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BIOMETRY OF YOUNG WHITE WAGTAILS (*Motacilla alba*) AND YELLOW WAGTAILS (*Motacilla flava*) CAUGHT IN THE GULF OF GDAŃSK REGION DURING AUTUMN MIGRATION

Marcin Polak

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ABSTRACT

Biometrics of juvenile 760 White Wagtails and 714 Yellow Wagtails migrating through the Gulf of Gdańsk region in autumn were studied between 1990 and 2000. In both species distributions of wing length, body mass and indices of wing shape were unimodal, with only one exception – in the White Wagtail the wing length distribution showed two peaks caused by sexual dimorphism. The mean body mass and reserves of fat in both species were low in comparison to other stopover sites. There were significant differences in mean weight between birds caught in the morning and in the evening. The majority of birds behave as energy minimising migrants and migrate with low fat reserves in small steps.

M. Polak, Dept. of Nature Conservation, Maria Curie-Skłodowska University, Akademicka 19, PL-20-033 Lublin, Poland; Dept. of Vertebrate Ecology and Zoology, Univ. of Gdańsk, Legionów 9, PL-80-441, Gdańsk, Poland, E-mail: mpolak@hektor.umcs.lublin.pl
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INTRODUCTION

The White Wagtail and the Yellow Wagtail are long-distance, diurnal migrants with wintering grounds in Mediterranean region, tropical Africa, India and south-eastern Asia. The direction of the birds migrating through southern Baltic in autumn is unclear. The part of recoveries indicate south-western and some south-eastern movements (Cramp 1988).

In Poland the White Wagtail and the Yellow Wagtail are numerous breeding and migrating species and their autumn migration continues from the beginning of August to October (Tomiałojć and Stawarczyk 2003). However, there were no particular studies on migration and biometry of these species in Poland. Only Busse and Halastra (1981) presented autumn migration at the Polish Baltic coast (catching and visual observations data), while Sikora (1994) described phenology and dynamics of spring migration of the Yellow Wagtail in the Gulf of Gdańsk region.

The aim of this study is an analysis of basics biometrics of first-year White and Yellow Wagtails passing the Gulf of Gdańsk during autumn migration.

MATERIAL AND METHODS

The Waterbird Research Group KULING caught wagtails in two places: at Rewa and at the mouth of the river Reda. They are localised very close to each other and therefore biometrics from both these sites were combined. At Rewa birds were caught on the sandy peninsula of a length varying from 500 to 2000 m (depending on the water level). The Reda mouth region contains patches of reedbeds and swamps, fragments of sandy beach, periodically emerging sand islets and the ash dump of the electric power station. More detailed description of the study area was given in the earlier paper (Meissner and Remisiewicz 1998).

Wagtails were caught between 1990 and 2000 in walk-in traps (Meissner 1998). Every year the fieldwork started in mid-July (since 1996 in the first week of July) and finished in the last days of September. The traps were checked every two hours from dusk to dawn. The number of traps varied between seasons from 20 to 40. All birds caught were aged (Svensson 1992). Wing length and wing formula were measured with stopped ruler (to the nearest mm, maximum chord method) and fat score was checked as described by Busse (2000). Birds were also weighed to the nearest 0.5 g by “Pesola” spring-balance. For the presentation of data decades (coupled neighbouring pentades: 39 + 40 – 10-19 July, 41 + 42 – 20-29 July, 43 + 44 – 30 July – 8 August, 45 + 46 – 9-18 August, 47 + 48 – 19-28 August, 49 + 50 – 29 August – 7 September, 51 + 52 – 8-17 September, 53 + 54 – 18-27 September) were used (Berthold 1973). All calculations were done by the statistical program STATISTICA.

RESULTS

Inter-seasonal variability of biometrics

During the years 1990-2000, a total of 760 juvenile White Wagtails and 714 juvenile Yellow Wagtails were caught and measured. Distributions of values of morphometric parameters: wing length, body mass and indices of wing shape – *e* and *l* (Busse 1986) in both species for all years are shown in Table 1. Almost all distributions were unimodal. Only in the case of wing length in the White Wagtail two distinct peaks appeared. To analyse the seasonal variability of the average biometric parameters only data for the White Wagtail from 1993 and 1996-1999 and for the Yellow Wagtail from 1993, 1996, 1997, 1999 were used, because in these years the number of caught individuals was sufficient for the analysis. In the White Wagtail

Table 1
Wing length, body mass and *e*-index distributions of White Wagtails (MOT.ALB) and Yellow Wagtails (MOT.FLA). Modes are given in bold.

Wing length			Body mass			*e*-index		
mm	MOT.ALB	MOT.FLA	g	MOT.ALB	MOT.FLA		MOT.ALB	MOT.FLA
74		2	11		1	30	1	0
75		2	12		1	31	0	1
76		14	13	2	17	32	0	0
77		33	14	3	83	33	0	1
78	2	50	15	6	167	34	4	1
79	0	77	16	22	**176**	35	0	0
80	0	87	17	69	111	36	2	0
81	3	105	18	121	32	37	0	3
82	7	**114**	19	131	13	38	1	1
83	6	97	20	**137**	3	39	1	3
84	19	63	21	89	1	40	1	1
85	45	32	22	37		41	0	3
86	89	14	23	15		42	2	2
87	**91**	6	24	4		43	1	6
88	77	1	25			44	3	13
89	75	0				45	2	9
90	86	1				46	2	20
91	**101**					47	3	28
92	56					48	8	25
93	38					49	12	28
94	17					50	22	**46**
95	2					51	35	36
96	1					52	34	50
						53	27	**52**
						54	47	28
						55	47	39
						56	**66**	37
						57	35	32
						58	**55**	28
						59	41	18
						60	39	16
						61	34	11
						62	21	13
						63	15	4
						64	19	6
						65	19	3
						66	6	4
						67	5	3
						68	3	3
						69	2	7
						70	3	3
						71	2	2
						72	1	4
						73	3	0
						74	1	3
						75	1	1
						76	2	1
						77	1	1
						78	0	0
						79	0	0
						80	1	0
						81	1	0
						82	0	0
						83	0	1
						84	1	0
						85	1	0
						86	1	0
						87	0	1

the wing length and body mass did not differ for birds trapped in subsequent seasons, but juveniles of this species differed in shape of the wing (Table 2). In the Yellow Wagtail differences in mean weight were significant and in wing length – nearly significant, but there were no differences in *e*- and *l*-indices (Table 3).

Table 2
Means, *SD* values (in brackets) and sample sizes (*n*) of wing length, body mass, *e*- and *l*-index for the young White Wagtails in subsequent years. Values *H* of Kruskal-Wallis test are shown. Significant *p* shown in bold.

	1993	1996	1997	1998	1999	*H*	*p*	1990-2000
Wing length	88.7 (2.6) *n* = 106	89.0 (2.6) *n* = 81	88.7 (2.9) *n* = 146	88.1 (2.7) *n* = 114	88.9 (2.8) *n* = 124	6.7	0.15	88.7 (2.8) *n* = 715
Body mass	20.72 (2.30) *n* = 29	20.15 (1.52) *n* = 78	20.17 (1.67) *n* = 152	20.57 (1.69) *n* = 117	20.20 (1.73) *n* = 123	6.2	0.19	20.31 (1.74) *n* = 636
e-index	58.2 (6.3) *n* = 102	57.5 (6.8) *n* = 76	57.6 (4.9) *n* = 126	55.2 (6.9) *n* = 105	56.7 (6.9) *n* = 114	16.2	< **0.003**	56.8 (6.3) *n* = 634
l-index	58.9 (6.0) *n* = 102	58.2 (6.7) *n* = 76	58.4 (4.6) *n* = 126	55.7 (6.9) *n* = 105	57.6 (6.7) *n* = 114	19.4	< **0.001**	57.6 (6.1) *n* = 634

Table 3
Means, *SD* values (in brackets) and sample sizes (*n*) of wing length, body mass and *e*- and *l*-index of the young Yellow Wagtails in subsequent years. Values *H* of Kruskal-Wallis test are shown. Significant *p* shown in bold.

	1993	1996	1997	1999	*H*	*p*	1990-2000
Wing length	81.3 (2.4) *n* = 140	80.6 (2.6) *n* = 130	81.2 (2.4) *n* = 103	81.3 (2.4) *n* = 114	7.0	0.07	81.2 (2.4) *n* = 698
Body mass	16.27 (1.39) *n* = 71	15.50 (1.23) *n* = 131	15.55 (1.24) *n* = 104	16.23 (1.32) *n* = 85	23.8	**< 0.0001**	15.86 (1.30) *n* = 605
e-index	54.7 (7.0) *n* = 136	54.6 (8.5) *n* = 130	53.2 (6.0) *n* = 95	52.4 (5.2) *n* = 81	4.9	0.18	53.6 (6.8) *n* = 602
l-index	55.1 (6.9) *n* = 136	54.8 (8.3) *n* = 130	53.7 (5.8) *n* = 95	52.5 (5.2) *n* = 81	6.2	0.10	53.9 (6.6) *n* = 602

Fat score

Wagtails caught in the Gulf of Gdańsk had low fat score. Most of them had fat score T_1 and T_2 – in White Wagtails 72.9% and in Yellow Wagtails 68.8% (Table 4 and 5). The percent share of individuals with T_0 were 19.7% and 23.3%, respectively. There was positive relation between fat score and weight in both species (Table 6).

Table 4
Numbers of young White Wagtails for subsequent fat scores in years 1990-2000

Fat score	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total
T_0	1		1	8	2		23	22	29	40	12	138
T_1	5	2	3	21	3	6	20	43	39	54	15	211
T_2	4	2	1	67	23	7	25	71	41	34	26	301
T_3		1	2	7	4	3	8	6	7	1	11	50
T_4				1				1				2

Table 5
Numbers of young Yellow Wagtails for subsequent fat scores in years 1990-2000

Fat score	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total
T_0	4	2	3	15	4	17	29	22	14	33	12	155
T_1	3	10	3	59	4	13	36	43	12	32	10	225
T_2	3	10	2	63	9	17	45	23	14	18	25	229
T_3	2	1	1	9		5	15	9		4	9	55
T_4	1									1		2

Table 6
Mean body masses, *SD* values (in brackets) and sample sizes (n) in juvenile White Wagtails and Yellow Wagtails for subsequent fat scores

	Fat-score			
	T_0	T_1	T_2	T_3
Motacilla alba	19.59 (2.41) n = 129	20.14 (1.70) n = 178	20.62 (1.61) n = 239	20.79 (1.77) n = 42
Motacilla flava	15.35 (1.15) n = 148	15.74 (1.29) n = 176	16.21 (1.36) n = 182	16.52 (1.23) n = 49

Stopover characteristics and daily activity

Only 30 (3.9%) young White Wagtails and 33 (4.6%) Yellow Wagtails were retrapped. The time of stay of White Wagtail retraps was longer (median = 15, range = 1-49 days) than Yellow Wagtails (median = 10, range = 1-35 days) and the difference was nearly significant (Mann-Whitney U-test: $U_{35,37}$ = 483, p = 0.06). Their

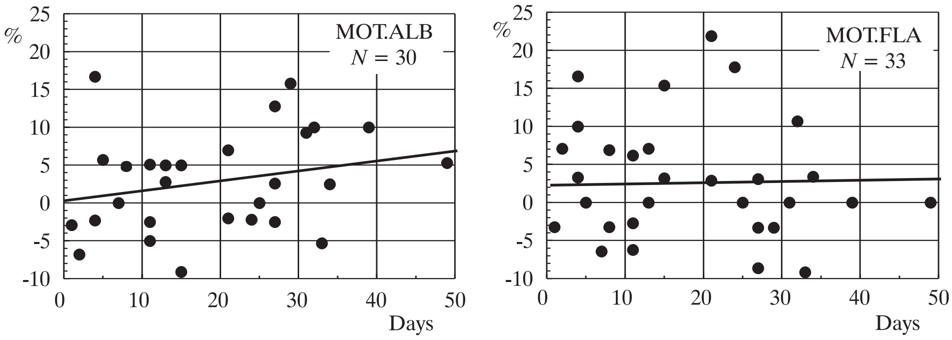


Fig. 1. Relative body mass changes in young White Wagtails (MOT.ALB) and Yellow Wagtails (MOT.FLA) caught more than once

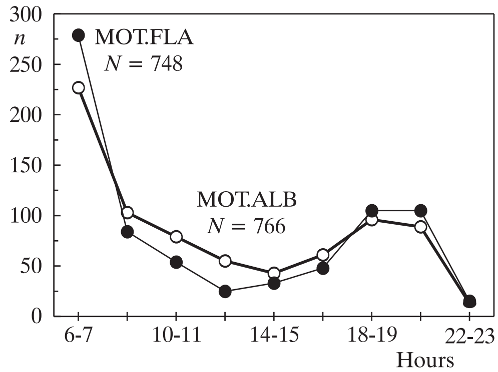


Fig. 2. The pattern of diurnal activity of juvenile White Wagtails (MOT.ALB) and Yellow Wagtails (MOT.FLA)

body mass did not show a clear increase during the stay (regression coefficients: White Wagtail – b = 0.146, p = 0.13, and Yellow Wagtail – b = 0.011, p = 0.93; Fig. 1). Significant differences occurred between body masses of White Wagtails caught in the morning (6.00-11.00 *a.m.*, mean = 19.79 g, *SD* = 1.63) and in the evening (6.00-11.00 *p.m.*, mean = 21.00 g, *SD* = 1.77; Mann-Whitney *U*-test: Z = -7.24, p < 0.00001). Also Yellow Wagtails were heavier at dusk (mean = 16.48 g, *SD* = 1.77) than after dawn (mean = 15.40 g, *SD* = 1.01; Mann-Whitney *U*-test: Z = -4.69, p < 0.00001). Wagtails were trapped during feeding on the ground and the time of catching was analysed to allow to determine the daily activity. In the study area both the species were feeding mainly in the morning and the second, smaller peak occurred in the evening (Fig. 2). In this study 43.1% of White Wagtails and 48.5% of Yellow Wagtails were caught between 6.00-9.00 *a.m.*

Biometrical comparisons between early and late migrating birds

Juveniles of the White Wagtail caught in subsequent decades did not differ significantly in average wing length (ANOVA: $F_{7,694}$ = 1.25, p = 0.27; Fig. 3), nor in

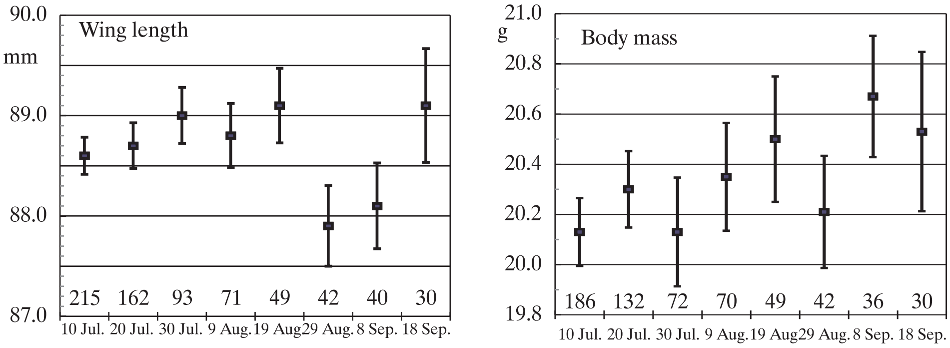


Fig. 3. Mean values (rectangles) plus/minus *SE* of winglength and bodymass of juvenile White Wagtails caught in the Gulf of Gdańsk region in subsequent decades in 1990-2000. Numbers below indicate decade sample sizes.

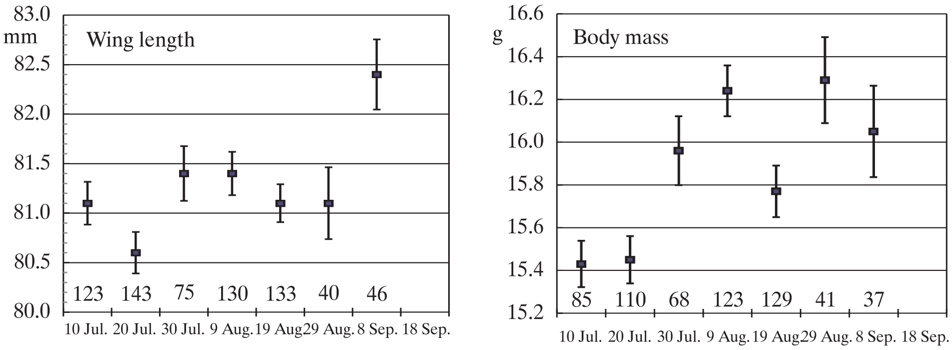
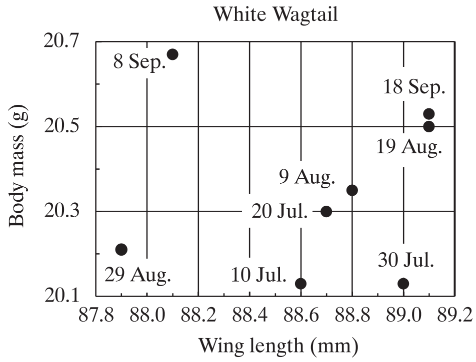


Fig. 4. Mean values (rectangles) plus/minus *SE* of winglength and bodymass of juvenile Yellow Wagtails caught in the Gulf of Gdańsk region in subsequent decades in years 1990-2000. Numbers below indicate decade sample sizes.

mean body mass (ANOVA: $F_{7,609} = 0.68$, $p = 0.69$; Fig. 3), but in the Yellow Wagtail the late migrants had longer wing (ANOVA: $F_{6,683} = 3.78$, $p = 0.001$; Fig. 4) and they were heavier than the individuals having passed earlier (Kruskal Wallis test: $H_{6,593} = 23.1$, $p = 0.0001$; Fig. 4). However, distributions of decade-groups at the wing length / body mass diagrams (Fig. 5) suggest that the above picture of biometrical structure of migrating wagtails could be oversimplified and it needs further studies.

In order to find differences in value of wing pointedeness (*l*-index) among wagtails trapped in the Gulf of Gdańsk earlier and later during the season, the study time was divided arbitrary into two periods – from the beginning of July to 14 August and from 15 August to the end of September. In both species the individuals migrating later had more rounded wings (Mann Whitney *U*-test: White Wagtail – $U_{474,173} = 36909$, $Z = 1.94$, $p = 0.052$, Yellow Wagtail – $U_{357,239} = 36864$, $Z = 2.81$, $p = 0.005$).



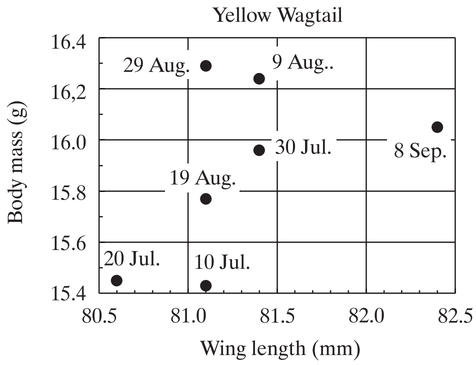


Fig. 5. Relative distributions of decade-groups (decades as in Figure 4) in wing length / body mass space for young White and Yellow Wagtails

DISCUSSION

The wing length analysis of young White Wagtails migrating through the Gulf of Gdańsk region showed two-peak character of this parameter distribution. The 4-5 mm difference was caused by sexual dimorphism between larger males and smaller females. This corresponds to the measurements from Glutz von Blotzheim and Bauer (1985) and Cramp (1988) taken mainly from museal skins. This study shows the lack of differences in the mean wing length of White Wagtails migrating in subsequent decades. Jentzsch (1989) ringing White Wagtails at a German roost from July to October also did not find changes in mean wing length during this time. In the Gulf of Gdańsk region the lack of sexual dimorphism in the distribution of wing length of young Yellow Wagtails was found. This result may be caused by unequal sex ratio in the study sample of birds and/or the passage of individuals belonging to different migrational populations. The impossibility to distinguish sex in both the species in juvenile plumage during the ringing complicates interpretation of data.

In both species of wagtails no remarkable differences in length of wing between seasons were found. The seasonal changes in this measurement of the juvenile birds were found in some passerines (Busse 1976), in the Coot (*Fulica atra*) (Fjeldså 1977), in the Wood Sandpiper (*Tringa glareola*) (Meissner 1997), in the Redshank (*Tringa totanus*) (Meissner 1999). These differences might be explained by diversity in food availability at the breeding grounds and by the fact that chicks that were not fed well grew slower and reached smaller size (Meissner and Włodarczak 1999). Only in the juveniles of Yellow Wagtail the inter-seasonal variability in mean body mass was found. This study showed the significant differences in shape of wing in White Wagtail with parallel lack of them in wing length between subsequent autumns. Similar situation was described for the Savi's Warbler (*Locustella luscinioides*) population from the Biebrza Marshes (Nowakowski 2002). This phenomenon can be explained by the stronger pressure of natural selection (weather and feeding conditions) for the wing shape than the wing length.

The weight of young White and Yellow Wagtails caught in the region of the Gulf of Gdańsk was low in comparison to other stopover sites and winter grounds (Wood 1978, Glutz von Blotzheim and Bauer 1985, Cramp 1988, Dougall and Appleton 1989, Spina and Massi 1992). Moreover, the majority of birds had small fat reserves. The long time of stay of the retraps and lack of remarkable increase in their body mass showed that the part of them was of local origin during dispersion and/or starting the migration. In Mediterranean region fast deposition of fat in Yellow Wagtails was found (Cramp 1988, Spina and Massi 1992). Wagtails migrating in the Gulf of Gdańsk region behave as energy minimising migrants and migrate in small steps having low fat reserves. Hereward (1979) noted the slow autumn migration of Yellow Wagtail in Europe.

Both species of wagtails were heavier in the evening than in the morning. The same differences occurred in the Grey Wagtails (*Motacilla cinerea*) migrating over Belgium in the autumn (Herremans 1988). Probably the birds trapped at the dawn had to rebuild energetic reserves, which were consumed during roosting. It seems to be confirmed by the fact that in this study half of birds were caught during feeding in the morning.

In the Gulf of Gdańsk region Yellow Wagtails migrating in the second half of autumn migration were heavier and they had longer and more rounded wings. One of the explanations to this differences is the later passage of northern subspecies *thunbergi*. *M. f. thunbergi* is a bit larger than *M. f. flava* (Cramp 1988, Svensson 1992). The subspecies *thunbergi* is a regular migrant in spring at the Polish seacoast (Sikora 1994) and this study suggests that this subspecies migrates through this region also in autumn, but lack of the observations might result from difficulties in distinguishing *M. f. thunbergi* from *M. f. flava* in immature and non-breeding plumage (Tomiałojć and Stawarczyk 2003).

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