

PHENOLOGY OF PASSERINE BIRD MIGRATION IN THE DANUBE DELTA, ROMANIA

Boris Droz^{1*}, Sabrina Joye¹, Alexandre de Titta¹,
Fabian Schneider¹, Sylvain Antoniazza^{1,2}

ABSTRACT

Droz B., Joye S., de Titta A., Schneider F., Antoniazza S. 2016. *Phenology of Passerine bird migration in the Danube Delta, Romania*. Ring 38: 25-43.

The Palearctic-African bird migration system has fascinated ornithologists for decades and is one of the most well-known. However, there is strong spatial variation in the level of knowledge, and the South-Eastern European Flyway (which passes through the Balkan Peninsula) has been studied far less than the Western European Flyway (which passes through the Iberian Peninsula and Italy). In this study, we describe the phenology of 16 common woodland species, with a detailed analysis of the pre-migration period as well as an age-specific analysis of the timing of migration. As a general trend for species wintering in sub-Saharan Africa, adult birds migrated before first-year birds, in contrast with short-distance Mediterranean wintering species, in which we observed no difference. We also provide information comparing the timing of the migration of birds with characters of subspecies of Willow Warbler *Phylloscopus trochilus* and Chiffchaff *Phylloscopus collybita*, which have not previously been reported.

B. Droz^{1*}, S. Joye¹, A. de Titta¹, F. Schneider¹, S. Antoniazza^{1,2}.

¹ Nos Oiseaux, Chemin de Serroue 1, 2037 Montmollin, Switzerland; ² Swiss Ornithological Institute, Seerose 1, 6204 Sempach, Switzerland; * corresponding author: B. Droz, e-mail: bodroz@bluewin.ch

Keywords: passerines, autumn migration, mist-netting, phenology, *Phylloscopus* subspecies, body moult

INTRODUCTION

The north-south migration route of summer visiting European passerines follows three main routes towards the African wintering grounds: the Western Flyway through the Iberian peninsula, the Central Flyway through Italy, and the South-Eastern European flyway through the Balkan peninsula (Bairlein 2001, 2003). Most migration studies have been carried out for the Western and Central Flyways (Busse 2001). Patterns such as general migration phenology (Bønløkke *et al.* 2006, Maumary

et al. 2007, Spina and Volponi 2009, Wernham *et al.* 2002), long-term population dynamics (Fiedler 1998, Jenni and Naef-Daenzer 1986), response to climate fluctuations (Both *et al.* 2006, Jenni and Kéry 2003, Sokolov *et al.* 1999) or stopover ecology (Schaub and Jenni 2000, Schaub *et al.* 2004) have been intensively studied, but much less so for the South-Eastern European Flyway.

On the South-Eastern European flyway, in autumn passerines are constrained between the Carpathians and the Black Sea coast while heading towards the Balkan Peninsula. About 900 million birds fly through this peninsula each autumn (Zehndjiev and Liechti 2003), a number similar to that for the Western flyway through Germany, Northern Italy, France and Spain (Bruderer and Liechti 1999, Liechti *et al.* 1996). The Danube delta, the second largest European delta after that of the Volga, is situated where the geographic constraints between the Carpathians and the Black Sea coast are relatively high (Fig. 1). This underscores the geographically important role of the Danube delta for the South-Eastern European flyway. Moreover, it is an attractive place for stopover and feeding due to the relatively small human presence and land use in the area (Goriup *et al.* 2007). The Danube Delta is a Biosphere Reserve (DDBR, IUCN Management Category IV), and according to Birdlife International (Heath *et al.* 2000), of its 580,000 ha total surface area (Delta and Dobrodgia) seven Important Bird Areas (IBA) cover a combined 491,000 ha.

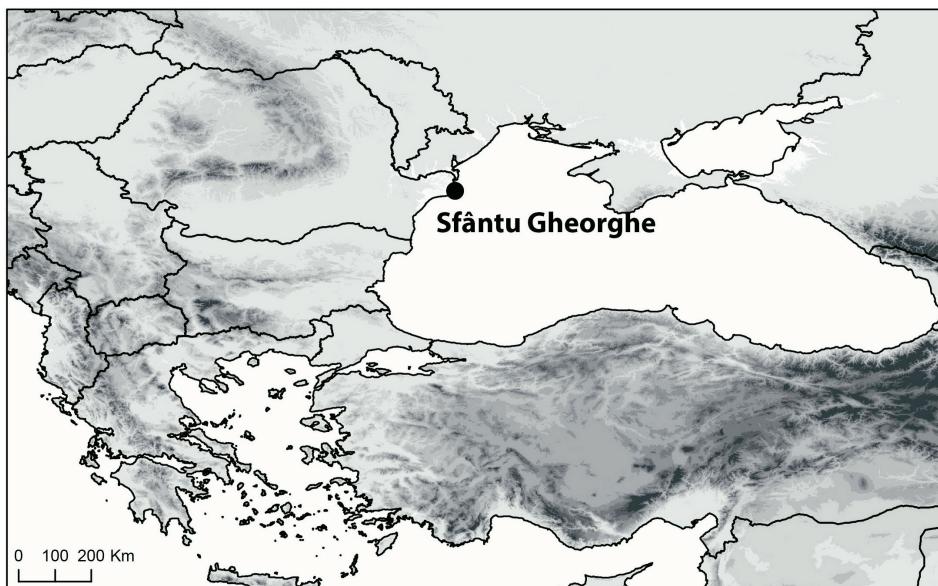


Fig. 1. Geographic location of the study area in Romania, Cartographic data © 2008 by Consortium for Spatial Information (CGIAR-CSI)

Recent studies for the Balkan Peninsula have provided information on spring migration for various passerines, raptors and waders (Schmitz 1998, Schmitz and Legge 2003, Schmitz *et al.* 2001). The migration of the threatened Paddyfield Warbler

Acrocephalus agricola and Red-breasted Goose *Branta ruficollis* has also been well documented by Csörgo and Kelemen (2000) and Dereliev (2006), respectively. Additionally, several reports and regional communications have been published concerning autumn migration through reed habitats (Ion 2009, Ion and Viorel 2005, Kalocsa *et al.* 2007, Kalocsa *et al.* 2010, Stöcker 1998, Tamas and Peter 1998). However, migration timing and patterns have not yet been fully established and are still poorly documented for the most abundant species, such as woodland birds.

Here, we present a description of the phenology of 16 woodland migrant species. Ringing effort was continuous for two consecutive autumns, in a relatively dry forest patch of the Danube delta, bordered to the east by the Black Sea and to the west by reed beds.

METHODS

Study site and monitoring

The study area is located about one kilometre north of the village of Sfântu Gheorghe (44°54'N 29°35'E, Fig. 1) and covers about 1 km² of different habitats (forest, bushes, open land, grassland, and channels). The main structure is a plantation of poplars mixed with alders, willows, pines and diverse bushes, mainly Russian Olive *Elaeagnus angustifolia* and Sea Buckthorn *Hippophae rhamnoides*.

The ringing activity was conducted during the autumns of 2007 and 2008 (21st July to 8th November in 2007 and 18th July to 26th October in 2008). Before sunrise 546 meters of 17 mm meshed mist nets were opened and trapping was continuous when weather permitted (no rain and no strong wind, i.e. Beaufort scale ≤ 5). All nets were checked every hour. The proportion of daylight time with nets open was $64.8 \pm 29.4\%$.

The birds caught were marked with aluminium rings of the Romanian Ringing Centre, and aged and sexed according to Jenni and Winkler (1994) and Svensson (1992). Capture time, wing and third primary lengths, and body mass were recorded for each bird. Fat scores and muscle scores were recorded according to Kaiser (1993) and the *Manual of Field Methods* (Bairlein *et al.* 1995), respectively. Finally, stages of the post-juvenile body moult were estimated as the percentage of new body feathers for the first-year birds.

Identification of *Phylloscopus* with characters of subspecies

Birds with characters of subspecies of the *Phylloscopus* genus were identified for adult birds only, when they had unambiguous and marked characters. Therefore birds without specific characters or juveniles were considered by default to belong to the nominal subspecies. Age was estimated by skull pneumatisation and the moult limit in the greater coverts. Additional appreciation of the colour of underparts was taken for Willow Warbler *Phylloscopus trochilus* as described Jenni and Winkler (1994). Birds with characters of subspecies were morphologically identified following Clement *et al.* (1998) and Svensson (1992). Additionally, a criterion of primary projection was used for Common Chiffchaff *Phylloscopus collybita* as described by Demongin

(2013). Briefly, when the length of the second primary was similar to that of the eighth or between the lengths of the eighth and ninth primaries, birds were considered to have characters of *P. collybita collybita*. However, when the length of the second primary was similar to that of the seventh or between that of the seventh and eighth primaries, birds were considered to have characters of *P. collybita abietinus*. Finally, birds with characters of *P. trochilus yakutensis* generally had a wing length greater than 70 mm and a green-grey body feather tint. Our morphological identifications suggest caution due to the large interspecific variation of the *Phylloscopus* genus across Europe and suffer from a lack of genetic data. Further phenological and biometric analyses were performed for the birds with characters of subspecies.

Phenology

Turdidae and *Sylvidae*, taxonomy following Cramp (1992), generally must complete their post-juvenile or post-breeding body moult before they begin migration. Therefore, we considered an incomplete first-year body moult to be an indicator of a pre-migratory state. On the other hand, *Paridae* may start their migration during the last stages of body moult (Jenni 1984, Jenni and Winkler 1994). Additional data, from the same site but acquired in nets with irregular capture effort, were included for the pre-migration analysis. Transition from pre-migration to the migration period was evaluated by plotting the proportion of first-year birds with completed body moult among all first-year birds as a function of the pentad number. Then, the transitions were assessed by linear regression on data with the proportion of the first-year birds with completed body moult below 1 (end of pre-migration). The start of the pre-migration period was defined by the pentad axis intercept defined by the linear regression. The weight of the first-year birds divided by the length of the third primary (normalization) is reported for four species during the pre-migration period and compared to the migration period. The Kolmogorov-Smirnov median test (KS) was used to evaluate the difference between the pre-migration and migration period.

Phenology was reported by pentads (year divided into 5-day periods), so the work period was from pentads 41 to 63 (Berthold 1973). For each pentad, the sum of ringed birds from both years was divided by the proportion of daylight time with open nets to normalize data during the ringing period. Recaptures for the same pentad were not included in the phenology calculation. Differences in phenology between years, age classes and birds with characters of subspecies were tested using a two-sample Kolmogorov-Smirnov median test. The Song Thrush *Turdus philomelos* and the Great Tit *Parus major* were not included in the analysis because age was not consistently reported and the proportion of adults was too small for both species.

RESULTS

Among 16 bird species with more than 100 individuals caught the phenology between the two years was not significantly different (KS test for all species separately p -value always > 0.1) and the two years were therefore merged for further analysis. The general pattern of migration/catching phenology for these two years is presented

in Figure 2. The species presented in detail are shown in Figure 3 and 5: they are European Robin *Erithacus rubecula*, Thrush Nightingale *Luscinia luscinia*, Common Redstart *Phoenicurus phoenicurus*, Blackbird *Turdus merula*, Song Thrush *Turdus philomelos*, Garden Warbler *Sylvia borin*, Eurasian Blackcap *Sylvia atricapilla*, Lesser Whitethroat *Sylvia curruca*, Common Chiffchaff *Phylloscopus collybita*, Willow Warbler *Phylloscopus trochilus*, Goldcrest *Regulus regulus*, Spotted Flycatcher *Muscicapa striata*, Red-breasted Flycatcher *Ficedula parva*, Great Tit *Parus major*, Blue Tit *Parus caeruleus* and Red-backed Shrike *Lanius collurio*. The seasonal distribution of uncommon species caught at the Sfântu Gheorghe ringing site can be found in the Appendix (Table A1 – those with at least 10 individuals, Table A2 – all less numerous).

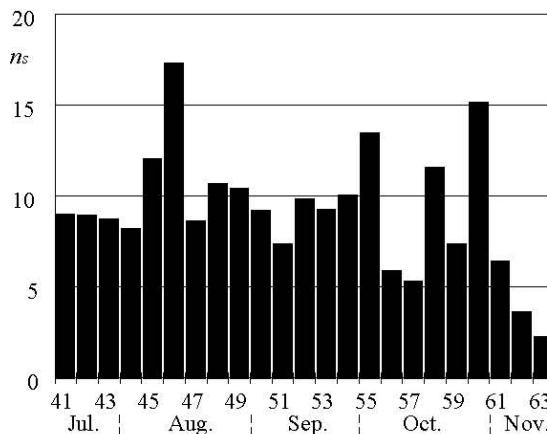
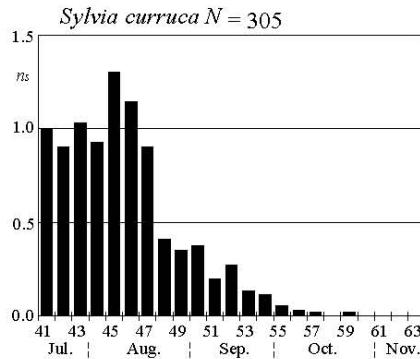
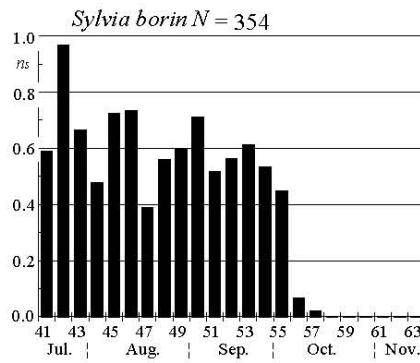
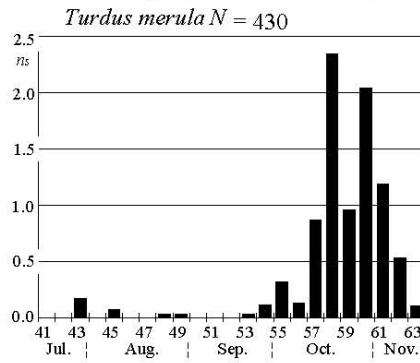
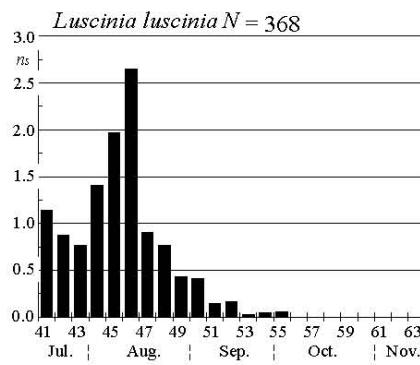
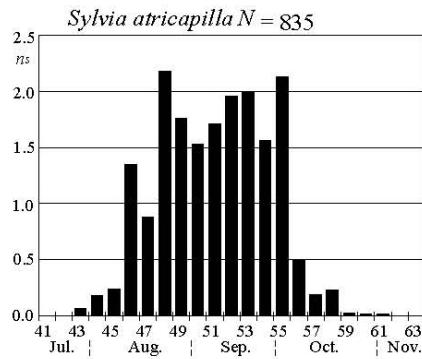
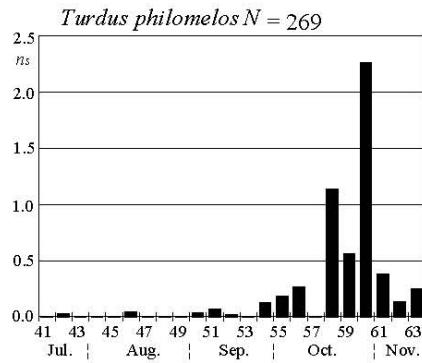
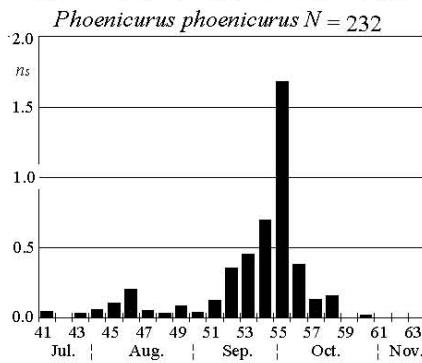
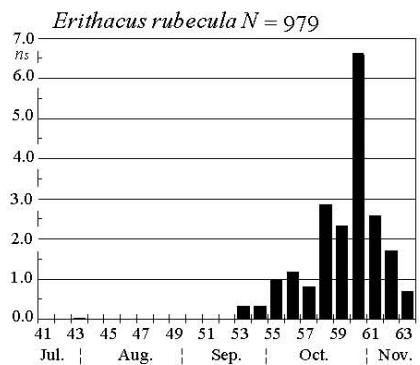


Fig. 2. General pattern of catching dynamics at Sfântu Gheorghe, 2007-2008. ns – numbers of ringed birds were summed up by pentads and normalized (divided) by daily catching activity.

Pre-migration period of first calendar-year birds

Thrush Nightingale, Common Redstart, Blackbird, Garden Warbler, Eurasian Blackcap, Lesser Whitethroat, Willow Warbler, Spotted Flycatcher, Blue Tit, Great Tit and Red-backed Shrike were caught from the start of our ringing activities when their migration had not yet begun and were consequently considered species breeding within our study site or the surrounding area.

Among these breeding species, incomplete first-year body moult (i.e. complete juvenile plumage or active post-juvenile moult) meant that these were birds in their pre-migration period. This was observed in Thrush Nightingale, Garden Warbler, Eurasian Blackcap and Lesser Whitethroat at the beginning of the capture period. For these species, the proportion of first-year birds with completed body moult increased linearly and significantly (Table 1) into the migration period. The last individuals with an incomplete post-juvenile moult were found in pentads 48, 50, 50 and 51 for these species, respectively (Fig. 4, Table A2). Incomplete post-juvenile body moult was also observed for Blue Tit and Great Tit (Fig. 4). However, these species are



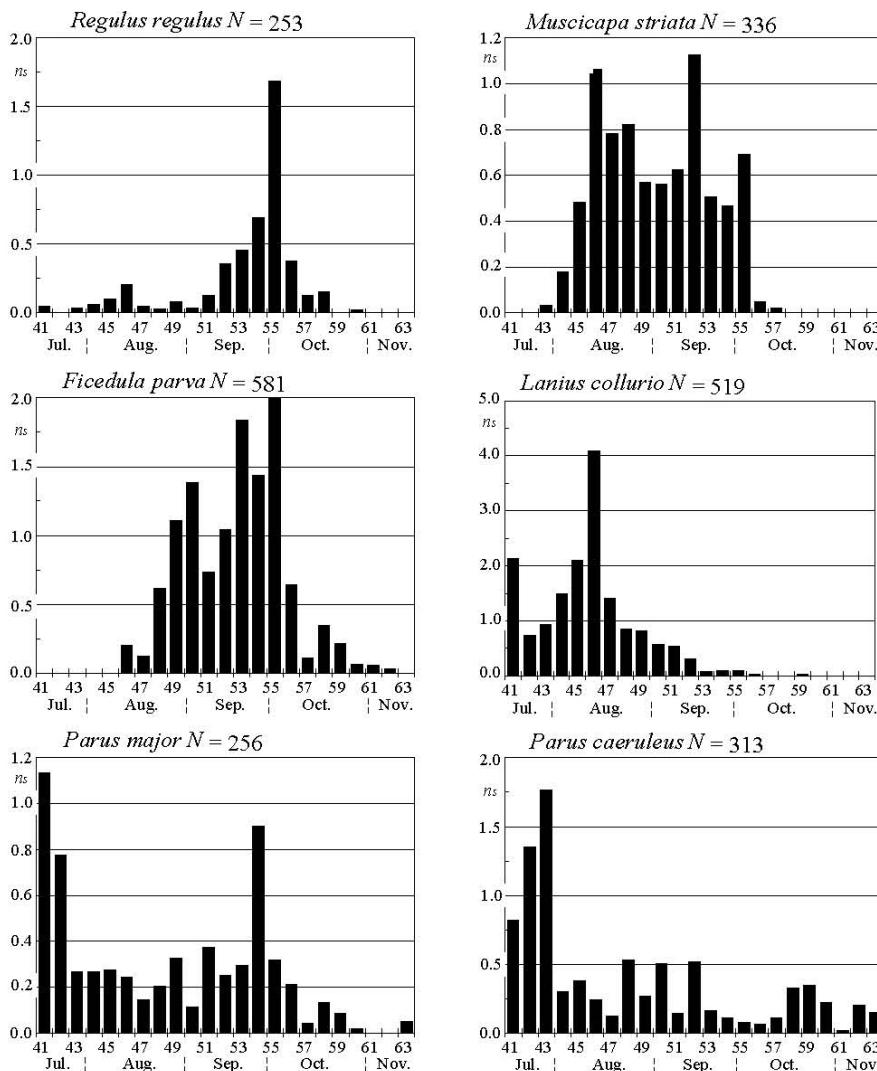


Fig. 3. Phenology of the 14 most numerous species at Sfântu Gheorghe, 2007-08. n_s – numbers of ringed birds were summed up by pentads and normalized (divided) by daily catching activity.

considered partial migrants and do not exhibit the typical timing succession of moult and migration (Nowakowski and Chrusciel 2004, Nowakowski and Vahatalo 2003). Moreover, our study site was located on both their breeding and winter quarters (Busse *et al.* 2014). In Thrush Nightingale, Garden Warbler and Lesser Whitethroat the ratio of body mass to third primary length was significantly smaller for the pre-migration period than for the subsequent pentads (Table 1). This indicates that migrating birds of these three species were heavier than the pre-migratory birds in Sfântu Gheorghe. This suggests that the beginning of this linear increase period, re-

ported in Table 1 (Start pentad), marks the start of the local first-year bird migration season. Further exploration of our data shows no significant difference in the proportion of adults (KS, p -value = 0.30) and juveniles (KS, p -value = 0.19) between the pre-migration and migration periods as reported by Jenni (1984).

Table 1

Characteristics of the pre-migration period. **Complete body moult:** linear regression of the proportion of first-year birds with entire body plumage post-juvenile as a function of the pentad number – the starting pentad defines the pentad intercept and R^2 the Pearson's coefficient of the linear regression applied through the pre-migration period. **Normalized weight:** the weight of the first-year birds divided by the length of the third primary (normalization) during the pre-migration period and compared to the period after; p -values based on a Kolmogorov-Smirnov test indicate the significance between the data sets during and after the pre-migration period.

	Number of first-year birds	Complete body moult		Normalized weight		
		Starting pentad	R^2	Pre-migra- tion	Migration	p -value*
<i>Luscinia luscinia</i>	355	44	0.75	0.36 ± 0.05	0.44 ± 0.08	0.001
<i>Sylvia borin</i>	328	45	0.90	0.30 ± 0.11	0.32 ± 0.04	0.007
<i>Sylvia atricapilla</i>	865	47	0.62	0.33 ± 0.07	0.33 ± 0.05	0.400
<i>Sylvia curruca</i>	285	45	0.85	0.22 ± 0.02	0.24 ± 0.03	0.008

* significant differences in bold

General phenology and differences between age classes

The phenologies, except for two *Phylloscopus* species described in more detail below, are presented in Figure 3. In Lesser Whitethroat and Red-breasted Flycatcher, first-year birds migrated through Sfântu Gheorghe significantly earlier than adult birds (Table 2). On the other hand, adults migrated through Sfântu Gheorghe significantly earlier than juveniles in Thrush Nightingale, Garden Warbler, Spotted Flycatcher, Blue Tit and Red-backed Shrike. For the remaining species no significant differences were found, which suggests a simultaneous migration of juveniles and adults.

Phenology and biometry of *Phylloscopus* with characters of subspecies

The migration phenology of the two *Phylloscopus* species discussed is varied (Fig. 5). Birds with characteristics of *P. collybita collybita* migrated on average 5 days earlier than *P. collybita abietinus* (Table 3). Birds with characteristics of *P. trochilus acrecola* and *P. trochilus yakutensis* migrated on the same schedule (KS, p -value = 0.10), but migrated through Sfântu Gheorghe on average 17 days later than birds with characters of the nominal subspecies (Table 3). The phenology of birds with characters of the *P. trochilus* nominal subspecies showed a clear two-peak shape (Fig. 5). We classified this subset of data using sex discrimination criteria (wing length < 67.5 mm female \geq 67.5 mm male) such as those previously described by Didrickson *et al.* (2007) and Tiainen and Hanski (1985), with no consideration of age (minor effect reported from

the authors) and checking the difference between the data sets from each of the two years (KS, p -value = 0.7 – not significant). We established that the first peak of migration was mostly composed of female birds (up to 80%) and the second of males (up to 90%). Therefore females migrated on average 25 days before males (KS, p -value = 0.02).

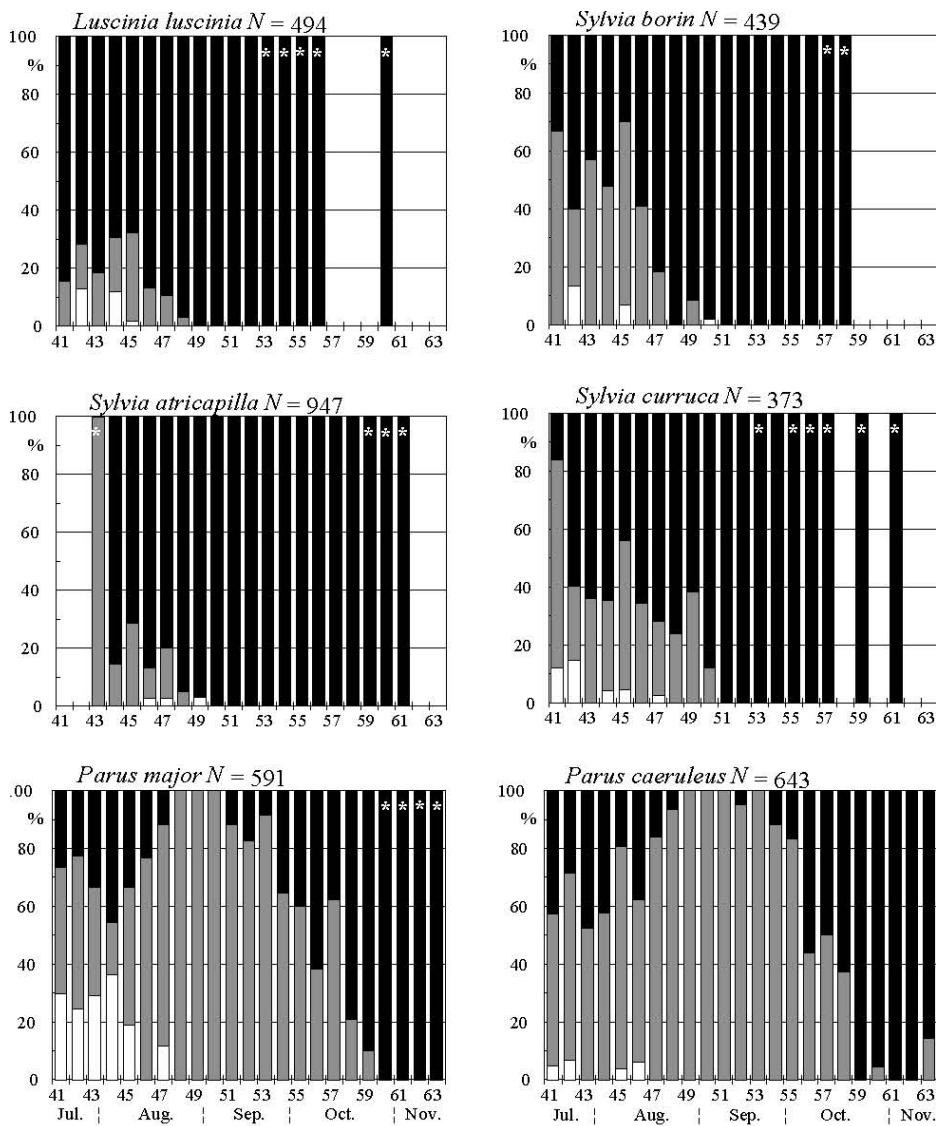


Fig. 4. Percentage of moult scores for first-year birds with a juvenile post-breeding body moult per pentad. Total number of inspected individuals is given as N . Numbers of individuals inspected in each pentad are listed in *Appendix Table A3*. Here * – less than 6 individuals in a pentad. White bars – whole juvenile body plumage, grey bars – moulting body feathers, black bars – entire body plumage post-juvenile.

Table 2

Migratory median of some species recorded at the Sfântu Gheorghe ringing station.
Statistical significance of differences is indicated for the Kolmogorov-Smirnov
median test between first-year and adult migration median time

	First-year		Adult		Significance
	N	Median	N	Median	
Short-distance migrants					
<i>Erithacus rubecula</i>	802	20 Oct.	177	18 Oct.	*
<i>Turdus merula</i>	351	18 Oct.	79	15 Oct.	
<i>Regulus regulus</i>	242	21 Oct.	11	22 Oct.	
<i>Parus caeruleus</i>	273	28 Aug.	40	11 Sep.	*
Sub-Saharan migrants					
<i>Luscinia luscinia</i>	330	15 Aug.	38	19 Aug.	**
<i>Phoenicurus phoenicurus</i>	205	24 Sep.	27	23 Sep.	
<i>Sylvia borin</i>	309	2 Sep.	45	10 Aug.	***
<i>Sylvia atricapilla</i>	795	13 Sep.	40	9 Sep.	
<i>Muscicapa striata</i>	266	10 Sep.	70	25 Aug.	***
<i>Lanius collurio</i>	384	21 Aug.	135	8 Aug.	***
<i>Sylvia curruca</i>	263	16 Aug.	42	23 Aug.	*
Eastern migrant					
<i>Ficedula parva</i>	517	19 Sep.	64	29 Sep.	***

Significance: * – $p < 0.1$, ** – $p < 0.01$, *** – $p < 0.001$

Table 3

Migratory median time of *Phylloscopus* species individuals with characters of different subspecies recorded at the Sfântu Gheorghe ringing station.

Note cautions in the text – p. 32

n	Median	n	Median	Significance
<i>Ph. c. collybita</i>		<i>Ph. c. abietinus</i>		
307	13 Oct.	11	18 Oct.	**
<i>Ph. t. trochilus</i>		<i>Ph. t. acreedula/yakutensis</i>		
706	7 Sep.	36	24 Sep.	***

Significance after Kolmogorov-Smirnov median test: ** – $p < 0.01$, *** – $p < 0.001$

The wing length of *P. collybita abietinus* (63.7 ± 2.6 mm, $n = 16$) was significantly greater (KS, p -value = 0.03) than that of *P. collybita collybita* (61.5 ± 3.6 mm, $n = 460$). Overall, *P. trochilus yakutensis* wing length (71.7 ± 4.7 mm, $n = 6$) was significantly greater (KS, p -value = 0.02) than in the other two groups of individuals with characters of subspecies, with no significant difference observed between the wing length of *P. trochilus trochilus* (67.9 ± 3.1 mm, $n = 788$) and that of *P. trochilus acreedula* (68.6 ± 3.4 mm, $n = 31$; KS, p -value = 0.12). Additionally, no clear patterns of wing length modification were observed during migration for birds with characters of the nominal subspecies. Interestingly, we observed that every adult bird with characters of *P. trochilus yakutensis* presented a suspended moult in its great coverts (limit

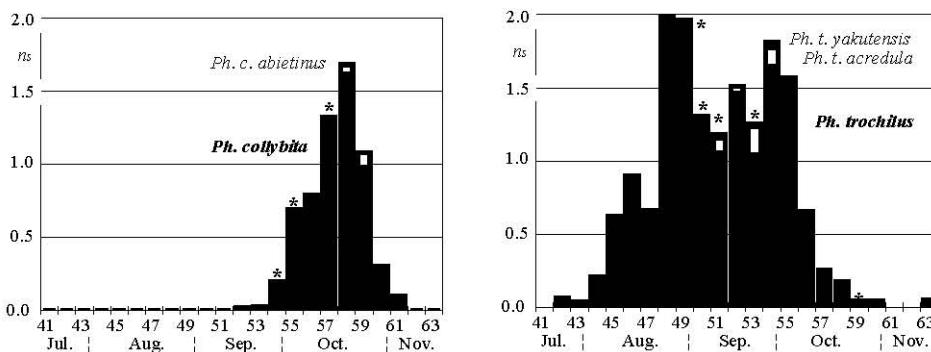


Fig. 5. Migration pattern of birds with characters of subspecies of *Phylloscopus collybita* (*Ph. c. abietinus* – white) and *Phylloscopus trochilus* (*Ph. t. acreedula* – white, *Ph. t. yakutensis* – top black). * – share of rare subspecies not visible on graph due to scale. Low black – individuals not identified to the subspecies level.

at GC 4-5) at our study site. These six birds were clearly identified as adults and had a suspended moult. Thus we expect them to present a special feature of moult that was not observed for the other subspecies. More effort would be required to obtain a clear pattern of moult in adults of this subspecies.

DISCUSSION

Differences in the phenology of different age classes of same species

We found that in species wintering in sub-Saharan Africa, adult birds migrated before first-year birds, with the exception of the Thrush Nightingale and Lesser Whitethroat. This phenology is consistent with long-term observations in the Western Flyway (Hüppop and Hüppop 2004) and the general literature (Newton 2008). The timing difference between adults and first-year birds is probably due to the moult schedule, with adult birds finishing their moult before first-year birds. Therefore, adults are able to migrate earlier than first-year birds (Cristol *et al.* 1999). In contrast, short-distance Mediterranean wintering species, except the European Robin and Blue Tit, showed no observable difference in timing between adults and juveniles. These species do migrate later than long-distance species, and both adults and juveniles moult before departure (Ginn and Melville 1983, Jenni and Winkler 1994). Finally, the eastward migrating species Red-breasted Flycatcher showed a migration pattern in which juveniles left before adults. We suggest that first-year birds of these two species disperse regionally before migration in order to explore new breeding sites for the following year (Newton 2008). This dispersion was exhibited by more first-year birds during the first part of the phenology. Our hypothesis is supported by the fact that first-year eastward migrant species reported in the literature are generally more likely to disperse than species migrating southward, such as in the case of reverse migration (i.e., long distance dispersion in the opposite direction to migration, Thorup 2004).

Migratory routes

For 2007, comparison with the peak of migration (mean) of similar species on Olenevka Crimea (45°25'N, 32°30'E, Diadicheva and Matsievskaya 2000, Diadicheva *et al.* 2005), situated about 240 km north-east of Sfântu Gheorghe, showed an earlier peak as compared to our study site, ranging from 6 to 45 days for long-distance migrating bird species. We suggest that this large range of values between the two sites are species-dependent and reflect the different migrating strategies of each species (flight speed, flying along the coast or across water bodies, time of stopover) but that in general the birds passing through Olenevka and Sfântu Gheorghe followed the same flyway (Newton 2008).

In contrast, the Kalimok Field Station (44°00'N 26°26'E, Zehlindjiev *et al.* 2010), located 260 km southwest of Sfântu Gheorghe, exhibits an earlier peak of migration than Sfântu Gheorghe for some species. We suggest that this discrepancy in timing between locations could be induced by differences in migration strategies between inland and coastal areas. One hypothesis is of a longer stopover, where migrating birds might be able to refuel at coastal sites but not necessarily at inland sites, which might explain the discrepancies between sites. Another hypothesis is that the proportion of local and pre-migratory birds varies between sites. If there are many pre-migratory birds at one site, the apparent median of 'migration' would be earlier than if there are only a few or no pre-migratory birds in the area. This underscores the need for a good description of pre-migratory birds on a local scale to compare study sites.

ACKNOWLEDGEMENTS

This work was supported by the Fondation Dr. Joachim de Giacomi of the Swiss Academy of Science, Nos Oiseaux, The Swiss Association for the Protection of Birds SVS/BirdLife Switzerland, Société vaudoise des Sciences naturelles (SVSN), Cercle ornithologique de Fribourg (COF), Centre d'Etude et de Protection des Oiseaux, Bienne et environs (CEPOBE), Der Europäische Tierschutzstiftung, Naturfreunde Schweiz, le Cercle Ornithologique d'Yverdon (COSNY), Rocha International, the foundation of Les Granettes and BNF – Swiss qualification program, no. 1332.1.

The authors would like to acknowledge Marie Monney, Valère Martin, Alexis Pochelon and Frédéric Vaidie for their significant help during field work and for recording data; Dr. Mircea Gogu-Bogdan from the Romanian Ornithological Center, Academy of Agricultural and Forestry Sciences, and Bucurlescu Bogdan and Adnana from Sfântu Gheorghe for their technical support during the project; Dr. Przemysław Busse and Mike Reed for providing unpublished data from ringing stations; Jacques Laesser, Lukas Jenni, Przemysław Busse and the anonymous reviewers for their comments on an earlier draft of the manuscript; Maiann Suhner and Noemi Helfenstein for translating Russian and Hungarian literature; And Mike Bowman for significantly improving the language of this manuscript. Finally, we would like to thank the many young ornithologists from several countries who helped and participated in the fieldwork.

REFERENCES

Bairlein F. 2001. *Results of bird ringing in the study of migration routes and behaviour*. Ardea 89: 7-19.

Bairlein F. 2003. *The study of bird migrations – some future perspectives*. Bird Study 50: 243-253.

Bairlein F., Jenni L., Kaiser A., Karlsson L., van Noordwijk A., Peach W., Pilastro A., Spina F., Walinder G. (eds). 1995. *Manual of Field Methods, ESF-Network Field instruction*. European Science Foundation, Wilhelmshaven, Germany.

Berthold P. 1973. *Proposals for the standardization of the presentation of data of annual events, especially of migration data*. Auspicio 5: 49-59.

Bønløkke J., Madsen J. J., Thorup K., Pedersen K. T., Bjerrum M., Rahbek C. (eds). 2006. *The Danish Bird Migration Atlas. Rhodos, Humlebæk, Denmark*. (in Dutch).

Both C., Bouwhuis S., Lessells C., Visser M. 2006. *Climate change and population declines in a long-distance migratory bird*. Nature 441: 81-83.

Bruderer B., Liechti F. 1999. *Bird migration across the Mediterranean*. In: (eds). Proc. 22nd Int. Ornithol. Congr. BirdLife South Africa, Durban. pp. 1983-1999.

Busse P. 2001. *European Passerine Migration System – What is known and what is lacking*. Ring 23: 2-36.

Busse P., Zaniewicz G., Cofta T. 2014. *Evolution of the western Palaearctic Passerine migration pattern presentation style*. The Ring 36: 3-21.

Clement P., Helbig A.J., Small B. 1998. *Taxonomy and identification of chiffchaffs in the Western Palearctic*. British Bird 91: 361-376.

Cramp (eds). 1992. *Handbook of the birds of Europe, the middle east and north Africa*. Oxford, New-York.

Cristol D.C., Baker M.B., Carbone C. 1999. *Differential migration revisited: latitudinal segregation by age and sex class*. Current Ornithology 15: 33-87.

Csörgő T., Kelemen A.M. 2000. *Autumn migration of Paddyfield Warbler Acrocephalus agricola in the Danube delta region*. Ornis Hungarica 10: 137-140. (in Hungarian).

Demongin L. (eds). 2013. *Guide d'Identification des oiseaux en main. Mortsel (B)*. (in French).

Dereliev S.G. 2006. *The Red-breasted Goose Branta ruficollis in the new millennium: a thriving species or a species on the brink of extinction?* In: Boere G. C., Galbraith C. A., Stroud D. A. (eds). *Waterbirds around the world: A global overview of the conservation, management and research of the world's waterbird flyways*. The Stationery Office, Edinburgh, UK. pp. 619-623.

Diadicheva E., Matsievskaya N. 2000. *Migration routes of waders using stopover sites in the Azov-Black Sea region, Ukraine*. Die Vogelwarte 40: 161-178.

Diadicheva E.A., Popcnko V.M., Koshelev A.I. 2005. *Passerines of Molochnyy Liman in the period of seasonal migrations*. Branta 8: 133-159. (in Russian).

Didrickson Ö.K., Didrickson J., Busse P. 2007. *Autumn migration dynamics, body mass, fat load and stopover behaviour of the Willow Warbler Phylloscopus trochilus at Manyas Kusçenneti National Park (NW Turkey)*. Ring 29: 67-89.

Fiedler W. 1998. *Trends in ringing numbers of Redstarts (Phoenicurus phoenicurus) and Wrynecks (Jynx torquilla) in Southern Germany*. Die Vogelwarte 39: 233-241. (in German).

Ginn H. B., Melville D. S. (eds). 1983. *Moult in birds*. British Trust for Ornithology, Tring, Herts (UK).

Goriup P., Baboianu G., Cherichko J. 2007. *The Danube Delta: Europe's remarkable wetland*. British Birds 100: 194-213.

Hanski J.K., Tiainen J. 1991. *Morphological variation in sympatric and allopatric populations of European Willow Warblers and Chiffchaffs*. Ornis Fennica 68: 1-16.

Heath M.F., Evans M.I., Hoccom D.G., Payne A.J., Peet N.B. (Eds). 2000. *Important Bird areas in Europe: priority sites for conservation*. Birdlife International, Wageningen, The Netherlands.

Hüppop K., Hüppop O. 2004. *An atlas of bird ringing at the island of Helgoland. Part 2: Phenology in the trapping garden from 1961 to 2000*. Vogelwarte 42: 285-343. (in German).

Ion C. 2009. *Passerines Migration along the Habitats from the Danube Delta Biosphere Reservation*. Analele Stiintifice ale Universitatii "Al.I. Cuza" Iasi, s. Biologie animala LV: 173-185.

Ion P., Viorel P. 2005. *The Composition of the Avis fauna on the Lupilo Ground in the Migratory Period*. Analele Stiintifice ale Universitatii "Al.I. Cuza" Iasi, s. Biologie animala LI: 205-216.

IUCN, UNEP 2014. World Database on Protected Areas (WDPA). www.protectedplanet.net. accessed 28 June 2014.

Jenni L. 1984. *Pattern of autumn migration, based on bird caught at Col de Bretolet, with special reference to premigration movements*. Ornithologische Beobachter 81: 183-213. (in German).

Jenni L., Kéry M. 2003. *Timing of autumn bird migration under climate change: advances in long-distance migrants, delays in short-distance migrants*. Proc. R. Soc. Lond. B. 270: 1467-1471.

Jenni L., Naef-Daenzer B. 1986. *Frequencies of migrating birds caught on an alpine pass in comparison with numbers of breeding birds in the area of origin*. Ornithologische Beobachter 83: 95-110. (in German).

Jenni L., Winkler R. (eds). 1994. *Moult and ageing of European passerines*. Academic Press, London.

Kaiser A. 1993. *A New Multi-Category Classification of Subcutaneous Fat Deposits of Songbirds*. Journal of Field Ornithology 64: 246-255.

Kalocsa B., Tamas E.A., Marinov E.M. 2007. *Preliminary evaluation of the data gathered during bird ringing at the Grindul Lupilor Ornithological Monitoring Centre, in August 2004, 2005 and 2006*. Scientific Annals of the Danube Delta Institute for Research and Development (DDNI) 13: 35-44.

Kalocsa B., Tamas E.A., Reed M., Marinov E.M. 2010. *Evaluation of bird ringing data at the Grindul Lupilor Ornithological Monitoring Centre from 2004 to 2009*. Scientific Annals of the Danube Delta Institute for Research and Development (DDNI) 16: 7-18.

Liechti F., Peter D., Lardelli R., Bruderer B. 1996. *The Alps, an obstacle for nocturnal broad front migration – a survey based on moon-watching*. Journal of Ornithology 137: 337-356. (in German).

Maumary L., Vallotton L., Knaus P. (eds). 2007. *Les oiseaux de Suisse*. Station ornithologique Suisse et Nos Oiseaux, Montmollin. (in French).

Newton I. 2008. *The Migration ecology of Birds*. Elsevier, Cambridge, UK.

Nowakowski J.K., Chruściel J. 2004. *Speed of autumn migration of the Blue Tit Parus caeruleus along the eastern and southern Baltic coast*. Ring 26: 3-12.

Nowakowski J.K., Vahatalo A.V. 2003. *Is the Great Tit Parus major an irruptive migrant in North-east Europe?* Ardea 91: 231-243.

Schaub M., Jenni L. 2000. *Fuel deposition of three passerine bird species along the migration route*. Oecologia 122: 306-317.

Schaub M., Liechti F., Jenni L. 2004. *Departure of migrating European robins Erithacus rubecula from a stopover site in relation to wind and rain*. Animal Behaviour 67: 229-237.

Schmitz M. 1998. *Regular spring passage of Citrine Wagtail Motacilla citreola along the western Balck Sea coast*. Die Vogelwelt 6: 323-327. (in German).

Schmitz M., Legge H. 2003. *Notes on the spring migration and breeding distribution of some passerine species in the Razim-Sinoie lagoon system and the Romanian Dobrogea*. Limicola 17: 49-76. (in German).

Schmitz M., Legge H., Sudfeldt C. 2001. *Spring migration and breeding of waders and waterbirds in the Razim-Sinole lagoon system, E-Romania*. Vogelwelt 22: 295-328. (in German).

Sokolov L., Markovets M., Morozov Y. 1999. *Long-term dynamics of the mean date of autumn migration in passerines on the Courish Spit of the Baltic Sea*. Avian Ecology and Behaviour 2: 1-18.

Spina F., Volponi S. (Eds). 2009. *Italian Bird Migration Atlas*. Vol. 2: Passeriform. ISPRA – MATTM, Roma. (in Italian).

Stöcker B. 1998. *Zusammenarbeit in der Beringung von Zugvögeln: Internationales Beringscamp in Histria*. Der Falke 45: 140-143.

Svensson L. 1992. *Identification Guide to European Passerines*. BTO, Stockholm.

Tamas P., Peter L.P. 1998. *The 1996 and 1997 Grindul Chituc Ornithological Camps*. Milvus 98: 24-26.

Thorup K. 2004. *Reverse migration as a cause of vagrancy: Capsule Reverse migration in autumn does not occur to the same degree in all species of migrants, but is related to migratory direction*. Bird Study 51: 228-238.

Tiainen J., Hanski J.K. 1985. *Wing shape variation of Finnish and central European Willow Warbler Phylloscopus trochilus and Chiffchaffs Ph. collybita*. Ibis 127: 365-371.

Wernham C., Toms M.P., Marchant J. H., Clark J.A., Siriwardena G.M., Baillie S.R. (eds). 2002. *The migration atlas movements of the birds of Britain and Ireland*. T & A D Poyser, London.

Zehtindjiev P., Ilieva M., Bogdanova M.I. 2010. *Temporal Dynamics of Passerine Bird Migration in the Eastern Part of the Balkan Peninsula*. Ardeola 57: 375-386.

Zehtindjiev P., Liechti F. 2003. *A quantitative estimate of the spatial and temporal distribution of nocturnal bird migration in south-eastern Europe – a coordinated moon-watching study*. Avian Science 3: 37-45.

Appendix Table A1
Catching dynamics of species with moderate numbers of individuals caught. Numbers given indicate normalized
catching results per pentad. Top results for species given in bold.

	N	Number of pentad																						
		41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
<i>Accipiter nisus</i>	44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.06	0.05	0.02	0.10	0.07	0.24	0.15	0.10
<i>Accipiter brevipes</i>	10	0.00	0.03	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Caprimulgus europaeus</i>	16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Aleodin atthis</i>	22	0.05	0.06	0.07	0.03	0.10	0.00	0.06	0.08	0.06	0.02	0.02	0.03	0.00	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Coracina garnieri</i>	24	0.00	0.35	0.20	0.06	0.21	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
<i>Picus canus</i>	18	0.05	0.03	0.10	0.09	0.00	0.04	0.00	0.00	0.03	0.07	0.00	0.02	0.05	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Dendrocopos major</i>	13	0.14	0.03	0.07	0.00	0.00	0.04	0.02	0.06	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Arthus trivialis</i>	13	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.08	0.02	0.05	0.04	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Trochocercus troglodytes</i>	50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.11	0.23	0.20	0.16	0.04
<i>Phoenicella modesta</i>	17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.07	0.12	0.04	0.07
<i>Phoenicurus ochruros</i>	34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.09	0.10	0.03
<i>Sarcocela rubra</i>	34	0.00	0.00	0.00	0.03	0.03	0.08	0.02	0.06	0.14	0.19	0.02	0.03	0.02	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Turdus iliacus</i>	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Locustella naevia</i>	10	0.00	0.03	0.03	0.00	0.03	0.00	0.00	0.06	0.05	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
<i>Acrocephalus schoenobaenus</i>	17	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.08	0.02	0.09	0.00	0.05	0.02	0.00	0.00	0.06	0.02	0.02	0.00	0.00	0.11	0.23	0.20
<i>Acrocephalus palustris</i>	33	0.23	0.19	0.17	0.42	0.55	0.73	0.22	0.03	0.11	0.04	0.04	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Acrocephalus scirpaceus</i>	26	0.00	0.03	0.13	0.06	0.17	0.04	0.05	0.00	0.11	0.02	0.00	0.00	0.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Acrocephalus arundinaceus</i>	31	0.00	0.06	0.03	0.06	0.14	0.33	0.20	0.06	0.05	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Sylvia nisoria</i>	39	0.05	0.06	0.10	0.15	0.21	0.49	0.15	0.03	0.03	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Sylvia communis</i>	91	0.00	0.00	0.03	0.15	0.14	0.53	0.27	0.29	0.49	0.11	0.07	0.13	0.11	0.13	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Phylloscopus subalpinus</i>	48	0.00	0.10	0.10	0.18	0.14	0.12	0.07	0.03	0.11	0.04	0.05	0.15	0.11	0.05	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Ficedula albicollis</i>	54	0.00	0.03	0.03	0.21	0.24	0.69	0.29	0.09	0.11	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Ficedula hypoleuca</i>	29	0.00	0.00	0.03	0.09	0.03	0.08	0.05	0.15	0.08	0.02	0.00	0.10	0.03	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Oreothraupis callipeplus</i>	110	0.09	0.16	0.20	0.21	0.45	0.04	0.22	0.09	0.05	0.37	0.00	0.29	0.08	0.03	0.04	0.00	0.02	0.21	0.00	0.18	0.00	0.00	0.00
<i>Oriolus oriolus</i>	39	0.27	0.16	0.20	0.03	0.14	0.04	0.07	0.09	0.08	0.11	0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Passer montanus</i>	34	0.00	0.00	0.45	0.03	0.24	0.20	0.00	0.00	0.00	0.02	0.00	0.00	0.05	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Fringilla coelebs</i>	47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>Carduelis spinus</i>	29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.16	0.04	0.00	0.00	0.02	0.02	0.04	0.03	0.00	0.22

Appendix Table A2

Phenology dates for species ringed less than ten times at Sfântu Gheorghe, 2007-2008

	<i>n</i>	Earliest	(Single)	Latest
<i>Ixobrychus minutus</i>	1	—	19 Sep.	—
<i>Anas platyrhynchos</i>	1	—	18 Sep.	—
<i>Circus cyaneus</i>	1	—	24 Oct.	—
<i>Buteo buteo</i>	2	2 Oct.		30 Oct.
<i>Falco tinnunculus</i>	3	15 Aug.		15 Sep.
<i>Falco vespertinus</i>	4	23 Jul.		1 Aug.
<i>Scolopax rusticola</i>	5	17 Oct.		31 Oct.
<i>Tringa ochropus</i>	1	—	2 Aug.	—
<i>Asio otus</i>	8	22 Jul.		30 Oct.
<i>Merops apiaster</i>	1	—	1 Aug.	—
<i>Upupa epops</i>	6	22 Jul.		17 Aug.
<i>Jynx torquilla</i>	4	18 Aug.		10 Sep.
<i>Dryocopus martius</i>	8	23 Jul.		25 Oct.
<i>Dendrocopos syriacus</i>	1	—	9 Aug.	—
<i>Dendrocopos minor</i>	4	26 Jul.		7 Sep.
<i>Hirundo rustica</i>	8	10 Sep.		25 Sep.
<i>Delichon urbica</i>	3	6 Sep.		7 Sep.
<i>Anthus campestris</i>	1	—	10 Sep.	—
<i>Motacilla flava</i>	2	24 Aug.		27 Aug.
<i>Motacilla alba</i>	6	9 Aug.		07 Sep.
<i>Luscinia svecica</i>	1	—	18 Sep.	—
<i>Saxicola torquata</i>	8	24 Sep.		3 Nov.
<i>Oenanthe oenanthe</i>	1	—	9 Sep.	—
<i>Turdus pilaris</i>	2	24 Oct.		27 Oct.
<i>Turdus viscivorus</i>	3	13 Oct.		13 Oct.
<i>Locustella lusciniooides</i>	7	28 Jul.		26 Oct.
<i>Acrocephalus sp.</i>	4	13 Aug.		6 Sep.
<i>Phylloscopus fuscatus</i>	1	—	30 Sep.	—
<i>Regulus ignicapillus</i>	5	15 Oct.		3 Nov.
<i>Parus ater</i>	2	19 Oct.		19 Oct.
<i>Certhia familiaris</i>	9	14 Sep.		7 Nov.
<i>Pica pica</i>	7	26 Jul.		31 Oct.
<i>Nucifraga caryocatactes macrorhynchos</i>	1	—	9 Oct.	—
<i>Corvus corone cornix</i>	1	—	30 Jul.	—
<i>Sturnus vulgaris</i>	1	—	31 Jul.	—
<i>Fringilla montifringilla</i>	1	—	2 Oct.	—
<i>Carduelis chloris</i>	4	1 Nov.		1 Nov.
<i>Carduelis carduelis</i>	8	3 Aug.		24 Sep.
<i>Loxia curvirostra</i>	2	14 Oct.		14 Oct.
<i>Pyrrhula pyrrhula</i>	1	—	4 Nov.	—
<i>Coccothraustes coccothraustes</i>	3	16 Oct.		1 Nov.

Appendix Table A3
Numbers of individuals inspected for the moult stage in successive pentads

Total N/ no of pentads	1	2	3	4	5	6	7	8	9	10	11	12	13
<i>Luscinia luscinia</i>	494	32	39	38	59	62	91	56	32	19	35	13	7
<i>Sylvia borin</i>	439	6	30	21	21	30	27	22	23	24	54	40	38
<i>Sylvia atricapilla</i>	947	1	7	7	38	35	78	69	91	119	95	78	101
<i>Sylvia curruca</i>	373	25	47	36	48	43	26	39	21	13	25	13	14
<i>Parus major</i>	591	30	49	24	22	21	13	17	19	26	30	60	23
<i>Parus caeruleus</i>	643	21	74	76	26	16	25	31	30	65	44	41	17