PHENOLOGY OF PASSERINE BIRD MIGRATION IN THE DANUBE DELTA, ROMANIA

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ABSTRACT

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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 *Phyloscopus collybita*, which have not previously been reported.

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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 (Zehtindjiev 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 km^2 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 ± 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).
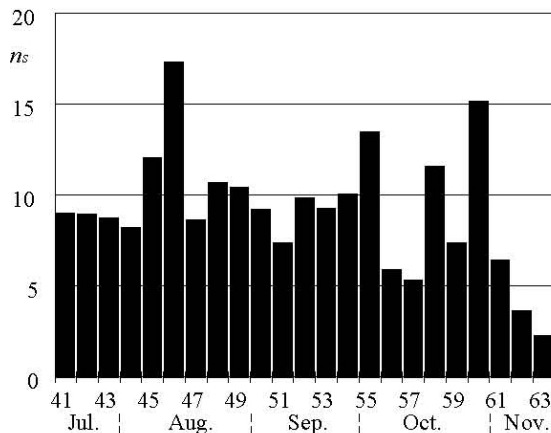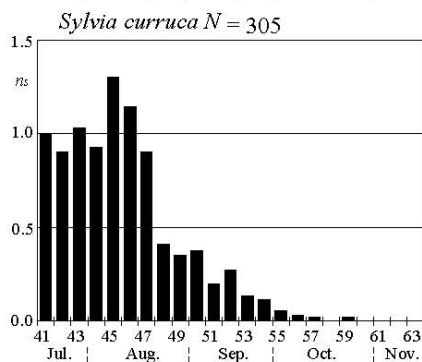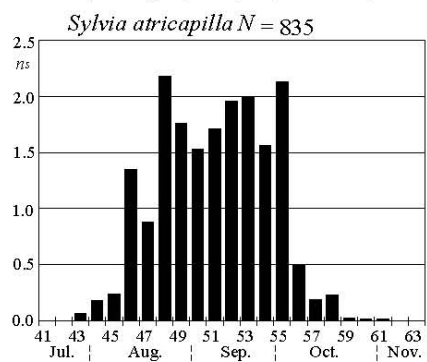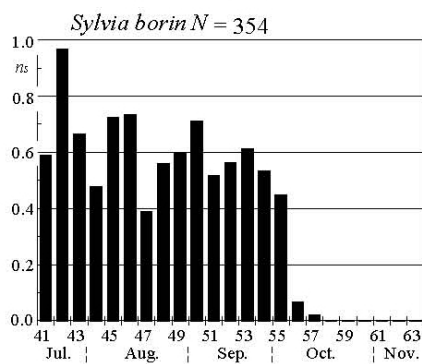

Fig. 2. General pattern of catching dynamics at Sfântu Gheorghe, 2007-2008. n_s – numbers of ringed birds were summed up by pentads and normalized (divided) by daily catching activity.

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.
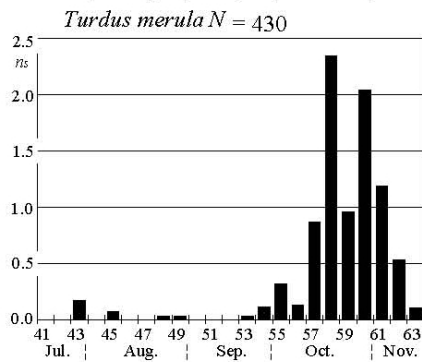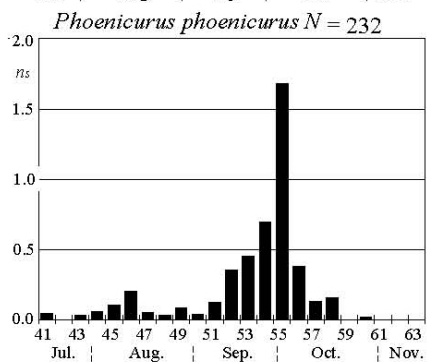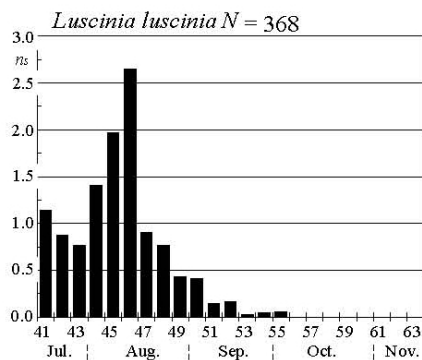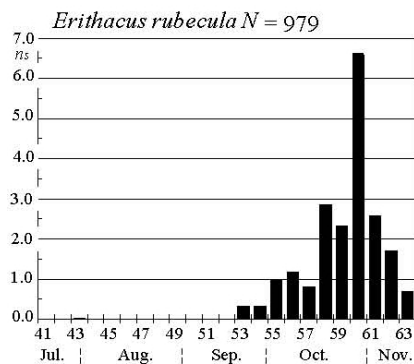
Among these breeding species, incomplete first-year body moult (i.e. complete juvenile plumage or active post-juvenile moult) meant that these were birds in their pre-migration period. This was observed in Thrush Nightingale, Garden Warbler, Eurasian Blackcap and Lesser Whitethroat at the beginning of 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

Erithacus rubecula N = 979

Luscinia luscinia N = 368

Phoenicurus phoenicurus N = 232

Turdus merula N = 430

Turdus philomelos N = 269

Sylvia borin N = 354

Sylvia atricapilla N = 835

Sylvia curruca N = 305
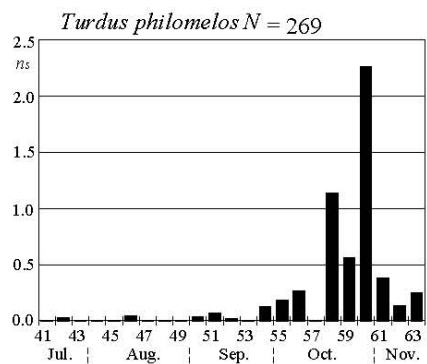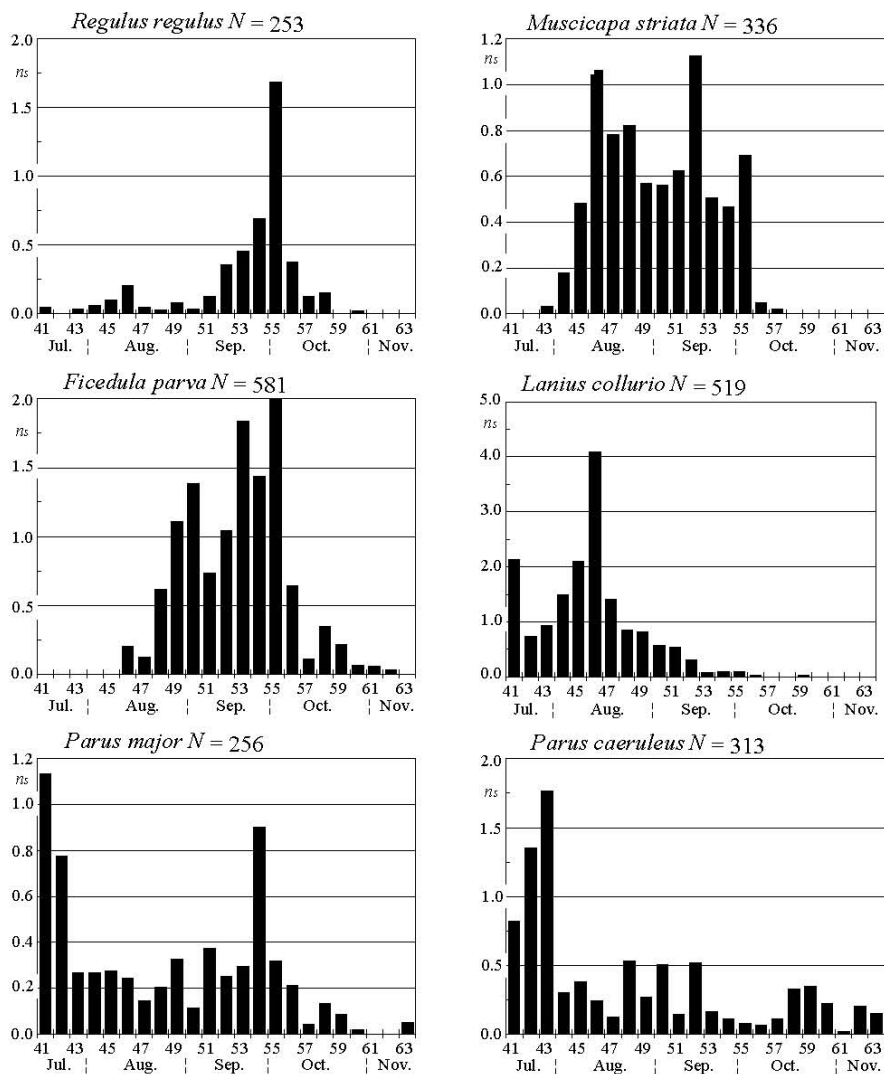
Fig. 3. Phenology of the 14 most numerous species at Sfântu Gheorghe, 2007-08. n_s – numbers of ringed birds were summed up by pentads and normalized (divided) by daily catching activity.

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-migration	Migration	*p*-value*
Luscinia luscinia	355	44	0.75	0.36 ± 0.05	0.44 ± 0.08	**0.001**
Sylvia borin	328	45	0.90	0.30 ± 0.11	0.32 ± 0.04	**0.007**
Sylvia atricapilla	865	47	0.62	0.33 ± 0.07	0.33 ± 0.05	0.400
Sylvia curruca	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 acredula* 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 ≥ 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).

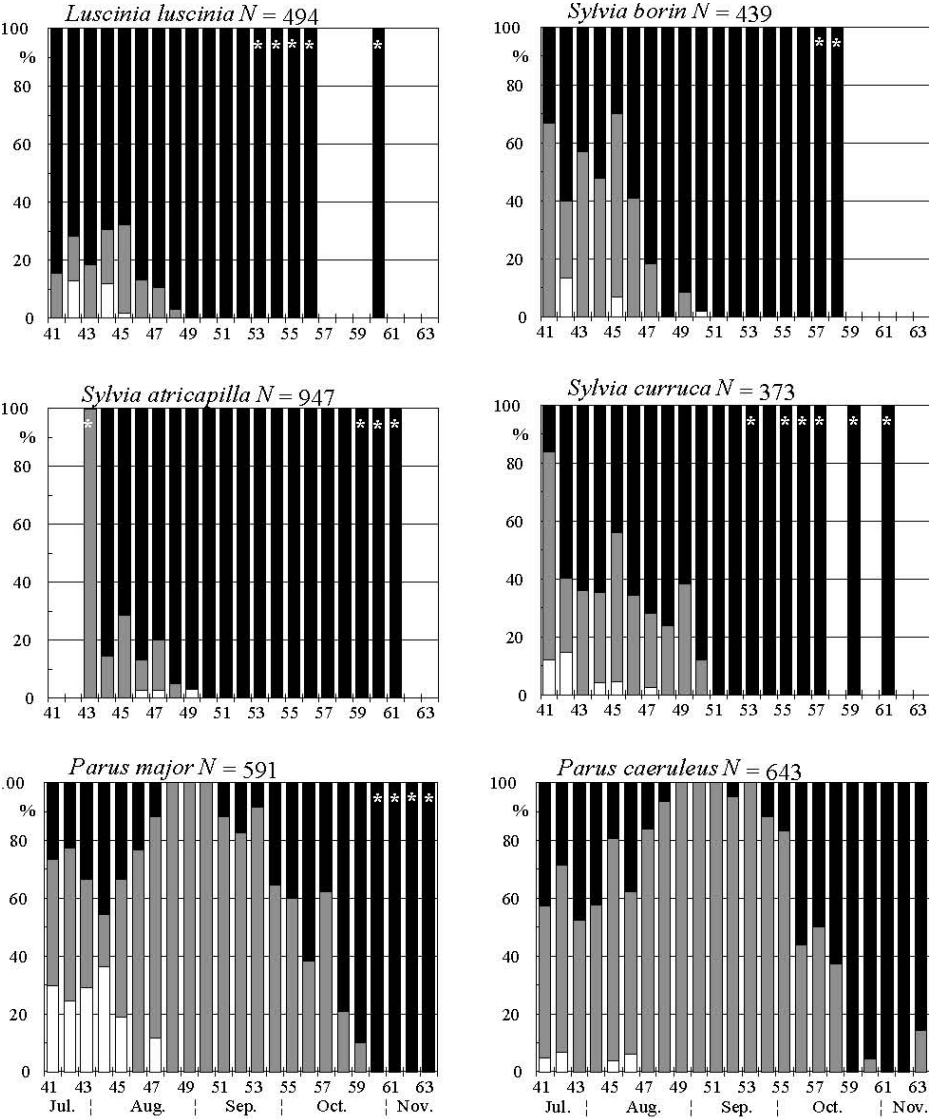Fig. 4. Percentage of moult scores for first-year birds with a juvenile post-breeding body moult per pentad. Total number of inspected individuals is given as *N*. Numbers of individuals inspected in each pentad are listed in *Appendix Table A3*. Here * – less than 6 individuals in a pentad. White bars – 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					
Erithacus rubecula	802	20 Oct.	177	18 Oct.	*
Turdus merula	351	18 Oct.	79	15 Oct.	
Regulus regulus	242	21 Oct.	11	22 Oct.	
Parus caeruleus	273	28 Aug.	40	11 Sep.	*
Sub-Saharan migrants					
Luscinia luscinia	330	15 Aug.	38	19 Aug.	**
Phoenicurus phoenicurus	205	24 Sep.	27	23 Sep.	
Sylvia borin	309	2 Sep.	45	10 Aug.	***
Sylvia atricapilla	795	13 Sep.	40	9 Sep.	
Muscicapa striata	266	10 Sep.	70	25 Aug.	***
Lanius collurio	384	21 Aug.	135	8 Aug.	***
Sylvia curruca	263	16 Aug.	42	23 Aug.	*
Eastern migrant					
Ficedula parva	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
Ph. c. collybita		*Ph. c. abietinus*		
307	13 Oct.	11	18 Oct.	**
Ph. t. trochilus		*Ph. t. acredula/yakutensis*		
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 acredula* (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
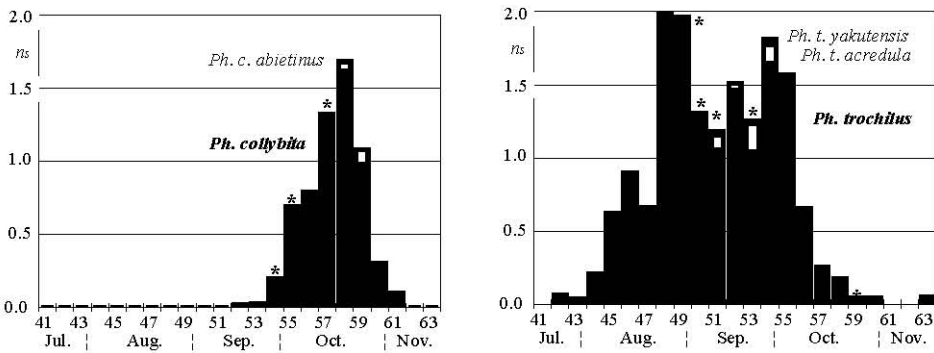
Fig. 5. Migration pattern of birds with characters of subspecies of *Phylloscopus collybita* (*Ph. c. abietinus* – white) and *Phylloscopus trochilus* (*Ph. t. acredula* – white, *Ph.t. yakutensis* – top black). * – share of rare subspecies not visible on graph due to scale. Low black – individuals not 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, Zehtindjiev *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

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Appendix Table A1

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

	N	Number of pentade																					
		41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
Accipiter nisus	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	0.08	0.06	0.05	0.02	**0.10**	0.07	**0.24**	**0.15**	**0.10**	**0.10**
Accipiter brevipes	10	0.00	0.03	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	**0.04**	**0.10**	**0.03**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Caprimulgus europaeus	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
Alcedo atthis	22	0.05	0.06	0.07	0.03	**0.10**	0.00	0.00	0.06	**0.08**	0.06	0.02	0.02	0.03	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Coracias garrulus	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	0.00
Picus canus	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	0.02	0.00	0.00	0.00	0.00	0.00
Dendrocopos major	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	0.02	0.00	0.00	0.00	0.00	0.00
Anthus trivialis	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	0.07	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00
Troglodytes troglodytes	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	0.07	0.00	0.11	**0.23**	**0.20**	0.16	0.04	**0.23**	**0.15**
Prunella modularis	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	0.02	0.04	0.07	0.12	0.04	0.07	0.05
Phoenicurus ochruros	34	0.00	0.00	0.00	0.03	0.03	0.08	0.02	0.03	0.00	0.00	0.00	0.00	0.03	0.02	0.07	0.00	0.02	0.04	0.09	**0.40**	**0.10**	0.03	0.00
Saxicola rubetra	34	0.00	0.00	0.00	0.03	0.03	0.08	0.02	0.06	**0.14**	**0.19**	**0.09**	0.02	0.03	0.02	0.07	0.00	0.02	0.00	0.02	0.00	0.00	0.00	0.00
Turdus iliacus	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	0.02	0.00	0.02	**0.14**	**0.12**	**0.17**	0.00
Locustella fluviatilis	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	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acrocephalus schoenobaenus	17	0.00	0.00	0.00	0.00	0.07	**0.08**	0.02	**0.09**	0.00	0.00	0.05	0.02	0.00	0.00	0.06	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Acrocephalus palustris	83	0.23	0.19	0.17	**0.42**	**0.55**	**0.73**	0.22	0.03	0.11	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	0.00
Acrocephalus scirpaceus	26	0.00	0.03	**0.13**	0.06	**0.17**	0.04	0.05	0.00	**0.11**	0.02	**0.09**	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acrocephalus arundinaceus	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
Sylvia nisoria	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
Sylvia communis	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
Phylloscopus sibilatrix	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
Ficedula albicollis	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
Ficedula hypoleuca	29	0.00	0.00	0.03	**0.09**	0.03	0.08	0.05	**0.15**	0.08	0.02	**0.10**	**0.10**	0.03	**0.08**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aegithalos caudatus	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
Oriolus oriolus	39	**0.27**	**0.16**	**0.20**	0.03	0.14	0.04	0.07	0.09	0.08	0.11	0.02	0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Passer montanus	34	0.00	**0.45**	0.03	0.09	**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	0.02	0.00	0.00	0.00	0.00	0.00
Fringilla coelebs	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
Carduelis spinus	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	0.08	0.00	**0.20**

Appendix Table A2
Phenology dates for species ringed less than ten times at Sfântu Gheorghe, 2007-2008

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

Appendix Table A3

Numbers of individuals inspected for the moult stage in successive pentads

Total *N* no of pentade:	*N*	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
Luscinia luscinia	494	32	39	38	59	62	91	56	32	19	35	13	7	1	5	3	1				1			
Sylvia borin	439	6	30	21	21	30	27	22	23	24	54	40	38	26	37	29	7	2	2					
Sylvia atricapilla	947			1	7	7	38	35	78	69	91	119	95	78	101	133	52	15	21	3	3	1		
Sylvia curruca	373	25	47	36	48	43	26	39	21	13	25	13	14	4	9	4	2	2		1		1		
Parus major	591	30	49	24	22	21	13	17	19	26	30	60	23	35	96	30	34	16	24	10	3	3	3	3
Parus caeruleus	643	21	74	76	26	26	16	25	31	30	65	44	41	17	17	6	25	8	24	18	22	14	10	7