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Biometrics and moult of Grey Plover (*Pluvialis squatarola*) in northeastern Italy

By Lorenzo Serra and Renzo Rusticali

Abstract: SERRA, L., & R. RUSTICALI (1998): Biometrics and moult of Grey Plover (*Pluvialis squatarola*) wintering in northeastern Italy. Vogelwarte 39: 281–292.

Grey Plovers (*Pluvialis squatarola*) wintering in northeastern Italy were morphometrically closer to the populations which use the East Atlantic Flyway than those following eastern routes, but differences in biometrics appeared too small for reliable considerations on breeding origins. Body mass seasonal variations showed a clear mid-winter peak, reaching 250 g both in adults and first-years. No body mass increase was observed in spring, suggesting early, short movements to pre-migratory staging areas where energy reserves are accumulated. Adult primary moult was estimated in 93 days, with mean starting day on 18 August and mean closing date on 19 November. Two concurrently active primary moult cycles were observed on second year birds in September–October.

Key words: Grey Plover (*Pluvialis squatarola*), biometrics, body mass variations, primary moult, wintering, Italy.

Addresses: Avian Demography Unit, Department of Statistical Sciences, University of Cape Town, Rondebosch 7700, South Africa; Istituto Nazionale per la Fauna Selvatica, via Cà Fornacetta 9, I-40064 Ozzano Emilia, Italy (current address) (L. S.); Santa Giulia di Porto Tolle, I-45010 Ivica RO, Italy (R. R.).

1. Introduction

The Grey Plover (*Pluvialis squatarola*) is a circumpolar, monospecific breeding wader with a slight clinal morphometric variation in wing length and bill shape along its Palearctic breeding range (GLUTZ VON BLOTZHEIM et al. 1975, CRAMP & SIMMONS 1983). Western Siberian birds, breeding eastward to Taimyr Peninsula are characterised by short wings and bills, migrate along the East Atlantic Flyway and winter southward to West Africa (BRANSON & MINTON 1976, PROKOSCH 1988, SMIT & PIERSMA 1989, WYMENGA et al. 1990, EXO & WAHLS 1996). Eastern Siberian birds are larger and are supposed to follow more direct, inland routes to the Mediterranean-Black-Sea region (VAN DIJK et al. 1986, SPIEKMAN et al. 1993), reaching also the western shores of Africa till its southern tip (SUMMERS & WALTNER 1979, HARRISON et al. 1997).

The Mediterranean wintering population was estimated in 26,000 birds, compared with 168,000 calculated for the whole East Atlantic Flyway inclusive of the Mediterranean (SMIT & PIERSMA 1989). Grey Plovers are mainly concentrated in Tunisia and Italy, smaller numbers being present in Egypt, Spain and France (SMIT 1986, VELASCO & ALBERTO 1993, ATTA et al. 1994, BACCETTI et al. 1996). Large flocks seem to occur only in the tidal areas of the Gulf of Gabès, Tunisia, and in northeastern Italy. These two areas supporte over 50% of the total Mediterranean wintering population (VAN DIJK et al. 1986, BACCETTI et al. 1996).

Despite its relatively broad distribution and almost continuous seasonal presence in the Mediterranean coastal wetlands, very little is known for this region about phenology (MOTIS et al. 1981, MARTINEZ VILALTA 1985, BRITTON & JOHNSON 1987, CASINI et al. 1992), biometrics and moult (VAN DIJK et al. 1986, SPIEKMAN et al. 1993, MEININGER 1994). Available information on measurements and moult for the Palearctic breeding populations comes from northwestern Europe (MEISE 1952, BOERE 1976, BRANSON & MINTON 1976, PROKOSCH 1988), west Africa (PIENKOWSKI et al. 1976, DICK & PIENKOWSKI 1979, ENS et al. 1989, LESINK & MEININGER 1990, WYMENGA et al. 1990, 1992) and India (BALACHANDRAN et al. in press).

The aims of this paper are to describe biometrics of the northeastern Italian wintering population and to discuss, within the framework of what is known about Palearctic populations: (a) the primary moult pattern of adults and second-year birds; (b) the seasonal body mass variation in relation with bird age and timing of migration.

2. Study area and methods

Grey Plovers were captured at two of the most important wintering sites in Italy: the Lagoon of Venice (45°11'–45°33'N, 12°07'–12°38'E) and the Po Delta (44°48'–45°11'N, 12°15'–12°32'E). These two areas stretch for ca. 140 km along the north Adriatic sea coast, forming an almost continuous chain of wetlands. A wide variety of habitats are present, from fresh- to hypersaline-waters. Grey Plovers were usually observed feeding on tidal mudflats and roosting on sandy beaches or sandbars. In the Lagoon of Venice the pans of traditional fishfarms ('valli') were also used when pans were dry or water levels lowered, according to fish production seasonal requirements. The median mid-January population size for the Lagoon of Venice between 1992–96 was 256, while in the Po Delta 335 birds were counted in January 1994 (Baccetti et al. 1996). The Italian grand total was estimated at ca. 1750 wintering birds, 51% of which was concentrated in the Lagoon of Grado and Marano, bordering the northern edge of the study area (Baccetti et al. 1996).

Grey Plovers were trapped at night in mist-nets at high tide roosts or during pre-roosting movements between 1990–96 in the Lagoon of Venice and 1988–96 in the Po Delta during regular year-round wader ringing activities carried out 1–2 times per month, according to spring tides and weather conditions.

The non-breeding period from August to May is hereafter referred to wintering season. The year was divided into days, numbered from 1 July.

Birds were aged according to Prater et al. (1977) and Cramp & Simmons (1983), mainly relying on features of upper wing coverts for the identification of first-year birds and on primary abrasion and moult pattern for separating second-year from older birds. Some second-years still retained some upper wing inner median coverts of the juvenile plumage by October, after the end of their first complete moult. The following age categories have been used: first-year (1y) = bird in its first year of life from 1 July to 30 June; second-year (2y) = bird in its second year of life from 1 July to September/October; third-year or older (3y+) = bird after its second year from 1 July until the end of primary moult in September/November; adult = bird after its first year from 1 July to 30 June: second-years, when identified, have not been included among adults. Apart from primary moult and wing length analyses, birds were usually divided into first-years and adults.

All birds were ringed and the following standard measurements were taken according to Prater et al. (1977): maximum wing chord and tarsus+toe lengths to the nearest mm by means of a stopped ruler, total head, bill from feathering, nalospi (distance from the distal edge of the nostril to bill tip) and tarsus lengths to the nearest 0.1 mm with a dial calliper. Body mass was recorded with electronic balances with a digital scale of 0.1 g. Birds were usually processed within 1 hour from net-checking and no correction was applied for body mass decrease. First-years retrapped in wintering seasons following that of ringing have been considered for their first retrap (no second retraps of the same first-year have occurred) as new birds and included in all the adult analyses, while adult retraps have been excluded from all the analyses except for temporal presence. It has been assumed that after 30 November all first-years had completed wing feather and body growth, and in order to test this hypothesis they have been divided in two groups: birds caught before or after this date.

Primary moult was recorded according to Ginn & Melville (1983), scoring old feathers 0, new ones 5 and growing ones 1 – 4. Primary moult scores were then converted to percentage feather mass grown (PFMG) using relative masses calculated by Underhill & Summers (1993). Timing, duration and speed of moult were obtained applying the model of Underhill & Zucchini (1988) and we considered the data to be of type 2: i.e. it has been assumed that the population arrived in the study area before the onset of moult and remained in the area thereafter. Birds in suspended primary moult or with two active moult centres were excluded from the calculation of the moult parameters.

The seasonal variation of body mass was described using the weighed moving average of Summers et al. (1992), applying a stronger smoothing parameter, 20 instead of 10 in equation 1 of the above mentioned paper, accounting for the smaller numbers of observations available in our sample (cf. Balachandran et al. in press).

We wish to thank all the ringers of the Anonima Limicoli for having made their data available. Corpo Forestale dello Stato provided access permissions to Riserva Naturale di Gorino. Anabela Brandao let us kindly use her programme for moult parameter calculations and Rene Navarro was of invaluable help in solving all our computer troubles. LS acknowledges Consiglio Nazionale delle Ricerche for a grant (203.04.14, 29/9/95) which enabled him to work at this paper and the Percy FitzPatrick Institute of the University of Cape Town for having hosted him during his stay in South Africa. Nicola Baccetti and Les Underhill usefully commented on and improved an earlier draft of the paper.

3. Results

3.1 Ringing results and recoveries

In seven consecutive years of activity, 114 adults (August–May), 16 second-years (July–October) and 65 first-years (September–May) have been ringed; no recoveries of foreign ringed birds were made or recoveries of our birds abroad have been reported by now. So far, only one recovery links Italy with other countries: one bird ringed at Langebaan Lagoon (33°12'S, 18°07'E), South Africa, on 7 February 1981, was collected at Savio river mouth (44°18'N, 12°18'E), 75 km south of Po Delta, on 20 August 1985 (ringed PRETORIA D 6020).

Nineteen local recoveries (15 ringing retraps and 4 shot birds) were obtained from the Po Delta out of 111 adults and 61 first-years ringed there, all coming from areas neighbouring the ringing site. Four adults were retrapped within the same wintering season, after 10, 29, 162 and 182 days respectively (dates: 13/10 – 23/10/1990; 20/1 – 18/2/1993; 21/9/1991 – 2/3/1992; 9/9/1991 – 10/3/1992). Fifteen birds (12 adults and three first-years) were recovered in following wintering seasons, nine after one and six after two. The overall period of presence spans between early September to mid-March (Fig. 1).

3.2 Biometrics and body mass

Wing length difference between 3y+ birds with old primaries (August–November, $\bar{x} = 202.9$ mm, S.D. = 4.3, n = 24) and adults with a new set (October–December, $\bar{x} = 206.2$ mm, S.D. = 3.3, n = 17) was significant (t-test = 2.62, p = 0.012), accounting for 3.3 mm, i.e. 1.6% of total length. Ne-

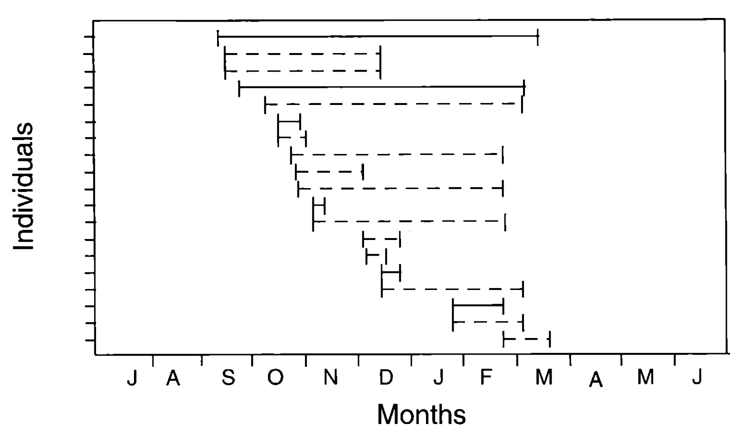

Fig. 1: Elapsed time between ringing and recovery of 19 Grey Plovers in northeastern Italy. Solid lines indicate that ringing and recovery have occurred in the same wintering season, dashed lines represent recoveries obtained in following years, i.e. dates have been connected ignoring possible differences in timing of presence in the area between years.

Abb. 1: Zeitraum zwischen Beringung und Wiederfund von 19 Kiebitzregenpfeifern in Nordostitalien. Durchgezogene Linien: Beringung und Wiederfund in derselben Überwinterungsperiode, gestrichelte Linien: Wiederfunde aus folgenden Jahren ungeachtet des zwischenzeitlichen Aufenthaltes.

vertheless, a linear regression of adult wing length on days between October and May was not significant ($r = 0.23$, $F_{1,45} = 2.63$, $p = 0.11$). Consequently, wing length for the local wintering population was estimated grouping all the adults caught in October–May, considering only the birds which attained a complete moult. The existence of a similar relation with time was assumed also for tail length.

First-years were significantly smaller than adults in all measurements but tarsus+toe (Table 1). First-years averaged ca. 4–5% less than adults in bill and nalospi length, ca. 3% in wing length, and ca. 2% in total head and tarsus length.

Linear regressions of all the first-year measurements as dependent variables on time period reported in days from 1 July were not significant. Dividing the first years into two temporal classes (Table 2), before and after 30 November, significant differences were observed between each of the two first-year classes and adults for wing and tail lengths, while no differences were found between first-year categories (Table 3). Total head and nalospi lengths of the earliest group of first-years differed by the second one and adults, while bill lengths were different between each age/time category; tarsus lengths differed only between the earliest group of first-years and adults (Table 3).

Both age classes built up weight in November, showing a broad winter plateau spanning from December to February and a following, rapid decrease in March (Fig. 2). Between September and November, when both age classes were present, first-years were leaner than adults, although means were significantly different only in October (t-test; $t = 3.90$, $df = 47$, $p < 0.001$), probably due to the low numbers of birds sampled in the other months (Table 4). From the onset of winter to spring, monthly means of first-years and adults varied according to the same pattern and showed very close mean and range values. No birds were available for June and only a few for April and May (Table 4). There is no evidence of pre-migratory spring body mass increase, but the lowest values observed in May among adults might be referred to passage birds.

3.3 Primary moult

No first-year birds were observed starting primary moult. Sixteen second-years were observed between July and October, their primary moult scores are shown in Table 5. By August and early September second-years had all already completed the primary moult and were in their first winter plumage. Six second-years showed two generations of new primaries, indicating the presence of two sequential primary moult cycles. These two cycles were found simultaneously active only in bird

Table 1: Biometrics of first-year and adult Grey Plovers ringed in northeastern Italy between 1988–96 and t-tests between the measurements of the two age categories.

Tab. 1: Meßwerte von einjährigen und adulten Kiebitzregenpfeifern, die von 1988–1996 in Nordostitalien beringt wurden. t-tests zwischen Messungen der zwei Altersklassen.

	First-years			Adults					
	Mean ± S.D.	Min-Max	n	Mean ± S.D.	Min-Max	n	t	df	p
Wing[1] (mm)	197.8 ± 6.1	182–212	63	204.2 ± 4.3	195–215	55	[2]6.67	111.7	0.000
Tail[1] (mm)	74.0 ± 3.2	66–80	58	79.6 ± 3.5	73–88	48	8.44	104	0.000
Total head (mm)	67.6 ± 2.0	62.8–71.4	61	69.0 ± 1.5	65.5–73.0	82	[2]4.64	108.2	0.000
Bill (mm)	28.4 ± 1.5	23.3–32.0	65	29.4 ± 1.3	26.4–32.5	89	4.76	152	0.000
Nalospi (mm)	17.3 ± 1.4	10.6–20.1	60	18.2 ± 0.8	15.9–20.1	78	[2]4.58	87.6	0.000
Tarsus+toe (mm)	82.9 ± 2.3	77–89	60	83.6 ± 2.5	78–89	85	1.79	143	0.076
Tarsus (mm)	48.0 ± 2.0	43.1–51.7	65	48.9 ± 1.8	44.5–52.7	89	2.89	152	0.004

[1] only adults from October to May with completed primary moult have been included.
[2] t-test for unequal variances.

Table 2. Measurements of first-year birds divided in two temporal classes (September–November, December–May).
Tab. 2: Messungen einjähriger Vögel, eingeteilt in zwei zeitliche Klassen (September–November, Dezember–Mai).

		Mean ± S.D.	Min-Max	n
Wing (mm)	Sept–Nov	197.1 ± 5.7	182–206	36
	Dec–May	198.8 ± 6.5	184–212	27
Tail (mm)	Sept–Nov	73.3 ± 2.9	66–79	32
	Dec–May	74.9 ± 3.4	68–80	26
Total head (mm)	Sept–Nov	67.1 ± 2.0	66.8–71.2	34
	Dec–May	68.2 ± 1.9	64.9–70.4	24
Bill (mm)	Sept–Nov	28.1 ± 1.6	23.3–32.0	38
	Dec–May	28.8 ± 1.3	26.6–30.9	27
Nalospi (mm)	Sept–Nov	17.0 ± 1.4	10.6–19.0	33
	Dec–May	17.8 ± 1.2	15.8–20.1	27
Tarsus (mm)	Sept–Nov	47.6 ± 2.1	43.1–51.5	38
	Dec–May	48.5 ± 1.8	44.7–51.7	27

Table 3. One-way ANOVA and Student-Newman-Keuls test (* = p < 0.05; – = NS) among measurements of adults (a) and first-year birds divided in two temporal classes (c1 = September–November, c2 = February-March) as in Tables 1 and 2, respectively.
Tab. 3: One-way ANOVA und Student-Newman-Keuls Test (* = p < 0.05; – = NS) zwischen Messungen adulter (a) und einjährger Vögel, eingeteilt in zwei zeitliche Klassen (c1 = September–November, c2 = Februar–März) wie in Tab. 1 und 2.

	wing			tail			total head			bill			nalospi			tarsus		
ANOVA	$F_{2,107} = 19.2$ $p < 0.0001$			$F_{2,95} = 36.5$ $p < 0.0001$			$F_{2,152} = 15.7$ $p < 0.0001$			$F_{2,168} = 13.8$ $p < 0.0001$			$F_{2,146} = 18.0$ $p < 0.0001$			$F_{2,168} = 3.9$ $p < 0.023$		
S-N-K test	c1	c2	a	c1	c2	a	c1	c2	a	c1	c2	a	c1	c2	a	c1	c2	a
c1		–	*		–	*		*	*		*	*		*	*		–	*
c2			*			*			–			*			–			–

no. 11. Two birds, no. 10 and 16, indicated that the second cycle can be finished by November or earlier, while birds no. 14 and 15 were in arrested or suspended moult. All the observed second cycle moult stages except no. 12, were compatible in timing and scoring with the ‘regular’ post-breeding adult moult (Fig. 3).

Adult primary moult started in August (Fig. 3). Only four adults (all age 3y+) were trapped before the onset of primary moult, between 6–18 August, 46 were in active moult and 52 showed completed moult. The first adult with complete moult was observed on 5 October and the last one actively moulting on 21 December. Three birds out of 14 trapped in January–February were observed with primary moult suspended at p8. In March, nine out of 25 adults were resuming primary moult; the lowest observed point of moult resumption was p6. In April and May no adults out of six showed signs of suspension or active primary moult. The frequencies of suspended vs. completed moults in January–February and active vs. completed in March were not significantly different χ^2 test).

The estimate of the moult parameters for the adult autumn primary moult gave the following results: mean start 18 August (SE = 5.9), mean duration 93 days (SE = 8.1), mean closing day 19 November (SE = 4.1), standard deviation 21.8 (SE = 2.6).

4. Discussion

4.1 Biometrics and origin of birds

Mean wing length of adult Grey Plovers in northeastern Italy was 2.7% larger than those observed at the Wash, England, but the differences between the other available samples along the East Atlantic coast of Europe, Africa and India were all below (Table 6). Hence, wing length showed relatively slight differences on a wide geographical range of resting/wintering sites and does not appear to be a very useful measurement for investigating the breeding origin of wintering Grey Plovers (ENGELMOER et al. 1987). Moreover, the observed geographical pattern of mean wing lengths does not reflect the expected cline of increasing means along a North-South axis, as could be supposed

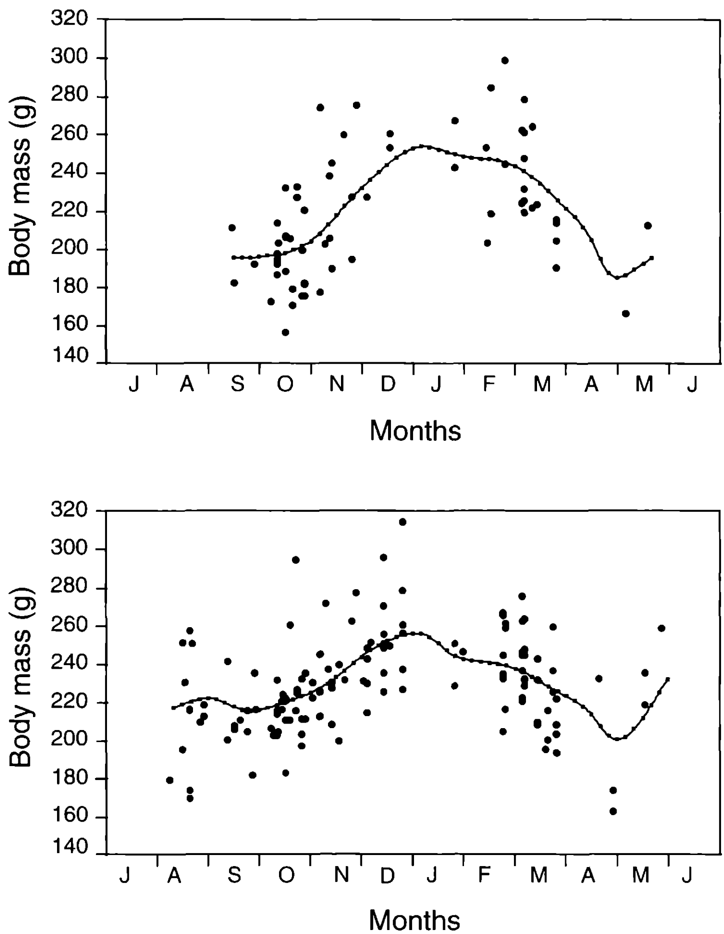

Fig. 2: Temporal variation of body mass in first-year (a) and adult (b) Grey Plovers in northeastern Italy. Lines represent smoothed means (see Methods). Dots refer to one or more birds.

Abb. 2: Zeitliche Änderung des Körpergewichts bei einjährigen (a) und adulten (b) Kiebitzregenpfeifern in Nordostitalien. Linien stellen gleitende Mittelwerte dar (siehe Methoden). Punkte beziehen sich auf einen oder mehrere Vögel.

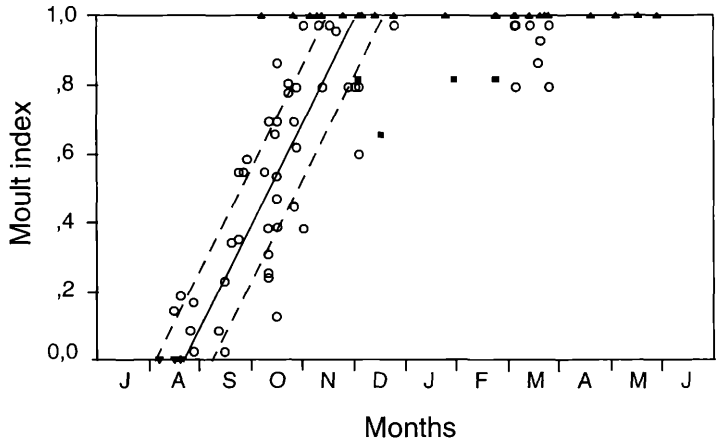

Fig. 3: Primary moult pattern of adult Grey Plovers in northeastern Italy. The solid line represents the estimated moult progression, dashed lines contain 95% of the population of active moulters. Open circles indicate birds in active moult, triangles birds before and after moult, solid squares birds with suspended moult. Birds in suspended moult or in active moult in March have not been used for the estimate of moult parameters (see Methods).

Abb. 3: Muster der Handschwingenmauser adulter Kiebitzregenpfeifer in Nordostitalien. Durchgezogene Linie: angenommener Mauserverlauf, gestrichelte Linien repräsentieren 95% der aktiv mausernden Vögel. Offene Kreise: Vögel in aktiver Mauser, Dreiecke: Vögel vor und nach der Mauser, gefüllte Quadrate: Vögel mit Mauserunterbrechung. Vögel, die im März die Mauser noch nicht beendet hatten, wurden nicht berücksichtigt (siehe Methoden).

Table 4. Monthly body mass means of first-year and adult Grey Plovers. Significant mean differences between age categories obtained only in October (t-tests; $t = 3.86$, $df = 36.5$, $p < 0.001$).

Tab. 4: Monatliche Mittelwerte des Körpergewichts einjähriger und adulter Kiebitzregenpfeifer. Signifikante Unterschiede zwischen den Altersklassen wurden nur im Oktober ermittelt (t-test; $t = 3.86$, $df = 36.5$, $p < 0.001$).

		Mean ± S.D.	Min-Max	n
August	first-years	–	–	–
	adults	205.8 ± 19.9	170.0–231.0	9
September	first-years	196.0 ± 14.3	183.0–212.0	3
	adults	210.9 ± 16.6	182.0–242.0	8
October	first-years	196.3 ± 20.7	157.0–233.5	23
	adults	215.7 ± 12.8	183.5–295.0	24
November	first-years	227.1 ± 33.2	178.0–275.0	12
	adults	235.8 ± 20.8	200.0–277.9	18
Dec.–February	first-years	253.2 ± 28.3	204.0–299.5	10
	adults	250.9 ± 22.9	205.0–315.0	29
March	first-years	232.8 ± 25.1	191.0–279.0	15
	adults	231.7 ± 22.4	201.0–276.0	15
April	first-years	–	–	–
	adults	190.0 ± 37.6	163.0–233.0	3
May	first-years	190.0 ± 32.5	167.0–213.0	2
	adults	238.0 ± 20.1	219.0–259.0	3

Table 5. Trapping dates and primary scores of second-year Grey Plovers. Figures in bold indicate those feathers that had been recently renewed during the post-juvenile primary moult and hence the presence of two primary generations. Scores according to Ginn & Melville (1983).

Tab. 5: Fangdaten und Handschwingenmauserwerte zweijähriger Kiebitzregenpfeifer. Zahlen in Fettdruck bezeichnen Schwungfedern, die während der postjuvenilen Handschwingenmauser erneuert wurden und somit das Vorhandensein zweier Handschwingengenerationen. Mauserwerte nach Ginn & Melville (1983).

	Date	Primary score
1	5 July	3321000000
2	11 July	5432100000
3	14 August	5555555555
4	18 August	5555555555
5	18 August	5555555555
6	19 August	5555555555
7	30 August	5555555555
8	9 September	5555555555
9	21 September	555442**0000**
10	25 September	5555555554
11	11 October	55555554**0**4
12	11 October	554**0000000**
13	16 October	555555531**0**
14	16 October	555555**0000**
15	19 October	55555**00000**
16	19 October	5555555421

by the presence of such a gradient from West to East on Siberian breeding grounds (GLUTZ VON BLOTZHEIM et al. 1975, CRAMP & SIMMONS 1983).

The significant difference in wing length before and after moult provides further caution in the use of this measurement to separate populations (PIENKOWSKI & MINTON 1973). The lower abrasion rates between old and new primaries observed in England and India, both accounting for 0.5% of wing length, compared with 1.6% of this study, can be explained by the fact that we have introduced an upper date limit in December for the new feather bird category (BRANSON & MINTON 1976, BALACHANDRAN et al. in press).

Italian adult mean bill length was shorter than all the recorded samples from Palearctic wintering areas or passage sites (Table 7). From bill length it could therefore be supposed that Italian wintering Grey Plovers had a dominant component of western Siberian birds, being long-billed Grey Plovers considered to have eastern origins, but the geographical distribution of bill lengths seems far from clear and in disagreement with that suggested by wing length. Furthermore, the absence of recoveries linking Italy with the East Atlantic Flyway leads to hypothesise the use of distinct, more eastern routes for Italian Grey Plovers, and consequently also a more eastern origin.

First-years completed their feather growth by the end of November, but showed shorter mean wing and tail lengths than adults after this period. At the same time, total head, nalospi, tarsus+toe and tarsus lengths reached adult values, while bill length remained shorter than in adults, indicating that a longer period is required for reaching adult values. First-year mean bill length recorded at the German Wadden Sea during spring migration was still shorter than that of adults (29.3 vs. 29.8 mm), although not significantly (PROKOSCH 1988).

4.2 Body mass

The body mass pattern of adults over the period August to March closely resembled that observed at the Wash, i.e. distinctive of sites characterised by mid-winter fattening (BRANSON & MINTON

Table 6. Wing lengths of adult Grey Plovers from different parts of the non-breeding range. Percentages are referred to the Italian mean value of 204.2 mm.
Tab. 6: Flügellängen adulter Kiebitzregenpfeifer aus verschiedenen Teilen des außerbrutzeitlichen Verbreitungsgebietes. Prozentwerte beziehen sich auf den in Italien errechneten Mittelwert von 204,2 mm.

		Mean ± S.D.	n	Period	Reference
England	–2.7%	198.8 ± 5.3	1124	August–May	Branson & Minton 1976
Germany[1]	–1.2%	201.7 ± 5.1	227	April–May	Prokosch 1988
Tunisia	–0.2%	203.7 ± 7.3	115	March–May	Spiekman et al. 1993
Egypt	–1.4%	201.4 ± 2.1	9	March–April	Meininger & Schekkerman 1994
Mauritania[2]	–1.0%	202.0 ± 4.4	4	October	Lensink & Meininger 1990
Mauritania	–0.9%	202.4 ± 5.1	11	February–April	Ens et al. 1989
Guinea Bissau	–2.4%	199.4 ± 5.5	25	December–February	Wymenga et al. 1992
India	–0.2%	203.8 ± 5.8	189	September–February	Balachandran et al. in press

[1] = males only but sex difference not significative
[2] = old primaries

1976), but monthly averages were constantly lower in Italy apart for March. Lower means before November in Italy might be explained by the presence of birds gaining weight at the Wash before embarking into a further migration step, but the winter peak difference, accounting for ca. 30 g, is probably related to different local stress factors such as food availability and weather conditions (Johnson 1985). In spring, pre-migratory body mass increase was not evident at our study area, possibly because birds moved early in the season towards other sites located within a distance they can reach without carrying heavy energy loads. Similar movements are probably performed by Dunlins *Calidris alpina* wintering in Tunisia (Spiekman et al. 1993) and also by other arctic wader species wintering in the west Mediterranean.

First-years showed the same temporal body mass variation of adults, accordingly to the same pattern described for first-years wintering at the Wash (Branson & Minton 1976). In northeastern Italy, the two age categories had similar mass values from November onwards, while in England adults were ca. 40 g heavier than first-years at December peak. Energy reserves are highly regulated by birds, directly responding to local conditions: higher reserves at increasing risks. Age-related diffe-

Table 7. Bill lengths of adult Grey Plovers from different parts of the non-breeding range. Percentages are referred to the Italian mean value of 29.4 mm.
Tab. 7: Schnabellängen adulter Kiebitzregenpfeifer aus verschiedenen Teilen des außerbrutzeitlichen Verbreitungsgebietes. Prozentwerte beziehen sich auf den in Italien errechneten Mittelwert von 29,4 mm.

		Mean ± S.D.	n	Period	Reference
England	+2.3%	30.1 ± 1.4	852	August–May	Branson & Minton 1976
Germany[1]	+1.4%	29.8 ± 1.4	222	April–May	Prokosch 1988
Tunisia	+4.8%	30.8 ± 1.3	82	March–May	Spiekman et al. 1993
Egypt	+0.7%	29.6 ± 1.1	9	March–April	Meininger & Schekkerman 1994
Mauritania	+6.8%	31.4 ± 0.5	6	October	Lensink & Meininger 1990
Mauritania	+1.4%	29.8 ± 1.8	11	February–April	Ens et al. 1989
Guinea Bissau	+6.6%	31.5 ± 1.2	112	December–February	Wymenga et al. 1992
India	+9.2%	32.1 ± 1.2	263	September–February	Balachandran et al. in press

[1] = males only but sex difference not significative

rences in body reserves at mid-winter peak are well known for waders and have been interpreted as an indication of different feeding efficiency or resource exploitation (Johnson 1985). The fact that adults and first-years at our study area respond in the same way to weather stress suggests that age-related differences can be interpreted only at local level and not as a general feature of the species.

4.3 Primary moult

Adults started primary moult soon after their arrival in August and there was no indication of further immigration into the area after the end of September, when 95% of the population had started the moult. The low number of birds trapped before the onset of moult can be explained by its rapid start once the birds have reached the wintering site. A pressure for an immediate start of the moult can be easily explained as an adaptment to a relatively short time for moulting between the relatively late settlement in the moulting areas and the arrival of severe weather conditions (BOERE 1976). The absence of birds in suspended primary moult at its earlier stages, in contrast with the observations from Morocco (PIENKOWSKI et al. 1976), the Wadden Sea (BOERE 1976) or the Wash, where the migrant turn-over was high and suspended birds accounted for 25–40% of the population in August (BRANSON & MINTON 1976), might indicate that emigration, at least during moult period, was negligible. The arrival of birds in suspended moult, quickly resuming it after having settled, cannot be excluded, but their proportion must be very low. The same can be assumed for active migrants with open moult, because migration and moult are mutually exclusive processes in waders performing long non-stop flights, as the Grey Plover does (KOOPMAN 1986, ZWARTS et al. 1990, PIERSMA & JUKEMA 1993).

Advanced points of primary moult suspension were observed only after the end of November, when last moulters can possibly be forced to discontinue moult by the incoming winter season, although one bird was found completing the growth of the outermost primary on 21 December. Moult resumption was observed only in March (from mid-March at the Wash) and no suspended birds were found during spring months, suggesting that pre-breeding migration follows primary moult completion.

The estimated mean duration of 93 days for adults which did not interrupt the autumn moult fits to the 90 and 90–100 days calculated for the Wash, England, and the Dutch Wadden Sea, despite the different methods used for obtaining these estimates; moult periods were also almost synchronous at these three sites (BOERE 1976, BRANSON & MINTON 1976). Moult in northeastern Italy was faster than in India, where starting date and moult duration calculated using the same statistical model were 1 September and 127 days, respectively (BALACHANDRAN et al. in press). If the difference in moult timing can at least be partly explained in terms of distance from the breeding grounds and the date of arrival in the moulting area, then the different duration of moult could be attributed, at the individual level, to a lower moult speed. A prolongation of moult period from northern to southern wintering sites has been described for several wader species and it is generally linked with the 'benign' nature of the climate in the wintering area (PIENKOWSKI et al. 1976, SUMMERS et al. 1989, MARKS 1993).

The first cycle of second-year primary moult cannot be described by our data, it only appeared that it was usually completed by the end of August, as observed in northern Europe (BOERE 1976, BRANSON & MINTON 1976). The presence of a second sequential cycle, in some cases concurrently active with the first, as well as the pre-winter suspension of this second cycle, was previously described for the Wadden Sea and Morocco, though it was explained as a resumption of the post-breeding primary moult of the previous year (BOERE 1976, PIENKOWSKI et al. 1976). Our data instead referred only to second-years, as in India (BALACHANDRAN et al. in press). The absence of retained old primaries among adults at their arrival in Italy after the post-breeding migration could be linked to the presence of a longer period with favourable conditions before pre-breeding movements than in northern Europe, allowing a greater proportion of winter suspended birds to complete their moult.

We do not have direct evidence whether suspended cycles of second-years are resumed at the end of the winter, although the absence of birds with suspended moult from March would lead to assume that they generally complete the cycle.

4.5 Timing of presence and site fidelity

Adult Grey Plovers settled in the study area from the beginning of August to mid September, first-years appearing only from September. Local retraps indicated that at least a part of the wintering population did not leave the area until March, although there is some evidence from spring resumed primary moult that some birds could move earlier. Late winter movement and pre-migration gathering sites have been described from different parts of the wintering range (CASINI et al. 1992, LIVERSIDGE et al. 1958, MARTINEZ VILALTA 1985, MOTIS et al. 1981) but there are no indications to speculate further yet. The high proportion of local retraps from year to year and the absence of recoveries from other wintering sites indicated a strong site fidelity. Besides the overwintering population, the presence of migrants using the area as a stop-over site during southward migration was confirmed by an August recovery of a South African ringed bird, and the passage of birds heading to the breeding grounds in spring was suggested by some lean birds caught in April and May.

5. Zusammenfassung

Überwinternde Kiebitzregenpfeifer (*Pluvialis squatarola* in) NE-Italien weisen nach morphometrischen Befunden Merkmale auf, die eher denen der westsibirischen Brutpopulation entsprechen, also Vögeln, die auf dem Zug ins Winterquartier (südwärts bis Westafrika) den westeuropäischen Küsten folgen (East Atlantic Flyway). Die gefundenen Unterschiede gegenüber der ostsibirischen Population, die auf der direkteren Inlandroute in die Schwarzmeer- und Mittelmeerregion zieht, sind jedoch zu gering, um eindeutige Aussagen über die Herkunft der Vögel zu treffen. Die jahreszeitlichen Körpergewichtsänderungen zeigten sowohl bei den Adultvögeln als auch bei Einjährigen mit 250 g einen deutlichen Mitwintergipfel. Im Frühjahr wurde kein Körpergewichtsanstieg festgestellt. Dies läßt vermuten, daß die Energiereserven erst in nahegelegenen Zwischenrastgebieten vor dem eigentlichen Wegzug aufgefüllt werden. Die Handschwingenmauser der Adultvögel vollzog sich innerhalb von 93 Tagen (mittlerer Zeitpunkt des Mauserbeginns: 18. 8., mittlerer Zeitpunkt des Mauserendes: 19. 11.). Bei den Zweijährigen wurden von September bis Oktober zwei gleichzeitig aktive Zyklen der Handschwingenmauser festgestellt.

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