POLISH JOURNAL OF ECOLOGY (Pol. J. Ecol.)	60	4	797–804	2012

Regular research paper

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TIMING OF AUTUMN MIGRATION AND BIOMETRIC CHARACTERISTICS OF MIGRATING POPULATIONS OF EUROPEAN ROBIN (*ERITHACUS RUBECULA* L., 1758) IN NORTH-EASTERN POLAND

ABSTRACT: We studied the autumn migration of the European robin (*Erithacus rubecula*) through north-eastern Poland. During the study period 2002–2004 we analysed a total of 2375 individuals: 1991 first-year birds and 349 adults. First-year birds had shorter wings than adults. Body condition was influenced by age, year of migration fat content and arrival time. Our results show that first-year birds arrived earlier, had low-fat levels and were in a comparatively poorer body condition to that of the adults and were less effective foragers. Stopover length decreased during the migration season for both age groups as a result of rush to their wintering areas because of winter approach. We found that adult females arrived later than adult males.

KEY WORDS: European robin, migration ecology, stopover, body condition, fat reserve

1. INTRODUCTION

Generally, the autumn migration is less studied in comparison to the spring (Newton 2008). The natural selection on timing is weaker because of the rush during the passage to the breeding grounds in the spring period (Tryjanowski and Yosef 2002). The migration of the European robin *Erithacus rubecula* (hereafter robin) is well studied along the Baltic coast (Remisiewicz 2001, 2002, Sciborska and Busse 2004, Adamska and Filar 2005, Adamska and Rosińska 2006, Meina *et al.* 2007), but the knowledge of their SE migration through Central Europe is less understood (Polak and Szewczyk 2007, Gyimóthy *et al.* 2011). Robins which follow this flyway originate from the north-east *i.e.*, Finland and Russia, and head to western and southern wintering grounds (Ginter *et al.* 2005), as evidenced from the ringing data from north-eastern Poland (Tumiel *et al.* 2010).

Before a migration, birds have to complete moult: adults – the post-breeding and first-years – the partial post-juvenile (Svensson 1992). After that they start to gain fat (hyperphagy) necessary for migration (Cramp 1998, Berthold 1993). Passerines spend *ca* 90% of their time on migration (Chernetsov *et al.* 2004). Robins interrupt their migration at stopover sites to refuel energetic reserves using time-minimization strategy (Carlisle *et al.* 2005, Nowakowski *et al.* 2005). The migrants aim to maximize food intake and restore fat reserves at the stopover site, however the Robins migrating over land do not need to refuel maximum fat because there is always the possibility to stopover (Karlsson *et al.* 1988). Known factors affecting stopover length are weather conditions (Schaub *et al.* 2004), physiological and genetic determinants (Alerstam *et al.* 2003), geographic location, habitat condition and migration strategies (Meina *et al.* 2007).

Here we present results of our study on the migration timing and biometrics of robins on their SE flyway. We aimed to analyse the variation of wing length and body condition in relation to the year, capture time, fat reserve and age. We expected to find differences in migration dynamics of first-year and adult birds as well as between males and females. We hypothesised that fat reserve is an important physiological determinant in relation to age, arrival time and sex. Finally we examined stopover length in relation to arrival time, body condition, fat reserve, sex and age of migrating birds.

2. STUDY AREA

The study was conducted during the autumn migration in years 2002–2004 (2002: 1 August – 12 October, 2003: 10 July – 4 November, 2004: 28 June – 2 November) at the water reservoir Siemianówka (52°55'N, 23°50'E) in northern-eastern Poland (for details see Polakowski *et al.* 2004). The data were collected in the frame of Biology Students Scientific Club at Institute of Biology, University of Białystok. The mean number of nets was 36 per year (about 360 meters length in total). Nets were located within willows (*Salix* sp.), reedbed (*Phragmites* spp.), meadow and around the 40-years old pinestand (*Pinus sylvestris*). They were checked from dusk to dawn every hour and additionally once after sunset.

3. METHODS

All trapped birds were ringed and aged (Svensson 1992). The wing length was measured as the maximum flattened chord with a stopped-ruler to the nearest 1 mm (Busse 2000). Fat level was determined based on Busse (2000) classification scale *i.e.*, 0–8; and categorized as low-fat LF = 0–1 and as high-fat HF = 2–8. Birds were weighed with a "Pesola" spring balance with an accuracy of 0.5 g. To compare the relative body condition of robins the body condition index was used (BCI, body mass divided by the wing length, Yosef and Tryjanowski 2002). If robins were recaptured, only fat scores and weights were taken. Juvenile robins were excluded from the analyses because they had not yet started the autumn migration (Berthold 1993). Birds were sexed according to a range proposed by Pettersson (1983), for adults: male > 75 mm; female < 72 mm; and first-years: male > 74 mm; female < 71 mm. We successfully sexed 65.8% of captured birds.

We used factorial ANCOVA to analyse the influence of different variables (fat, age, year) on wing length and body condition with catching time as the covariate. If ANCOVA was significant, a Tukey test was used as comparison. To estimate the minimum stopover length, the number of days between the last and the first capture of individual robins were used (Yosef and Chernestov 2005). Kruskal-Wallis and Mann-Whitney U tests were used to compare stopover durations of different surveyed groups. Trapping time was presented as standardized Julian dates, which were calculated for each bird and season as the residual from the seasonal median. The statistical analyses were done with Statistica 8.0 (StatSoft Inc., Tulusa). Means are presented with 95% confidential limits (CL).

4. RESULTS

4.1. Wing chord length and body condition in relation to age, fat content and the capture time

During the study period 2002–2004 total of 2375 birds were ringed (2002: 773, 2003: 530, 2004: 1072): 1991 first-years and 349 adults. In general adult birds had a longer wing-chord length than first-year individuals (Table 1; $P < 0.05$). However, there were no significant differences between years ($P = 0.633$) as well as between fat categories ($P = 0.96$). The period of capture did not influence wing length ($P > 0.4$). Nor was there a significant interaction between these factors ($P = 0.14$).

The body condition of adults was better than that of first-year birds (Table 1; $P < 0.05$). Birds were in significantly lower body condition in 2002 than 2003 and 2004; (Tuckey test, Table 1; $P < 0.0001$) and was evident in

Table.1. ANCOVA of wing chord length and body condition in relation to age, fat content and capture time. Bold values are significant, P <0.05. ^{AB} and ^{AC} indicate significance of Tuckey test (P <0.05).

		Mean	CL	N total	F	df	P
Wing chord length							
Age	adults	72.50 mm	72.19 – 72.82	289	5.789	1.19	**<0.05**
	first-year individuals	72.09 mm	71.99 – 72.20	1728			
Year	2002	72.34	72.06 – 72.63	639			
	2003	72.36	72.01 – 72.71	431	4.57	2.19	0.633
	2004	72.20	71.98 – 72.41	858			
Fat	0-1	72.30	72.02 – 72.57	1003	0.003	1.19	0.96
	≥ 2	72.30	72.12 – 72.49	925			
Period of capture							0.4
Body condition							
Age	adults	0.231	0.229 – 0.234	222	7.74	1.18	**<0.05**
	first-year individuals	0.227	0.226 – 0.228	1557			
Year	$2002^{AB, AC}$	0.223	0.221 – 0.226	592	24.30	1.766	**<0.0001**
	2003^{B}	0.231	0.228 – 0.233	420			
	2004^{C}	0.234	0.232 – 0.236	767			
Fat	0-1	0.223	0.221 – 0.225	940	46.52	1.766	**<0.0001**
	≥ 2	0.235	0.234 – 0.237	839			
Period of capture							**<0.0001**

the number of LF individuals compared to HF ones (n_{HF} = 839; n_{LF} = 940; P <0.0001). Birds trapped later in the season were in significantly better body condition than the vanguard (P <0.0001). We did not find any significant interaction between the above mentioned factors (P = 0.4).

4.2. Fat content

The number of adults *vs* young birds with HF was significantly different (67% *vs* 44%; χ^2 = 115.71, df = 1, P <0.0001). Also significantly different were the numbers of the adult sexes (69.9% female *vs* 52.6% males; χ^2 = 6.04, df = 1, P <0.05). However, we did not find any significant difference between first-year birds (females = 44.4%, males = 44.3%; χ^2 = 0.00, df = 1, P> 0.05). There was also no difference between the sexes according to body condition change (Kruskal-Wallis test: H_3 = 4.33, P> 0.05) and fat content change (Kruskal-Wallis test: H_3 = 3.85 P> 0.05) during the stopover.

4.3. Phenology

The migration of robins started in early August and finished in November. The first-year robins arrived significantly earlier than adults (Mann-Whitney U test: Z = 4.45, P <0.001; adults: median = 10, lower quartile = -8, upper quartile = 18, first-years: median = -1.5, upper 13.5). There was no difference in phenology between the sexes in the first-year birds (Mann-Whitney U Test, Z = 1.53, *P*> 0.05; Fig. 1). However, adult males arrived significantly earlier than adult females (Mann Whitney. U Test, Z = 3.07, *P* <0.01; Fig. 1), as well as LF adults than HF adults (Mann-Withney U test, Z = -8.0, *P* <0.0001; Fig. 2) and LF first-years than HF first-years (Mann-Withney U test, Z = - 14.38, *P* <0.0001; Fig. 2).

4.4. Retraps and stopover duration

There were 323 (14%) individuals retrapped: 263 (81%) first-years and 60 (19%) adults. The proportion of retrapped birds did not differ among the three seasons (χ^2 = 4.26, df =2, *P* = 0.2), as well as between adults and first-years (χ^2 = 0.53, df = 1, *P*= 0.47). Retrapped birds were in the better body condition than at first capture (paired-t-test, t = –4.09, df = 191 *P* <0.0001; first capture BCI: means = 0.226, CL: 0.224–0.228; retrapped BCI: means = 0.231, CL: 0.229–0.234). Also, we found that adults gained weight more efficiently, the positive correlation coefficient was higher between body condition index of first and last capture of adults (r = 0.51, *P* <0.05, n = 19) than of first-year birds (r = 0.21, *P* <0.05, n = 172). We did not find any difference between sexes in the stopover length (Mann-Whitney U Test, U = 2558, Z = -0.51, *P* <0.05).

Birds stayed at the stopover site between 1 to 57 days (median = 7 days, lower quartile = 3, upper quartile 27). The minimum stopover length was the same for all 3 seasons (Kruskal-Wallis test: H_2 = 1.08, *P* = 0.58). Young birds stayed at the stopover site for the same period as adults (Mann-Withney test U, Z = –0.35, *P*> 0.05; first-years: median = 7 days,, lower quartile = 3, upper quartile =24, range 1–57, n = 198; adults: median = 6 days, range: 1–56, n=25, lower quartile = 3, upper quartile = 38.

We recorded differences between birds from the different age and fat categories during the minimum stopover length (Kruskal-Wallis test: H_3 = 29.46, *P*<0.0001, n = 224; Fig. 3). Young LF birds remained significantly longer than young HF birds (post hoc test: Z = 5.16, *P* <0.0001) and LF adults than HF first-years (post hoc test: Z = 3.34, *P* <0.05). However there were no differences between other groups (*post hoc*: *P*> 0.05).

First-year birds that stayed longer at the stopover site were fatter and in better condition. We found a positive correlation between duration of stopover and body condition (r = 0.22, t = 2.93, *P* <0.01, n = 168) and between duration of stopover time and fat content (r = 0.21, t = 2.97, *P* <0.01, n = 187). However for adults we did not find significant difference (*P*> 0.05). We also noted that first-year birds (r = –0.68, t = -13.00, *P* <0.001, n = 176) as well as adults (r = –0.57, t = -3.62, *P* <0.01, n = 29) stay shorter at the stopover at the end of migration period. However, foraging efficiencies were similar and there was no relationship between BCI change and

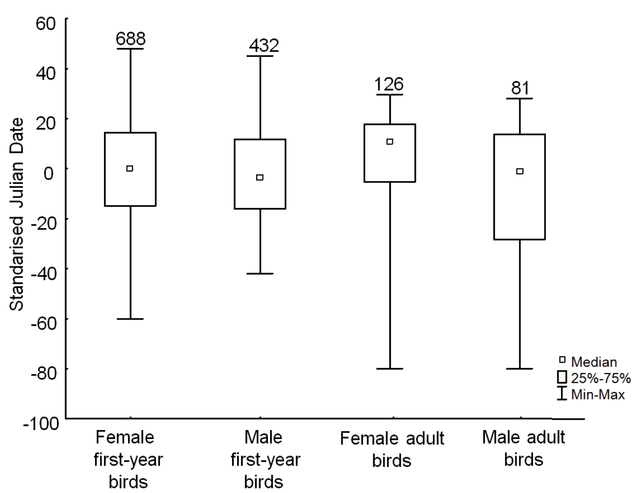

Fig. 1. Arrival time of different sex-age groups of European Robin. Numbers indicate sample sizes.

phenology for both groups as well as relationship between fat change and arrival time (all $P > 0.05$).

5. DISCUSSION

In general, adult robins had longer wings than first-years, which concurs with other studies (see Cramp 1998). Svensson (1992) suggested that it was caused because of greater damage to the feathers in the first-year individuals. Migration year, fat content, period of capture did not influence wing length. Our results could suggest that captured robins derived from the same population, however results of the directional preferences of robins tested here (Polakowski 2005), as well as recoveries collected during Siemianówka studies (Tumiel *et al.* 2010) revealed that different populations pass this area and winter in different quarters. Our results can be also biased by the fact that some birds could belong to the local population. The data from the different studies in Europe show the wing-length of robins differ in subsequent periods of the migration and, also suggest different populations (Busse 1974, Busse and Maksalon 1986).

Our analysis clearly showed that migration season, fat content, age and period of capture had a significant effect on body condition. Its results from different environment condition during breeding period, migration and stopover sites. The inter-annual variation of body mass and body condition has been also noted for other passerines (*e.g.*, Yosef and Chernetsov 2004, 2005). Adult birds firstly have to finish their breeding period and only after that adults and young must complete their moult and accumulate fat reserves prior to migration (Berthold 1993). The fact that we have observed that first-year robins arrived earlier than adults is in accordance with the known breeding biology of this species. Adult birds need more time to prepare for the migration and usually leave the breeding grounds after fledging two broods (Cramp 1998). Moreover, their complete post-breading moult, which includes plumage, flight and the tail feathers takes more time than the partial post-juvenile moult (Adriaensen 1986, Svensson 1992, Cramp 1998, Polak and Szewczyk 2007, Gyimóthy *et al.* 2011). We did not find any differences between sexes in arrival time of the first-year birds. We think that this is the result of the simultaneous moult in both the sexes because juveniles do not breed (Svensson 1992, Cramp 1998). However, we noted that adult females arrived later and were fatter. This can be explained by tendency for males to minimize their time on the breeding grounds (Yosef and Tryjanowski 2002). Moreover, females are engaged longer in breeding and need extra time to moult the brood patch (Svensson 1992). During that time females can gain more fat. Differences of migration dynamics between sexes in robins are also described in the study from Norway (Mehlum 1981).

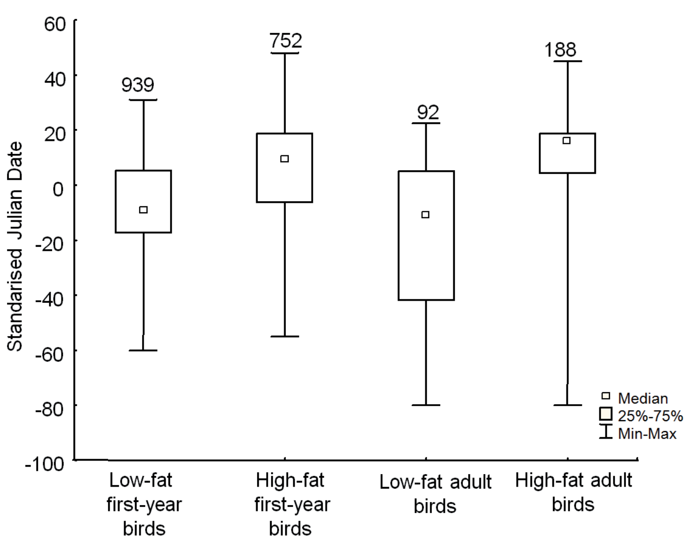

Fig. 2. Arrival time of different fat-age groups of European Robin. Numbers indicate sample sizes.

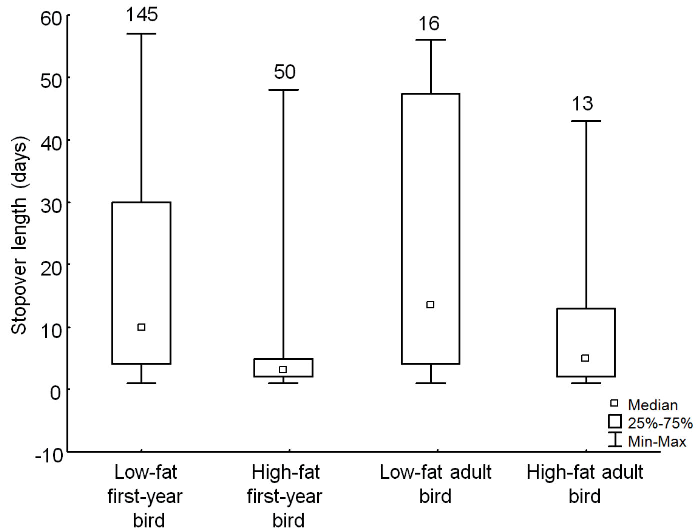

Fig. 3. The minimum stopover length of different fat-age groups of European Robin (*Erithacus rubecula*). Numbers indicate sample sizes.

We recaptured 14% of the birds (13% of all first-years, 17% of all adults) which suggests that the Siemianówka reservoir is an important stopover site for both age groups of robins. Our study showed that first-year and adult birds were in the better condition after stopover. Additionally, adults foraged more efficient, and were fatter than first-year birds. However, only first-year birds which stayed longer at the stopover site were fatter and in better condition. The important factor deciding whether the first-year birds stayed at stopover was fat content. First-year LF robins had longer stopover length than HF ones (Fig. 3). Our results could be the outcome of differential efficiency in fat accumulation in the different age groups. Further, this could be explained by the different peaks of migration wherein adults arrived later, were fatter and better prepared. Our results could also be explained by life-experiences of adults which know their migration route (Berthold 1993). They do not need to rush to wintering areas and are more successful in feeding and, in consequence, did not need as much time to gain appropriate loads of mass and fat (Telleria and Perez-Tris 2004, Meina *et al.* 2007).

The strategy of the robins is to refuel at stopover sites during (Pettersson and Hasselquist 1985). Ringing recoveries from Poland showed that birds which migrated later passed shorter migration distance (Remisiewicz 2001). The birds that arrived at the Siemianówka reservoir later, had more fat, because we assume they had more time to refuel at other stopover sites and/or came from more northern population. The arrival time was an important factor that influenced stopover length. Birds migrating later in the season stayed for a shorter period of time at the stopover site. It can be explained by the fact that during late autumn birds rush to their wintering areas. It seems to be similar in many species examples where, in general, birds migrating later have more fat and appear to travel at higher speeds (Jenni and Schaub 2004). However, the birds at the Siemianówka reservoir did not increase the rate of fat refuelling and the mass change during the autumn. Our results contradict other studies which claimed that during the late autumn birds are in greater stress and increase their body mass faster (Ehnbom *et al.* 1993, Meina *et al.* 2007, Polak and Szewczyk 2007).

In conclusion, first-year robins arrived earlier, had less fat and were in weaker condition. Fat content appears to be the deciding factor that influences the decision to remain at the stopover site only for young birds. Adult birds arrived later in the season, were fatter and in better condition. They were more effective foragers, what implicated decision to stay or not to stay at the Siemianówka reservoir did not depend on fat content and appears to be based more on their past experiences as well as on competition with the first-year birds. The stopover length decreased for both age group following the migration period due to the end of autumn. However, we did not note that during the late autumn birds from both groups gained mass and fat faster. We also showed that adult females arrived later than adult males what could be explained by different parental care during the brood.

ACKNOWLEGMENTS: We are very grateful to Magdalena Remisiewicz, Piotr Tryjanowski and Jan R.E. Taylor for the important comments to the manuscript. We would like to thank to all people worked in the organization of this studies, mainly to: M. Broniszewska, P. Busse, W. Chętnicki, G. Grzywaczewski, A. Krasnodębska, T. Mokwa, A. Myrcha, M. Skoracki, J.R.E. Taylor as well as for the leaders of the fieldwork: R. Bargiel, Ł. Borek, T. Cofta, M. Keller, P. Marczakiewicz, Ł. Meina, K. Mokwa, J.K. Nowakowski, D. Piec, M. Polak, R. Mikusek, T. Mokwa, M. Sidelnik, M. Ściborski, T. Tumiel, P. Wencel. We are also very grateful to about 200 people for their assistance in the fieldwork. The research was carried out under auspices of the SEEN (SE European Bird Migration Network) and partially supported by the Regional Fund for Water Resources and Protection of the Environment in Białystok and the Students Parliament of the Białystok University. The Regional Bureau of Melioration and Water Management allowed us to stay at their property.

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Received after revision May 2012