Acta Zoologica Academiae Scientiarum Hungaricae 57(2), pp. 203–218, 2011

WING-LENGTH, BODY MASS AND FAT RESERVES OF ROBINS (*ERITHACUS RUBECULA*) DURING AUTUMN MIGRATION IN HUNGARY

GYIMÓTHY, ZS.[1], GYURÁCZ, J.[2], BANK, L.[3], BÁNHIDI, P.[3]
FARKAS, R.[4], NÉMETH, Á.[5] and CSÖRGŐ, T.[6]

[1]*University of West Hungary, Faculty of Forestry, H-9400 Sopron, Ady Endre u. 5, Hungary*
[2]*University of West Hungary, Department of Zoology*
H-9700 Szombathely, Károlyi Gáspár tér 4, Hungary
[3]*BirdLife Hungary, H-1121 Budapest, Költő u. 21, Hungary*
[4]*Aggtelek National Park, H-3758 Jósvafő, Tengerszem oldal 1, Hungary*
[5]*Kiskunság National Park, H-6001 Kecskemét, Liszt Ferenc u. 19, Hungary*
[6]*Eötvös Loránd University, Department of Anatomy, Cell- and Developmental Biology*
H-1117 Budapest, Pázmány Péter sétány 1/C, Hungary

The aim of this study was to analyse the patterns of autumn migration of Robins *Erithacus rubecula* in Hungary. Capturing and ringing of birds took place at the bird ringing stations of BirdLife Hungary in Tömörd, Sumony, Ócsa, Izsák, and Szalonna between the 13th of August and the 27th of October, 2004. During this period 3671 individuals were captured and 553 were recaptured at the five study sites. In September–October, the birds migrating across geographically more distant study sites differed from each other the most. They came from various northern areas. The mean of the stored fat of the ringed birds in October was the smallest in the wooded areas of Szalonna, although the increase of fat of the recaptured birds was the biggest here. These study sites, which differ in vegetation, may play different role in migration. We conclude that the stopover area and the fall migration period do affect the wing-length, body mass and fat store of migratory Robins and that there is interactive effect of both ringing site and month.

Key words: *Erithacus rubecula*, autumn migration, wing-length, body mass, fat reserves

INTRODUCTION

The Robin (*Erithacus rubecula*) is a geographically widely spread species and it is absent only from the most northern areas of Europe. The Robin exhibits all possible migratory strategies, from sedentary populations in the south to fully migratory populations in the north, and partially migratory populations in between (CRAMP *et al.* 1993).

Most Hungarian populations leave the Carpathian Basin by mid-September, and winter in the Apennine Peninsula and on the surrounding islands. Smaller numbers migrate to winter in the Iberian Peninsula, North Africa or in the Balkan Peninsula. Autumn migration in Hungary peaks in the second half of September and in the first half of October, while the peak of the spring migration is in late March and early April (GYURÁCZ & CSÖRGŐ 2009). Birds migrating through Hungary in September–October originate mainly from Slovakia, Poland and Ukraine, while the majority of late October and November migrants presumably come from southern Sweden and southern Finland, the Baltic States, and northwestern Russia (REMISIEWICZ 2001, 2002, ŚCIBORSKA & BUSSE 2004, ADAMSKA & ROSIŃSKA 2006, ROSIŃSKA & ADAMSKA 2007).

The different migratory strategies have affected wing shape evolution in this species. Pointedness of the Robin wing increases following a latitudinal cline from south to north Europe. The mean wing-length may suggest the mean geographic origin of a sample of birds (CRAMP *et al*. 1993, GYURÁCZ *et al*. 2005, 2006, ROSIŃSKA 2007). Robins caught during autumn migration at European ringing sites in subsequent periods of migration season differed in biometrical and morphological data. In some places like the stations located in Sweden, Norway, Hungary and southern Italy some differences in wing-length were observed. The mean wing-length of northern birds was greater than in the case of birds that originated from Hungary and Italy (PETTERSON & LINDHOLM 1983, KARLSSON *et al*. 1988, LÖVEI *et al*. 1986, ATLI & NÉMETH 1998).

Small migratory passerines use different fat accumulation and flight strategies to make safe, energy-saving and sufficiantly fast movements to their wintering areas. Fat deposition and migration strategies depend on possibilities of finding suitable fattening stopover-sites during migration. During its migration, the Robin spends the majority of time in stopover sites where it can regain its body mass and fat reserves that is necessary for migration (PETTERSON & HASSELQUIST 1985). The Robin is common in the hills and mountains of Hungary, in wooded bushy habitats (SCHMIDT 1998). However, during migration it can also be found in suboptimal areas (flatland, wetland habitat and reeds) where it does not occur otherwise (PRATO & PRATO 1983, BOTTONI & MASSA 1991, GYURÁCZ & CSÖRGŐ 2009).

The aim of this study was to investigate autumn migration of Robins in Hungary through the examination of intra-seasonal changes of wing-length, body mass and fat reserves. First, we expected that wing-length, body mass and fat reserves of Robins will differ between study sites since birds captured at different sites arrive from different geographical locations. Second, we expected that wing-length, body mass and fat reserves of Robins will differ between months since birds captured in different months arrive from different geographical locations. Third, we expected that there will be interactive effect of both ringing site and month which influences the mean wing-length, body mass and fat reserves.

MATERIALS AND METHODS

Our studies took place at the bird ringing stations (Fig. 1) of BirdLife Hungary Actio Hungarica in West Hungary (Tömörd: 47°22'N, 16°41'E), South Hungary (Sumony: 45°58'N, 17°56'E), Central Hungary (Ócsa: 47°19'N, 19°13'E, Izsák: 46°47'N, 19°21'E) and North Hungary (Szalonna: 48°27'N, 20°42'E) between the 13th of August and the 27th of October, 2004. The chosen period for this study was the overlap interval of the bird ringing work in the five areas, but it did not cover all of the autumn migration season of Robin. The study sites differed in their vegetation. For catching the birds numbered mist-nets (12 meter long and 2.5 meter high with 5 shelves and a mesh size of 16 mm) were used: Tömörd: forest (4 nets), bushy area (11 nets), grassland with scrubs (8 nets), marsh (6 nets). Sumony: reed-bed, places dappled with reed-mace (18 nets), and bushy area (32 nets). Ócsa: agricultural area and grassland (12 nets), reed-bed (10 nets), bushy and closed wooded area (67 nets). The entire study site was fragmented and mosaical. Izsák: the most expanded association is reed-bed (52 nets). Szalonna: gallery forest along the Bodva brook (40 nets).

During the study period at the five bird ringing stations 3671 individuals (3075 juveniles and 596 adults) were captured in a total of 260 mist nets altogether. From these individuals, 553 birds were recaptured: 485 juveniles and 68 adults.

Birds were ringed, aged and their body mass (±0.1 g) and wing-length (±1 mm) were measured (SVENSSON 1992). The fat reserves were estimated visually according to KAISER 1993 – ranking from 0 (no fat) to 8 (bulging fat). Body mass and fat deposits were measured again in recaptured birds. By using the body mass alone without estimation of fat reserves could lead to significant errors due to possible changes in water content of the body and muscle weight changes (PETTERSON & HASSELQUIST 1985). In order to have as homogenous group of birds as possible only first-year individuals were included in this study. The standard periods, in which the numbers of birds ringed were high enough, was established for the months (August–October). The main migration waves also coincided with these three months (GYURÁCZ *et al.* 2008). The mean wing-length, body mass and fat in-

Fig. 1. Location of ringing sites

Table 1. The mean wing-length of juveniles that captured at the same site was compared between each month, the significant differences in bold (Tukey HSD test)

Izsák	month	August	September	October
	Mean±SD (N)	72.41±1.78 (12)	72.41±2.06 (68)	72.22±1.90 (149)
	August		NS	NS
	September			NS
Sumony	month	August	September	October
	Mean±SD (N)	71.46±1.59 (49)	72.11±1.89 (221)	72.5±1.91 (206)
	August		**p < 0.05**	**p < 0.001**
	September			NS
Szalonna	month	August	September	October
	Mean±SD (N)	71.78±1.87 (175)	71.94±2.00 (360)	72.03±1.91 (382)
	August		NS	NS
	September			NS
Tömörd	month	August	September	October
	Mean±SD (N)	72.28±1.71 (39)	72.21±2.24 (233)	72.68±1.93 (225)
	August		NS	NS
	September			NS
Ócsa	month	August	September	October
	Mean±SD (N)	71.48±2.08 (89)	71.53±2.30 (325)	72.26±2.16 (231)
	August		NS	**p < 0.05**
	September			**p < 0.05**

dices were calculated from the biometrical data every month and ringing site. They were compared by two-way ANOVA in which the factors were the study site and the month of capture and by posthoc Tukey HSD test with the exception of fat. Fat was not normally distributed therefore it was analysed with the help of the Kruskal-Wallis and Mann-Whitney test (FOWLER & COHEN 1991). Birds captured at different sites every month were arranged in groups on the basis of wing-length and body mass by cluster analysis (Euclides distance and Ward-Orlóczy method, PODANI 1997). Since during the study period few adults were captured the analysis of the biometrical data was restricted to juveniles. Body mass and fat deposit of captured and recaptured birds were compared by Wilcoxon test at the various study sites with the exception of Izsák, where only a few individuals were recaptured during the study period. The Past computer program was used for statistical analysis (HAMMER *et al.* 2006).

RESULTS

The mean wing-length of juvenile birds increased from August to October (ANOVA, month, $F = 15.43$, $df = 2$, $p < 0.001$). At two study sites, the monthly means of the wing-length of captured birds differed significantly from each other, whereas at the other three study sites, the difference was not significant (Table 1).

Table 2. The mean body mass of juveniles that captured at the same site was compared between each month, the significant differences in bold (Tukey HSD test)

Izsák	month	August	September	October
	Mean±SD (N)	15.07±0.65 (13)	15.37±0.90 (70)	16.22±1.23 (151)
	August		NS	**p < 0.001**
	September			**p < 0.05**
Sumony	month	August	September	October
	Mean±SD (N)	15.83±1.25 (48)	15.89±0.90 (220)	17.09±1.56 (205)
	August		NS	**p < 0.001**
	September			**p < 0.001**
Szalonna	month	August	September	October
	Mean±SD (N)	16.12±1.08 (168)	16.62±1.22 (375)	16.77±1.42 (382)
	August		**p < 0.001**	**p < 0.001**
	September			NS
Tömörd	month	August	September	October
	Mean±SD (N)	15.82±1.00 (39)	16.17±1.20 (238)	17.0±31.55 (227)
	August		NS	**p < 0.001**
	September			**p < 0.001**
Ócsa	month	August	September	October
	Mean±SD (N)	15.13±1.08 (86)	15.64±1.19 (338)	16.33±1.37 (246)
	August		**p < 0.001**	**p < 0.001**
	September			**p < 0.001**

The mean body mass of captured juveniles increased significantly during the study period at all of the five study sites (ANOVA, month, $F = 114.7$, $df = 2$, $p < 0.001$, Table 2). Mean fat deposits also increased at all study sites during autumn, although the third fat class was not reached in mean at any of the places. There were significant differences between the monthly mean fat deposits at the each site (Kruskal-Wallis test, Tömörd: $H = 89.01$, Sumony: $H = 201.5$, Ócsa: $H = 102$, Izsák: $H = 38.7$, Szalonna: $H = 64.28$, $p < 0.001$, Table 3).

In August, there was no significant difference observed in wing-length of the individuals migrating across the different study sites. In September, the mean wing-length of the birds was significantly shorter in Ócsa than in Izsák and Tömörd. In October, the mean wing-length measured at Szalonna was significantly shorter than that measured at Tömörd (ANOVA, ringing site, $F = 9.06$, $df = 4$, $p < 0.001$, Table 4). According to cluster analysis the wing-length of birds captured at close ringing sites showed greater similarities in August and September than in October (Fig. 2). Several significant differences could be found between

Table 3. The mean fat reserves of juveniles that captured at the same site was compared between each month, the significant differences in bold (Mann-Whitney test)

Izsák	month	August	September	October
	Mean±SD (N)	0.76±0.83 (13)	1.36±1.12 (93)	2.17±1.19 (254)
	August		NS	**p < 0.001**
	September			**p < 0.001**
Sumony	month	August	September	October
	Mean±SD (N)	0.20±0.45 (49)	1.54±0.88 (222)	2.74±0.98 (206)
	August		**p < 0.001**	**p < 0.001**
	September			**p < 0.001**
Szalonna	month	August	September	October
	Mean±SD (N)	0.38±0.53 (181)	0.91±0.99 (360)	1.22±1.19 (387)
	August		**p < 0.001**	**p < 0.001**
	September			**p < 0.05**
Tömörd	month	August	September	October
	Mean±SD (N)	0.35±0.77 (39)	1.47±1.20 (240)	2.33±1.33 (229)
	August		**p < 0.001**	**p < 0.001**
	September			**p < 0.001**
Ócsa	month	August	September	October
	Mean±SD (N)	0.05±0.27 (89)	0.78±1.14 (340)	1.50±1.22 (233)
	August		**p < 0.001**	**p < 0.001**
	September			**p < 0.001**

the mean body mass of the birds captured at different sites. In all of the three months the mean body mass of birds captured at Ócsa and Izsák was the lowest (ANOVA, ringing site, $F = 45.51$, $df = 4$, $p < 0.001$, Table 5). According to cluster analysis the body mass from October showed that birds migrated through Szalonna

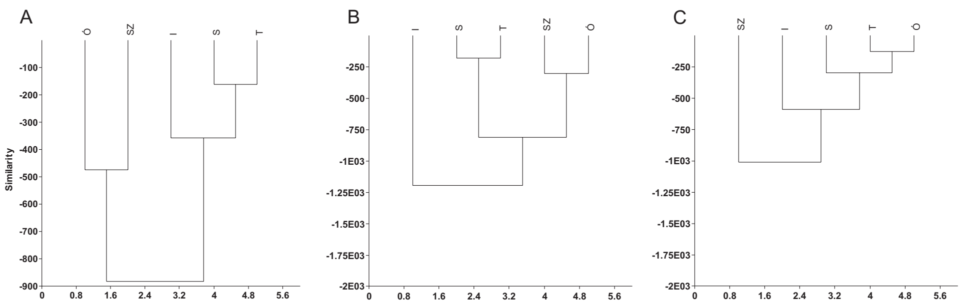

Fig. 2. Dendrogram of the cluster analysis of the juveniles' wing-length in August (A), September (B), October (C) at the study sites (Euclides distance and Ward-Orlóczy method)

Table 4. The mean wing-length of juveniles that captured at the same month was compared between each site, the significant differences in bold (Tukey HSD test)

August	study site	Izsák	Sumony	Szalonna	Tömörd	Ócsa
	Mean±SD	72.41±1.78	71.46±1.59	71.78±1.87	72.28±1.71	71.48±2.08
	N	12	49	175	39	89
	Izsák		NS	NS	NS	NS
	Sumony			NS	NS	NS
	Szalonna				NS	NS
	Tömörd					NS
September	study site	Izsák	Sumony	Szalonna	Tömörd	Ócsa
	Mean±SD	72.41±2.06	72.11±1.89	71.94±2.00	72.21±2.24	71.53±2.30
	N	68	221	360	233	325
	Izsák		NS	NS	NS	**p < 0.05**
	Sumony			NS	NS	NS
	Szalonna				NS	NS
	Tömörd					**p < 0.05**
October	study site	Izsák	Sumony	Szalonna	Tömörd	Ócsa
	Mean±SD	72.22±1.90	72.5±1.91	72.03±1.91	72.68±1.93	72.26±2.16
	N	149	206	382	225	231
	Izsák		NS	NS	NS	NS
	Sumony			NS	NS	NS
	Szalonna				**p < 0.05**	NS
	Tömörd					NS

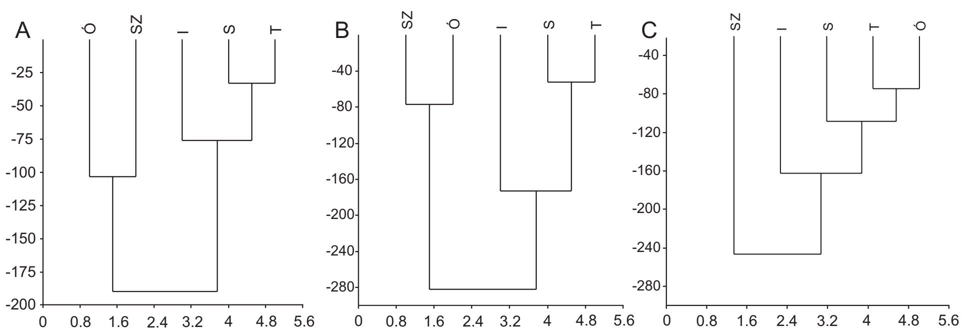

Fig. 3. Dendrogram of the cluster analysis of the juveniles' body mass in August (A), September (B), October (C) at the study sites (Euclides distance and Ward-Orlóczy method)

Table 5. The mean body mass of juveniles that captured at the same month was compared between each site, the significant differences in bold (Tukey HSD test)

August	study site	Izsák	Sumony	Szalonna	Tömörd	Ócsa
	Mean±SD N	15.07±0.65 13	15.83±1.25 48	16.12±1.08 168	15.82±1.00 39	15.13±1.08 86
	Izsák		**p < 0.05**	**p < 0.001**	**p < 0.05**	NS
	Sumony			NS	NS	NS
	Szalonna				NS	**p < 0.05**
	Tömörd					NS
September	study site	Izsák	Sumony	Szalonna	Tömörd	Ócsa
	Mean±SD N	15.37±0.90 70	15.89±0.90 220	16.62±1.22 375	16.17±1.20 238	15.64±1.19 338
	Izsák		**p < 0.001**	**p < 0.001**	**p < 0.001**	NS
	Sumony			**p < 0.001**	NS	NS
	Szalonna				**p < 0.05**	**p < 0.001**
	Tömörd					**p < 0.001**
October	study site	Izsák	Sumony	Szalonna	Tömörd	Ócsa
	Mean±SD N	16.22±1.23 151	17.09±1.56 205	16.77±1.42 382	17.03±1.55 227	16.33±1.37 246
	Izsák		**p < 0.001**	**p < 0.001**	**p < 0.001**	NS
	Sumony			NS	NS	**p < 0.001**
	Szalonna				NS	**p < 0.05**
	Tömörd					**p < 0.001**

could be separated from those that migrated through the other four study sites (Fig. 3). There were significant differences in fat deposits of the birds captured at different sites in all months of the study (Kruskal-Wallis test, Aug.: $H = 22.24$, Sept.: $H = 119$, Oct.: $H = 240$, $p < 0.001$). In August and September the mean fat deposits of birds captured in Ócsa was the lowest, although Ócsa differed no significantly from Sumony and Tömörd. In October it was the lowest in Szalonna. In the migration peak period (October), the mean fat store of birds migrating across the study sites was the lowest in Szalonna (Table 6).

Changes in the body mass and fat deposits of the recaptured birds were different at the various study sites. Fat deposits were greater at the last recapture than at the first capture. In three study sites, there were significant differences in the estimated fat deposits between the captured and recaptured individuals. The largest scale of growth (106%) was measured in Szalonna, the smallest scale of growth (10%) was in Sumony (Fig. 4). In three study sites, there were significant differ-

Table 6. The mean fat resreves of juveniles that captured at the same month was compared between each site, the significant differences in bold (Mann-Whitney test)

August	study site	Izsák	Sumony	Szalonna	Tömörd	Ócsa
	Mean±SD N	0.76±0.83 13	0.2±0.45 49	0.38±0.53 181	0.35±0.77 39	0.05±0.27 89
	Izsák		**p < 0.05**	NS	NS	**p < 0.05**
	Sumony			NS	NS	NS
	Szalonna				NS	**p < 0.001**
	Tömörd					NS
September	study site	Izsák	Sumony	Szalonna	Tömörd	Ócsa
	Mean±SD N	1.36±1.12 93	1.54±0.88 222	0.91±0.99 360	1.47±1.2 240	0.78±1.14 340
	Izsák		NS	**p < 0.001**	NS	**p < 0.001**
	Sumony			**p < 0.001**	NS	**p < 0.001**
	Szalonna				**p < 0.001**	**p < 0.001**
	Tömörd					**p < 0.001**
October	study site	Izsák	Sumony	Szalonna	Tömörd	Ócsa
	Mean±SD N	2.17±1.19 154	2.74±0.98 206	1.22±1.19 387	2.33±1.33 229	1.5±1.22 233
	Izsák		**p < 0.001**	**p < 0.001**	**p < 0.001**	**p < 0.001**
	Sumony			**p < 0.001**	**p < 0.001**	**p < 0.001**
	Szalonna				**p < 0.001**	**p < 0.001**
	Tömörd					**p < 0.001**

ences in the mean body mass between the captured and recaptured individuals. The largest scale of growth (5%) was measured in Ócsa, the smallest scale of growth (1%) was in Sumony (Fig. 5).

DISCUSSION

Considerable variation was found in body mass and wing-length of the birds that migrated through the study sites. The change in the wing-length was not significant neither in Szalonna nor in Tömörd, but the shortest mean wing-length was measured of birds that were captured in August in Ócsa, Sumony and Szalonna. They could have been local individuals that bred in Hungary, because the mean wing-length of northern birds, which migrates through Hungary in September and October, is greater, since wing-length is related to the length of their journey. The

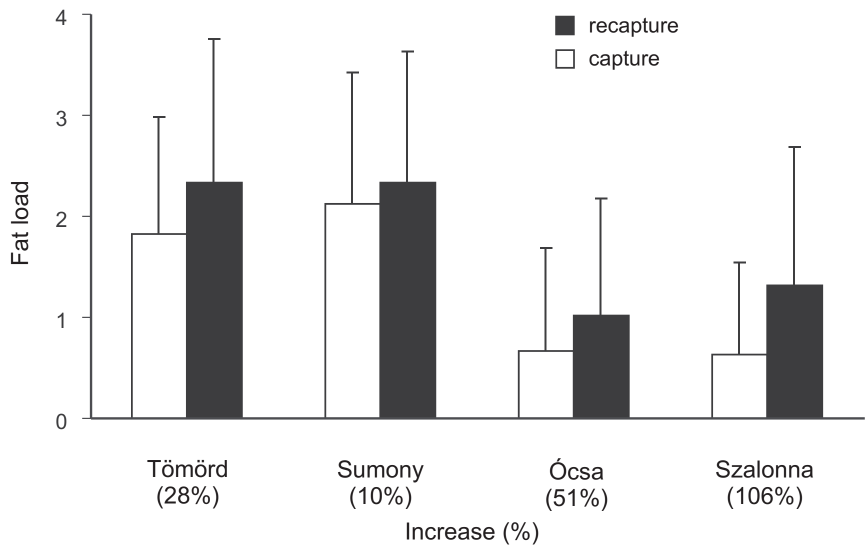

Fig. 4. Mean fat reserves changes of the recaptured juveniles (Wilcoxon test, Tömörd, N = 84, W = 1282, $p < 0.05$; Sumony, N = 105, W = 1079, NS; Ócsa, N = 141, W = 1967, $p < 0.05$; Szalonna, N = 124 W = 1757, $p < 0.001$. Since only a few individuals were recaptured in Izsák during the study period therefore this site is not in the figure.)

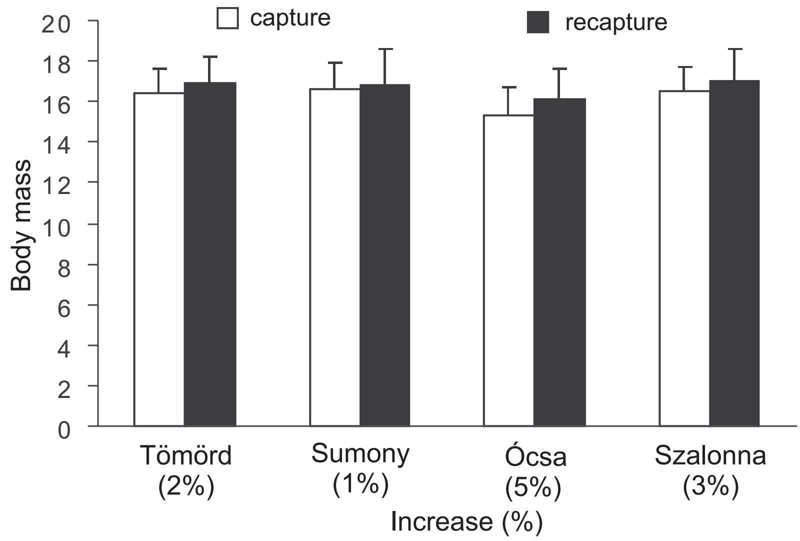

Fig. 5. Mean body mass changes of the recaptured juveniles (Wilcoxon test, Tömörd, N = 84, W = 1986, $p < 0.05$; Sumony, N = 104, W = 2744, NS; Ócsa, N = 141, W = 7135, $p < 0.001$; Szalonna, N = 124 W = 4279, $p < 0.05$. Since only a few individuals were recaptured in Izsák during the study period therefore this site is not in the figure.)

longer distance the bird has to migrate, the more pointed and longer its wings are (KIPP 1958, CSÖRGŐ & LÖVEI 1986, LÖVEI *et al*. 1986, MIKLAY & CSÖRGŐ 1991, KOVÁTS *et al.* 1998, GYURÁCZ *et al*. 2008). This tendency was not valid for the study site of Izsák because large mean wing-lengths were measured here in all of the months of the study. A possible reason for this was that only a few Robins bred in reed-bed and its surroundings, so there were probably a small number of local short-winged birds at this site. Only those birds were present here that came from north and whose wings were longer.

The lowest body mass and fat deposits were observed in the case of birds captured in August; these spent the longest period of time at each study site (GYIMÓTHY *et al.* 2011). The mean body mass of birds captured in August was the greatest in the wooded areas of Szalonna and the smallest in the reed-beds of Izsák. In August, Szalonna differed no significantly from Tömörd, and neither did Izsák from Ócsa. The latecomer northern birds had continually greater mean body mass and were in better condition, so the time spent on stopover steadily decreased during the study period (GYURÁCZ & CSÖRGŐ 2009). These northern birds were in a suitable condition to continue their journey, thus they left the areas after the short stopover.

The stock of birds, which were ringed in August, was homogeneous at the study sites based on the data of wing-length. The shortest mean wing-length was observed in the case of birds that migrated across the study site of Ócsa in September. Ócsa differed no significantly from Sumony and Szalonna. This can be explained by the greater presence of short-winged local individuals at the site. The local breeding birds left the study sites by the middle of September; none of them were recaptured later (GYURÁCZ & CSÖRGŐ 2009). Wings of birds that came from a shorter distance and migrated across the study site of Szalonna in October were the shortest and were very different from that of the others that presumably originated from more distant northern territories. Based on the monthly analysis of body mass and wing-length at each site, it has been found that the birds migrated across geographically more distant study sites differed from each other the most. Most possibly they came from various northern territories. Those birds that migrated across geographically less distant sites showed greater similarities. Since birds are divided according to a geographical gradient based on their body mass and wing-length values, these differences cannot be considered as errors of measurement.

Concerning all study sites, the thinnest birds were captured in the reed-beds of Izsák during the whole study period. These individuals may have been crowded out from the optimal habitats by larger dominant birds (CUADRADO 1991, PÉREZ-TRIS *et al.* 2000, CATRY *et al.* 2004, TELLERÍA & PÉREZ-TRIS 2004, GYURÁCZ *et* *al.* 2005, POLAK & SZEWCZYK 2007). The subdominant juvenile migrating individuals may go to such habitats that they measured badly beforehand because of their lack of experience and they leave it soon.

Only 1.03% of birds were recaptured here (GYIMÓTHY *et al*. 2011). The highest proportion of recaptures was in Sumony and Ócsa (15–20%) (GYIMÓTHY *et al*. 2011). The reason could be that many birds with fat scores 0–1 in August were in a relatively poor condition. These birds could regain their fat reserves in the study sites that was necessary for migration. The wings of juveniles were still in growth, therefore they spent also more time in the study sites.

The recaptured birds increased their fat store during their stopovers at each Hungarian study area excepting birds recaptured in Izsák. These bushy habitats provide enough food for even the northern birds to increase their body mass to a great extent, although they spend less and less time in those territories. According to our earlier study in Tömörd, the Robins stopped over in October, could only slightly gain weight but possessed relatively great body mass on their arrival. Moreover, the mean stopover time in this month was the shortest (GYIMÓTHY *et al*. 2011). These northern birds possessed enough body mass to leave the site after a short stopover. Robins do not need great fuel stores if they travel over the land, i.e. enjoy the continuous stopover possibility (KARLSSON *et al*. 1988). In a Russian study, some Robins were captured when taking off for migratory flight with pretty low fuel stores (CHERNETSOV *et al.* 2004). If the migratory fat deposits of a Robin become exhausted, it regains its fat deposits and body mass at the refuelling place in 10 days (PETTERSSON 1983, PETTERSSON & LINDHOLM 1983, ANTLI & NÉMETH 1998). These values could be influenced by the fact that thin birds are more active in the morning and during the day and birds possessing greater fat deposits move with less intensity at the specific sites (LIND *et al*. 1999, TITOV 2001). According to another study the studied individuals stopped over 1–14 days. They found no clear relationship between stopover duration and energetic condition on arrival (TSVEY *et al.* 2007).

Birds passing through our study sites originate from various breeding places. It can be deduced from the comparative studies of wing-length, recapture rates, various stopover times of migrating birds, different extent of body mass and fat deposit growth that the role of the ringing places is different from the point of view of the nourishment and resting of migrating birds. Establish of home range is characteristic of the species during autumn migration as well (TITOV 1999*a, b*, CHERNETSOV & BOLSHAKOV 2006). It has been shown that in autumn, Robins gain mass at stopover sites when they have a small home range, at least those that arrive with depleted fuel stores and need to refuel (CHERNETSOV & MUKHIN 2006). Adult and dominant birds with greater wing-length and better condition occupy the wooded and dense bushy habitats (GYURÁCZ *et al*. 2005). The majority of migrating birds not only rest but also increase their fat deposits at the study sites. The greatest mean body mass and wing-length were measured in the case of those birds that were captured in bushy, wooded habitats (GYURÁCZ *et al.* 2005, 2006). The wooded bushy area of Szalonna is one of the most important resting and refuelling places of Robins. The longest mean stopover time (GYIMÓTHY *et al*. 2011) and the greatest extent of fat reserves growth were observed here. The closed area of Izsák with its reed-bed habitat has only peripheral importance for migrating individuals. The areas, which differ in geographical location and in vegetation, may play different role in migration.

We conclude that the stopover area and the fall migration period (month) do affect the wing-length, body mass and fat store of migratory Robins and that there is interactive effect of both ringing site and month. However, we found no evident reasons of differences between morphological features of birds migrating in the months and stopover sites.

*

Acknowledgements – We would like to thank to all those who took part in field-work and the members of the BirdLife Hungary for the bird ringing and the data collecting work. The study was partially supported by the University of West Hungary (TÁMOP 4.22-08/1-2008-0020, TÁMOP 4.2.1/B-09/1/KONV-2010-0006)

REFERENCES

ADAMSKA, K. & ROSIŃSKA, K. (2006) Directional preferences of the Robin (Erithacus rubecula) and the Blackcap (Sylvia atricapilla) during autumn migration at Arosio (N Italy) in 2005. *Ring* **28**(2): 101–111.

ANTLI, I. & NÉMETH, CS. (1998) Madárvonulás-dinamikai vizsgálatok vörösbegy (Erithacus rubecula) populációin a Soproni-dombvidék tájegység területén. (Migration dynamics of Robin (Erithacus rubecula) in the Sopron-hills, Western Hungary.) *Ornis Hungarica* **8**(1): 153–162. [In Hungarian with English abstract]

BOTTONI, L. & MASSA, R. (1991) The migration of the Robin Erithacus rubecula in the central Pre-Alps of Italy. *Ringing & Migration* **12**: 48–53.

CATRY, P., CAMPOS, A., ALMADA, V. & CRESSWELL, W. (2004) Winter segregation of migrant European robins Erithacus rubecula in relation to sex, age and size. *Journal of Avian Biology* **35**: 204–209.

CHERNETSOV, N. & BOLSHAKOV, C. V. (2006) Spatial behaviour of some nocturnal passerine migrants during stopovers. *Acta Zoologica Sinica* **52**: 599–601.

CHERNETSOV, N. & MUKHIN, A. (2006) Spatial behaviour of European robins Erithacus rubecula during migratory stopovers: a telemetry study. *Wilson Journal of Ornithology* **118**: 364–373.

CHERNETSOV, N. S., SKUTINA, E. A., BULYUK, V. N. & TSVEY, A. L. (2004) Optimal stopover decisions of migrating birds under variable stopover quality: model predictions and the field data. *Zhurnal obschei biologii* **65**(3): 211–217.

CRAMP, P., PERRINS, C. M. & BROOKS, D. J. (1993) *Birds of Europe the Middle East and the Nord Africa.* Oxford University Press, Oxford. 610 pp.

CUADRADO, M. (1991) Wing length criteria for sex determination of Robins Erithacus rubecula wintering in southern Spain. *Ornis Svecica* **1**: 55–57.

CSÖRGŐ, T. & LÖVEI, G. (1986) Egy fészkelő csilpcsalp füzike (Phylloscopus collybita) populáció szárnyalakjának jellemzése. [Wing shape characteristics of a breeding population of the Chiffchaff (Phylloscopus collybita).] Pp. 155–158. *In:* MOLNÁR, GY. (ed.): *Magyar Madártani és Természetvédelmi Egyesület II. Tudományos Ülése, Szeged.* [in Hungarian]

FOWLER, J. & COHEN, L. (1991) *Statistics for Ornithologists*. BTO Guide 22. London. 176 pp.

GYIMÓTHY, ZS., GYURÁCZ, J., BANK, L., BÁNHIDI, P., FARKAS, R., NÉMETH, Á. & CSÖRGŐ, T. (2011) Autumn migration of Robins (Erithacus rubecula) in Hungary. *Biologia* **66**(3): 548–555. DOI: 1.2478/s11756–011–0039–9

GYURÁCZ, J., BÁNHIDI, P. & GYIMÓTHY, ZS. (2005) Habitat selection and migration dynamics of the migrating populations of Robins Erithacus rubecula in the autumn migration period. The 5th Conference of the European Ornithologits' Union, Strasbourg. *Alauda* **73**(3): 296–297.

GYURÁCZ, J., BÁNHIDI, P. & GYIMÓTHY, ZS. (2008) A vörösbegy (Erithacus rubecula) vonuló populációinak élőhely-választása és vonulásdinamikája az őszi vonulási időszakban. [Habitat choice and dynamics of migrating populations of the Robin (Erithacus rubecula) during the autumn migration season.] *Ornis Hungarica* **15–16**: 25–34. [in Hungarian]

GYURÁCZ, J. & CSÖRGŐ, T. (2009) Vörösbegy (Erithacus rubecula). Pp. 440–442. *In:* CSÖRGŐ, T., KARCZA, ZS., HALMOS, G., MAGYAR, G., GYURÁCZ, J., SZÉP, T., BANKOVICS, A., SCHMIDT, A. & SCHMIDT, E. (eds): *Magyar madárvonulási atlasz.* [Hungarian Bird Migration Atlas.] Kossuth Kiadó, Budapest. 672 pp. [in Hungarian]

GYURÁCZ, J., GYIMÓTHY, ZS., NÉMETH, T. & BÁNHIDI, P. (2006) A vörösbegy Erithacus rubecula territoriális viselkedése az őszi vonulási időszakban. [Territorial behaviour of the Robin Erithacus rubecula in the autumn migration period.] *7. Magyar Ökológus Kongresszus, Budapest. Előadások és poszterek összefoglalói.* P. 74. [in Hungarian]

HAMMER, O., HARPER, D. A. T. & RYAN, P. D. (2006) PAST (Paleontological Statistics Version 1.38), University of Oslo, Oslo. 69 pp.

KAISER, A. (1993) A new multi-category classification of subcutaneous fat deposits of songbirds. *Journal of Field Ornithology* **64**(2): 246–255.

KARLSSON, L., PERSSON, K., PETTERSSON, J. & WALINDER, G. (1988) Fat-weight relationships and migratory strategies in the Robin Erithacus rubecula at two stop-over sites in south Sweden. *Ringing & Migration* **9**: 160–168.

KIPP, F. A. (1958) Zur Geschichte des Vogelzuges auf der Grundlage der Flügelanpassungen. *Vogelwarte* **19**: 233–242.

KOVÁTS, L., CSÖRGŐ, T. & PALKÓ, S. (1998) A függőcinege (Remiz pendulinus) vonulása és telelése a Kárpát-medencében. (Migration and wintering of the Penduline Tit (Remiz pendulinus) in the Carpathian Basin.) *Ornis Hungarica* **8**(1): 169–175. [In Hungarian with English abstract]

LIND, J., FRANSSON, T., JAKOBSSON, S. & KULLBERG, C. (1999) Reduced take-off ability in robins (Erithacus rubecula) due to migratory fuel load. *Behavioral Ecology and Sociobiology* **46**: 65–70.

LÖVEI, G. SCEBBA, S., MINICHIELLO, F. & MILONE, M. (1986) Seasonal activity wing shape, weights and fat reserve variation of Robins (Erithacus rubecula) in Southern Italy. *In:* FARINA,

A. (ed.): *First Conference on Bird Wintering in The Mediterranean-Ricerche di Biologia delle, Selvaggina* **10**(1): 229–242.

MIKLAY, GY. & CSÖRGŐ, T. (1991) A fitisz füzikék (Phylloscopus trochilus) és a sisegő füzikék (Phylloscopus sibilatrix) vonulásdinamikája és szárnymorfológiai jellemzői. Pp. 140–148. [Migration dynamics and wing shape characteristics of Willow (Phylloscopus trochilus) and Wood Warblers (Phylloscopus sibilatrix).] *In:* GYURÁCZ, J. (ed.): *Magyar Madártani és Természetvédelmi Egyesület III. Tudományos ülése, Szombathely.* [in Hungarian]

PETTERSSON, J. (1983) The autumn migration of the Robin Erithacus rubecula at Ottenby. *Vår Fågelvärld* **42**: 333–342. [In Swedish with English summary]

PETTERSSON, J. & HASSELQUIST, D. (1985) Fat deposition and migration capacity of Robins Erithacus rubecula and Goldcrest Regulus regulus at Ottenby, Sweden. *Ringing & Migration* **6**: 66–76.

PETTERSSON, J. & LINDHOLM, C. (1983) The sequential passage of different Robin Erithacus rubecula populations at Ottenby. *Ornis Fennica* **3**: 34–36.

PÉREZ-TRIS, J., CARBONELL, R., & TELLERIA, L. J. (2000) Abundance distribution, morphological variation and juvenile condition of robins, Erithacus rubecula (L.), in their Mediterranean range boundary. *Journal of Biogeography* **27**: 879.

PODANI, J. (1997) *Bevezetés a többváltozós biológiai adatfeltárás rejtelmeibe.* Scientia Kiadó, Budapest, 412 pp. [in Hungarian]

POLAK, M. & SZEWCZYK, P. (2007) Relation between stopover length and time and body parameters of European Robin Erithacus rubecula (L., 1758) during autumn migration (Central Poland). *Polish Journal of Ecology* **55**(3): 511–517.

PRATO, S. R. D. da & PRATO, E. S. DA (1983) Densities of Robins in North-east Greece in Autumn. *Ringing & Migration* **4**: 243–244.

REMISIEWICZ, M. (2001) The pattern of winter-quarters of robins Erithacus rubecula migrating in autumn through the souther Baltic coast. *Ring* **23**(1–2): 37–53.

REMISIEWICZ, M. (2002) The spatio-temporal pattern to Robin (Erithacus rubecula) migration: evidence from ringing recoveries. *In:* BOTH, C. & PIERSMA, T. (eds): *The avian calendar: exploring biological hurdles in the annual cycle.* The Third Conference of the Conference of the European Ornithologits' Union, Groningen. *Ardea* **90**(3) (special issue): 489–502.

ROSIŃSKA, K. (2007) Biometrics and morphology variation within sex-age groups of Robins (Erithacus rubecula) migrating through the Polish Baltic coast. *Ring* **29**(1–2): 91–106.

ROSIŃSKA, K. & ADAMSKA, K. (2007) Biometrics variation and directional preferences of immature Robins (Erithacus rubecula) caught in northern Italy during autumn migration in 2005. *Ring* **29**(1–2): 107–120.

SCHMIDT, E. (1998) A vörösbegy (Erithacus rubecula). Pp. 314. [The Robin (Erithacus rubecula).] *In:* HARASZTHY, L. (ed.): *Magyarország madarai.* Mezőgazda Kiadó, Budapest. [in Hungarian]

ŚCIBORSKA, M. & BUSSE, P. (2004) Intra-seasonal changes in directional preferences of Robins (Erithacus rubecula) caught on autumn migration at Bukowo-Kopań ringing station (in Poland) in 1996. *Ring* **26**(1): 41–58.

SVENSSON, L. (1992) *Identification guide to European Passerines*. 4th ed. Naturhistoriska Riksmuséet. Stockholm. 375 pp.

TELLERIA, L. J. & PÉREZ-TRIS, J. (2004) Consequences of the settlement of migrant European Robins Erithacus rubecula in wintering habitats occupied by conspecific residents. *Ibis* **146**(2): 258–268.

TITOV, N. (1999*a*) Individual home ranges of Robins Erithacus rubecula at stopovers during autumn migration. *Vogelwelt* **120**: 237–242.

TITOV, N. (1999*b*) Home ranges in two passerine nocturnal migrants at a stopover site in autumn. *Avian Ecology and Behaviour* **3**: 69–78.

TITOV, N. (2001) Fat score and temporal pattern of diurnal movements of Robins (Erithacus rubecula) at stopovers sites during autumn migration. The 3rd Conference of the European Ornithologits' Union, Haren/Groningen. *Programme and abstract book.* P. 102.

TSVEY, A., BULYUK, V. N. & KOSAREV, V. (2007) Influence of body condition and weather on departures of first-year European robins, Erithacus rubecula, from an autumn migratory stopover site. *Behavioral Ecology and Sociobiology* **61**: 1665–1674.

Revised version received March 25, 2010, accepted December 7, 2010, published June 10, 2011