

# BIOMETRICS AND PRIMARY MOULT OF THE GREY PLOVER (*Pluvialis squatarola*) CAUGHT DURING AUTUMN MIGRATION THROUGH THE PUCK BAY\*

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## ABSTRACT

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Biometrics and primary moult of the Grey Plover were studied at the Gulf of Gdańsk coast (Poland) in years 1983-1995, from mid-July to the end of September. A total of 402 birds was caught, including 273 adults, within which 95 females and 95 males were identified. All measurements of adults were significantly larger than measurements of juveniles. Females had significantly longer wing and bill and lower total head length than males. On average, adults were significantly heavier than juveniles, and females were heavier than males. Adult Grey Plovers migrating from the end of July to mid-August had significantly longer wings and bills than those migrating from the second half of August to mid-September. This fact was a result of the earlier females' migration. 17.9% of migrating adults had already started moult of first to third (in one case fourth) primaries. 25.3% males and 14.7% females started moult, but this difference was not significant.

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**Key words:** Grey Plover, *Pluvialis squatarola*, moult, biometrics, migration

## INTRODUCTION

The Grey Plover breeds in the northern parts of Nearctic and Palearctic regions, between 66° a 75° of northern latitude (Glutz von Blotzheim *et al.* 1975, Cramp and Simmons 1983). The southern Baltic coast is situated on the relatively well known migration route, which proceeds from western Siberia to western Africa through the coast of western Europe (Branson and Minton 1976; Meltofte 1987, 1993; Meininger and van Swelm 1989; Hötter and Kölsch 1993; Krupa 1997).

The data about primary moult of adult Grey Plover based on the large samples of caught birds came especially from Branson and Minton (1976). These authors

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stated that 25-40% birds coming to Wash Bay (E England) had suspended primary moult. However, Gromadzka and Serra (1998) showed that at least a part of birds started the moult of primaries at the early stage of migration (N Poland) having begun the moult at the breeding grounds (Cramp and Simmons 1983, Hötker 1995).

This study aims mainly to describe the biometrics of Grey Plovers migrating through the Puck Bay and to present the data about the moult of primaries.

## METHODS

The studies were carried out by Waterbird Research Group KULING in years 1983-1995, from mid-July to the end of September (in 1983 – only to mid-September).

The study area included three sites at the Puck Bay coast, in the western part of the Gulf of Gdańsk (Fig. 1): at Jastarnia (a mixture of communal sewage plant, dry and wet meadows and a narrow stripe of beach), at Rewa (a narrow sandy peninsula, about 1 km long) and at the mouth of the Reda river (a sandy beach and periodically emerging sandy islands). More detailed description of the study area can be found in other papers (Brewka *et al.* 1987, Sikora and Meissner 1992, Meissner and Sikora 1995, Krupa 1997).

Waders were caught in walk-in traps (Meissner 1998a). The traps were checked every two hours from dawn to dusk, and also at night if the birds were feeding inten-

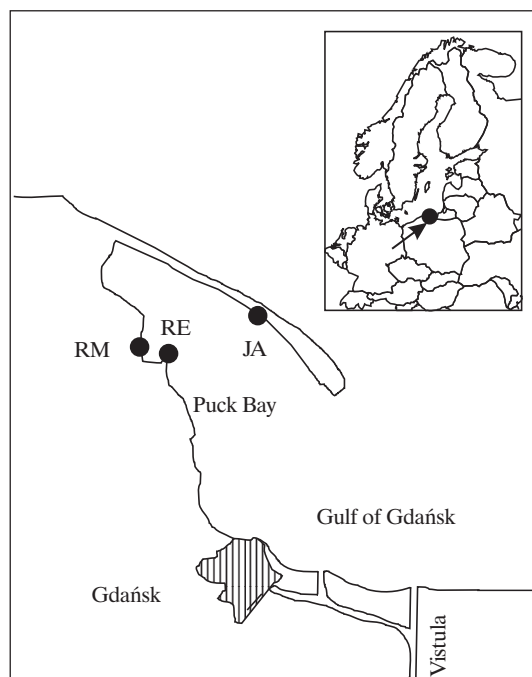


Fig. 1. Study area. RM – Reda mouth, JA – Jastarnia, RE – Rewa.

sively, especially during a full moon. The traps were frequently moved because of changes of water level. Birds were ringed and aged, and when it was possible their sex was determined according to plumage characters (Prater *et al.* 1977). The sex of adult birds was determined only when their plumage's coloration was in complete accordance with the guide (Prater *et al.* 1977) – if determining was questionable, we gave it up.

Wing length (maximum chord – Evans 1986) was measured to the nearest 1 mm using a ruler with a stop. Total head length (Green 1980), bill length and tarsus length (Prater *et al.* 1977) were also measured. These measurements were taken with callipers to the nearest 0.1 mm. Birds were also weighed to the nearest 2 g with a Pesola spring balance.

To describe the trapping patterns only the first catching of each individual was registered. Data were pooled into 5-day periods – pentades (Berthold 1973), and in the analysis of biometrics differences among birds migrating in different time, decades (joined pentades) were used.

Only birds staying at the study area, for which the time span between trapping in subsequent days was not shorter than 17 hours, were used to analysis of the body mass changes (Meissner 1997a).

In adult birds the primary moult was recorded in the 5-score scale: 0 – old feather, 1 – feather missing or feather in pin, 2-4 – following stages of growing feather, 5 – full grown new feather (Ashmole 1962).

The significance of differences between juvenile and adult birds was tested using the parametric *t*-test and nonparametric Mann-Whitney *U*-test. The significance of differences between adult birds caught by us and by other authors was tested using the *t*-test, and among birds migrating in subsequent periods by the one-way ANOVA (Zar 1996).

## RESULTS

In years 1983-1995, a total of 129 juvenile and 273 adult Grey Plovers were caught and measured. 95 females and 95 males were determined. The measurements from all three study sites did not differ significantly (*t*-test,  $p > 0.05$ ), so the data were analysed together. Trapping patterns were also presented for all the study sites together.

### Trapping patterns

The seasonal catching dynamics showed a clear segregation between the time of migration of adult and juvenile Grey Plovers (Fig. 2). The first adult bird was caught at the beginning of July, and the first juvenile birds – in mid-August. The catching dynamics of young birds was unimodal and peaked between 13 and 25 September. The catching dynamics of adult birds was bimodal and peaked in periods: 14-23 August and 3-12 September. The peak of females' catching was in the second half of

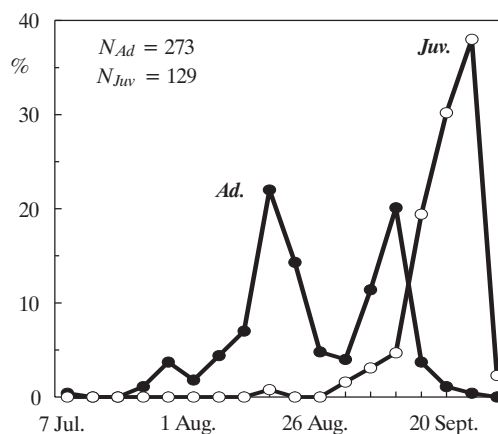


Fig. 2. Seasonal trapping dynamics of adult (Ad.) and juvenile (Juv.) Grey Plovers

August. The catching dynamics of males was bimodal, it showed a clear peak in the second half of August and later the number of birds increased again in the first half of September (Fig. 3).

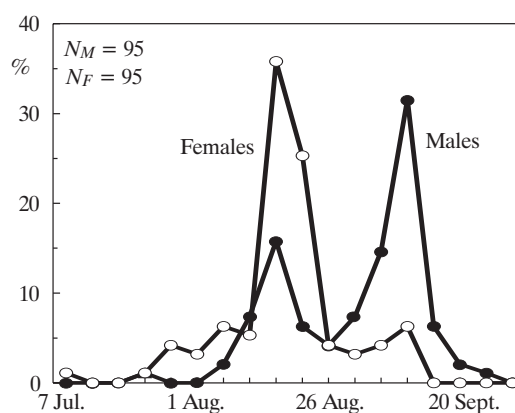


Fig. 3. Seasonal trapping dynamics of adult male and female Grey Plovers

The daily catching dynamics of juvenile and adult birds did not differ significantly (Kolmogorov-Smirnov test:  $d = 0.079$ ,  $p > 0.05$ ).

### Biometrics

Adults had significantly higher wing, total head, bill and tarsus lengths than juveniles (Table 1). The body mass of Grey Plovers varied from 125 g to 300 g. Adults were on average significantly heavier than juveniles. In females, wing and bill lengths were significantly higher than in males, and the total head length was significantly lower than in males (Table 2). Females weighed significantly more than males. Only the tarsus length did not differ significantly between sexes. Distribu-

tions of the majority of measurements (except for juvenile body mass), were unimodal.

Table 1  
Comparison of measurements of juvenile and adult Grey Plovers.  
*U* – results of Mann-Whitney test, *t* – results of *t*-test

Measurement	Juveniles			Adults			Test	<i>p</i>
	Mean	<i>SD</i>	<i>N</i>	Mean	<i>SD</i>	<i>N</i>		
Total head length	66.14	2.00	121	67.66	2.02	257	<i>U</i> = 7.08	< <b>0.01</b>
Bill length	28.07	1.28	117	29.57	1.54	256	<i>t</i> = 9.18	< <b>0.001</b>
Tarsus length	46.79	2.00	78	47.56	1.78	193	<i>t</i> = 3.14	< <b>0.01</b>
Wing length	196.1	4.4	118	202.4	4.7	207	<i>t</i> = 11.92	< <b>0.001</b>
Body mass	180.8	18.3	125	192.5	27.1	265	<i>U</i> = 3.52	< <b>0.01</b>

Table 2  
Comparison of measurements of adult female and male Grey Plovers.  
*U* – results of Mann-Whitney test, *t* – results of *t*-test

Measurement	Females			Males			Test	<i>p</i>
	Mean	<i>SD</i>	<i>N</i>	Mean	<i>SD</i>	<i>N</i>		
Total head length	67.16	1.93	88	68.18	1.77	91	<i>t</i> = 3.66	< <b>0.001</b>
Bill length	29.80	1.40	89	29.25	1.38	87	<i>U</i> = 2.52	< <b>0.05</b>
Tarsus length	47.67	1.92	64	47.21	1.69	76	<i>t</i> = 1.48	<i>ns</i>
Wing length	203.2	4.4	70	201.3	4.3	74	<i>t</i> = 2.68	< <b>0.01</b>
Body mass	196.8	18.3	92	184.6	27.1	94	<i>U</i> = 2.99	< <b>0.01</b>

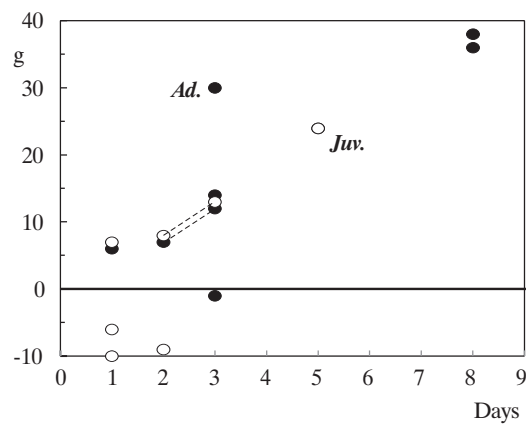


Fig. 4. Body mass changes of adult and juvenile Grey Plovers retrapped at the Puck Bay. The day and the body mass at first trapping is denoted as 0. Individuals retrapped twice are connected by dashed lines.

Changes in the body mass of birds retrapped at the study area (Fig. 4) varied from -10 g to +38 g (mean = 11.7,  $SD = 16.4$ ,  $N = 13$ ). Mean daily increase of the body mass was 2.1 g ( $SD = 5.7$ ), maximum daily increase was 10 g (in an adult bird from 192 g to 222 g after 3 days), and maximum daily body mass decrease was -10 g (in a juvenile bird from 186 g to 176 g after 1 day).

Adult Grey Plovers caught from the end of July to mid-August had significantly longer wings (ANOVA:  $F = 5.259$ ,  $p < 0.01$ ; Tukey test,  $p < 0.01$ ) and bills (ANOVA:  $F = 4.239$ ,  $p < 0.01$ ; Tukey test,  $p < 0.01$ ) than those caught between the second half of August and mid-September. Nevertheless, the tarsus length (ANOVA:  $F = 0.826$ ,  $p > 0.05$ ) and the total head length did not differ significantly (ANOVA:  $F = 2.114$ ,  $p > 0.05$ ) – see Fig. 5.

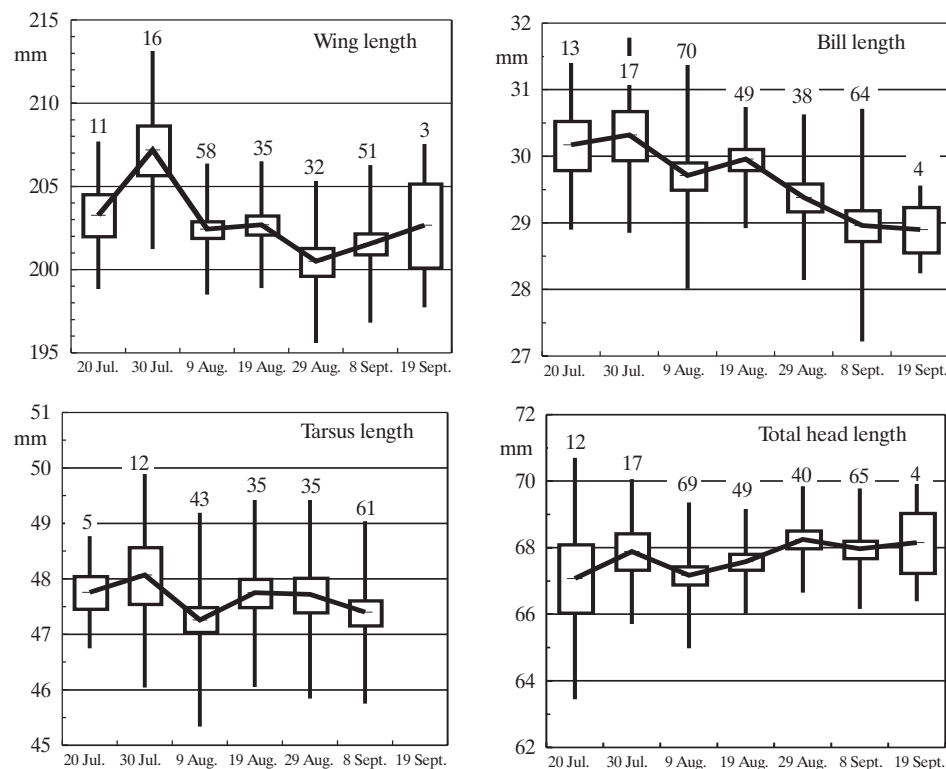


Fig. 5. Variability of measurements of adult Grey Plovers caught at the Puck Bay in subsequent decades. Horizontal line - mean value, rectangle – standard error (SE) and vertical lines – standard deviation (SD). Sample sizes are given above bars.

### Primary moult

Among the caught adults ( $N = 273$ ), 17.9% had started the moult of first to third (fourth in one case) primaries (Table 3). 14.3% of the birds were in suspended moult stages, and 3.7% in almost suspended moult stages (stages 4 or 4 and 5).

Table 3  
Primary score of moulting adult Grey Plovers caught  
in the Gulf of Gdańsk region

Primary score	$N_{ad.}$	Females	Males
4000000000	3	1	0
4400000000	1	0	1
5000000000	12	5	6
5400000000	4	1	2
5500000000	21	6	10
5540000000	1	0	0
5550000000	6	1	4
5554000000	1	0	1
Total moulting	49	14	24
Non-moulting	224	81	71

The first moulting birds (two males) were caught on 8 August, and the first moulting female – on 16 August. The percentage distribution of the moulting Grey Plovers in subsequent pentades showed two peaks in periods: 19-23 August and 8-12 September (Table 4). A difference between the percent of males (25.3%) and the percent of females (14.7%) that had started moult was nearly significant ( $\chi^2$ -test:  $\chi^2 = 3.29$ ,  $p = 0.07$ ).

Table 4  
The percent of primary moulting adult Grey Plovers in subsequent pentades

Pentade	Number of moulted primaries				Total	$N$
	1	2	3	4		
4-8 Aug.	0	8.3	8.3	0	16.7	12
9-13 Aug.	0	10.5	5.3	0	15.8	19
14-18 Aug.	5.0	5.0	3.3	1.7	15.0	60
19-23 Aug.	12.8	12.8	0	0	25.6	39
24-28 Aug.	0	7.7	0	0	7.7	13
29 Aug.-2 Sept.	0	0	9.1	0	9.1	11
3-7 Sept.	9.7	3.2	3.2	0	16.1	31
8-12 Sept.	7.3	20.0	1.8	0	29.1	55
13-17 Sept.	0	20.0	0	0	20.0	10

## DISCUSSION

The Grey Plover shows a clear time differentiation in the passage of adult and juvenile birds (Moltofte 1993, Moltofte *et al.* 1994, Gromadzka and Serra 1998). The trapping dynamics of adult and juvenile birds in our opinion corresponds with the migrating dynamics observed at the Puck Bay in 1984-1995 (Krupa 1997). The first peak of adult birds is composed mainly of the females, which leave the breeding grounds 2-3 weeks after hatching of the nestlings (Flint and Kondratiev 1977)

and probably of the males that lost broods. The males stay at the breeding grounds about 2 weeks longer than the females, as they take care of the chicks after fledging (Parmelee *et al.* 1967, Glutz von Blotzheim *et al.* 1975, Flint and Kondratiev 1977). The second peak of adult birds, observed about 2 weeks after the first one, shows that both sexes migrate in similar speed.

The mean wing length of Grey Plovers caught in subsequent pentades differed significantly. Birds migrating in the end of July had longer wings than birds migrating from the end of August to mid-September. Birds migrating in the second half of August had longer bills than birds migrating in the first half of September. Such distribution of measurements gives evidence of the earlier passage of females that are bigger than males (Table 2). It can be confirmed by data from breeding grounds (Exo and Stepanowa 2000). Engelmoer and Roselaar (1988) stated that females had longer wings but shorter bills than males. On the other hand, Grey Plover' males from the population breeding on Lake Pronchishcheva (NE Taimyr) were on average bigger than females (Schekkerman and van Roomen 1995). During migration most of the authors did not determine the sex of adult birds, except for Prokosch (1988), who did not find significant differences between males and females. The great discrepancies in the published data result from small samples of measured birds, and probably from comparing of different Grey Plover populations.

It is worth to note that the average total head length of adult females was significantly lower, while their bill length was significantly higher than in males. It indicates that males and females caught differed from each other in the proportions of skull. These differences can be characteristic for the females and the males of this species. Such differences can be also inter-population differences or both these factors can appear together. It is possible that we caught males and females originated from different populations.

We did not find a difference between sexes in the tarsus length, although Engelmoer *et al.* (1984) and Exo and Stepanowa (2000) found that the tarsus length has the highest discriminatory power to distinguish sexes.

Adult birds caught at the Puck Bay had significantly longer wing than birds caught at the Vistula mouth, in England and in Guinea Bissau, but shorter than birds wintering in Italy and India (Table 5). In both latter cases the differences result from comparison with Grey Plover's population which arrive to these wintering grounds from eastern Siberia. Besides, in the case of Italy, birds taken into consideration had already finished primary moult (Serra and Rusticali 1998, Balachandran *et al.* 2000).

The average bill length of birds caught by us was significantly shorter than birds caught in England, Tunisia, Guinea Bissau and in India, however did not significantly differ from birds caught at the Vistula mouth, in Germany and in Italy (Table 6). Probably also in this case, population differences among birds caught in different regions play an important role.

A potentially important reason of found differences can be a manner of taking measurements by different research groups. Comparing the measurements of Dun-

lins (*Calidris alpina*) caught twice (in few-day intervals) at two ringing sites located at the Gulf of Gdańsk in years 1983-1986, it was revealed that the wing length measured at the Vistula mouth was in most cases 1-2 mm shorter than the measurements taken at ringing sites of the Waterbird Research Group KULING (Meissner pers. comm.).

Table 5  
Wing lengths of adult Grey Plovers from different parts of the non-breeding range.  
Differences of mean measurements between data of this study and data  
of other authors were tested with *t*-test.

Localisation	Mean	SD	N	t	p	Reference
<b>N Poland</b>	<b>202.4</b>	<b>4.7</b>	<b>207</b>			<b>this study</b>
N Poland	200.5	5.5	49	2.46	<b>&lt; 0.05</b>	Gromadzka and Serra 1998
Germany <sup>1)</sup>	201.7	5.1	227	1.48	<i>ns</i>	Prokosch 1988
England	198.8	5.3	1124	9.13	<b>&lt; 0.001</b>	Branson and Minton 1976
Tunisia	203.7	7.3	115	1.94	<i>ns</i>	Spiekman <i>et al.</i> 1993
Guinea Bissau	199.4	5.5	25	2.96	<b>&lt; 0.01</b>	Wymenga <i>et al.</i> 1992
India	203.8	5.8	189	2.65	<b>&lt; 0.01</b>	Balachandran <i>et al.</i> 2000
Italy <sup>2)</sup>	204.2	4.3	55	2.57	<b>&lt; 0.05</b>	Serra and Rusticali 1998

<sup>1)</sup> males only, but difference between sexes not significant; <sup>2)</sup> only adults with completed primary moult

Table 6  
Bill lengths of adult Grey Plovers from different parts of the non-breeding range.  
Differences of mean measurements between data of this study and data  
of other authors were tested with *t*-test.

Localisation	Mean	SD	N	t	p	Reference
<b>N Poland</b>	<b>29.6</b>	<b>1.5</b>	<b>256</b>			<b>this study</b>
N Poland	29.4	1.7	64	0.85	<i>ns</i>	Gromadzka and Serra 1998
Germany <sup>1)</sup>	29.8	1.4	222	1.42	<i>ns</i>	Prokosch 1988
England	30.1	1.4	852	4.82	<b>&lt; 0.001</b>	Branson and Minton 1976
Tunisia	30.8	1.3	82	6.01	<b>&lt; 0.001</b>	Spiekman <i>et al.</i> 1993
Guinea Bissau	31.5	1.2	112	11.02	<b>&lt; 0.001</b>	Wymenga <i>et al.</i> 1992
India	32.1	1.2	263	19.97	<b>&lt; 0.001</b>	Balachandran <i>et al.</i> 2000
Italy	29.4	1.3	89	1.04	<i>ns</i>	Serra and Rusticali 1998

<sup>1)</sup> males only, but difference between sexes not significant

Birds caught in the Gulf of Gdańsk region, both at the Puck Bay and at the Vistula mouth, were lighter than birds caught at further stages of migration (Dick and Pienkowski 1979, Lesink and Meininger 1990, Gromadzka and Serra 1998). Most probably, the area of Southern Baltic coast (devoid of tides) does not ensure optimal feeding conditions. Such thesis could be confirmed by short time of birds stop-over at the Puck Bay, where the median was 2.6 days ( $N = 7$ ) for young birds and 4.0 days ( $N = 9$ ) for adults (Krupa 1997). Also the low mean daily increase of the body mass is worth to mention. We observed the great decreases of the body mass in short period of time after first catching, then the body mass increased. This phe-

nomenon occurs similarly in Dunlin (Meissner 1998b). Probably, it is impossible for the birds to accumulate sufficient fat reserves, what forces them to migrate further in small steps (Krupa 1997). At the Vistula mouth, the median time of birds staying was 1.0 day ( $N = 9$ ), and the mean body mass of adult birds was significantly lower than in case of birds caught by us ( $t$ -test:  $t = 4.639$ ,  $p < 0.001$ ; Gromadzka and Serra 1998). One should remember that the samples of birds retrapped, both at the Puck Bay and at the Vistula mouth, were small. But probably the Vistula river region, with feeding areas in the form of beaches, is less attractive for Grey Plovers than the diverse coasts of the Puck Bay.

The observed daily trapping pattern of the juveniles and the adults was similar. However, Gromadzka and Serra (1998) found differences in the intensity of trapping between both age groups, what indicates a different use of the feeding area by the birds. Such situation probably is caused by relatively low prey abundance in that place. We should remember that adult and juvenile birds migrate through the Gulf of Gdańsk at the same time through about 2 months, although to the end of August the juvenile Grey Plovers were observed sporadically and in very low numbers and the adult birds in significant numbers were observed to mid-September (Krupa 1997). Thus, competition between adult and juvenile Grey Plovers could take place throughout 2 weeks. The differences in the trapping intensity of both age groups could be caused by fact, that the birds were caught during periods with a different length of the bright part of day. However, it could not be excluded that it is the experience that influences the different feeding intensity of adult and juvenile birds (Groves 1978, Hockey *et al.* 1998).

Birds caught in subsequent decades were characterised by relatively constant mean body mass. However, in October (after finishing of our research) the passage of juvenile Grey Plovers is still intensive (Meissner and Sikora 1995). Gromadzka and Serra (1998) found, that juvenile birds migrating in the first half of October were significantly heavier than those migrating by the end of September. The body mass increase of the late migrants was observed also in other waders *e.g.* Snipe – *Gallinago gallinago* (Greve and Gloe 1974), Dunlin (Pienkowski *et al.* 1979, Onnen 1991) and Common Sandpiper – *Actitis hypoleucos* (Meissner 1997b). Additional fat reserves could be used by birds in some problems with food finding (Pienkowski *et al.* 1979).

Adult Grey Plovers start the moult of coverts and primaries at the breeding grounds (Cramp and Simmons 1983, Hötter 1995). More moulting males than moulting females at breeding grounds were found on the Taimyr Peninsula, at the Sibiryakov Island, at the mouth of the Pyasina river (Chylarecki and Sikora data, after Gromadzka and Serra 1998) and in the Lena delta (Exo and Stepanowa 2000). In Denmark and England, the birds caught during migration were in suspended or almost suspended primary moult. Most frequently they had 1-3 primaries moulted (Boere 1976, Branson and Minton 1976). Also Grey Plovers caught at the Puck Bay had 1-3 primaries moulted, only one male had moulted also the fourth primary. The majority of moulting birds caught there was similar to those recorded at the Vistula

mouth (Gromadzka and Serra 1998). The low share of birds in suspended moult and the absence of birds in active primary moult suggest that the fat reserves accumulated by birds during migration were enough only for the passage, hence the birds suspended moulting in this period.

Grey Plovers reach the wintering grounds in Italy in August – they arrive with old feathers and start active moulting immediately after arrival. The presence of arriving birds with suspended moult stages or with active moult cannot be excluded, but their proportion must be very low (Serra and Rusticali 1998). Based on the biometric data (Serra and Rusticali 1998) and the analysis of recoveries (Krupa 1997) it can be stated, that the Grey Plovers wintering in Italy come from another population and another migration route than the birds migrating through the Gulf of Gdańsk.

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