

BIOMETRICS VARIATION
AND DIRECTIONAL PREFERENCES
OF IMMATURE ROBINS (*Erithacus rubecula*)
CAUGHT IN NORTHERN ITALY DURING
AUTUMN MIGRATION IN 2005

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ABSTRACT

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.

Inter-seasonal changes of biometry and preferred migration directions of Robins were studied according to data collected during autumn migration in northern Italy at the Arosio Bird Observatory (45° 43'N, 9° 12'E). Altogether 598 immature Robins were caught and 187 orientation tests were performed. Wing, tail and tarsus length, wing shape and weight were analysed in subsequent five migration waves distinguished according to migration dynamics. General pattern of migration as well as graphs with distribution of preferred directions in subsequent waves were prepared. In the case of tail length and weight their average values in subsequent waves were significantly different. Decrease of wing length was noted along the season. On the contrary, increasing trend was observed in the case of tail length and wing shape. Results of orientation tests showed that SSE direction was predominant (34%). SW direction was not clearly marked and its percentage was 23%. Distribution of directions slightly changed in subsequent migration waves. Noted results suggest passage of Robins heading to the Mediterranean basin and Apennine winter quarters. Obtained inter-seasonal changes of biometry and preferred directions can be an effect of differences in migration time between this groups or gradual inflow of more northern populations what the authors discuss here.

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INTRODUCTION

Northern Italy is an interesting area for scientists investigating phenomenon of bird migration and wintering. Region of the Alps and the Pre-Alps is very important for birds during their migration. In this part of Europe the main migratory flyways for passerines cross over and represent an important stopping and feeding area (Schubert *et al.* 1986). Migration routes existing now are a consequence of populations' expansion from refuges to central and northern Europe (Busse 1987, 2001; Berthold 1993, Burton 1995, Hagemeyer and Blair 1997). Moreover, the Po Valley region is an important wintering area for resident and migrant species (Vigorita *et al.* 1986).

Robins migrating through the Pre-Alps and staying at stopover sites for refueling before continuing their migration (Bottoni *et al.* 1991) originate mainly from northern Europe (Scandinavia, Finland, the Baltic area) and also from central and eastern Europe (Germany, the Czech Republic, Slovakia, Russia) (Vigorita and Reguzzoni 2004, Scebba and Capasso 2006). Recoveries from Robins ringed in Lombardy during autumn migration indicate that these birds head to France, Spain, Portugal, Northern Africa (Vigorita and Reguzzoni 2004), a part of them direct to Tuscany and the Po Valley region. Results of orientation tests conducted in the Arosio Bird Observatory (Northern Italy) in 2005 showed very clear SSE direction while SW direction was dispersed (Adamska and Rosińska 2006). Cited results stand in accordance with the recoveries and suggest migration of birds heading to different winter quarters through Lombardy area, however it must be remembered that in this region resident and migrant populations can overlap (Schubert *et al.* 1986). It is interesting fact that Robins tested in orientation cages showed strong tendency towards SSE direction, which indicates the Apennine Peninsula, although most of the recoveries from birds caught in the Lombardy region came from Algeria, Morocco, France, Spain or Portugal. Probably a study of preferred directions in subsequent periods of autumn migration or in relation to biometry can clear up this phenomenon. In southern Italy during autumn migration two groups of Robins were observed – with more pointed and more rounded wings (Lövei *et al.* 1986). Birds with more pointed wings, supposedly more northern birds, migrated most intensively in October and earlier than Robins with more rounded wings which made up the bulk of the migrants. Robins caught during passage at other European ringing stations in subsequent periods of autumn migration differed in biometrical and morphological data as well. In some places like the stations located in Sweden or Norway some changes in wing length were observed (Mehlum 1981, Pettersson 1983, Pettersson and Lidholm 1983, Karlsson *et al.* 1986). Variation in the number of unmoulted coverts is well known in young Robins caught during autumn migration in Sweden, Russia or Poland (Karlsson *et al.* 1986, Pettersson *et al.* 1990, Rymkevich 1990, Ginter *et al.* 2005). Some studies showed intra-seasonal changes in directional preferences of Robins caught on autumn migration (Ściborska and Busse

2004, Adamska and Filar 2005). Observed differences can result from the passage of birds directing to different winter quarters or originating from various areas. Some papers showed variable time of migration for different sex groups (Pettersson 1983, Saurola 1983, Pettersson *et al.* 1990).

The aim of this study was to investigate intra-seasonal changes of some biometrical characteristics and directional preferences. Moreover, we analysed directional preferences of immature Robins migrating in autumn through Northern Italy in relation to biometrical data, what is an extension of earlier results from the orientation tests conducted in this region (Adamska and Rosińska 2006).

MATERIAL AND METHODS

Data were collected in 2005 during autumn migration at the Arosio Bird Observatory, Lombardy region in Northern Italy (45°43'N, 9°12'E). It is located 360 m a.s.l., in western part of the Pre-Alps. This modern observatory developed from the ancient *Roccolo* facility (typical for Lombardy region), dating back to 1710. Arosio is situated along one of the main migratory flyways for passerines, representing also an important stopping and feeding area (Fornasari 1987, Scebba and Capasso 2006).

Field methods

Birds were caught in mist-nets. Nets were controlled every hour from dawn to dusk. Caught birds were ringed, measured and weighed. Wing length (maximum chord method), tail length ("to the back" method) and wing formula measurements were taken. The wing formula was recorded by measuring the distances between the wing tip and subsequent primaries (from the second to the eighth) (Busse 2000). All measurements were taken to the nearest 1 mm, using a ruler. Besides, the tarsus length measurement was taken (Svensson 1992). Afterwards, randomly selected Robins were tested for directional preferences in the Busse's cage, according to a standard method proposed by this researcher (Busse 1995, 2000). The cage was a flat, circular structure with a side wall divided into eight sectors; it was placed in protecting cover and oriented according to N-S axis. Preparation of the cage for the experiment included covering its vertical side wall with a stripe of foil from a roll. Cage tests were performed at the roof of the observatory building. Most tests were conducted in the daytime: 6.00 *a.m.* – 7.00 *p.m.*, all birds were tested not later than two hours after they had been caught in the nets. Scratches and holes on foil were treated as signs of bird activity and next were counted sector by sector.

Data analysing

In the Lombardy region the most intensive period of Robin migration occurs at the end of September and in November (Schubert *et al.* 1986, Scebba and Capasso 2006), therefore data on 598 immature Robins caught in term: 22 Sep. – 28 Oct.

used in the analyses composed nearly 90% of immature Robins caught at the Arosio Bird Observatory. Besides, in this period all measurements were taken by the same person. Orientation tests were performed during 30 days (28 Sep. – 28 Oct.) – totally 187 tests were completed. Wing, tail and tarsus lengths, wing shape and weight were analysed. Wing asymmetry (E') and pointedness (L) indices were calculated according to formulas proposed by Busse (1989, 2000) based on wing formula measurements:

$$E = \frac{p}{p} \frac{d}{d} 100\%$$

$$L = \frac{p}{w} \frac{d}{d} 100\%$$

where:

p – a sum of distances from wing tip to the tips of proximal primaries,

d – a sum of distances from wing tip to the tips of distal primaries,

w – wing length.

Average values of these parameters were calculated for the whole studied period and for subsequent migration waves of this season according to percentage catching dynamics. For this purpose, for each day the percent value was calculated in relation to the average daily number of immature Robins to draw the migration dynamics. The obtained dynamics were divided into five migration waves according to the minima of the dynamics (Busse 1996; see Fig. 1). Intra-seasonal changes of studied parameters were checked in subsequent migration waves (ANOVA). Trends of analysed measurements were studied applying general linear model (GLM).

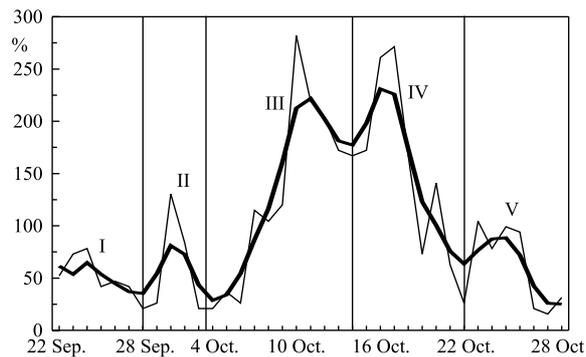


Fig. 1. Percentage migration dynamics of immature Robins (thin line), smoothed using moving average (thick line) and its division into migration waves (vertical lines; Roman numbers – numbers of waves)

The data of orientation tests were elaborated using a non-standard calculation procedure proposed by Busse and Trocińska (1999) and Ożarowska (2005) that could be applied to multimodal circular distributions. General pattern of migration

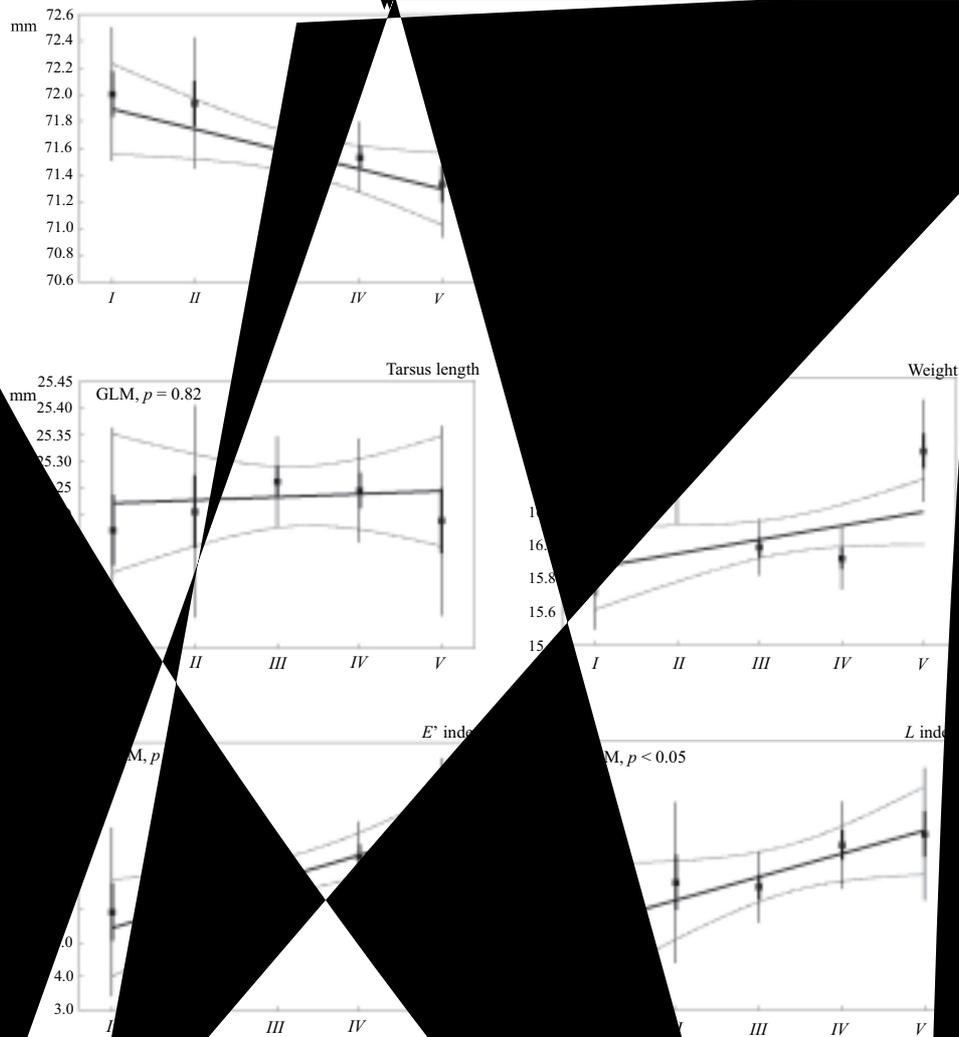
as well as graphs with distribution of preferred directions in subsequent waves were prepared. Moreover, graphs for birds divided into groups according to wing and tail length were prepared. All statistical comparison were performed using χ^2 -test, values of χ^2 were used also for rough estimation of the size of differentiation between two data distributions. Similarly, regression coefficient was used to test the accordance of these data.

RESULTS

Average values of analysed measurements are presented in Table 1. Five migration waves were distinguished according to migration dynamics (Fig. 1). Averages of subsequent waves were significantly different only in the case of tail length and weight (ANOVA: tail length – $F_{4,567} = 14.23, p < 0.001$; weight – $F_{4,568} = 4.88, p < 0.001$), however average values of wing length and shape were changing during autumn season as well (Fig. 2). In the case of tail length birds caught at the end of analysed season had on average longer tail than Robins migrating earlier (*post-hoc* Neuman-Keul's test: average values of waves *I* and *II* were in all cases significantly shorter than average values of waves *III*, *IV* and *V*). Mean weight in Robins was changing along the season. On the turn of September (wave *II*) and at the end of October (wave *V*) average values of weight were higher than in the remaining part of migration, what was confirmed by the results of *post-hoc* Neuman-Keul's test (in all cases average values of waves *II* and *V* were significantly different from average values of the remaining waves; Fig. 2). Changes in average values of tarsus length were not observed along the season (ANOVA: $F_{4,575} = 0.32, p = 0.86$; Fig. 2). In the case of wing length, tail length and wing shape some trends were observed (Fig. 2). A slight decrease of wing length was noted along the season (GLM: $y = 72 - 0.149x, p < 0.05, N = 574$). On the contrary, an increasing trend was observed in the case of tail length (GLM: $y = 60.1 + 0.635x, p < 0.001, N = 572$). Wing shape indices (*E'* and *L*) also showed an increase towards the end of migration period (GLM: *E'* index: $y = 4.72 + 0.723x, p < 0.05, N = 547$; *L* index: $y = 40.7 + 0.259x, p < 0.05, N = 547$).

Table 1
Average measurements of immature Robins caught at the Arosio Bird Observatory during the analysed period

Measurement	Average	SD	N
Wing length	71.55	1.77	574
Tail length	62.15	2.41	572
Tarsus length	25.23	0.68	575
Weight	16.01	1.29	573
<i>E'</i> index	7.15	6.87	547
<i>L</i> index	41.58	3.12	547



distribution of directions for immature Robins in Busse's cage is very similar to that in the field. Total distribution of the preferred headings is given in Figure 3. One direction is predominant – SSE direction (34%), SW direction is also clearly marked, although its percentage was 23% (Table 2). The percentage of southern directions is higher than in the field, opposite to normal direction during autumn migration, observed in Arosio was 10% and here low and reached 19% for NW and 18% for NE headings.

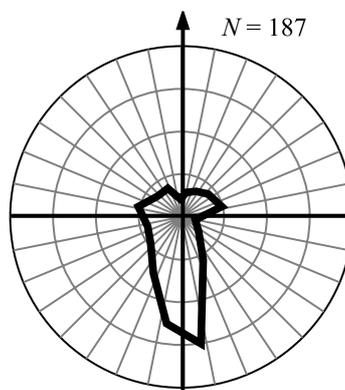


Fig. 3. Distributions of the preferred directions (given in 16 sectors) shown by immature Robins in 2005

Table 2
Share of preferred directions of Robins caught at the Arosio Bird Observatory
in subsequent waves

Wave	<i>N</i> tests	SSE (%)	SW (%)	N (%)
<i>II</i>	20	25	14	32
<i>III</i>	51	19	35	33
<i>IV</i>	90	36	22	37
<i>V</i>	24	38	8	47
Total	187	34	23	37

Radar graphs were also prepared for the distinguished migration waves. Distributions of directions for these periods are presented in Figure 4. Because of a small size of the sample the first wave was excluded from further analyses. In subsequent periods of the Robin's passage, the observed migration directions compared to overall directional pattern show some differentiation. Proportion of headings was slightly changing during studied season (Table 2). In all described waves (except for wave *III*) Robins showed SSE direction as a dominant one. This direction became clearer in subsequent periods and its share in the last wave reached 38%. The SW direction constituted 35% in wave *III*, however it was poorly represented and rather diffused in the remaining waves (in wave *V* – only 8%). Similarly, in wave *II* also the ESE direction dominated, but its value gradually decreased in subsequent waves. The W direction was visible in waves *III* and *IV* and its percentage was 14% and 18%, respectively. In addition, the share of northern directions during studied periods gradually increased (from 32% in wave *II* to 47% in wave *V*). Statistically, the obtained results show that distributions of headings in studied waves were rather similar (wave *II* and *III* – χ^2 -test: $p = 0.40$, regression coefficient: $r = 0.05$, $p = 0.05$; wave *III* and *IV* – χ^2 -test: $p = 0.99$, regression coefficient: $r = 0.80$, $p = 0.001$; wave *IV* and *V* – χ^2 -test: $p = 0.94$, regression coefficient: $r = 0.65$, $p = 0.01$).

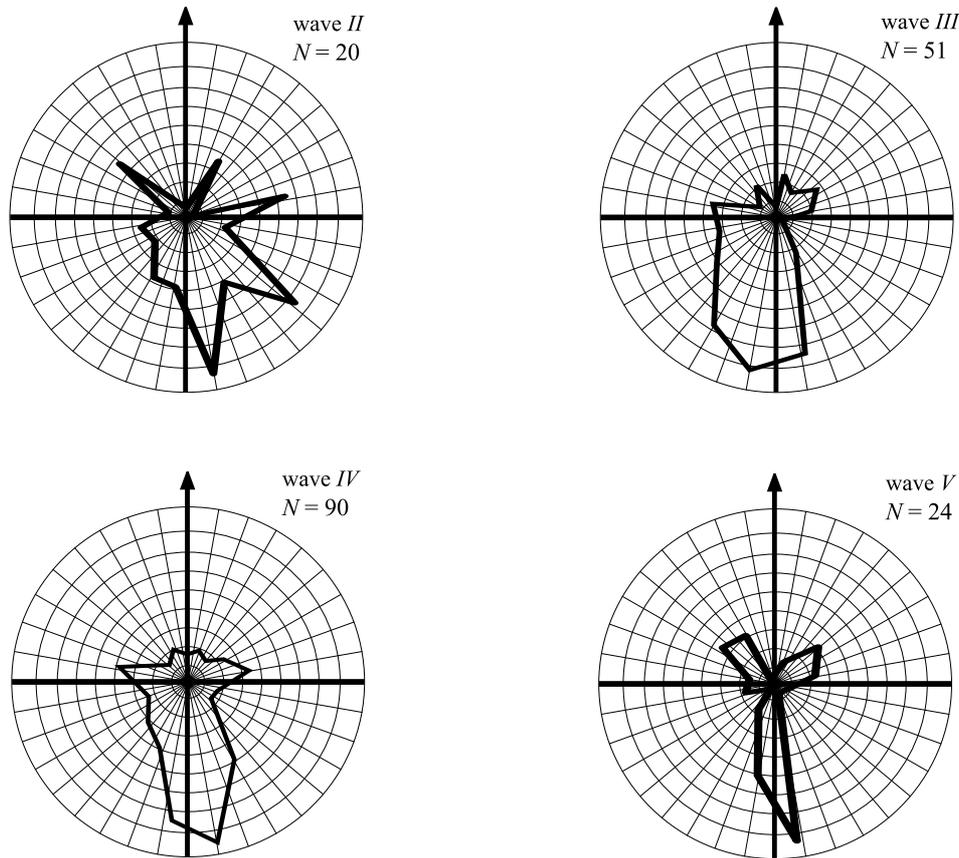


Fig. 4. Distributions of the preferred directions (given in 16 sectors) shown by immature Robins in subsequent migration waves

We analysed directional preferences for birds with particular length of wing and tail. According to the median of wing length (72 mm) Robins were divided into two groups: (1) birds with wing length to 72 mm inclusive and (2) birds with wing longer than 72 mm. Birds from the first group indicated SSW direction as a dominated one (22%), with the percentage of SSE (the main direction for all birds) reaching 18%. The latter direction was preferred by birds with longer wing (SSE – 35%), SSW was also indicated (17%). Birds from these two groups seem to be similar (χ^2 -test: $p = 0.94$; regression coefficient: $r = 0.77$, $p = 0.001$). Similar division according to the median of tail length (62 mm) was done and two groups of Robins were analysed: (1) birds with tail length to 62 mm inclusive and (2) those with tail longer than 62 mm. Directional preferences demonstrated by birds with shorter and longer tail were also similar (χ^2 -test: $p = 0.96$; regression coefficient: $r = 0.82$, $p = 0.001$). In both cases the SSE direction was the dominant one and represented 28 and 32%, respectively.

DISCUSSION

Robins migrating through the Italian Pre-Alps originate mainly from northern Europe as well as from central and eastern Europe (Vigorita and Reguzzoni 2004, Scebba and Capasso 2006). Nearly 70% of Robins recovered in Italy come from the Baltic region (Scebba and Olivieri del Castillo 1983). According to recoveries from this region three south-western direction routes of migration were distinguished: Western (along the North Sea and the Atlantic coast to Portugal, Spain and Morocco), Mediterranean (along the Mediterranean coast to Spain, Morocco and Algeria) and Apennine (toward the Apennine Peninsula, Sardinia, Corsica and Tunisia) (Remisiewicz 2002). In Northern Italy Robins migrating along the Apennine route separate into two groups: birds heading toward the Apennine Peninsula and those heading toward Corsica and Sardinia. The cited author suggests that birds migrating through the Italian Alps and the Po Valley represent only the Apennine group, whereas the recoveries of the Lombardy region from autumn migration and wintering period indicate that Robins migrating through this region head towards France, Spain, Sardinia, Corsica, Balearic, Morocco, Algeria, Tunisia and some towards Tuscany (Vigorita and Reguzzoni 2004). Therefore, this could indicate that Robins migrating through the western Pre-Alps head not only towards Apennine winter quarters. Results of orientation tests seem to confirm this, because directions' distribution of Robins tested at the Arosio Bird Observatory showed very clear SSE direction and not clearly marked SW direction as well as W direction (Adamska and Rosińska 2006). The SSE and SSW directions point at the Apennine Peninsula, Sardinia and Corsica and probably show migration along the Apennine route. The SW direction could indicate migration along the Mediterranean coast, despite the fact that this direction was not clearly marked in our study. The W direction could indicate migration toward the Mediterranean basin as well but through alpine passes or valleys, what can be confirmed by recoveries. Robins ringed during autumn migration in the Lombardy region were recovered in the French Pre-Alps and in the Rhone Valley (Vigorita and Reguzzoni 2004). In another part of the Italian Pre-Alps at Passo di Spino Station similar orientation tests were conducted and their results showed only one – SW migration direction (Fornasari *et al.* 2003). In that case the results probably indicate local direction along Lake Garda. It is worth to note that the results of orientation tests showed SSE direction as a preferred one, however recoveries from Robins ringed in Lombardy indicate that birds migrating through this region head mainly to the Mediterranean winter quarter. Most of them (nearly 80%) come from Algeria (Adamska and Rosińska 2006). Analysis of the Song Thrush recoveries showed similar results to the Robin (Andreotti *et al.* 1999). The authors suggest that Song Thrushes follow two main routes from the Pre-Alps region: a major one – birds funnel along the coast heading to Spain, the Balearics and Algeria, and a minor one – birds head toward south-east to Tuscany and Lazio. Probably in both species the lower rate of Apennine recoveries is caused by lower

ringing activity in this region. Nevertheless, the orientation tests' results in our study indicate that the Apennine route is also a very important one.

It is quite often noted that directional preferences of birds tested in orientation cages pointed at northern directions that were opposite to the standard directions for autumn migration. This phenomenon was observed in Robins tested at stations in Poland. In that case proportion of northward directions was higher than that at Arosio and comprised: 49% at the Polish Baltic coast (Busse and Trocińska 1999) and over 60% in southern Poland (Adamska and Filar 2005). At the Arosio station, on the contrary, the reversed directions rate was lower (37%). Such cases of reversed migration were often observed in natural conditions (Alerstam 1978, Richardson 1978, Busse 1992, Berthold 1993, Remisiewicz and Baumanis 1996, Phillips 2000, Åkesson *et al.* 2002, Komenda-Zehnder *et al.* 2002). This phenomenon is still not well-studied, however it could result from several reasons. It could be explained according to the axial behaviour hypothesis, *i.e.* that birds have genetically encoded migration direction axiality – directed towards breeding and wintering grounds (Busse 1992). Specific conditions of orientation cage could cause birds to show direction that is opposite to the standard one during their autumn migration. Stressed by the limited space of the cage, birds could show directions towards familiar environment and places well-known for them, *i.e.* direction of their arrival. Proportion of reversed directions indicated by tested birds could depend on specific character of a studied place, its topography and geographical position.

Biometrical differentiation of migrants during the season observed in this study can be an effect of the different population or sex groups passage (Pettersson 1983, Saurola 1983, Pettersson *et al.* 1990). Our results showed that Robins in subsequent migration waves had more and more shorter wings and longer tails. In southern Norway similar trend of wing length changes was observed (Mehlum 1981), but at some stations in Sweden this trend was contrary (Pettersson 1983, Pettersson and Lindholm 1983, Karlsson *et al.* 1986). In all these cases the authors explained this phenomenon by different time of sexes migration. Although males have longer wings, tails and tarsi than females (Madsen 1997, Cramp 2002, Rosińska 2007), simultaneously a decreasing trend of the wing length and an increasing trend of the tail length during the season were observed. This could support migration of different population groups. Wing shape of caught birds also changed during the season. At the end of the analysed period the caught Robins had more pointed and asymmetric wings than at the beginning of the season. In southern Italy, on Vivara Island, two different groups of wing shape were found (more pointed and rounded wings' birds) (Lövei *et al.* 1986). The authors supposed that Robins with more pointed wings belonged to more northern populations. It was noted that these birds migrated most intensively in October, before the majority of individuals with more rounded wings appeared on the island. The birds with more rounded wings were more erratic. Our results were different because the rate of birds with more pointed wings increased at the end of the analysed period. These differences can result from different characteristics of both study places. Lombardy region is a stopover and

foraging area, whereas Robins passing Vivara Island were rather at the last stage of migration. Similarly to our study the cited authors noted changes of body mass during season, although their analysis was based on longer time periods. Weight of a bird during migration depends on migration strategy, weather conditions or body size (Ehnbom *et al.* 1993, Zimin 2003). The increase in weight observed on the turn of September and at the end of October could be caused by the migration of birds heading to more distant winter quarters or by the passage of large-sized birds of northern and eastern origin. According to the results of this study, the higher body mass at the end of migration (end of October) seems to be an effect of migration of Robins originating from more northern area, what is also supported by the results of wing shape analysis. It would correspond with the variation in the extent of moult. In late migrants the reduction of the extent of greater coverts moult was observed amongst Robins caught at the Arosio Bird Observatory (unpublished data). Similar phenomenon was noted through the Polish and Swedish Baltic coast and north-western Russia (Karlsson *et al.* 1986, Pettersson *et al.* 1990, Rymkevich 1990, Ginter *et al.* 2005). The authors explained this phenomenon by an inflow of birds coming from more northern breeding areas. Winter recoveries from birds ringed before 15 August in Sweden and in Finland showed that only Robins from Finland, thus more northern areas, were recorded in the Po Valley (Pettersson and Lindholm 1983). Therefore, it is possible that Robins migrate through the Lombardy region at the end of October and later head to the Po Valley region, an important wintering area (Vigorita *et al.* 1986). The increasing share of northern directions in subsequent waves observed in our study can indicate that in the course of season Robins become less erratic and probably spend winter in the Po Valley. These birds could belong to the birds of more northern origin. This would also correspond with wing-shape changes of Robins caught at the Arosio station. Probably the birds with more pointed and asymmetric wings caught at the end of the analysed period originate from more northern areas. Intra-seasonal changes in directional preferences of tested Robins seem to confirm this, however they could result from the migration of Robins heading to different winter quarters. This phenomenon was noted according to investigations conducted at the Polish Baltic coast (Ściborska and Busse 2004) and in the Beskid Niski Mountains (S Poland) as well (Adamska and Filar 2005). Changes of directions' distribution were noted during the season, however these differences were not statistically significant. The SSE direction was clear in all distinguished periods, however the rate of SW direction changed during the season. At the end of September two eastern directions were preferred, *i.e.* SSE and ESE, what could indicate the migration towards the Apennine winter quarter (toward the Apennine Peninsula, Sardinia, Corsica and Tunisia). It was also confirmed by average migration dates of Robins in the distinguished routes (Remisiewicz 2002). According to the author, Robins following the Apennine route start their migration earlier than birds heading to the Mediterranean winter quarter. In the first half of October the rate of SW and W directions increased. Most probably Robins migrating along the Mediterranean coast and through alpine passes or valleys joined to the Apen-

nine group and migration of both populations lasted simultaneously almost to the end of October. At this time only one, SSE direction was preferred and probably these were Robins migrating along the Apennine route but for shorter distances. The earliest migrants of the Apennine route reach the most distant parts of winter quarter and later migrants winter nearer breeding area (Remisiewicz 2002), what suggest that Robins migrating later through the Lombardy region winter in the Po Valley. That corresponds with the discussion above.

Summing up, the intra-seasonal differences in biometry and in directional preferences of tested Robins noted at the Arosio Bird Observatory in 2005 probably were caused by differences in migration of birds heading to the Mediterranean winter quarter (along the Mediterranean coast and through alpine passes or valleys) and to the Apennine winter quarter (toward the Apennine Peninsula and toward Sardinia and Corsica), as well as by gradual inflow of more northern Robins. It must be emphasized, however, that in this study only one season was analysed, therefore studies continued during next seasons could probably clear up this phenomenon.

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