

MIGRATORY STATE: BODY MASS AND FAT LEVEL
OF SOME PASSERINE LONG-DISTANCE MIGRANTS
DURING AUTUMN MIGRATION IN NORTH-EASTERN
BULGARIA

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ABSTRACT

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Body condition of 3224 migrating birds of Great Reed Warbler (*Acrocephalus arundinaceus*), Sedge Warbler (*A. schoenobaenus*), Willow Warbler (*Phylloscopus trochilus*), Red-backed Shrike (*Lanius collurio*) and Whitethroat (*Sylvia communis*) was studied at Kalimok Station, NE Bulgaria (41°00'N 26°26'E) in the autumns of 1997-2003. The mean values of the fat level and the body mass were calculated for each species and year and were compared with similar data of various parts of the Palaearctic-African Migration System. Distinct variations in the mean values of studied parameters in different years were recorded. The dynamics of the accumulated subcutaneous fat and the body mass during the autumn varied in different species and either increase or decrease of the values during a certain season were registered. Age-determined differences in the studied characteristics were found. The timing of the passage of the first-year and adult birds can influence the dynamics of the mean fat level and the mean body mass. The lack of selective environment in NE Balkan Peninsula allows the passage of conspecific birds in various migratory states. The realisation of their migration adaptations highly depends on environmental conditions during the period of passage.

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INTRODUCTION

The accumulation of considerable amount of energy reserves is a typical feature of the long-distance migrants, which have to cross large ecological barriers like the Mediterranean Sea and Sahara in their way to wintering grounds (Dolnik 1975, Berthold 2001). Therefore, the physiological parameters such as the body mass and

the fat level are frequently used indicators of energetic reserves of birds during migrations. In western and northern Europe as well as in Sahara, a significant number of studies concerning fat accumulation of trans-Saharan migrants have been carried out (Biebach 1990, Bairlein 1992, Akesson *et al.* 1995, Schaub and Jenni 2000). In contrast, the Balkan Peninsula is still a white spot and only data on some local populations are available (Akriotis 1998).

The aim of the present study is to characterise the physiological condition of the species studied at a point along the East-European migratory flow during the autumn migration. On the basis of these data, we also attempt to answer the question: Do mean values of the fat level and the body mass indicate particular migration strategies of the species or are they simple responses to the ecological conditions during the current season?

MATERIAL AND METHODS

The present study is a part of a complex research program on the passerine migration started in 1995 in the Balkan Region. The data was collected during the periods from the beginning of August to the middle of October in 1997-2003 at Kalimok Field Station situated near Danube riverbank in NE Bulgaria (41°00'N 26°26'E). Birds were mist-netted in two main habitats, the area of former fishponds overgrown by reeds (*Phragmites communis*) and the deciduous mixed forest (*Robinia pseudoacacia* and *Fraxinus oxycarpa*). For 7 autumn seasons, 3224 birds of the Great Reed Warbler (*Acrocephalus arundinaceus*), Sedge Warbler (*Acrocephalus schoenobaenus*), Willow Warbler (*Phylloscopus trochilus*), Red-backed Shrike (*Lanius collurio*) and Whitethroat (*Sylvia communis*) were ringed and measured according to ESF (European Science Foundation) project (Bairlein 1995) and SEEN (South East European Bird Migration Network) standards (Busse 2000) – see Table 1. For the purposes of the present study, the body mass (to the nearest 0.5 g), the visible fat reserves estimated on a nine-class scale (Kaiser 1993) and the body feathers moult intensity in a three-score scale (0 – no feathers growing, 1 – between 1 to 20 feathers growing, 2 – more than 20 feathers growing) were used. Moulting birds scored with 2 were not included into the analysis.

Table 1
Numbers of individuals studied

	1997	1998	1999	2000	2001	2002	2003	Total
<i>Acrocephalus arundinaceus</i>	40	16	141	35	244	88	118	868
<i>Acrocephalus schoenobaenus</i>	69	10	249	188	267	127	147	1057
<i>Phylloscopus trochilus</i>	16	48	109	197	193	111	98	772
<i>Lanius collurio</i>	19	74	51	83	78	37	69	411
<i>Sylvia communis</i>	6	8	30	79	98	31	50	302
Total	150	156	580	582	880	394	482	3224

RESULTS

Fat level

For the five studied species, the means of the fat level for each year were obtained (Table 2). The Great Reed Warbler showed relatively constant and the lowest mean fat levels (2.5 ± 1.8 , range = 2.0-2.9) while the Whitethroat had the highest mean fat score and great variation in the mean values between the years (3.9 ± 1.8 , range = 3.0-4.8). We also observed considerable variations in the fat levels between different seasons in all studied species. No general pattern in the dynamics of the fat depositions representative for all the species at the same time was found. Neither years of good conditions nor years with bad ones were identified for the studied species considered together.

Table 2
Fat scores (mean \pm SD)

	1997	1998	1999	2000	2001	2002	2003	Total
<i>A. arundinaceus</i>	2.3 ± 1.8	2.1 ± 2.2	2.0 ± 1.7	2.8 ± 2.0	2.9 ± 1.8	2.9 ± 1.7	2.3 ± 1.9	2.5 ± 1.8
<i>A. schoenobaenus</i>	3.5 ± 2.1	2.8 ± 1.0	3.1 ± 1.7	2.5 ± 1.9	3.7 ± 1.9	4.0 ± 2.0	3.2 ± 2.1	3.3 ± 1.9
<i>Ph. trochilus</i>	3.2 ± 1.2	3.9 ± 1.2	2.7 ± 1.8	3.5 ± 2.0	3.5 ± 1.8	4.3 ± 1.7	4.0 ± 1.8	3.4 ± 1.9
<i>L. collurio</i>	3.0 ± 2.1	2.9 ± 1.9	2.6 ± 1.6	1.9 ± 1.9	3.6 ± 2.0	3.8 ± 2.3	2.2 ± 2.0	2.7 ± 2.0
<i>S. communis</i>	4.5 ± 1.1	4.8 ± 1.8	3.0 ± 1.6	4.4 ± 1.8	3.7 ± 1.7	4.6 ± 1.7	3.5 ± 1.8	3.9 ± 1.8

Body mass

The body mass mean values of the five studied species for each year (Table 3) showed considerable variations. They corresponded to the variations of the fat levels and did not follow a general pattern for all the species. According to the standard deviation, the body mass values are less variable compared with those of the fat level.

Table 3
Body mass (mean \pm SD)

	1997	1998	1999	2000	2001	2002	2003	Total
<i>A. arundinaceus</i>	28.5 ± 4.7	30.8 ± 5.2	28.5 ± 3.7	29.0 ± 3.9	29.4 ± 4.7	29.3 ± 4.1	29.0 ± 4.3	29.1 ± 4.3
<i>A. schoenobaenus</i>	11.9 ± 2.6	11.0 ± 0.8	11.8 ± 1.5	11.5 ± 1.5	12.0 ± 1.8	12.7 ± 2.2	12.1 ± 1.8	11.9 ± 1.8
<i>Ph. trochilus</i>	8.5 ± 1.1	9.6 ± 1.2	9.3 ± 1.6	9.6 ± 1.6	9.1 ± 1.5	10.4 ± 1.9	9.9 ± 1.7	9.6 ± 1.7
<i>L. collurio</i>	28.2 ± 5.5	30.1 ± 5.2	29.5 ± 4.4	28.0 ± 3.9	29.7 ± 4.5	31.0 ± 5.2	27.9 ± 4.1	29.2 ± 4.7
<i>S. communis</i>	14.8 ± 1.9	17.6 ± 2.2	15.2 ± 2.2	17.0 ± 3.1	15.6 ± 2.3	16.7 ± 3.1	16.0 ± 2.7	16.1 ± 2.7

DISCUSSION

In the studied long-distance migrants, considerable variations in the means of the fat level and the body mass between years have been registered. A possible reason for this could be the passage of birds in various migratory stages through the territory of the Balkan Peninsula. The age, sex and population composition of the migrants in particular periods of the season could influence the values of the studied parameters. The average fat levels and body masses should remain equal between the subsequent years if the composition of the migrants is similar. According to our results, the physiological parameters of the birds vary by years. Hence, we could suggest a change of the migrants composition, but the sequence of the populations during the autumn migration must be relatively constant as we have no evidence for the fast changes in the breeding areas of the species. Therefore, the annual variations in the migratory state of the same populations are only possible explanation of our results.

External factors, *i.e.* the environmental conditions during the period of the passage and the habitat quality in the stopover sites are also known to influence the fat accumulation of migrating birds (Yong *et al.* 1998). They, as well as the lack of selective environment, are more likely to have direct impact on the values of the fat level and body mass registered in NE Bulgaria. Willow Warblers caught in Sahara desert, a highly selective environment, has shown low variations (0.4 g) in the body mass between years (Biebach 1990); in contrast, the birds of the same species at the Kalimok station have considerably bigger variation ($SD = 1.7$ g).

The most numerous species, the Sedge Warbler, allows a more precise analysis and comparisons of the studied parameters by years. The variations in the fat level and the body mass were similar but the latter is more convenient because of the lower subjectivity and the more numerous range classes.

To check whether the age structure of migrants could be a reason for the between years differentiation in studied parameters, the body masses of adults and first year birds were analysed separately (Table 4). Comparison by pairs of all years revealed significant differences in eight cases. In two cases, the significant differences were due to the body mass variation in adults, in other five due to the first year birds and in one because of both ages. Yearly values of body mass of adults caught in Kalimok in 1999 and 2000 were much lower than at Ukrainian station Cholgini (Zakala *et al.* 2004) in the same years (11.52 and 11.44 *versus* 12.73 and 12.79 g); for immatures 1999 values were the same (11.86 and 11.81 g), while in 2000 Ukrainian birds were significantly heavier (12.28 *versus* 11.42 g in Kalimok).

During the course of season the body mass, as assessed in Kalimok, usually grows but there is visible variation in this respect. The linear regression trend line of the body mass indicates the increase, decrease or remains stable during the season (Table 5). The same was found in Cholgini for years 1999 and 2000 (Zakala *et al.* 2004).

Table 4

Comparison of the body mass of the Sedge Warblers between different years.
Body mass (mean \pm *SD*), number of birds studied (*N*) and *t*-test values are given.
Levels of significance: * $-p < 0.05$, ** $-p < 0.01$, *** $-p < 0.001$, others *ns*.

	Mean \pm <i>SD</i>	<i>N</i>	1997	1999	2000	2001	2002
All measured birds							
1997	11.87 \pm 2.55	63					
1999	11.79 \pm 1.47	245	0.226				
2000	11.46 \pm 1.50	178	1.19	2.266*			
2001	12.01 \pm 1.75	262	0.417	1.527	3.51***		
2002	12.71 \pm 2.23	123	2.228*	4.168***	5.439***	3.088**	
2003	12.09 \pm 1.77	142	0.615	1.674	3.341***	0.416	2.508*
First year birds							
1997	11.13 \pm 1.65	35					
1999	11.81 \pm 1.51	216	2.297*				
2000	11.42 \pm 1.61	130	0.931	2.248*			
2001	11.75 \pm 1.59	219	2.059*	0.458	1.832		
2002	12.72 \pm 2.23	108	4.529***	3.833***	5.076***	4.086***	
2003	11.77 \pm 1.47	94	1.998*	0.262	1.658	0.107	3.648***
Adult birds							
1997	11.89 \pm 2.61	18					
1999	11.52 \pm 0.99	20	0.564				
2000	11.44 \pm 1.01	46	0.711	0.303			
2001	13.36 \pm 1.92	38	2.135*	4.82***	5.568***		
2002	12.71 \pm 2.31	14	0.947	1.82	2.006*	0.934	
2003	12.71 \pm 2.13	48	1.191	3.134**	3.71***	1.49	0.009

Table 5

Slope of the linear regression trendline in the body mass
of Sedge Warblers in the course of autumn.
Number of weighed birds (*N*)
and significance level ($p < 0.05$ in bold) are given.

	<i>N</i>	Slope	<i>p</i>
1997	63	0.039	0.015
1998	10	-	-
1999	245	0.017	0.001
2000	178	0.012	0.023
2001	262	-0.012	0.069
2002	123	0.024	0.003
2003	142	-0.005	0.530

The Willow Warbler, a species known in Bulgaria during migrations only, was a subject of numerous studies on fat accumulation carried out in different parts of its migratory range (Table 6). Data from northern Europe – Ottenby (Sweden) and Helgoland (Germany) – show body masses of Willow Warbler significantly lower than registered in NE Bulgaria. They increase southwards and on the Mediterranean islands (Cyprus and Karpathos), just before the large forthcoming barriers, they show the highest values. There are no differences between our results and those from the coast of Egypt, after the crossing of the Mediterranean Sea. The mean values of the body mass of Willow Warblers from Bulgaria are almost equal to those registered at the rocky desert (northern parts of Egypt) and at a small oasis in Sahara (Algeria). After the desert crossing the mean body mass of the Willow Warblers is approximately equal to the fat-free body mass of the species. The variations in the body mass and the fat level by years and the intermediate values from Bulgaria compared with the same parameters from other places (Table 6) could be explained by the lack of a selective environment in the region allowing the conspecific passage of birds in various body conditions. The realisation of their migration adaptations highly depends on environmental conditions during the period of the passage.

Table 6

Body mass (g) of Willow Warblers on autumn migration in various parts of Europe and Africa

Location	Mean \pm SD	N	References
Ottenby (Sweden)	8.2 \pm 0.7	81	Akesson <i>et al.</i> (1995)
Bukowo (Poland)	8.8 \pm 0.98	2349	P. Busse (pers. comm.)
Helgoland (Germany)	8.6 \pm 0.96	161	Dierschke and Bindrich (2001)
NE Bulgaria	9.6 \pm 1.65	772	Present paper
Karpathos Is. (Greece)	10.9 \pm 1.28	82	Biebach (1990)
Cyprus	9.8	271	Moreau (1969)
Algerian Sahara	9.8 \pm 1.1	104	Bairlein (1992)
Dhleil (Jordan)	9.5 \pm 1.18	98	P. Busse (pers. comm.)
Egypt – coast	9.2 \pm 1.31	43	Moreau and Dolp (1970)
Egypt – desert	9.7 \pm 1.22	427	Biebach <i>et al.</i> (1986)
Port Sudan (Sudan)	7.0	95	Biebach after Nikolaus (1990)

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