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Regular research paper

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RELATION BETWEEN STOPOVER LENGTH AND TIME  
AND BODY PARAMETERS OF EUROPEAN ROBIN  
*ERITHACUS RUBECULA* (L., 1758) DURING AUTUMN MIGRATION  
(CENTRAL POLAND)

**ABSTRACT:** The relation between age, body parameters and the stopover behaviour of a small, short-distance, migratory bird during the season of autumn (August–October) was studied. Capture-recapture data of 1018 first-year and 89 adult European Robins migrating through central Poland (“Kaliszany” ringing station, 21°48'E, 51°05'N) in autumn between 1997 and 2005 were analysed. Body mass, length of wing and tail of young Robins caught and stayed at the stopover site showed significant seasonal variation. Immature Robins made longer stopovers (median = 4 days, 1–41) in the area than older ones (median = 3 days, 1–32). The stopover duration decreased continuously during the season. However, body mass changes at the staging site was not related to the age of birds. The birds migrating in the second half of autumn (late September–October) period accumulated fat faster than birds migrating in the early season. Our analyses confirmed that late migrants stayed for shorter stopovers and gained more body mass than early migrating birds due to a shift in migration strategy as an adaptation to time stress.

**KEY WORDS:** stopover ecology, autumn migration, biometrics, migratory behaviour

1. INTRODUCTION

During migration period, birds have to rebuild their energetic reserves several times at a number of staging sites (Weber *et al.* 1999, Carlisle *et al.* 2005). Passerines during migration spend as much as *ca.* 90% of time at stopovers (Chernetsov *et al.* 2004). Migrant behaviour at staging site is mainly shaped by the need to maximise food intake, and fat is deposited in order to be subsequently used during flight. The most important factors affecting the initiation and the continuation of migration are weather and endogenous (physiological and genetic) determinants (Berthold 1993, Zehnder *et al.* 2001, Alerstam *et al.* 2003, Schaub *et al.* 2004). A recent study indicated that migrants can start off together from their extensive breeding grounds and arrive simultaneously at stopover sites located over an extensive area (Nowakowski *et al.* 2005).

The European Robin *Erithacus rubecula* (hereafter Robin) is a short-distance and nocturnal migrant in Europe. Robins crossing through Poland originate mainly from Sweden, Finland, Baltic countries, Belarus and north-western Russia (Remisiewicz *et al.* 1997). It has been assumed that Robins

migrating early in autumn originated mainly from southern Baltic region, while later birds came from the north-eastern part of breeding range – e.g. Finland, Russia (see Ginter *et al.* 2005). Generally, the earliest migrating Robins head to more western parts for wintering grounds, while the late migrants are directed to eastern winter quarters (Remisiewicz 2002, Ściborska and Busse 2004). Robins passing through central Poland migrate mainly to the “Apennine” and “Balcan” winter quarters (Remisiewicz 2001, 2002). Analysis of our ringing recoveries support this hypothesis, because Robins trapped at ringing station in Kaliszany were recorded in Switzerland, Corsica and Croatia (unpublished data). Migrants such as Robins complete their migrations in a series of flights interrupted by stopovers when fuel reserves are replenished. The Robin is an example of species using the time-minimisation strategy of migration (see Åkeson and Hedenström 2000, Nowakowski *et al.* 2005).

The main aim of this study is to characterise the stopover pattern of Robins, based on the data of birds trapped at ringing station in Kaliszany (Central Poland). In this

paper, the inter-annual variation of the wing and tail length and body mass is presented. We expect that young birds on their first migration should experience longer stopovers. Finally, we tested and described stopover decisions of Robins migrating through the central Poland in response to stress caused by progressing autumn. According to Fransson (1995) we may expect that a late start of migration may force individuals to migrate faster to reach their destination in time and birds have to increase their food intake and fuel deposition rate later in the season. Migration speed may be under selection pressure and stopover periods should become shorter due to the progress of the autumn.

## 2. MATERIAL AND METHODS

Robins were caught during a continuous trapping operation of migrants at the ringing station in the middle Vistula valley near Kaliszany (21°48'E, 51°05'N, Lublin region). Fieldwork started in mid-August and finished in mid-October (see details in Table 1). The mist-nets localised mainly in the willow thickets *Salix* spp. were checked

Table 1. Numbers of ringed and proportion of retrapped Robins in two age classes for successive autumn seasons 1997–2005. Data from ringing station in Kaliszany (Central Poland).

	Immature		Adult	
	Number of ringed	Number of recaptured (%)	Number of ringed	Number of recaptured (%)
15 Aug–19 Oct 1997	399	95 (24)	54	7 (13)
19 Jul–4 Oct 1998	353	57 (16)	24	5 (21)
1 Aug–29 Oct 1999	742	117 (16)	45	7 (16)
5 Aug–28 Oct 2000	793	95 (12)	65	10 (15)
18 Aug–25 Oct 2001	947	195 (21)	102	28 (28)
21 Aug–9 Oct 2002	906	173 (19)	68	15 (22)
16 Aug–1 Oct 2003	399	31 (8)	23	1 (4)
23 Aug–16 Oct 2004	879	112 (13)	84	8 (10)
20 Aug–16 Oct 2005	698	143 (21)	147	8 (5)
Total	6116	1018 (17)	612	89 (15)

every one-hour from dusk to dawn. The number of nets (*ca.* 50) and the ringing procedures were stable between seasons. Detailed description of the study area and the methods of the fieldwork were given in the previous paper (Grzywaczewski *et al.* 1998). Birds were aged according to Svensson (1992) and two age categories (immature – 1 year old and adult – > 1 year old) were recognised. We measured individuals to analyse the inter-seasonal variability of morphometric parameters. Wing length (“maximum chord method”) and wing tail (“to the back method”) were measured with stopped ruler to the nearest 1 mm as described by Busse (2000). The number of adults was insufficient for more detailed comparisons and they were excluded in the analyses of inter- and intra-seasonal variation of the morphometric parameters. Every year the accuracy and the repeatability of measurements taken by different ringers were checked as described by Busse (1984). Robins were also weighed with accuracy to 0.5 g by “Pesola” spring-balance. We used only data from the first captures to calculate the inter-annual variation of biometrical characteristics. All re-

captured birds were weighed with the same precision and data from the first and the last capture were used in the analyses.

True stopover duration is difficult to estimate because birds were usually not trapped immediately after arrival nor just before leaving the study area (Holmgren *et al.* 1993). According to Yosef and Chernetsov (2005), to estimate stopover duration we used the minimum stopover length – the number of days between the last and the first capture of an individual. The stopover duration was analysed statistically by use non-parametric tests (Mann-Whitney and Kruskal-Wallis test). For the analyses and presentation of data successive decades like: 14–23 August, 24 August–2 September, 3–12 September, 13–22 September, 23 September–2 October, 3–12 October, 13–22 October were used (Berthold 1973). The birds from the outside this period or from the extremes decades were excluded in some analyses, because the sample size was insufficient. We estimated the changes of body mass during stopover as percentage of the initial body mass (see Meissner and Koziróg 2001, Yosef and Chernetsov 2004). The statistical methods followed So-

Table 2. Inter-annual variation of wing length (mm), tail length (mm) and body mass (g) in young Robins ringed at ringing station in Kaliszany (Central Poland) in 1997–2005. Values given are means, SD and sample sizes (n). Within variable, values that have the same letter are statistically different (Tuckey test,  $P < 0.05$ ).

Year	Wing length (mm)	n	Tail length (mm)	n	Body weight (g)	n
1997	71.3 ± 1.9 <sup>AB</sup>	95	59.9 ± 2.5 <sup>AB</sup>	94	16.7 ± 1.4	93
1998	72.0 ± 1.8	53	59.5 ± 3.1	33	16.2 ± 1.1	57
1999	71.8 ± 1.9	113	59.7 ± 2.7 <sup>CD</sup>	113	16.1 ± 1.2	102
2000	72.5 ± 1.9 <sup>AC</sup>	92	61.0 ± 3.6 <sup>CEFGHI</sup>	90	16.4 ± 1.3	95
2001	71.4 ± 1.9 <sup>CD</sup>	193	59.5 ± 2.1 <sup>EJ</sup>	185	16.5 ± 1.2	190
2002	72.0 ± 1.7 <sup>A</sup>	141	58.8 ± 2.6 <sup>AF</sup>	133	16.2 ± 1.2	170
2003	71.5 ± 2.1	30	57.1 ± 3.3 <sup>BDGJK</sup>	21	15.9 ± 1.0	29
2004	72.4 ± 2.0 <sup>BD</sup>	99	61.5 ± 2.1 <sup>HK</sup>	96	16.5 ± 1.4	109
2005	71.9 ± 1.9	124	58.6 ± 2.7 <sup>I</sup>	125	16.6 ± 1.3	140
ANOVA	$F_{8,940} = 5.4$		$F_{8,890} = 8.1$		$F_{8,985} = 3.0$	
<i>P</i>	<0.00001		<0.00001		<0.01	

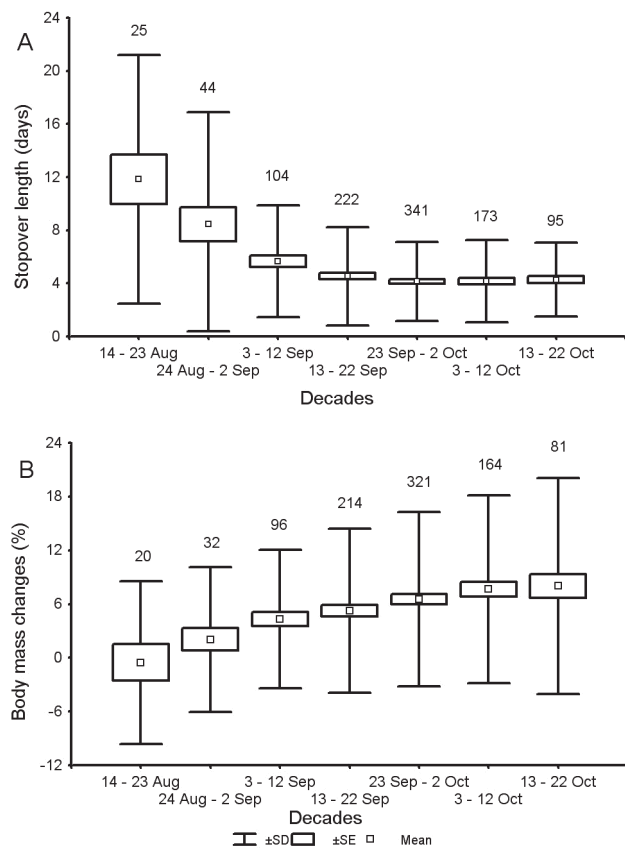


Fig. 1. Stopover length (A) and body weight changes (% of initial body mass – B) of retrapped young Robins in subsequent decades of autumn period at ringing station in Kaliszany (Central Poland). Data from 1997–2005. Numbers above lines indicate sample size.

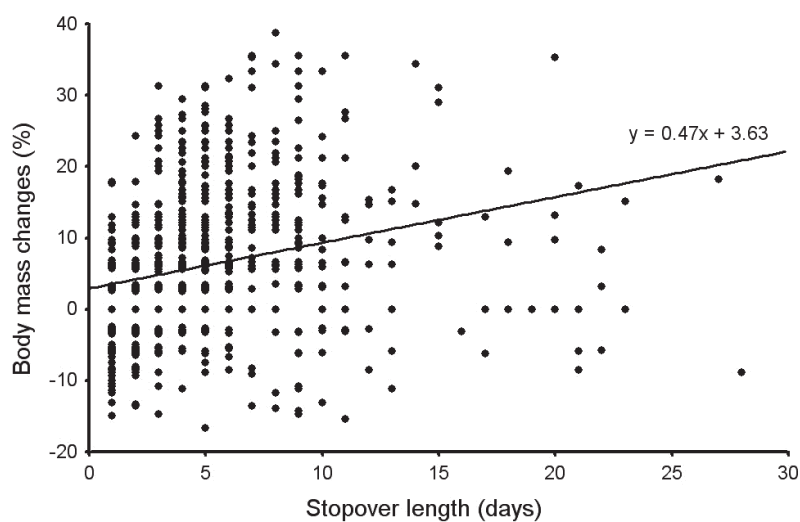


Fig. 2. Relative body mass changes (% of initial body mass) in immature Robins caught more than once at ringing station in Kaliszany (Central Poland) in relation to the stopover duration. Data from 1997–2005.

kal and Rohlf (1995). Variation of means among years was tested by use ANOVA. A Tukey multiple comparisons test was performed when an ANOVA was significant. Statistical analyses were carried out using Statistica 6.0, Statsoft Inc. 2001 package.

### 3. RESULTS

During the years 1997–2005, a total of 6116 immature and 612 adult Robins were caught. From all trapped birds 1018 (17%) young and 89 (15%) adult of the species were retrapped (Table 1). Numbers of retrapped young Robins did not differ between years (chi-square test  $\chi^2 = 12.37$ , 8 df,  $P = 0.136$ ), however the proportion of marked and resighted adults differ significantly in subsequent seasons ( $\chi^2 = 32.44$ , 8 df,  $P < 0.001$ ). Wing and tail length and body mass of young Robins caught and stayed in the stopover site showed a highly significant inter-seasonal variation (Table 2, one-way ANOVA). The minimum stopover length of young (median = 4 days, range – 1–41 days,  $N = 1018$ ) was longer than adult Robins (median = 3 days, range – 1–32 days,  $N = 89$ , Mann-Whitney test,  $U = 38834.5$ ,  $Z = 235739$ ,  $P < 0.05$ ). Immatures migrating in subsequent decades differ significantly in stopover duration (Kruskal-Wallis test  $H_{6, 1004} = 48.50$ ,  $P < 0.0001$ ) and birds caught in late autumn had a shorter stopover period (Fig. 1A). The body mass of young birds showed an increase during the stay ( $r = 0.21$ ,  $t = 6.7$ ,  $P < 0.0001$ ,  $N = 952$ ). Most recaptured Robins gained or did not change the body mass, however 206 out of 1018 (20%) young and 23 out of 89 (26%) adult birds showed a weight loss (Fig. 2). The rate of body weight change during stopovers did not differ between age classes (mass gain of immatures vs adults – 6 vs 5%, test  $t = 0.56$ ,  $P = 0.574$ ). Although the stopover length decreased continuously during the season young Robins gain more mass at stopover site due to progress of the autumn season ( $F_{6, 938} = 4.889$ ,  $P < 0.0001$ , Fig. 1B).

### 4. DISCUSSION

Young Robins that stayed at staging site showed remarkable differences in body mass,

length of wing and tail between years. The seasonal changes in these measurements of the juvenile birds were found in some passerines (Busse 1976, Yosef and Chernetsov 2004, 2005), Coot *Fulica atra* (Fjeldså 1977), some species of waders *Charadrii* (Meissner 1997, 1999). The explanation of such differences might be the variable conditions during both the breeding and migration seasons. The diversity in food availability at the breeding grounds during feeding by parents affect the growth of nestlings and chicks that were not well fed, who grow slower and reach a smaller size (Meissner and Włodarczyk 1999). The environmental conditions during flights and stopovers differ between the years and probably also have an influence on body mass and condition (Schaub and Jenni 2001, Yosef and Chernetsov 2005).

The theory assumes that adult birds move faster than immature ones, because they are more experienced and better prepared than naive birds (Fransson 1995). This study also indicated that young Robins stayed for longer at stopover site than adults. Several factors could have caused these differences. It could be produced by differences between age classes in the capacity to accumulate fat in the study area, because adult birds can be more experienced in utilisation of food resources and/or adults are likely to be dominant over juveniles and use high-quality habitats (see Telleria and Perez-Tris 2004). Some nocturnal migrants remain during stopovers within restricted areas; some even occupy temporary territories (Chernetsov *et al.* 2004). It has been found that Robins defend small territories during stopovers for a few days and individuals that cannot occupy a territory after arrival leave the stopover site very quickly (Szulc-Olech 1965, Schaub *et al.* 2004). Moreover, temporal and habitat variation in kind and availability of food may be the cause of the differences in stopover length (Figuerola and Bertolero 1998, Dierschke and Delingat 2001, Carlisle *et al.* 2005). However, the study indicates that fat accumulation rate at the staging site was not affected by age. Yong *et al.* (1998) also found no differences in rate of body mass gain among adult and first-year Wilson's Warblers during autumn migration. Another explanation may be related to the later migra-

tion of adult Robins. The autumn migration of adults of the species in central Poland proceeds slightly later in the season than younger ones and usually lasts from late September to mid-October (unpublished data). Kędzior (2002) has shown that migrating Blackcaps *Sylvia atricapilla* (L., 1758) tended to stay at staging site for a shorter time as the season progressed. Our results also show clearly that the stopover length decreased continuously during the autumn period. Analysis of ringing recoveries of Robins ringed in Poland showed that the birds early ringed in the first two decades of September migrated the farthest of all, while for the following decades the distance of recoveries was remarkably shorter (Remisiewicz *et al.* 1997, Remisiewicz 2001).

The overall migration speed depends on both flying time and time spent at stopover sites. However, the most important factor determining overall speed of passage is stopover duration (Schaub and Jenni 2001). A compensatory increase in migration speed for late individuals suggests adaptations to time stress (Fransson 1995). The reason for an increase in migration speed may be that there are several costs in terms of higher energy expenditure, and greater predation risk due to increased foraging and/or low availability of food resources. As a consequence there should be strong selective pressure on late migrants. This study showed that the birds migrating in the second half of autumn period accumulated fat faster than birds migrating in the early season. According to Ehnбом *et al.* (1993) late birds may gain more body mass due to a shift in migration strategy as an adaptation to a time stress. It has been suggested that the birds try to catch up with the earlier passage conspecifics (Yosef and Chernetsov 2004). Moreover, the first migrants could obtain the benefits from early occupation of the best sites in wintering habitats (Telleria and Perez-Tris 2004).

In conclusion, during autumn migration, variation in stopover length and body mass changes in Robins were related to age and the progress of autumn period. Young birds had longer stopovers than adults. As the season progressed, late birds gained more body mass and tend to stopover for a shorter time.

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