AGE AND SEASON RELATED DIFFERENCES IN MIGRATION DYNAMICS AND BODY CONDITIONS OF THREE ACROCEPHALUS SPECIES IN THEIR EAST EUROPEAN MIGRATION ROUTE

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Abstract. Although Türkiye, located on the Eastern European migration route, is an important passage site for many bird species, passerine migration has been little studied. This study will extend our knowledge on the migration phenology of *Acrocephalus* species. The aim of the study is to investigate the spring and autumn migration dynamics and biometrics in relation to age and season of *Acrocephalus scirpaceus*, *Acrocephalus arundinaceus*, *Acrocephalus palustris* passing the Kızılırmak Delta. 18 years of ringing data from Cernek Bird Ringing Station has been used for all three *Acrocephalus* species. Methodology is based on the capture and ringing of passerines. More birds were ringed in autumn than in spring for all three species. In spring adult mean arrival date is earlier than that of first-year birds, while there was no difference for autumn season. Long-term studies should be conducted in Türkiye, to better understand the migration strategies of various species in terms of age, sex and season.
Keywords: *body mass, migration strategy, passerine, biometrics, bird ringing*

Introduction

Millions of migratory birds migrate annually to take advantage of more than one seasonally changing environment to survive and reproduce by travelling thousands of kilometers between their breeding and wintering grounds in spring and autumn (Rappole, 2013). Migration biology of many bird species differs with populations, or with age and sex groups within the same population. These differences are observed in behaviors such as migration timing, distance, duration, and/or usage of various habitats as stopover and non-breeding sites (Newton, 2011; Maggini et al., 2020). Besides, spring and autumn migration duration differ within species regarding both the speed of migration and stopover duration in stopover areas (Tøttrup et al., 2012; Nillson et al., 2013). It has been revealed that the duration of migration in the case of some passerine species is shorter in the spring than in the autumn whereas in the case of non-passerine species autumn migration is shorter than spring migration (Kölzsch et al., 2016; Carneiro et al., 2019). Migratory bird numbers are declining due to lower food availability in northern latitudes, higher pathogen and parasite pressure and increased predation rates (Vickery et al., 2014; Kubelka et al., 2022). Therefore, the importance of understanding migration biology and phenology and conducting more detailed research is increasing.

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Türkiye is on the Eurasian–African migration route of many passerines and non-passerines crossing the country. Soaring birds funnel at Bosporus, Çoruh valley and in the South at Iskenderun Bay, while passerines use many sites during their broad front migration (Zalles and Bildstein, 2000). Türkiye is an important staging area while passerines passing from Europe to Africa and West Asia (Kirwan et al., 2008). Some of the species have site fidelity at stopover sites during their journeys. Therefore, it is important to identify the important stopover sites to take conservation measures if needed. Eurasian Reed Warbler = *Acrocephalus scirpaceus* (RW), Marsh Warbler = *Acrocephalus palustris* (MW), Great Reed Warbler = *Acrocephalus arundinaceus* (GRW) are long distance migrants. They breed abundantly in reed beds in temperate latitudes from Europe to Central Asia and winter in sub-Saharan Africa (Kennerley and Pearson, 2010). All three species are summer visitors and common passage migrants in Türkiye (Kirwan et al., 2008). Based on citizen science data, RWs and GRWs were recorded in spring passage from early March until late May in Türkiye, whereas MWs were recorded later from April to early June. Autumn passage in Türkiye occurs from early August to mid-October for all three species (Kirwan et al., 2008). However, there is no comprehensive study about migration dynamics of *Acrocephalus* species to demonstrate the migration phenology of those species in Türkiye. In this study, we aimed to reveal RWs, MWs and GRWs migration timing and dynamics between 2002-2019 passing the Kızılırmak Delta, Türkiye with regard to different seasons and ages. Besides, wing length and fuel loads of birds were investigated to better understand the migration biology of east European population migrating through Kızılırmak Delta.

Materials and methods

Study area and ringing activities

The study was carried out between 2002-2019 spring and autumn migration seasons in a coastal wetland at the southern edge of the Black Sea; the Kızılırmak Delta (41°38’ N, 36°05’E) in Samsun, Türkiye. It covers an area of approximately 45,000 ha with its wide variety of habitat types such as sea, river, lakes, reed beds, marshes, meadows, pastures, flooded forest, dunes and agricultural areas (Barış et al., 2005). All the birds were trapped using 39 mist-nets (19 7-meter-long and 20 12-meter-long mist-nets) (*Fig. 1; Table A1* in the *Appendix*) which were placed in scrub, herbaceous, low tree habitat (*Hippophae* sp., *Laurus* sp. *Rubus* sp.) (*Fig. 2; Table A2*) located between the Black Sea and the Cernek Lake. The nets were controlled every hour from sunrise to sunset, and in rainy days every half hour. Further details regarding the study area (Cernek Bird Ringing Station) and the applied method can be found in Barış et al. (2005). All trapped birds were identified using morphological characters, and the Walinder method was used to distinguish RWs from MWs (Walinder et al., 1988), besides some morphological characteristics. After species identification, birds were ringed with standard aluminum rings (diameter 2.6 mm). Two age groups (adult and first-year birds) was used, second calendar year birds in spring are also mentioned as the first-year birds). In autumn plumage characters and iris color were used for ageing. In spring plumage characters not reliable, therefore only color of soft parts (iris and leg color) has been used (Svensson, 2023). Adults have reddish-brown iris color, while first-year birds have dark grey iris. In autumn first-year birds have fresh plumage, while adults have worn plumage (Baker, 1997; Svensson, 2023). Birds without clear

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identification features were not aged and recorded as “N” (not aged). Birds weighed with a digital scale to the nearest 0.1 g. Flattened maximum wing chord and tail length were measured to the nearest millimeter. Assessment of the fat score was done according to Kaiser (1993).

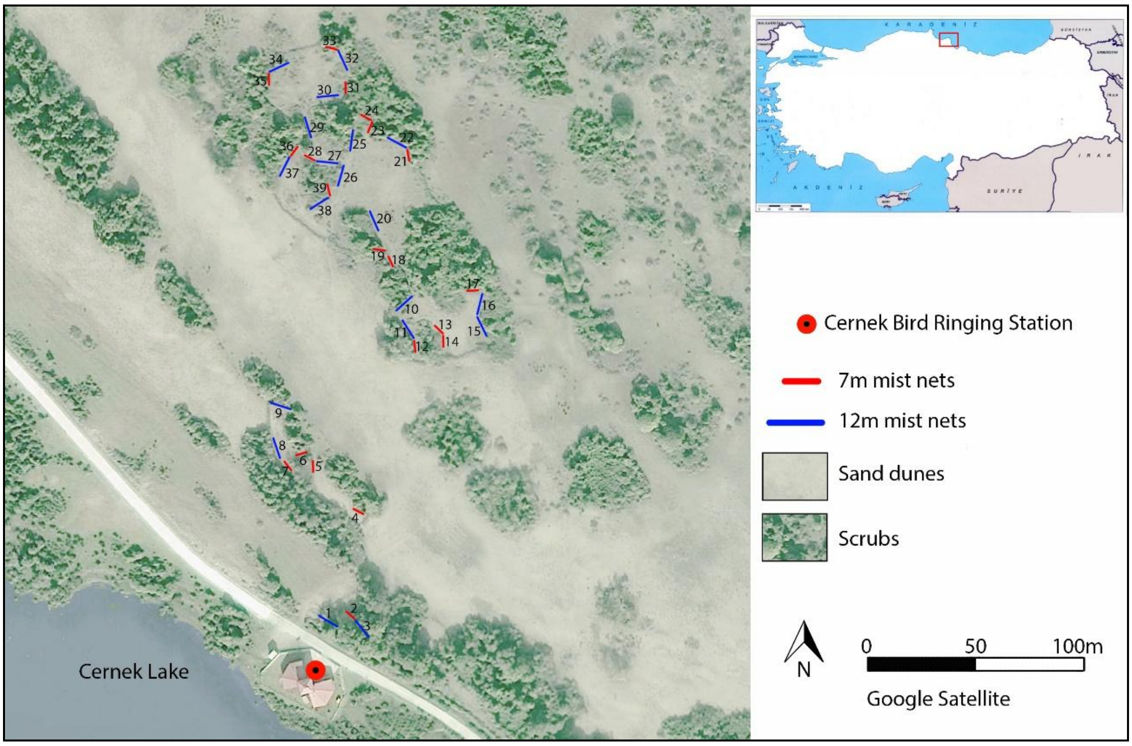

Figure 1. *Positions of the 39 mist-nets used in this study*

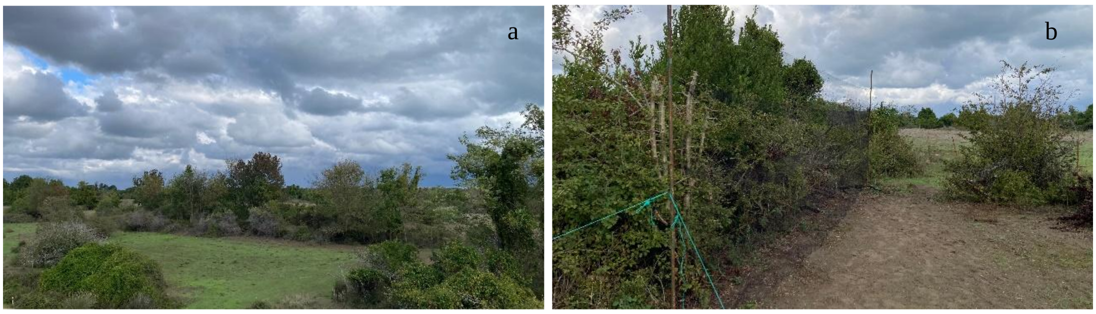

Figure 2. *(a) Habitat of the study site. (b) Mist-nets from the study site*

Data analysis

To describe the general bird numbers and seasonal migration dynamics of RWs, MWs and GRWs all data collected in the years 2002-2019 was used. The duration of the spring and autumn ringing sessions changed few days every year. Therefore, seasonal migration dynamics were identified by using the data between 17 March and 31 May for the spring and 17 August and 31 October for the autumn seasons. Since the autumn study did not start earlier than August 17, the earliest migration start date in the autumn was given as August 17 for species that probably started their autumn

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migration earlier. It should be noted that it may be earlier for some species. We have analyzed 18 years of data and the date of the first arrival in each year varies. The "first arrival earliest" date is the earliest date in a certain year within all 18 years, and the "first arrival latest" date is the latest first arrival date in a certain year within all years. Migration dynamics of all species were smoothed by using the 5-day running average formula. Expressed as the average number of individuals captured per day in all studied years. The "five-day running average" value is calculated for a particular day as the average of all data from that day, the two days before, and the two days after. The actual data for each day are replaced by the five-day running average value. The effect is to smooth the large-scale bird migration waves (for details see Busse, 2000). We applied standard statistical methods to describe and analyze the data. Mann-Whittney U test was applied to compare biometrics between seasons and age groups. $p < 0.05$ was accepted as significant. The data were analyzed using IBM SPSS Statistics (Version 22.0).

Results

As a result of 18 years of study, a total of 2,465 birds were trapped both in spring and autumn (*Table 1*). Birds ringed in autumn were more numerous than in spring. The number of first-year birds ringed in spring season is lower than adults in all species, whereas first-year birds ringed in autumn are more numerous than adults in RWs and MWs (*Table 1*).

Table 1. *Total numbers and age ratios of Acrocephalus species in spring and autumn*

Species	Spring			Autumn			Total
	FY	A	N	FY	A	N	
A. scirpaceus	79	123	37	917	173	8	1,337
A. palustris	12	36	16	310	223	1	598
A. arundinaceus	41	144	68	100	175	2	530

FY: first-year bird, A: adult, N: unidentified age

Spring migration dynamics

While RWs migrate intensively from late March till late May, MWs recorded from early May to late May and GRWs from mid-April to mid-May (*Table 2*; *Fig. 3*). It has been determined that the adults arrive to the area before first-year birds in spring in all three species (*Fig. 4*).

Table 2. *Earliest, latest and median spring migration dates of studied species between 2002-2019*

	Spring					
	First arrival		**Median**	**Latest arrival**		**Median**
	Earliest	**Latest**		**Earliest**	**Latest**	
A. scirpaceus	Mar 23	May 9	Apr 2	Apr 24	May 30	May 24
A. palustris	May 2	May 27	May 18	May 17	May 27	May 23
A. arundinaceus	Apr 8	May 14	Apr 27	Apr 21	May 30	May 22

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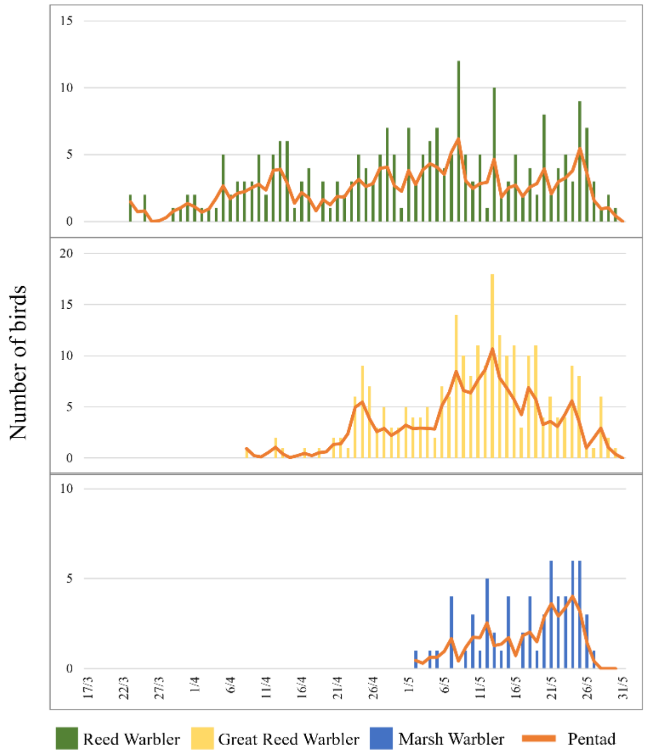

Figure 3. *Spring migration dynamics of reed warbler (upper), great reed warbler (middle) and marsh warbler (bottom)*

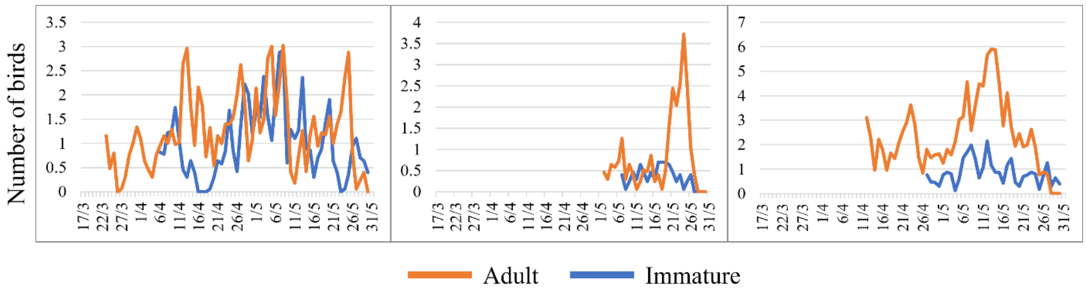

Figure 4. *Spring migration dynamics regarding age groups. Left: reed warbler, middle: marsh warbler, right: great reed warbler*

Autumn migration dynamics

Autumn passage of RWs, MWs and GRWs are intense in mid-August and decrease from the beginning of September (*Table 3*; *Fig. 5*). No difference was determined between arrival dates of adults and first-year birds in autumn (*Fig. 6*). However, first-year birds of RWs and MWs were observed to migrate in a longer time period than adults.

Wing length and body conditions

Wing length, body mass and fat scores of RWs, MWs and GRWs in spring and autumn are given in *Table 4*. The results of the statistical analyses showed a significant difference in fat scores between spring and autumn for GRWs (Mann-Whitney U, p = 0.000; *Table 5*). A significant difference was observed between first-year birds and

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adult fat scores of MWs in spring (Mann-Whitney U, p = 0.019; *Table 6*). All three species showed a significant difference between first-year birds and adults fat scores in autumn (Mann-Whitney U, RW: p = 0.000; MW: p = 0.015, GRW: p = 0.000; *Table 6*). Also, comparison between spring and autumn body mass showed a difference for all species (Mann-Whitney U, RW: p = 0.000; MW: p = 0.012, GRW: p = 0.000; *Table 5*). Difference between age groups regarding body mass in spring observed only for RWs (Mann-Whitney U, RW: p = 0.004; *Table 6*). However, analyses showed a difference between age groups in body mass in autumn for all three species (Mann-Whitney U, RW, MW, GRW: p = 0.000; *Table 6*). In addition, our study revealed a significant difference in wing length between spring and autumn (Mann-Whitney U, RW: p = 0.000; MW: p = 0.013, GRW: p = 0.000; *Table 5*) and between age groups in autumn (Mann-Whitney U, RW: p = 0.000; MW: p = 0.013; GRW: p = 0.012, *Table 6*) for all species. In spring, there is a difference in wing length between age groups for RWs and GRWs (Mann-Whitney U, RW: p = 0.006; GRW: p = 0.009; *Table 5*).

Table 3. *Earliest, latest and median autumn migration dates of studied species between 2002-2019*

	Autumn					
	First arrival		**Median**	**Latest arrival**		**Median**
	Earliest	**Latest**		**Earliest**	**Latest**	
A. scirpaceus	Aug 17	Sept 6	Aug 17	Sept 30	Oct 27	Oct 19
A. palustris	Aug 17	Sept 6	Aug 17	Sept 9	Oct 21	Sept 22
A. arundinaceus	Aug 17	Sept 7	Aug 17	Aug 20	Oct 23	Sept 16

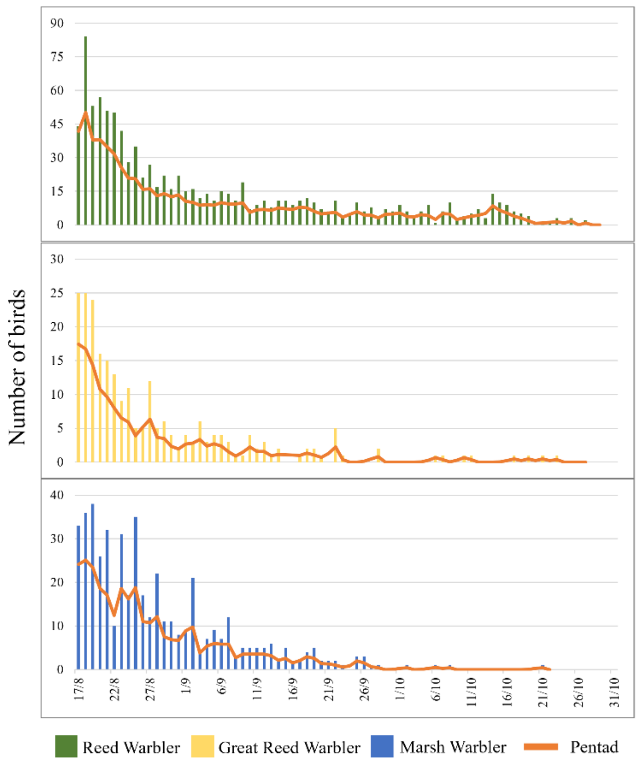

Figure 5. *Autumn migration dynamics of reed warbler (upper), great reed warbler (middle) and marsh warbler (bottom)*

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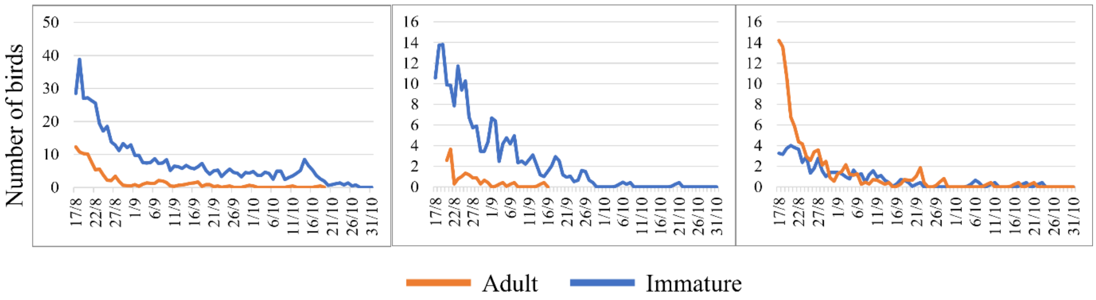

Figure 6. *Autumn migration dynamics regarding age groups. Left: reed warbler, middle: marsh warbler, right: great reed warbler*

Table 4. *Wing length, body mass and fat scores of adult and first-year birds in spring and autumn (mean ± SD)*

		Wing (mm)		**Body mass (g)**		**Fat scores**	
		Adult	**FY**	**Adult**	**FY**	**Adult**	**FY**
Spring	*A. scirpaceus*	68.40 ± 2.6 (N = 123)	67.60 ± 1.97 (N = 78)	12.38 ± 0.8 (N = 123)	12.13 ± 1.19 (N = 78)	2.5 ± 1.3 (N = 121)	2.27 ± 1.29 (N = 78)
	A. palustris	69.31 ± 1.75 (N = 36)	69.17 ± 2.29 (N = 12)	13.71 ± 1.25 (N = 34)	13.05 ± 2.6 (N = 12)	2.64 ± 1.17 (N = 36)	3.42 ± 1.24 (N = 12)
	A. arundinaceus	98.71 ± 2.86 (N = 143)	97.46 ± 2.71 (N = 41)	33.07 ± 3.99 (N = 143)	34.50 ± 3.54 (N = 40)	2.60 ± 1.16 (N = 131)	2.72 ± 1.1 (N = 39)
Autumn	*A. scirpaceus*	67.45 ± 2.04 (N = 173)	65.34 ± 2.31 (N = 916)	13.08 ± 2.55 (N = 168)	11.59 ± 1.83 (N = 891)	3.54 ± 2.04 (N = 172)	2.63 ± 1.99 (N = 916)
	A. palustris	69.24 ± 1.60 (N = 222)	68.79 ± 1.70 (N = 309)	13.61 ± 2.66 (N = 216)	12.37 ± 1.70 (N = 295)	3.31 ± 2.00 (N = 223)	2.74 ± 1.72 (N = 310)
	A. arundinaceus	96.21 ± 2.74 (N = 119)	95.10 ± 2.95 (N = 97)	38.11 ± 4.42 (N = 171)	32.55 ± 6.50 (N = 100)	5.36 ± 1.93 (N = 173)	3.78 ± 2.21 (N = 99)

N: sample size, FY: first-year birds

Table 5. *Results of Mann-Whitney U tests in seasonal variation on fat, body mass and wing length differences*

Fat	**Sample size**	**Z**	**p-Value**
A. scirpaceus	1,292	-1.458	0.145
A. arundinaceus	511	-11.192	0.000*
A. palustris	598	-0.369	0.712
Weight			
A. scirpaceus	1,291	-6.452	0.000*
A. arundinaceus	524	-7.289	0.000*
A. palustris	574	-2.510	0.012*
Wing			
A. scirpaceus	1,292	-11.874	0.000*
A. arundinaceus	467	-9.166	0.000*
A. palustris	596	-2.472	0.013*

*Statistically significant

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Table 6. *Results of Mann-Whitney U tests in age related variation on fat, body mass and wing length differences in different seasons*

Fat	Season	Sample size	Z	p-Value
A. scirpaceus	Spring	277	-1.550	0.121
	Autumn	1,088	-4.412	0.000*
A. arundinaceus	Spring	170	-0.906	0.365
	Autumn	272	-6.192	0.000*
A. palustris	Spring	48	-2.345	0.019*
	Autumn	533	-2.436	0.015*
Weight				
A. scirpaceus	Spring	279	-2.898	0.004*
	Autumn	1,059	-7.907	0.000*
A. arundinaceus	Spring	183	-0.221	0.825
	Autumn	271	-7.265	0.000*
A. palustris	Spring	46	-0.063	0.950
	Autumn	511	-3.981	0.000*
Wing				
A. scirpaceus	Spring	279	-2.740	0.006*
	Autumn	1,089	-10.427	0.000*
A. arundinaceus	Spring	184	-2.625	0.009*
	Autumn	216	-2.498	0.012*
A. palustris	Spring	48	-0.217	0.828
	Autumn	531	-2.485	0.013*

*Statistically significant

Discussion

Our study showed that the number of birds caught in autumn were higher than in spring for all three species. Studies on other migratory species in Kızılırmak Delta also revealed that autumn migration is more intensive than spring migration, and a possible explanation might be that the delta is the first suitable stopover area for migrants after crossing an ecological barrier, the Black Sea in autumn (Barış et al., 2005; Erciyas-Yavuz et al., 2015), with increased number of first-year birds on their first migration. It may also indicate loop migration (e.g. GRW Koleček et al., 2016) or different stopover strategies. In Europe, autumn migration has been reported to be more intensive for most species (Hüppop and Hüppop, 2005), while for RW migrating from Chad and Egypt it was the contrary and passing bird numbers in spring were higher (Ozarowska et al., 2011; Ottosson et al., 2002), which could be result of different geographical locations at different latitudes.

Besides, majority of migrants reduce the amount of time they spend at the stopover areas during spring migration or stopover less frequently to complete the spring migration period in a shorter time and reach their breeding grounds earlier (Tøttrup et al., 2012; Nillson et al., 2013). Shorter stopovers support the fact that fewer birds are caught in spring than in autumn. Besides, Kirwan et al. (2022) have reported that Central and Eastern European RW populations choose an easterly migration route, where birds passing from western Türkiye. However, in contrast to our findings, at Aras

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Ringing Station in eastern Türkiye, the number of RWs is nearly the same in autumn and spring and the number of GRWs is higher in spring than in autumn (DKMP, 2012, 2013, 2014, 2015, 2016, 2017). The nets at Aras Ringing Station are placed in reed-beds, and the station is located far from any ecological barriers in eastern Türkiye. Our nets are placed in an area dominated by shrubs. As the reed-beds are the primary habitat for *Acrocephalus* species, they may have preferred the optimal areas for them in order to make a shorter stopover and reach the breeding ground earlier in the spring, and therefore, they may have been captured less in the spring. The results of this study showed that the number of first-year birds were higher than adults in autumn, which might be the result of increased number of first-year birds in the migratory population in autumn after successful breeding season (Newton, 2008). Higher rate of first-year birds in autumn compared to spring was also reported in previous studies (Rguibi-Idrissi et al., 2003; Erciyas-Yavuz et al., 2015; Covino et al., 2020).

In spring, RWs passage from Türkiye starts from second week of March and ends in May, and a large part of the migratory population passes during April (Kirwan et al., 2008; Kennerley and Pearson, 2010). RWs spring passage from eastern, western and central Africa occurs from mid-February until late May (Bayly, 2003; Kennerley and Pearson, 2010). The species have been recorded in Egypt and Arabian Peninsula between March and June (Kennerley and Pearson, 2010; Ozarowska et al., 2011). They pass the east of the Baltic from mid-May to the beginning of June (Bolshakov et al., 2003), reach their breeding grounds in Northern Europe at the end of the April and the beginning of June (Kennerley and Pearson, 2010). All the studies that reveal the spring migration of RWs are similar to our study results. In autumn, Kirwan et al. (2008) stated that RWs migrate from Türkiye from the beginning of August to mid-October, and rarely until the end of October. Although there are few records from the Mediterranean even in the beginning of November, most of migrant population leaves Türkiye in mid-September (Kirwan et al., 2008). In our study, most of RWs were caught in mid-August, and there was decrease since the beginning of September. Autumn migration from northern Europe to wintering areas starts late June and continues until the beginning of October (Hall, 1996; Stolt, 1999; Bayly, 2003; Åkesson et al., 2002; Wilson et al., 2019). In eastern Europe, there is a record of the passage from 7 August to 20 August from the north of Poland (Jakubas and Wojczulanis-Jakubas, 2010). In Arabian Peninsula, the passage is observed from the end of July to the mid-November (Kennerley and Pearson, 2010). Ozarowska et al. (2011) reported that the passage from Egypt took place between the beginning of September and the end of October. The first birds arrive in Uganda and Kenya at the end of October and the passage continues until January. While RWs reach their wintering grounds in Botswana in southern Africa between November and January and stay there until the end of March, other RWs overwinter in Zambia until the beginning of April (Kennerley and Pearson, 2010).

Kirwan et al. (2008) stated that MWs pass from Türkiye from the beginning of April to the beginning of June. In our study, MWs were not observed during April. MWs leave wintering grounds between the end of March and the mid-April. While the arrival of the Black Sea coasts takes place around the end of April, arrival in the South of Russia and the east of Europe takes place in early May. Birds, arriving in Central Europe at the end of May, settle in their European breeding grounds in the last half of May and sometimes at the beginning of June (Kennerley and Pearson, 2010). In autumn, MWs pass intensively in the Kızılırmak Delta from mid-August to the beginning of September. Kirwan et al. (2008) reported that MWs pass through Türkiye

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from mid-August to mid-October with a peak of passage in September. Birds migrating from central Europe at the end of July-early September heading southeast and reach Türkiye and the Levant via the Balkans (Kennerley and Pearson, 2010).

Kirwan et al. (2008) reported that GRWs passing from Türkiye from early March to mid-April. However, they added that there could be a passage until the end of May in the eastern Anatolia. Horns et al. (2016) reported that GRWs arrive in north-eastern Türkiye between March 1 and May 28. Unlike them, GRWs were not captured during March in our study. Kennerley and Pearson (2010) stated that the wintering grounds were left in late March or early April and birds reach their breeding grounds in the Black Sea coasts in mid-April. It is stated that most of the GRWs in Eastern Europe and Central Asia follow an eastward route through Africa and perform loop migration. In their study, Horns et al. (2016) determined that birds passed over the Horn of Africa to the Arabian Peninsula, and they headed north in spring migration. In our study, GRWs pass Black Sea coast from mid-August to end of October during their autumn migration, with the peak in mid-August. Kirwan et al. (2008) reported that the autumn migration of GRWs in Türkiye take place between early August and mid-October. Horns et al. (2016) found that GRWs leave the north-eastern Türkiye between 31 July and 12 August and these individuals arrive at their first wintering grounds in an average of 39 days. Kennerley and Pearson (2010) reported that GRWs leave the breeding grounds in northern and eastern Europe and head to south at the beginning of September and the passage from northern and eastern Europe continues throughout August and September. Stepniewska et al. (2020) found that the passage through Poland and Bulgaria continue from the beginning of August to the end of September. GRWs in Kazakhstan leave their breeding grounds between the end of July and the end of September and heading to southwest, migrate over the Arabian Peninsula and pass the Red Sea to arrive in South Sudan and Uganda to spend their first half of the winter. The birds, which left their first wintering grounds at the end of November, migrated to the coasts of Mozambique and Tanzania to spend the second half of winter. During October, migration is observed intensively in the South of the Caspian Sea. GRWs are first seen on the Sudanese coast in late August, although arrivals in Northeast Africa can continue from mid-October to mid-November. The first birds arrive in Zambia and Malawi in November and the passage continues until January (Kennerley and Pearson, 2010).

RWs, MWs and GRWs’ passage lasts longer in autumn than spring in our study. In order to arrive breeding grounds earlier, the migration speed of species might be higher in spring than in autumn, and therefore the duration of stay in the stopover areas is shortened (Nilsson et al., 2013). Briedis et al. (2019) determined that the migration speed of some passerines migrating between sub-Saharan Africa and Europe was higher in spring than in autumn.

The migration dynamics of RWs and MWs in spring differ between age groups. Jakubas and Wojczulanis-Jakubas (2010) linked this situation with the migration speed of adults which is higher than first-year birds, and first-year birds could pass after adults in order to avoid competing with experienced adults. In autumn, there is no significant difference between age groups in terms of arrival dates in our study. However, this could be due to the fact that the ringing study in autumn in delta starts when all the species are at their peak of migration. If autumn ringing study in delta would start at the beginning of August or in the last weeks of July, autumn migration dynamics of all three species and the differences in migration dynamics between adults and first-year birds can be investigated.

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Considering the departure dates from the delta, it has been determined that the first-year birds of all species have longer migration duration than the adults and were recorded later in spring (except MWs) and autumn. Other studies on the migration of *Acrocephalus* species also showed that the first-year birds leave the area after the adults (Ormerod, 1990; Stolt et al., 1993; Bayly, 2003; Kovács et al., 2012; Bräger, 2022).

The GRWs were heavier and fatter in autumn than in spring. MW and RW were heavier in autumn while there was no significant difference in fat reserves. Ottosson et al. (2002) showed the opposite of this for GRW and RW in Nigeria. Yosef and Chernetsov (2005) have reported also intra-seasonal differences for RW in Eilat, where autumn birds were heavier. After crossing the Black Sea in autumn, we would expect that birds would have lower fat reserves and body mass compared to spring. However, since there is no time constraint in autumn migration, longer stays and slower migration may explain this result (Nilsson et al., 2013). Conversely, it can be advantageous to store less fat and be lighter in order to migrate quicker in spring (Alerstam, 2011). Seasonally changing flight and stopover strategies seem to be determinant in seasonally differences in body condition.

In autumn GRW, RW and MW adults are heavier and fatter than first-year birds. Other studies prove that there are differences between first-year birds and adults in terms of both fat and body mass (Merom et al., 1999; Zakala et al., 2004; Bayly, 2003; Jakubas and Woiczulanis-Jakubas, 2010). In all these studies, adults' fat reserves and body mass were higher than first-year birds'. Inefficient food intake of inexperienced or low social status of first-year birds matures in stopover sites might be the reason (Jakubas and Woiczulanis-Jakubas, 2010).

Wing length for all three species are seasonally different, and adults have longer wings in autumn. There is a significant difference in wing length between first-year birds and adults of all species which is documented across various bird species (Ozarowska et al., 2021; Deakin, 2023). They suggest that first-year birds' wings are adapted for maneuverability, while adults' wings are adapted for fast flight. The shorter wings of inexperienced first-year birds serve to enhance survival against some selection pressures such as predation and efficient feeding by increasing maneuverability. Conversely, the long wings of adults are attributed to an evolutionary adaptation for faster flight. Despite the potential decrease in maneuverability associated with longer wings, adult birds demonstrate a capacity to tolerate such pressures, likely owing to their accumulated flight experiences.

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APPENDIX

Table A1. *The length and the GPS coordinates for each mist-net and the ringing station*

Net number	Length (meter)	Lat	Long
Station		41.643128°	36.084169°
1	12	41.643358°	36.084189°
2	7	41.643339°	36.084356°
3	12	41.643267°	36.084484°
4	7	41.644013°	36.084319°
5	7	41.644137°	36.084097°
6	7	41.644208°	36.084013°
7	12	41.644167°	36.083908°
8	12	41.644267°	36.083836°
9	12	41.644455°	36.083893°
10	12	41.644954°	36.084875°
11	12	41.644855°	36.084873°
12	7	41.644748°	36.084947°

Net number	Length (meter)	Lat	Long
13	7	41.644833°	36.085084°
14	7	41.644758°	36.085138°
15	12	41.644833°	36.085415°
16	12	41.644957°	36.085396°
17	7	41.645028°	36.085304°
18	7	41.645169°	36.084778°
19	7	41.645203°	36.084699°
20	12	41.645350°	36.084678°
21	7	41.645654°	36.084918°
22	12	41.645746°	36.084812°
23	7	41.645806°	36.084653°
24	7	41.645841°	36.084603°
25	12	41.645754°	36.084543°
26	12	41.645574°	36.084462°
27	12	41.645632°	36.084413°
28	7	41.645652°	36.084268°
29	12	41.645852°	36.084230°
30	12	41.645940°	36.084364°
31	7	41.645999°	36.084502°
32	12	41.646141°	36.084528°
33	7	41.646196°	36.084430°
34	12	41.646117°	36.084064°
35	7	41.646038°	36.084009°
36	7	41.645691°	36.084132°
37	12	41.645609°	36.084079°
38	12	41.645429°	36.084323°
39	7	41.645510°	36.084390°

Table A2. *The plant species occurring in the mist-netting area and the nearest mist-nets next to these plant species*

Family	Plant species	Mist-nets
Lauraceae	*Laurus nobilis*	4, 5, 6, 7, 8, 9, 17, 18, 19, 21, 23, 24, 29, 30, 33, 35, 39
Rhamnaceae	*Frangula dodonei*	1, 5, 8, 9, 16, 17, 29, 30, 31, 34, 35
Rosaceae	*Rubus sanctus*	All mist-nets
Rosaceae	*Rubus canescens*	All mist-nets
Rosaceae	*Rosa canina*	6, 8, 10, 24, 26, 27, 28, 37
Rosaceae	*Pyracantha coccinea*	4, 9, 31
Rosaceae	*Pyrus communis*	1, 2, 3
Rosaceae	*Mespilus germanica*	4, 21
Rosaceae	*Crataegus monogyna*	4, 8, 9, 10, 13, 14, 23, 24, 25, 38, 39
Elaeagnaceae	*Hippophae rhamnoides*	All mist-nets
Smilacaceae	*Smilax excelsa*	All mist-nets
Vitaceae	*Vitis lobrusca*	4, 9, 15, 16, 19, 35, 36, 37
Moraceae	*Ficus carica*	1, 2, 3, 7, 9, 10, 16, 17, 18, 19, 20, 29, 34, 35, 36, 37

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Apocynaceae	*Periploca graeca*	1, 2, 3, 9, 29, 33, 34, 35, 36, 37
Cornaceae	*Cornus sanguinea*	5, 6, 7, 9, 15, 16, 18, 19, 30, 31, 32
Juncaceae	*Juncus acutus*	1, 2, 3, 5, 6, 9
Oleaceae	*Fraxinus angustifolia*	1, 2, 3, 5, 6, 7, 8

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