western areas than birds from eastern part of the range (Greenwood 1984, Wennerberg 2001). It seems that larger birds caught during migration in Greece and Bahrain came from more eastern breeding grounds, which was also supported by results of mtDNA analyses (Wennerberg 2001). It should be noted that in this species the difference in the beginning of egg laying along the east-west gradient of Arctic Russia reaches three weeks (Holmgren *et al.* 2001) and eastern populations begin migration after primary moult – later than those breeding more westerly (Glutz von Blotzheim *et al.* 1975, Gromadzka 1989). Vast majority of adults arriving to the study area in late August and September showed some features, such as colouration of inner primaries and wing coverts or finished moult of all flight feathers, typical for Dunlins inhabiting more eastern parts of the Siberian breeding range (Gromadzka 1989). This suggests that these birds may come from the eastern part of *C. a. alpina* or from the *C. a. centralis* breeding range. Thus, it seems that apart from *C. a. shinzii* there are two groups of Dunlins passing southern Baltic in autumn: birds from the western part of *C. a. alpina* breeding range, which migrate

earlier, and birds breeding further east, arriving later to the study area. Hence, the reason for a remarkable range of wing lengths in adult Dunlins (Fig. 6) is probably the fact that the analysed sample consisted of birds from a vast area, which differed in biometrics.

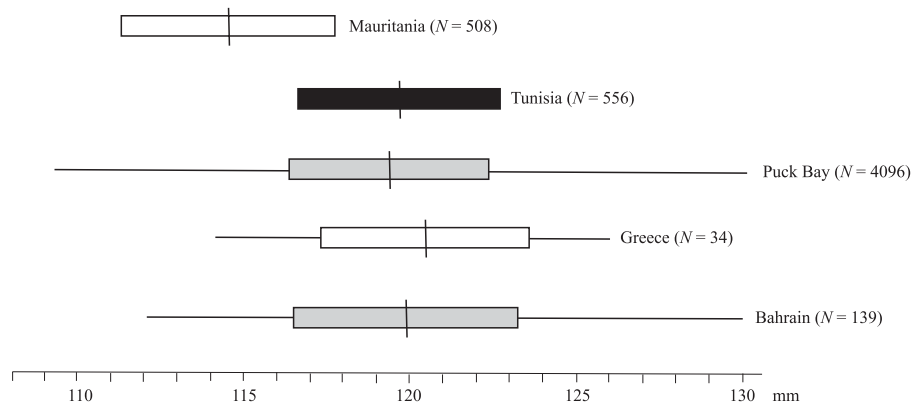


Fig. 6. Comparison of wing lengths of adult Dunlins caught at different sites. Vertical lines – mean values, rectangles – standard deviations ($\pm SD$), horizontal lines – ranges. Data from autumn and early winter (grey), from winter (black) and spring (white), after Meininger *et al.* (1987), Wymenga *et al.* (1990), Hirschfeld *et al.* (1992), van der Have *et al.* (1997) and this study.

In adults and second-year birds a not very clear bimodality in bill length, which is the best measurement to separate sexes in Dunlin, may be caused by the presence of birds from different geographical populations in the analysed sample. The studied period covered almost the whole period of adult and second-year birds migration, but only a little more than a half of the total period of juveniles passage (Meissner and Sikora 1995). Thus, probably the sample of juveniles was more homogeneous regarding population structure, because it consisted almost exclusively of the earlier migrants. Similar results were obtained by Onnen (1991) in northern Germany, where only bill and wing lengths of juvenile birds showed bimodal distribution.

The pattern of seasonal changes of the mean bill length in July and August described earlier by Zajac (1980) was caused by different migration time of both sexes. Females, which are larger than males, migrate earlier, when majority of males still remain in breeding grounds rearing chicks (Glutz von Blotzheim *et al.* 1975). Gradual increase of the mean bill length from the third decade of August and decrease in the end of September suggest that in this period adults from other than *C. a. shinzii* population passed the study area with larger females migrating earlier than males. As it was mentioned earlier, majority of these birds had finished primary moult and had “adult-buff” coverts, which were different from the earlier migrants. Similar pattern of seasonal changes of the mean bill and wing lengths was noted in the second-year birds. However, second-year Dunlins usually migrate somewhat earlier than older birds (Meissner and Strzałkowska 2006). The variation of mean measurements can indicate that a large part of these birds also take part in breeding. Gromadzka (1989)

claimed that the most of second-year Dunlins caught at the Polish Baltic coast in July and August had well developed incubation patches, implying that they at least started preparing to breed.

Juveniles caught in July must have been originating from local, Baltic population of *C. a. shinzii*, which is smaller than the nominative subspecies. In the first half of August, at the beginning of the main migration period of juvenile birds, their mean measurements were still lower than in the later stage of the passage. The same pattern was found in north-western Germany, where juveniles caught in August had also much shorter bill and wing lengths in comparison with birds from September (OAG Münster 1976). Juvenile birds from *C. a. shinzii* leave Baltic in the first half of August at the latest (Glutz von Blotzheim *et al.* 1975), thus the sample of birds trapped in the beginning of August might have consisted of individuals from both subspecies and this resulted in lower mean values of wing and bill lengths.

In Dunlin, females are larger than males. This difference is also well pronounced in juveniles (Meissner 2005). Therefore, the variation in measurements from year to year might result from changes in sex ratio. However, there is no evidence that autumn juvenile sex ratios vary between years or that birds of one sex are more likely to be caught than the other or that there are any between-sex differences in migration phenology. Moreover, the frequency distributions of bill measurements plotted separately for each year are bimodal and quite symmetrical suggesting that there is no skewing of sex ratios. Changes in the size of juveniles from year to year were described in other wader species (Meissner 1997, 2004; Meissner and Górecki 2006) and probably were caused by differences in food availability on the breeding grounds, *e.g.* due to weather conditions (Pearce-Higgins and Yalden 2002, Schekkerman *et al.* 2003). Bad weather can reduce insect availability in the Arctic (Hodkinson *et al.* 1996) and cause a reduction in the size of juveniles, because chicks fed with less food grow more slowly and reach a smaller size (Kersten and Brenninkmeijer 1995).

The bill, total head and tarsus lengths are skeletal measurements, while the value of wing length depends almost exclusively on feathers length. It is known that low food availability during the whole feather growth period may reduce wing length (Pehrsson 1987). Analysing correlations between these parameters (see Fig. 5), it seems that in a given season other factors had an influence on wing growth than on skeletal measurements.

ACKNOWLEDGEMENTS

We are grateful to all the colleagues from the WRG KULING ringing team, who helped in the fieldwork, especially to Maciej Kozakiewicz, Anna Włodarczak-Komościńska, Magdalena Remisiewicz, Dariusz Górecki, Cezary Wójcik, Norbert Pokorski, Mateusz Ściborski, Piotr Zięćik, Piotr Rydzkowski and Marcin Polak, who collected a lot of data used for this publication. This is the paper of the Waterbird Research Group KULING no 134.

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