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Exploratory analyses of migration timing and morphometrics of the Common Blackbird *(Turdus merula)*

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Abstract Ornithological studies often rely on long-term bird ringing data sets as sources of information. However, basic descriptive statistics of raw data are rarely provided. In order to fill this gap, here we present the fourth item of a series of exploratory analyses of migration timing and body size measurements of the most frequent Passerine species at a ringing station located in Central Hungary (1984–2016). First, we give a concise description of foreign ring recoveries of the Common Blackbird in relation to Hungary. We then shift focus to data of 6849 ringed individuals and 6081 recaptures derived from the ringing station, where birds have been trapped, handled and ringed with standardized methodology since 1984. Timing is described through annual and daily capture and recapture frequencies and their descriptive statistics. We show annual mean arrival dates within the study period and present the cumulative distributions of first captures with stopover durations. We present the distributions of wing, third primary, tail length and body mass, and the annual means of these variables. Furthermore, we show the distributions of individual fat and muscle scores, and the distributions of body mass within each fat score category. We distinguish the spring and autumn migratory periods, breeding and wintering seasons, ages (i.e. juveniles and adults) and the two sexes. Our aim is to provide a comprehensive overview of the analysed variables. However, we do not aim to interpret the obtained results, merely to draw attention to interesting patterns that may be worth exploring in detail. Data used here are available upon request for further analyses.

Keywords: Ócsa Bird Ringing Station, wing, third primary, tail length, body mass, fat, muscle, bird banding, capture-recapture, long term data, meta-analyses, Eurasian Blackbird, European Blackbird

Összefoglalás Madártani tanulmányokban gyakran elemeznek hosszútávú madárgyűrűzési adatsorokat, de az alapvető leíró statisztikák és exploratív elemzések általában nem hozzáférhetőek. E hiányt pótolandó, cikksorozatot indítottunk, melyben egy közép-magyarországi gyűrűző állomáson leggyakrabban előforduló énekesmadár fajok vonulás időzítésének és testméreteinek exploratív elemzéseit közöljük (1984–2016). A sorozat a negyedik tagjaként szolgáló jelen cikkben először áttekintjük a fekete rigó magyar gyűrűs külföldi és külföldi gyűrűs magyarországi megkerüléseit, majd rátérünk a faj egy magyarországi, 1984 óta standard módszerekkel dolgozó gyűrűzőállomásról származó 6849 gyűrűzött és 6081 visszafogott egyedétől származó adatainak elemzésére. Az időzítés jellemzéséhez az éves és a napi átlagos első megfogások és visszafogások leíró statisztikái mellett megmutatjuk az évenkénti átlagos érkezési időket és azok változását. Az éven belüli időzítést az első megfogások kumulatív eloszlásával ábrázoljuk feltüntetve a tartózkodási időket is. Közöljük a szárnyhossz, a harmadik evező hossz, a farokhossz és testtömeg leíró statisztikáit. Ábrázoljuk ezen változók éves átlagait, a zsír- és izomkategóriák gyakorisági eloszlását, valamint a testtömegek eloszlását zsírkategóriák szerinti bontásban. Az elemzésben elkülönítjük a vonulási (tavasz, ősz), költési és telelési időszakokat, a korcsoportokat (fiatal, öreg), illetve az ivarokat (hím, tojó). Célunk a vizsgált változók átfogó bemutatása és a bennük található mintázatok feltárása volt az eredmények interpretálása nélkül. Kérésre a cikkhez felhasznált adatsort rendelkezésre bocsátjuk.

Kulcsszavak: Ócsai Madárvárta, szárnyhossz, harmadik evező hossza, farokhossz, testtömeg, zsír, izom, madárgyűrűzés, hosszútávú adatsor, meta-analízis

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Introduction

Bird ringing or banding is one of the principal and oldest methods in use to study various aspects of avian populations (Robinson *et al.* 2009). Overwhelming amount of data has been collected in over a century of bird ringing, and has been used excessively in a diverse array of disciplines. However, compared to the amount of data available throughout the world, concise descriptive information suitable for meta- or comparative analyses is sporadically available (Gienapp *et al.* 2007, Harnos *et al.* 2015). Though purely descriptive studies are often hard to publish within the framework of current hypothesis-focused science, we feel that such studies may well play an outstanding role in generating new hypotheses for future studies. For this purpose, it is essential that descriptive studies apply the most appropriate statistical methodologies (Harnos *et al.* 2015, 2016). The bulk of currently available ringing data is often derived from long-term projects carried out at permanent ringing stations where large amount of individuals of various species are trapped simultaneously (Csörgő *et al.* 2016). These projects generally apply standardized methodologies in trapping, handling and data collection, thus information derived from these sites is suitable for location-wise comparisons (Schaub & Jenni 2000, Marra *et al.* 2004, Schaub *et al.* 2008, Tøttrup *et al.* 2010).

Here we present exploratory and descriptive statistics on the migration timing and morphometrics of the Common Blackbird *(Turdus merula)* between 1984–2016 from a Central European ringing station (Ócsa Bird Ringing Station, Hungary, see Csörgő *et al.* 2016 for details).

The Blackbird is a sexually dimorphic omnivorous passerine of the Turdidae family. Adult males are uniformly black, with orange coloured bills and eyes rings. The adult females are generally dull brown, with greyish-brown upperparts, streaked or spotted rufous-brown throat and dark yellowish brown bills. Juveniles are brownish, wilt light spotting throughout the head, back and underparts. The second year birds show contrast between older and newer great covers and have first generation primaries until the postnuptial moult (Cramp 1988, Svensson 1992, Demongin 2016).

Blackbirds are polytypical, with 4 European subspecies, namely *T. m. merula, T. m. aterrinus, T. m. azorensis, T. m. cabrerae*. The subspecies are quite similar in their appearance, virtually making the identification of a single individual impossible (Cramp 1988, Svensson 1992, Demongin 2016). However, wing length of males and females increases northwards (Cramp 1988, McCollin *et al.* 2015). The average wing length of males and females increases remarkably after the first moult by approx. 3 and 2 mms, respectively with considerable variation (Leverton 1989).

The species originally occurs on three continents: Europe, Asia, Africa, and it also has been introduced to Australia and New Zealand. The nominate subspecies is a common breeder across Europe, except northernmost Fennoscandia and northeastern Russian. *T. m. aterrinus* breeds in the countries of the Balkan Peninsula, southern Ukraine, and from Crimea to northern Iran. The *T. m. azorensi*s occurs in the Azores, while *T. m. cabrerae* in Madeira and western Canary Islands (Cramp 1988, Kentish *et al.* 1995, Collar 2005). In the last century this species has spread both northwards (Faeroes, Fennoscandia, Baltic countries), and southwards (Israel and North Africa) (Spencer 1975, Cramp 1988, Koskimies 1992, Selmi *et al.* 2003, Collar 2005, Newton 2008).

The Blackbird is classified as Least Concern in the IUCN Red List, the European population sizes are slightly increasing (Mulsow & Tomiałojc 1997, BirdLife International 2016). However, this tendency may have considerable large scale spatial variation. The Finnish breeding population showed a three-fold increase during the last decades (Valkama *et al.* 2014), while in the Netherlands the past two decades produced a decline in the number of breeding pairs (Dix *et al.* 1998). The British population has declined by appr. 30% since the early 1970s (Crick *et al.* 1998).

Turdus thrushes are important game species in the western and central Mediterranean countries, with annual bags comprising tens of millions of birds (McCulloch *et al.* 1992, Aebischer *et al.* 1999, Ricci 2001). In Italy, 96% of all ring recoveries are related to human activities, predominantly hunting, indicating that it is a significant cause of mortality (Spina & Volponi 2008). However, hunting pressure on thrushes is differs among countries and species. For instance, only 7.9% of the recovered Swedish Blackbirds (Fransson & Hall-Karlsson 2008), 4.2% (8% of found dead) of Danish birds (Bønløkke *et al.* 2006), 2.8% (23% of found dead) of the Finnish birds (Valkama *et al.* 2014), but 29.2% (89% of found dead) of Czech and Slovakian birds (Klvaňa 2008), 82% of Hungarian birds (BirdLife Hungary 2017) and 12% of Croatian birds (Budinski 2013) were killed by hunters. This pattern indicates that northern populations winter north of the Mediterranean countries, while central European populations are exposed to severe hunting pressures in the non-breeding season.The majority of Croatian Blackbirds are possibly residents, hence the low proportion of hunting related ring recoveries. These patterns are somewhat different to that in Song Thrushes (see Csörgő *et al.* 2017), where birds from northern European populations are also exposed to severe hunting pressures. The Usutu virus, a vector-borne flavivirus has also been responsible for severe local mass mortalities that have disproportionately affected this thrush species (Bakonyi *et al.* 2007).

Blackbirds breed in most habitats except open steppe type habitats, marshes and tundra. Since the mid-1850's the Blackbird has colonised most of European towns and suburbs (Snow 1966, Parslow 1967, Batten 1978). These urban populations continue to expand northeastward with a growing number of breeding pairs in towns (Cramp 1988, Luniak *et al.* 1990, Mulsow & Tomiałojc 1997, Collar 2005). Breeding birds here have seemingly better reproductive success compared to birds breeding in rural areas (Batten 1973) however, this difference has decreased in the Netherlands (Dix *et al.* 1998) in the past decades. Urban populations may also be more dense and have higher between-season recruitment rates (Batten 1973). For instance the mean rural woodland breeding density was 120 pairs per km^2, but for open areas of the town of Brno (Czech Republic) the density was 440 pairs per km^2 (Havlin 1963).

The mating system of Blackbirds is social monogamy, though a few exceptional cases of polygamy have been recorded. The parental care is biparental (Cramp 1988). According to Paradis *et al.* (1998), British birds have comparatively low average natal dispersal distance (3.3 km) and average breeding dispersal distance (3.2 km). Furthermore, natal dispersal distance increases from Denmark through Norway and Sweden to Finland, in line with increasing migratoriness of breeding populations (as measured by proportion of migrating and distances travelled) (Main 2002).

Various migratory strategies can be found among the subspecies and populations (resident, altitudinal, partial or obligatory migrant). *T. m. azorensis, T. m. cabrerae* and most of the *T. m. aterrinus* are residents. Only an average 4% of the ringed individuals of these subspecies move more than 20 kms (11% in the north and 3% in the south). The individuals that do move migrate to Ireland from the north and west, while the birds from the south and eastern areas migrate to France (Chamberlain & Main 2002). However, some birds of the *T. m. aterrinus* winter in Cyprus and Egypt (Ashmole 1962, Cramp 1988). Only the most northern populations can be considered obligate migrants. The British and central European populations have become progressively more sedentary during the last two centuries (Berthold 1993, 1999, Main 2000). The ratio of the migrants is estimated to be 89% in Finland, 76% in Sweden, 61% in Norway, 60% in the Czech Republic, 25% in Britain and Belgium and 16% in Danmark (Main 2002, Collar 2005, Klvaňa 2008).

The average migration speed is relatively slow (approx. 50 km/h) compared to other migrants (Alerstam 1976, Ellegren 1993). Blackbirds are nocturnal migrants. Migration intensity shows significant positive correlation to southwest and west winds, warm front passages and decreasing barometric pressure in spring, and eastwest northeast wind and cold front in autumn in Southern Sweden (Alerstam 1976, Berthold 1991).

Individuals of the nominated subspecies, *T. m. merula* from Fennoscandia, British Isles, Denmark and Germany migrate to either western Europe, or to southern Europe. There is a clear tendency, that birds from more eastern origin migrate to south (Ashmole 1962, Cramp 1988). The majority of birds leave Sweden in southwest direction, but a small proportion migrate in a northwest direction towards Norway (Fransson & Hall-Karlsson 2008). Ringing recoveries suggested that the main autumn direction of movement from eastern Finland is west-southwest. Of the five common thrush species of Finland, Blackbirds have the westernmost wintering range (Ashmole 1962, Huttunen 2004, Valkama *et al.* 2014). Migration routes of the Swedish and Finnish birds are similar, presumably because the Finnish breeding population originates from the Swedish population (Spencer 1975). Contrastingly, most of the Danish Blackbirds are resident: 58% have been recovered at the ringing sites during winter, and merely 16% moved more than 20 kms. Migrants from Fennoscandia and the Baltic countries pass Denmark and move further on to the Netherlands, Belgium, France, and to the British Isles (Bønløkke *et al.* 2006). A substantial proportion of German Blackbirds are resident; ring recoveries connect Germany with an area from West Ireland, Faeroes and North Finland to the Algerian Sahara and Greece. Blackbirds from North Germany migrate to westerly directions in autumn and are ringed in large numbers on the British Isles. From East and South Germany, they mainly migrate to southwest and are recovered mainly in South France. Fennoscandinavian and Baltic birds are also passage migrants in North Germany (Bairlein *et al.* 2014). Most of the birds ringed in the Czech Republic migrate south-southwest, via Austria, Germany and Switzerland, but a smaller proportion of the population migrates northwest to Belgium, northern France and Britain (Klvaňa 2008). In agreement with the above, morphometrics of first-captures in Italy show an increase in average wing length during the most intense phases of the autumn passage, likely due to the presence of birds of more northern origin (Schubert *et al.* 1986, Spina & Volponi 2008).

In general, the commencement of autumn migration starts late, relative to other obligate migrants. In Sweden, Blackbirds are typically present in September, with a gradual shift in trapping frequencies of these birds to Denmark in October and the Netherlands in November (Fransson & Hall-Karlsson 2008). Finnish birds are also still present locally in September, the autumn migration typically starts in October. Recoveries concentrate along the North Sea coastline towards Denmark in November (Valkama *et al.* 2014). In Denmark the local breeding population commences migration in October, coincidentally with the arrival of the trans-migrant birds coming from Fennoscandia and the Baltic countries (Bønløkke *et al.* 2006). In Germany, autumn migration starts in mid-September and lasts till November (Bairlein *et al.* 2014). In the Czech Republic migration generally occurs in September and October (Klvaňa 2008). The earliest foreign recoveries in Italy are typically in late August. The most intensive migration of Blackbirds is in October. In Lombardy capture frequencies peak in the first decade of October, while in more southern regions the peak occurs in the last decade. The intensity of migration gradually decays in November and completely halts by the first decade of December (Schubert *et al.* 1986, Spina & Volponi 2008).

Swedish and Finnish Blackbirds tend to arrive later, and to winter further south in Britain Ireland, than Norwegian birds. Approximately 24% of birds ringed in the British Isles were retrapped in Norway, 18% in Sweden, 17% in Germany and 13% in Denmark. The majority of foreign retraps here are also from these countries. Birds caught in autumn migration are retrapped in a large area ranging from Finland to Spain. Wintering retrap was also recorded from Iceland (Chamberlain & Main 2002). Winter recoveries of birds from Sweden are distributed on the British Isles, and on coastal western Europe from the gulf of Biscayne to the western coast of Norway and around the Baltic coastline. A fraction of birds also move to central and southern France and northern Italy (Fransson & Hall-Karlsson 2008). Birds originating from Finland winter in the UK, in the Netherlands and in Central France (Valkama *et al.* 2014). Recoveries of birds originating from Denmark show that this population also uses the British Isles, together with the Netherlands, Belgium and France for wintering (Bønløkke *et al.* 2006). Ring recoveries connect Germany to the range from the Faeroes and North Finland to the Algerian Sahara and from West Ireland to Greece. The winter quarters are separated: from Germany's northern regions birds move west and from the eastern and southern regions birds move south. A few birds stay in German to winter, originated from Fennoscandia and the Baltic region also (Bairlein *et al.* 2014). Blackbirds ringed in the Czech Republic winter mainly in Italy and France, and to a smaller degree on the Iberian Peninsula, meanwhile the birds from Slovakia winter in the Apennin Peninsula (Klvaňa 2008).Birds from Poland and Lithuania winter in Croatia (Budinski 2013), while some Croatian breeders winter in the central Mediterranean (Italy, southern France). Most of the birds recovered in Italy have been ringed east-northeast from Italy, with Hungary being the most represented country, together with Poland, the Czech Republic and Slovenia. Italy is also the wintering grounds of birds from the Balkans and from the eastern longitudes of European Russia, as well as from the Baltics (Spina & Volponi 2008).

Spring migration in Italy starts as early as the end of January and ends late April (Spina & Volponi 2008). In general, birds arrive to their breeding grounds in March-April, regardless of their breeding latitude. The arrival date in the Czech Republic is mainly in March , when the northern breeders still intensively migrate through the area (Klvaňa 2008). In Germany the migration starts in mid-february and lasts till late April when the northern breeders are still on their way (Bairlein *et al.* 2014). In Denmark, the spring migration pattern is similar and it peaks in April (Bønløkke *et al.* 2006). Finnish birds depart in February, and concentrate in southern Sweden during March, and arrive to their breeding sites in April (Huttunen 2004, Valkama *et al.* 2014). The majority of Swedish Blackbirds reach Denmark in March and by April most of the recoveries are found on the Swedish breeding site. Local breeders start the spring migration earlier then the birds originated from eastern areas (Fransson & Hall-Karlsson 2008).

While Blackbirds are unlikely to perform hard-weather movements in Britain (Snow 1966), some individuals may exhibit weather escape movements (Bairlein *et al.* 2014) in Germany.

The arrival dates in Christiansø (Baltic Sea) have advanced significantly indicating that large scale changes in climate or the environment may affect the species (Tøttrup *et al.* 2006).

The mean position of winter recoveries of Swedish birds has moved slightly towards northeast during the last decades (Fransson & Hall-Karlsson 2008). Migration distance has also shortened in case of Hungarian ringed Blackbirds (Németh 2017).

Blackbirds have sex specific migration strategies. Males are less likely to migrate, and if they do, they winter closer to the breeding sites compared to females (Bønløkke *et al.* 2006, Fransson & Hall-Karlsson 2008, Klvaňa 2008, Bairlein *et al.* 2014), hence the earlier arriving birds are usually males in Denmark and Finland (Tøttrup *et al.* 2006, Valkama *et al.* 2014).

Age groups showed no differential migratory behaviour in case of the British Blackbirds (Snow 1966). The relative frequency of age groups crossing to Ireland are similar. However, juveniles have higher relative frequencies amongst birds arriving from continental European both sexes (Chamberlain & Main 2002). While there was no difference in the tendency to migrate between male and female first year birds in Germany, with increasing age females tended to migrate, and males tended to winter in the breeding area (Schwabl 1983). Juveniles tend to winter closer to the breeding areas than adults (Huttunen 2004, Valkama *et al.* 2014), and there are more juveniles among the Swedish and Finnish birds migrating westward (captured in Norway) (Ashmole 1962). There is a slight difference in migration timing (adults migrate earlier and faster) in case if Swedish birds (Fransson & Hall-Karlsson 2008).

The occurrence of migratory and non-migratory individuals has been shown to be genetically determined in the Central European population. Sedentary birds breed closer to human settlements (town Blackbirds) in favourable habitats, preferably among themselves, whereas migratory individuals breed in less favourable habitats in woodland) further away from settlements, also preferring to mate among themselves (Schwabl 1983, Berthold 1993).

Blackbirds are very common breeders in Hungary. The species occurs in all types of arboreal habitats, in deciduous, mixed and coniferous woods, gallery forests, shrub-lands, orchards, gardens, and city parks. Blackbird populations have urbanised heavily since the first half of the 20th century. Urban populations are resident breeders of natural habitats and are mostly (partial) migrants (Csörgő & Gyurácz 2009).

According to Hungarian studies in Budapest, the urban breeding population is stable. While there are more males on higher areas, females tend to overwinter on lower altitudes. Their ratio depends on the weather conditions, meaning that the males show hard-weather escape equalising the sex ratio on lower altitudes (Csörgő & Kiss 1986, Ludvig *et al.* 1991). According to Móra *et al.* (1998), the survival rate of migratory, urban and rural residents increased between two time periods (1974–1982 and 1983–1992). The residents had the lowest survival rate in the first period and had the largest increase resulting more or less equal survival rates in the second period.

The species is protected in Hungary. Recently the Hungarian population shows a moderate population size increase (trend of breeding period: 2.41±0.34%, p<0.01, trend of wintering period: 2.761±0.86%, $p<0.01$, estimated to 1,100,000–1,450,000 pairs) (Hadarics & Zalai 2008, Szép *et al.* 2012, BirdLife Hungary 2017).

The Blackbird is also a common passage migrant from late February to March in spring and from late September until late October-early November in autumn (Hadarics & Zalai 2008, Csörgő & Gyurácz 2009).

In Hungary, the Blackbird appears equally during both the migratory, breeding and wintering seasons and some of them winter here (Csörgő & Gyurácz 2009).

Our aim is to provide a comprehensive overview of migration timing, body size measurements and inter-annual changes in these variables. Hopefully, these patterns will help formulate research questions and provide information for further higher level analyses. However, we do not aim to interpret the obtained results, merely draw attention to interesting patterns, that may be worth exploring in detail.

Materials and methods

Bird ringing data

The Ócsa Bird Ringing Station is situated in Central Hungary (N47.2970, E19.2104) in the Duna-Ipoly National Park in the immediate vicinity of Ócsa town. The study site is characterized by a post-glacial peat bog with a mosaic of habitats including open water surfaces, reedbeds, bushy vegetation and forests. It is situated in a humid continental transitional climate zone (for further details see Csörgő *et al.* 2016, ocsabirdringing.org). Birds were trapped with standard mistnets placed at standard locations throughout the study period. Trapping effort is seasonal and changed over the years (see Csörgő *et al.* 2016 for details).

The day of the year of first capture in spring and in autumn were considered as arrival (migration) timing of individual birds. Stopover duration was calculated as the difference of within season last and first captures excluding within day recaptures. Biometric measurements were taken following strictly standardized methods (Szentendrey *et al.* 1979, EURING 2015). Only data of the first captures were used in the analysis. We distinguished first calendar year birds (juveniles) from adults as well as the sexes in both age classes upon plumage characteristics (Cramp 1988, Svensson 1992, Demongin 2016), and we present all results according to these groups. We present data for spring , breeding and autumn migratory seasons separately; birds caught after the 50th and before the 120th day of the year were considered to be spring migrants and birds caught after the 250th and before the 320th day of the year were considered to be autumn migrants. A total of 6849 Common Blackbirds were captured and ringed between February and November; 410 males and 649 females in spring, 213 adult males and 194 adult females,1696 juvenile males and 1125 juvenile females in the breeding season and 118 adult males and 234 adult females, 894 juvenile males and 726 juvenile females in autumn (the rest of the birds were not aged and sexed) in the study period of 1984–2016. This total value constitutes ca. 8% of the 86,720 Common Blackbirds ringed in Hungary in this period.

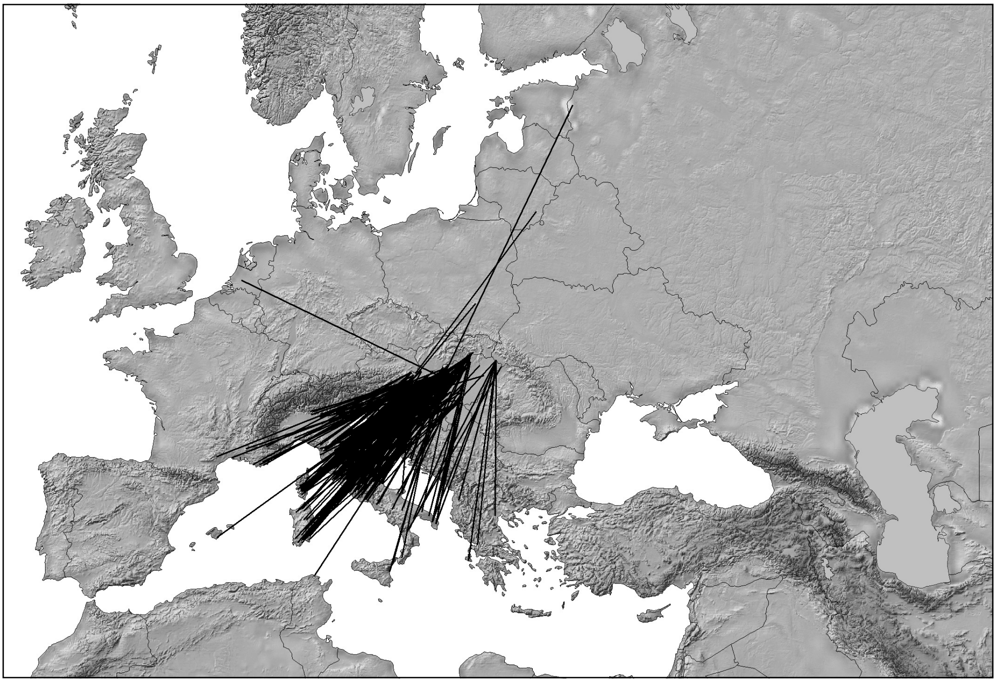
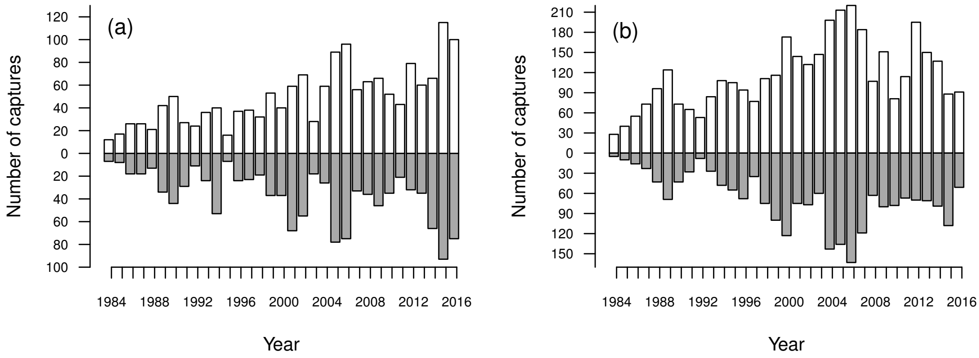


Figure 1. Foreign ring recoveries of Common Blackbirds. The data of birds ringed in Hungary and recovered abroad and the birds ringed abroad and recovered in Hungary are depicted

1. ábra Magyarországon jelölt és külföldön megkerült, illetve külföldön jelölt és Magyarországon megfogott fekete rigók

Statistical methods

To describe daily and yearly capture frequencies and the cumulative distribution of the date of first captures with recaptures, we used the functions of the `ringR` package (Harnos *et al.* 2015). Descriptive tables (mean, median, standard deviation (SD), minimum (min), maximum (max) values and sample size (N)) on the timing of migration, stopover duration, the length of wing, third primary and tail, and body mass were created by the `data.table` package (Dowle *et al.* 2013), which is highly effective in calculating summary statistics for different groups and subsets. The annual mean values of timing, body mass, wing-, third primary and tail lengths are plotted against time (year) on scatterplots. Loess smooth lines were fitted to highlight trends (Cleveland *et al.* 1992). The distribution of the same variables were represented with histograms and overlaied smooth histograms. Boxplots were used to show the body mass distributions by fat score categories. Fat and muscle score frequencies are shown using barplots. We distinguished seasonsage and sex groups throughout the analyses. For more details on the analysis, please visit ocsabirdringing.org. All analyses were carried out in R 3.4.0 (R Core Team 2017).



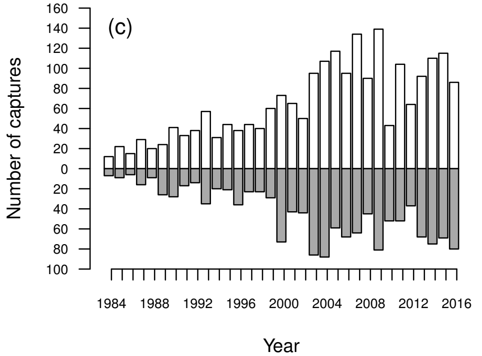


Figure 2. Annual capture (white bars) and recapture (grey bars) frequencies in spring (a), in the breeding period (b), and in autumn (c)

2. ábra Éves fogás (fehér oszlopok) és visszafogás (szürke oszlopok) gyakoriságok tavasszal (a), a költési időszakban (b) és ősszel (c)

Results

A total of 297 foreign recaptures were recorded between 1951 and 2016 in relation to Hungary *(Figure 1)*. Annual capture and recapture frequencies at the study site are shown in *Figure 2*. Within-year capture and recapture frequencies, together with cumulative distributions of individual first and last captures are depicted in *Figure 3*, while their respective descriptive statistics are presented in *Tables 1–2*. Changes in annual mean arrival dates throughout the study period and the distributions of within-year migration timing according to season, age and sex are presented in *Figure 4*. The trend of annual mean wing lengths and the distribution of wing length measurements according to season, age and sex are shown in *Figure 5*, while their respective descriptive statistics are presented in *Table 3*. Third primary length *(Figure 6, Table 4)*, tail length *(Figure 7, Table 5)* and body mass *(Figure 8, Table 6)* are presented in a similar fashion. Body mass in relation to season, age, sex and fat scores are visualized with boxplots in *Figure 9 a,c,e,g,i*. Finally, the distributions of fat and muscle scores grouped by season, age and sex can be found in *Figure 9 b,d,f,h,j* and *Figure 10*, respectively.

Capture and recapture frequencies

Yearly captures and recaptures

Table 1. Descriptive statistics of migration timing (day of the year)
1. táblázat A vonulás időzítés (év napja) leíró statisztikái

Season	Age	Sex	Mean	Median	SD	Min	Max	N
spring	adult	male	86.0	83.0	14.5	50	120	410
spring	adult	female	86.2	85.0	12.8	52	120	649
breeding	adult	male	172.0	177.0	28.5	121	247	213
breeding	adult	female	186.5	191.5	33.1	121	249	194
breeding	juvenile	male	201.0	201.0	23.1	127	249	1696
breeding	juvenile	female	203.8	202.0	22.3	127	249	1125
autumn	adult	male	284.9	286.0	13.6	251	318	118
autumn	adult	female	281.3	281.0	13.7	251	318	234
autumn	juvenile	male	282.4	282.0	16.3	250	320	894
autumn	juvenile	female	281.7	282.0	16.2	250	320	726

Table 2. Descriptive statistics of stopover duration (day)
2. táblázat A tartózkodási idő (nap) leíró statisztikái

Season	Age	Sex	Mean	Median	SD	Min	Max	N
spring	adult	male	18.2	16.0	12.3	1	60	252
spring	adult	female	14.4	10.5	12.5	1	58	264
autumn	adult	male	11.4	9.5	11.0	1	48	20
autumn	adult	female	13.3	10.0	12.9	1	48	33
autumn	juvenile	male	11.6	8.0	11.6	1	56	99
autumn	juvenile	female	12.9	9.0	12.7	1	65	95

Table 3. Descriptive statistics of wing length (mm)
3. táblázat A szárnyhossz (mm) leíró statisztikái

Season	Age	Sex	Mean	Median	SD	Min	Max	N
spring	adult	male	127.7	128.0	3.6	117	137	364
spring	adult	female	123.8	124.0	3.3	113	134	580
breeding	adult	male	126.6	126.0	3.0	120	133	107
breeding	adult	female	123.0	123.0	3.3	113	130	81
breeding	juvenile	male	126.0	126.0	3.2	112	136	1564
breeding	juvenile	female	123.2	123.0	3.0	96	133	1067
autumn	adult	male	130.4	130.0	3.3	122	137	107
autumn	adult	female	124.4	124.0	3.1	115	132	217
autumn	juvenile	male	127.0	127.0	2.9	117	137	848
autumn	juvenile	female	123.4	123.0	3.0	112	132	695

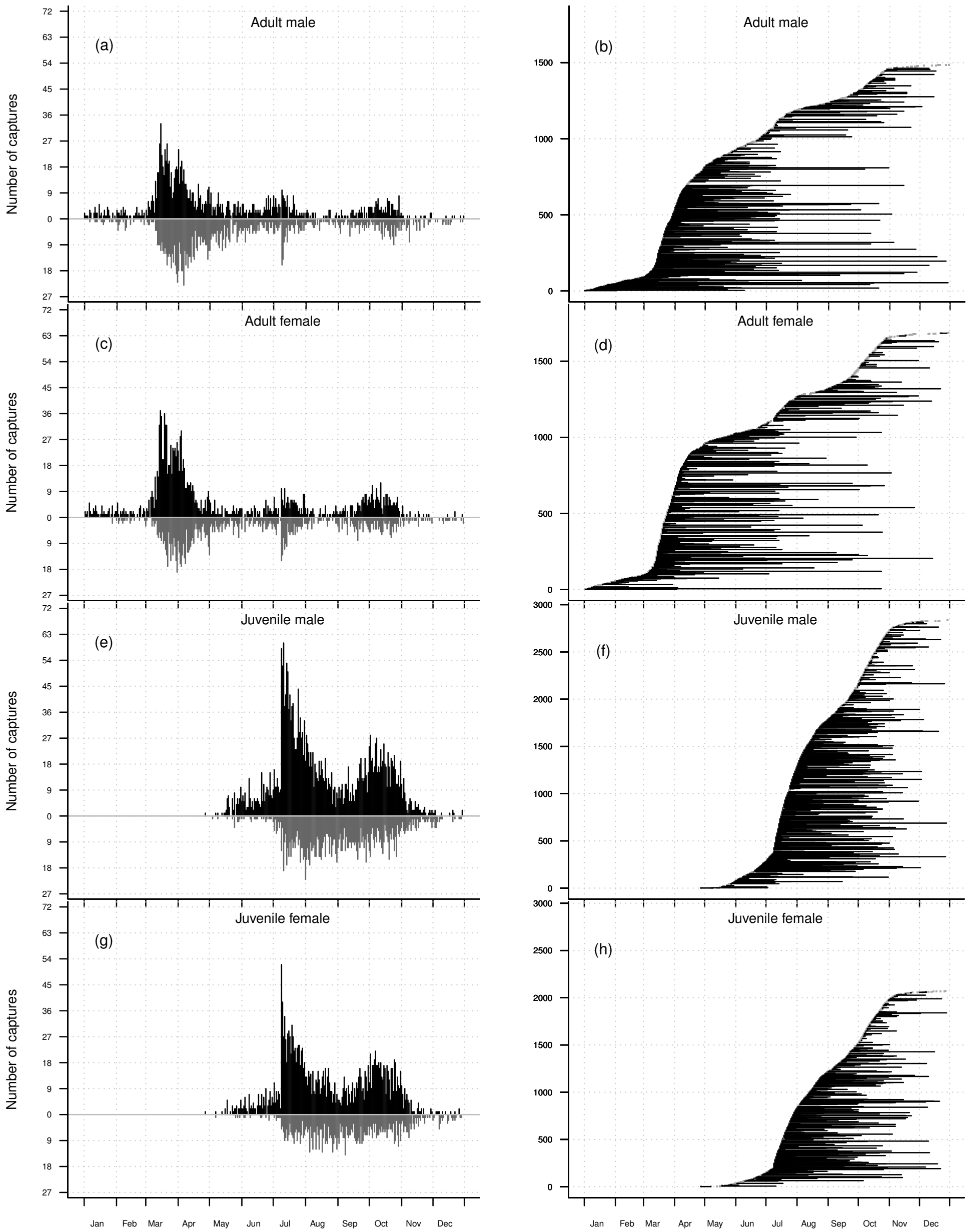


Figure 3. Within-year capture (black bars) and recapture (grey bars) frequencies (a, c, e, g) and cumulative distributions of individual first and last capture dates (b, d, f, h) according to age and sex

3. ábra Éven belüli fogás (fekete oszlopok) és visszafogás (szürke oszlopok) gyakoriságok (a, c, e, g) és az egyedek első és utolsó fogási dátumának kumulatív eloszlása (b, d, f, h) kor- és ivar csoportonként

Table 4. Descriptive statistics of third primary length (mm)
4. táblázat A harmadik evező hosszának (mm) leíró statisztikái

Season	Age	Sex	Mean	Median	SD	Min	Max	N
spring	adult	male	97.2	97.0	3.1	82	105	328
spring	adult	female	93.9	94.0	2.8	86	103	522
breeding	adult	male	96.2	96.0	2.5	88	102	87
breeding	adult	female	93.1	93.0	2.7	84	99	65
breeding	juvenile	male	95.5	96.0	2.9	84	110	1485
breeding	juvenile	female	93.2	93.0	2.7	64	107	1005
autumn	adult	male	99.3	99.0	2.9	93	106	104
autumn	adult	female	94.5	94.0	2.5	86	101	213
autumn	juvenile	male	96.4	96.0	2.6	84	106	815
autumn	juvenile	female	93.4	93.0	2.5	84	101	674

Table 5. Descriptive statistics of tail length (mm)
5. táblázat A farokhossz (mm) leíró statisztikái

Season	Age	Sex	Mean	Median	SD	Min	Max	N
spring	adult	male	106.9	107.0	5.0	90	124	359
spring	adult	female	103.3	103.0	4.9	87	117	566
breeding	adult	male	107.0	107.0	4.8	93	119	102
breeding	adult	female	102.4	103.0	4.1	86	111	77
breeding	juvenile	male	107.0	107.0	5.2	64	125	1530
breeding	juvenile	female	104.8	105.0	4.9	51	125	1047
autumn	adult	male	109.8	110.0	4.1	98	118	102
autumn	adult	female	104.1	105.0	4.7	89	118	217
autumn	juvenile	male	106.4	106.0	4.6	93	120	830
autumn	juvenile	female	103.3	103.0	4.7	87	120	681

Table 6. Descriptive statistics of body mass (g)
6. táblázat A testtömeg (g) leíró statisztikái

Season	Age	Sex	Mean	Median	SD	Min	Max	N
spring	adult	male	84.6	83.2	7.1	67.4	106.3	404
spring	adult	female	83.2	82.2	6.8	67.1	105.0	633
breeding	adult	male	82.8	83.0	4.7	72.7	102.0	207
breeding	adult	female	84.7	84.1	6.8	62.9	112.9	185
breeding	juvenile	male	81.5	81.2	5.8	61.5	105.0	1663
breeding	juvenile	female	80.7	80.4	5.7	61.0	100.0	1104
autumn	adult	male	87.7	87.5	5.6	76.0	102.4	117
autumn	adult	female	84.8	84.4	5.9	71.5	109.2	232
autumn	juvenile	male	85.9	85.1	5.4	60.7	111.1	879
autumn	juvenile	female	83.8	83.0	5.8	62.2	104.6	718

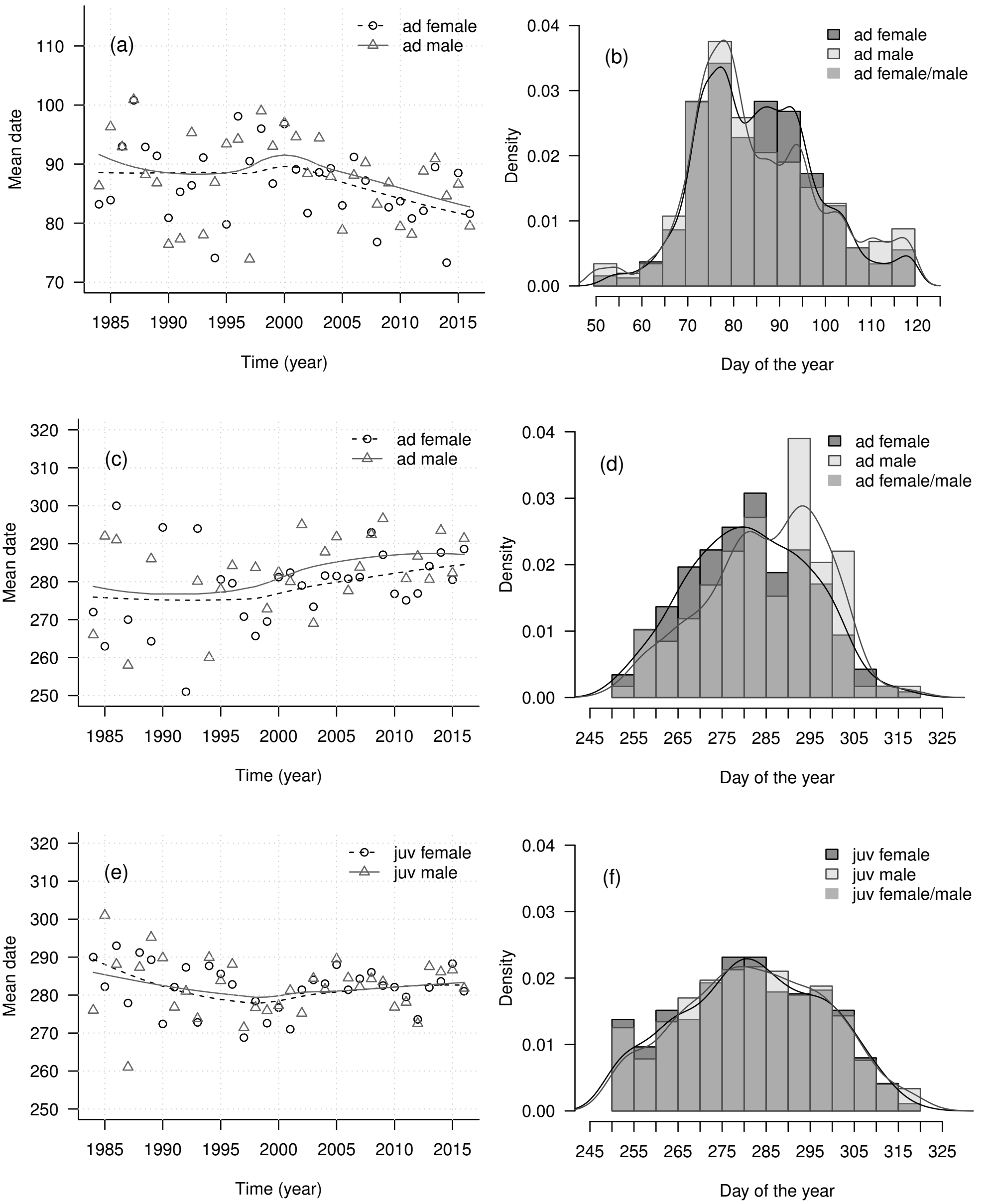
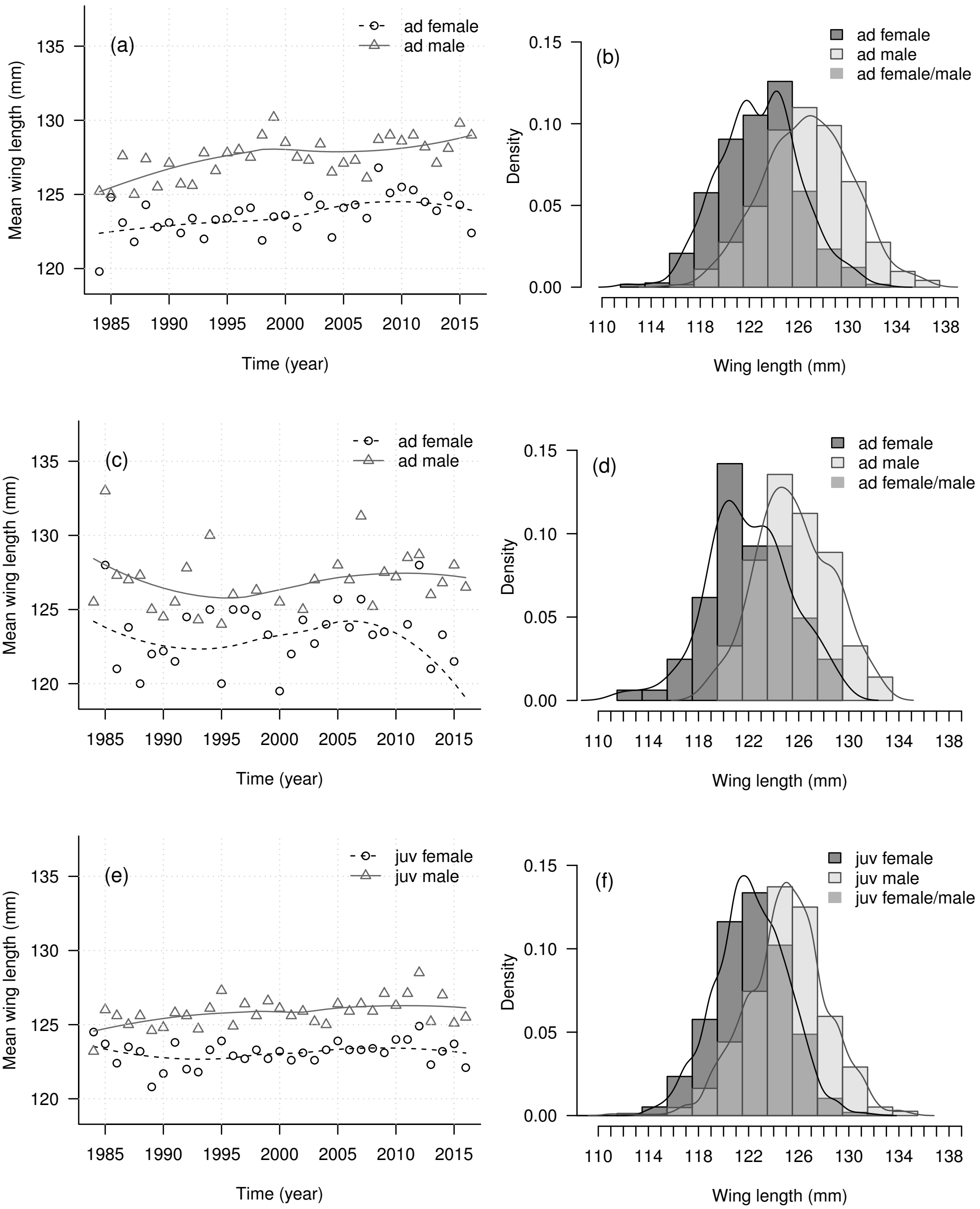


Figure 4. Annual mean migration timing (day of the year) throughout the study period and histograms/smoothed histograms of timing in spring (a–b) and in autumn (c–f)

4. ábra Az éves átlagos vonulás időzítés (év napja) a vizsgálati időszakban és az időzítés hisztogramja/simított hisztogramja tavasszal (a–b) és ősszel (c–f)


(a)
ad female
ad male
Mean wing length (mm)
Time (year)
(b)
ad female
ad male
ad female/male
Density
Wing length (mm)
(c)
ad female
ad male
Mean wing length (mm)
Time (year)
(d)
ad female
ad male
ad female/male
Density
Wing length (mm)
(e)
juv female
juv male
Mean wing length (mm)
Time (year)
(f)
juv female
juv male
juv female/male
Density
Wing length (mm)

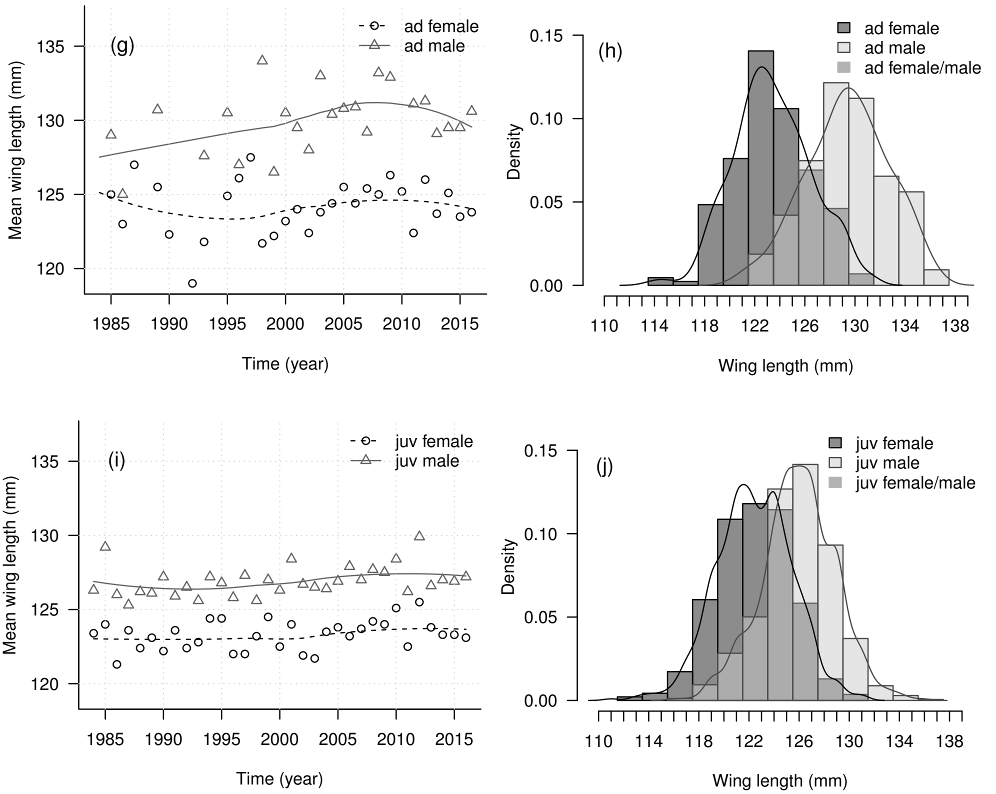
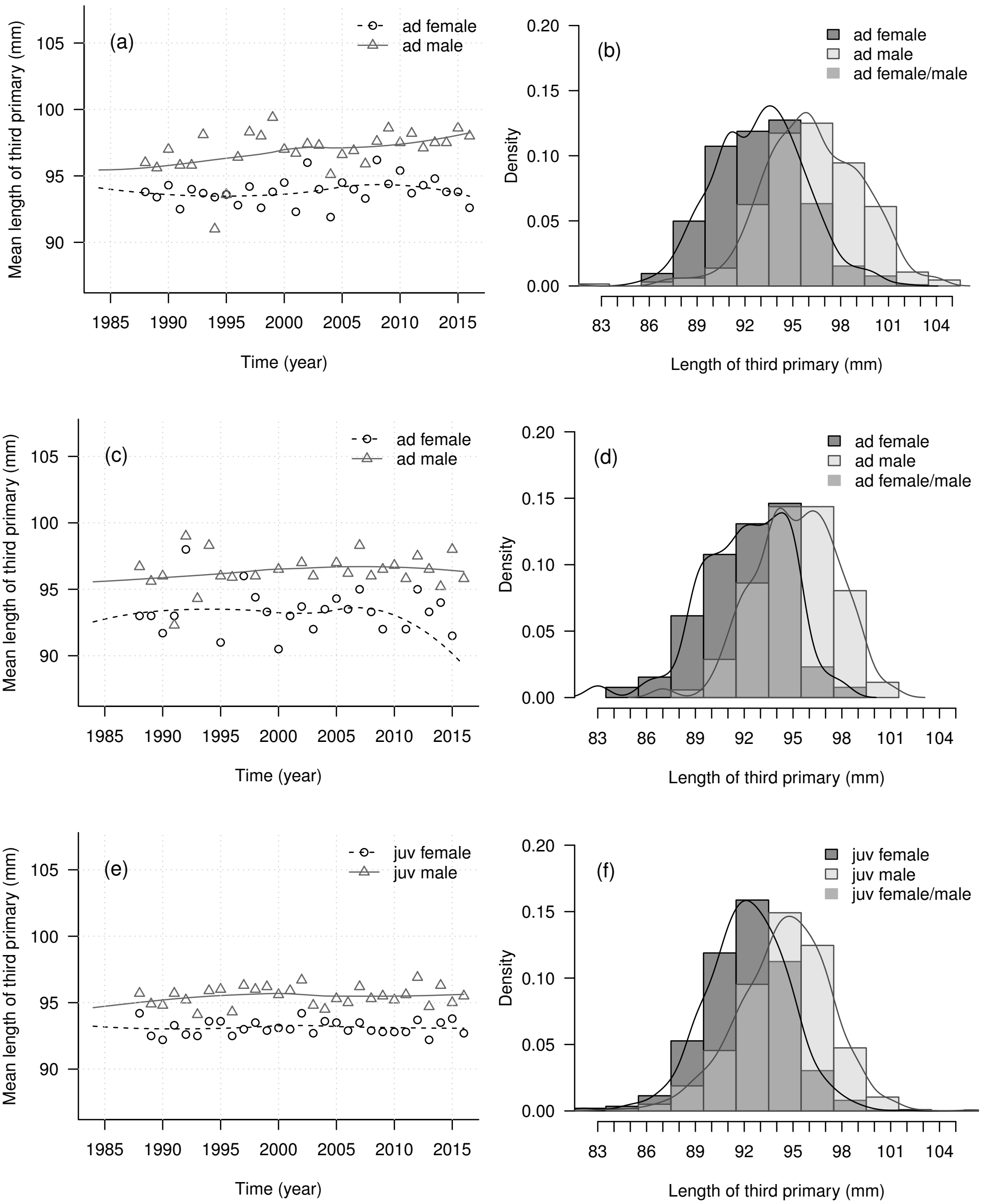


Figure 5. Annual mean wing length (mm) throughout the study period and histograms/smoothed histograms of wing length in spring (a–b) in the breeding period (c–f) and in autumn (g–j)

5. ábra Az éves átlagos szárnyhossz (mm) a vizsgálati időszakban és a szárnyhossz hisztogramja/simított hisztogramja tavasszal (a–b), a költési időszakban (c–f) és ősszel (g–j)


(a)
ad female
ad male
Mean length of third primary (mm)
Time (year)
(b)
ad female
ad male
ad female/male
Density
Length of third primary (mm)
(c)
ad female
ad male
Mean length of third primary (mm)
Time (year)
(d)
ad female
ad male
ad female/male
Density
Length of third primary (mm)
(e)
juv female
juv male
Mean length of third primary (mm)
Time (year)
(f)
juv female
juv male
juv female/male
Density
Length of third primary (mm)

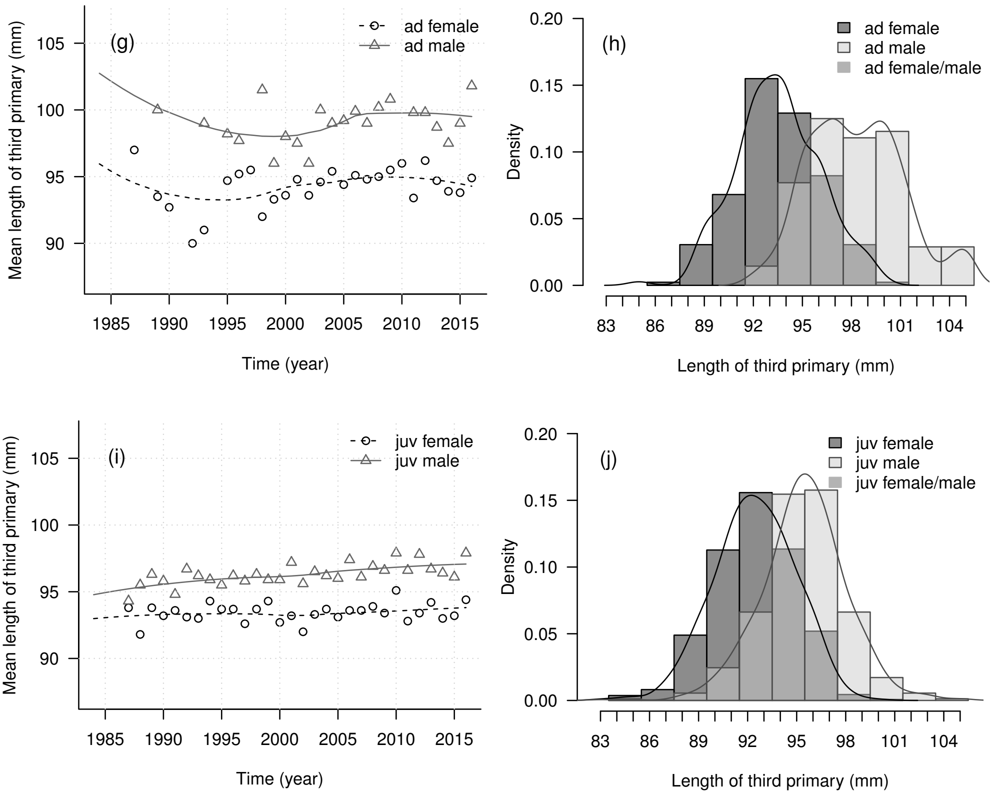
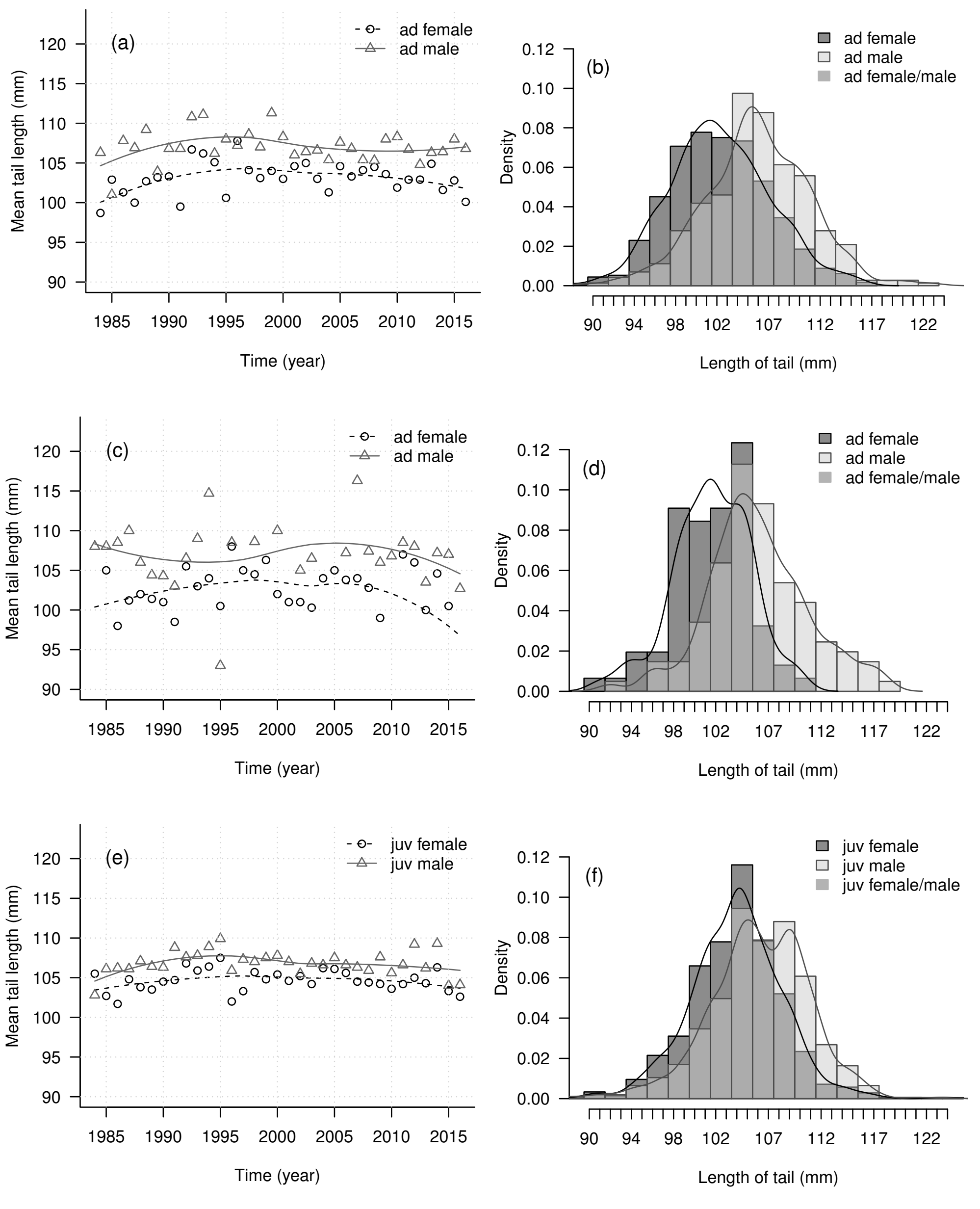


Figure 6. Annual mean third primary length (mm) throughout the study period and histograms/smoothed histograms of third primary length in spring (a–b) in the breeding period (c–f) and in autumn (g–j)

6. ábra Az éves átlagos harmadik evező hossz (mm) a vizsgálati időszakban és a harmadik evező hosszának hisztogramja/simított hisztogramja tavasszal (a–b), a költési időszakban (c–f) és ősszel (g–j)


(a)
ad female
ad male
Mean tail length (mm)
Time (year)
(b)
ad female
ad male
ad female/male
Density
Length of tail (mm)
(c)
ad female
ad male
Mean tail length (mm)
Time (year)
(d)
ad female
ad male
ad female/male
Density
Length of tail (mm)
(e)
juv female
juv male
Mean tail length (mm)
Time (year)
(f)
juv female
juv male
juv female/male
Density
Length of tail (mm)

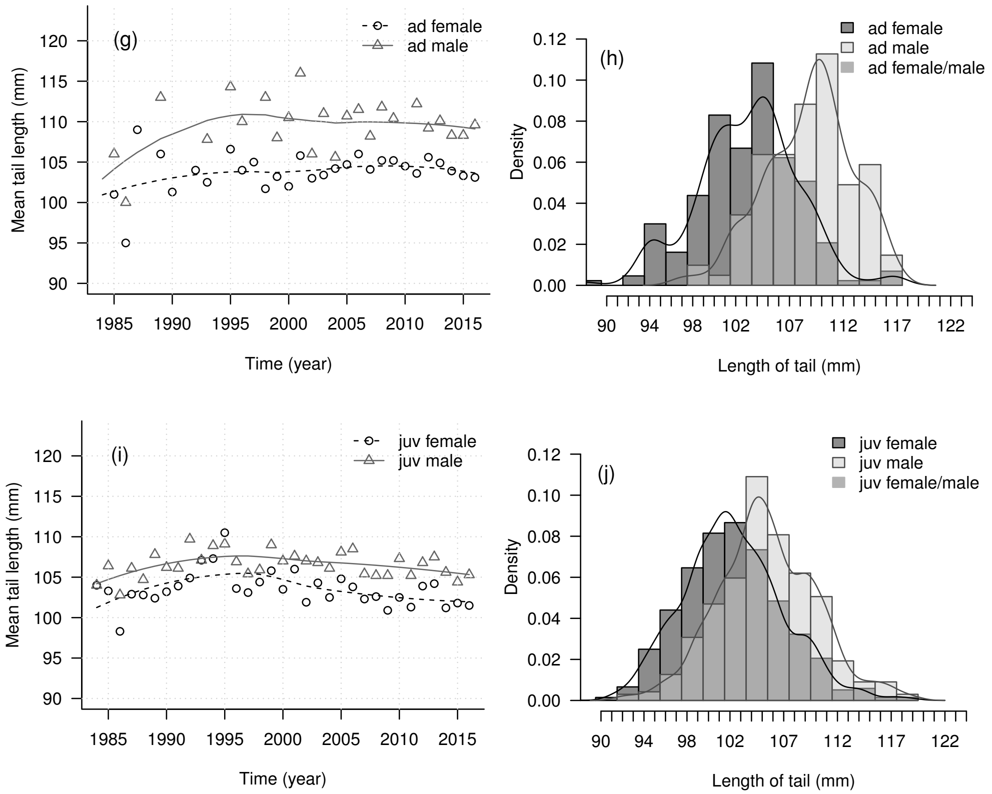
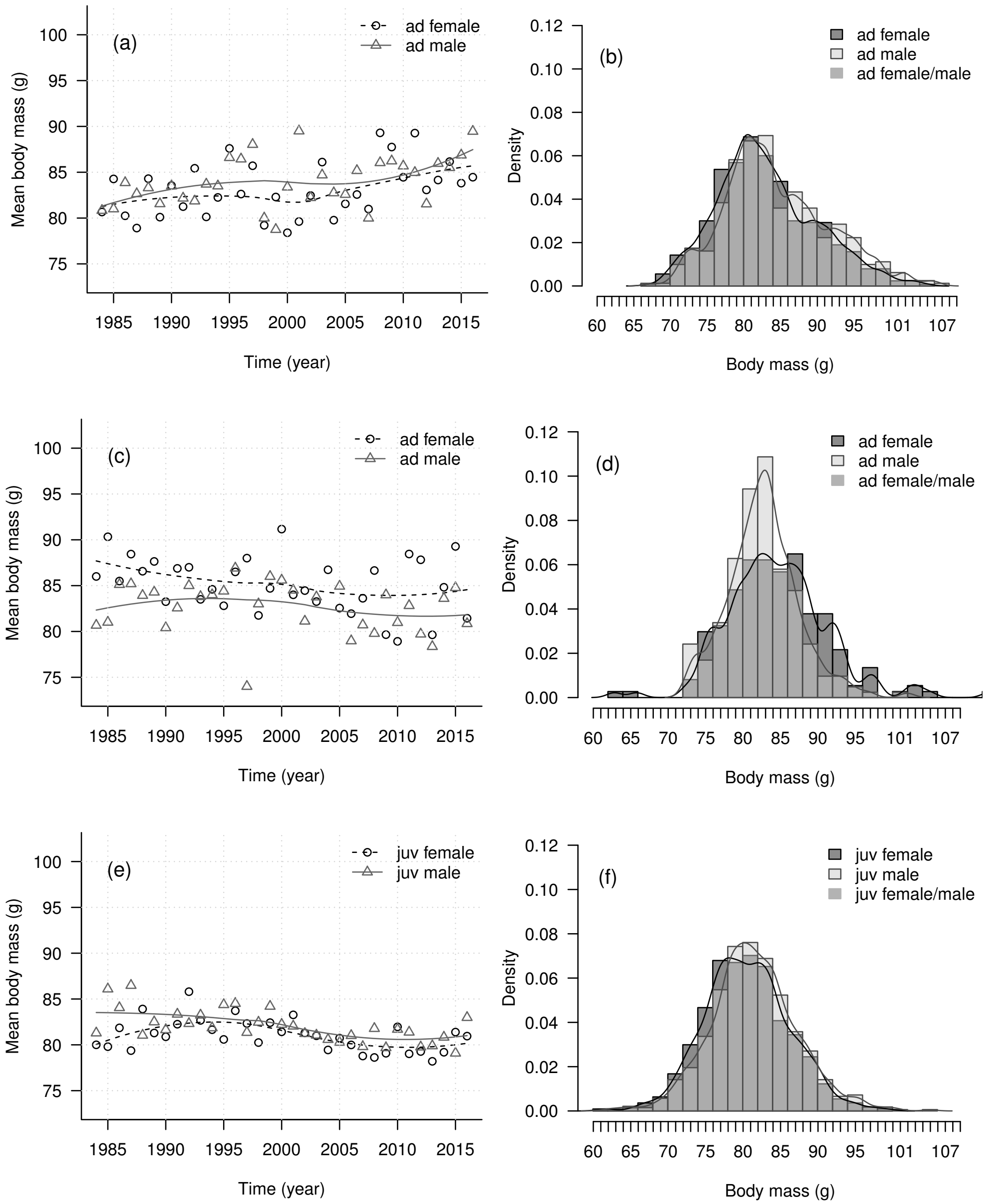


Figure 7. Annual mean tail length (mm) throughout the study period and histograms/smoothed histograms of tail length in spring (a–b) in the breeding period (c–f) and in autumn (g–j)

7. ábra Az éves átlagos farokhossz (mm) a vizsgálati időszakban és a farokhossz hisztogramja/simított hisztogramja tavasszal (a–b), a költési időszakban (c–f) és ősszel (g–j)


(a)
ad female
ad male
Mean body mass (g)
Time (year)
(b)
ad female
ad male
ad female/male
Density
Body mass (g)
(c)
ad female
ad male
Mean body mass (g)
Time (year)
(d)
ad female
ad male
ad female/male
Density
Body mass (g)
(e)
juv female
juv male
Mean body mass (g)
Time (year)
(f)
juv female
juv male
juv female/male
Density
Body mass (g)

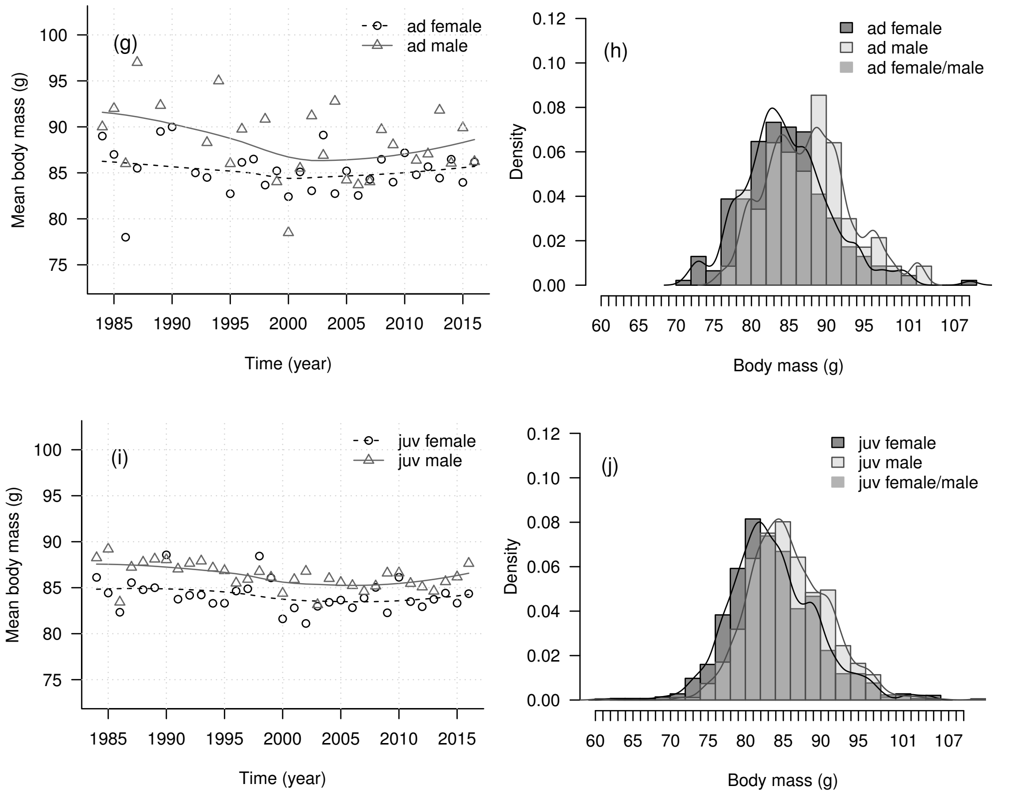
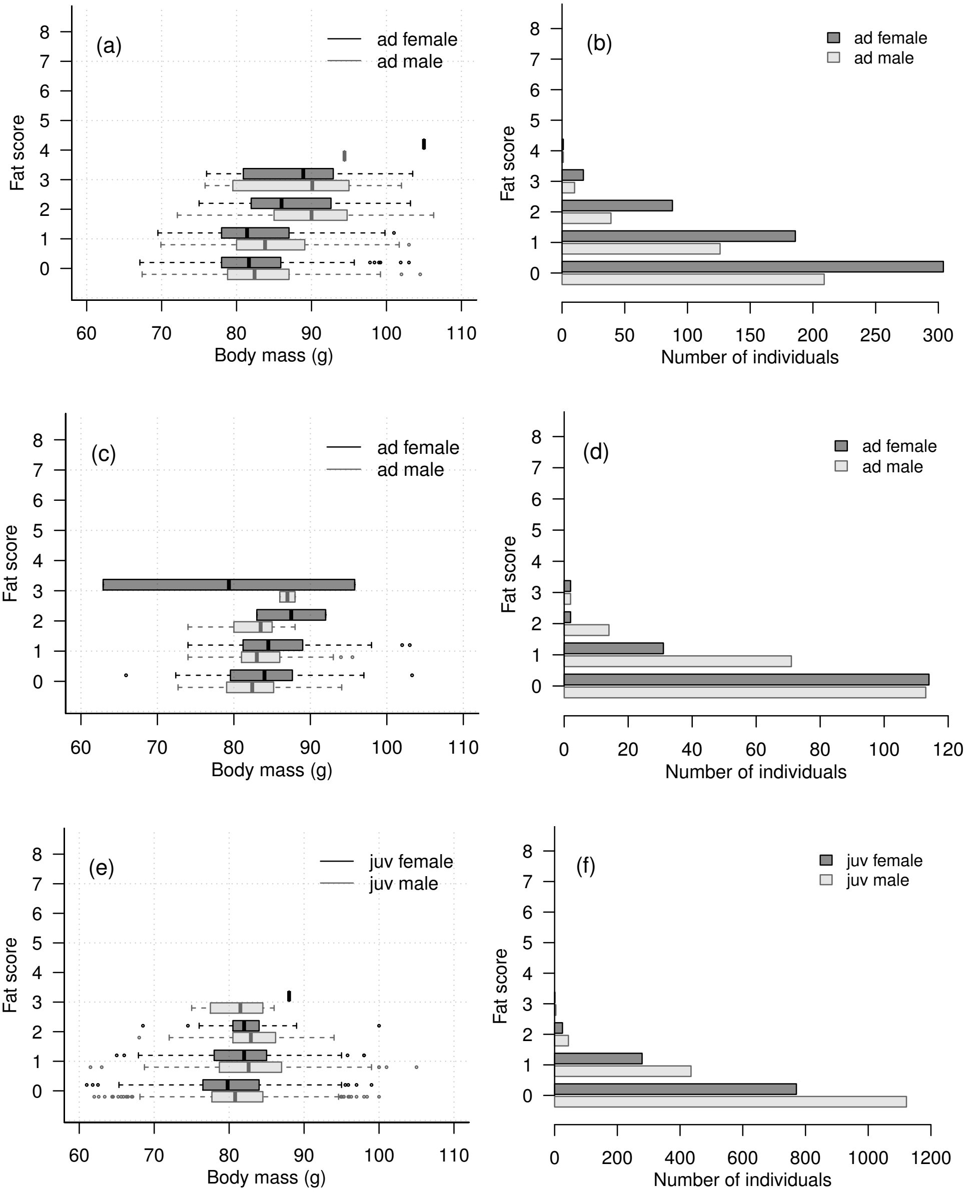


Figure 8. Annual mean body mass (g) throughout the study period and histograms/smoothed histograms of body mass in spring (a–b) in the breeding period (c–f) and in autumn (g–j)

8. ábra Az éves átlagos testtömeg (g) a vizsgálati időszakban és a testtömeg hisztogramja/simított hisztogramja tavasszal (a–b), a költési időszakban (c–f) és ősszel (g–j)


(a)
ad female
ad male
Fat score
Body mass (g)
(b)
ad female
ad male
Fat score
Number of individuals
(c)
ad female
ad male
Fat score
Body mass (g)
(d)
ad female
ad male
Fat score
Number of individuals
(e)
juv female
juv male
Fat score
Body mass (g)
(f)
juv female
juv male
Fat score
Number of individuals

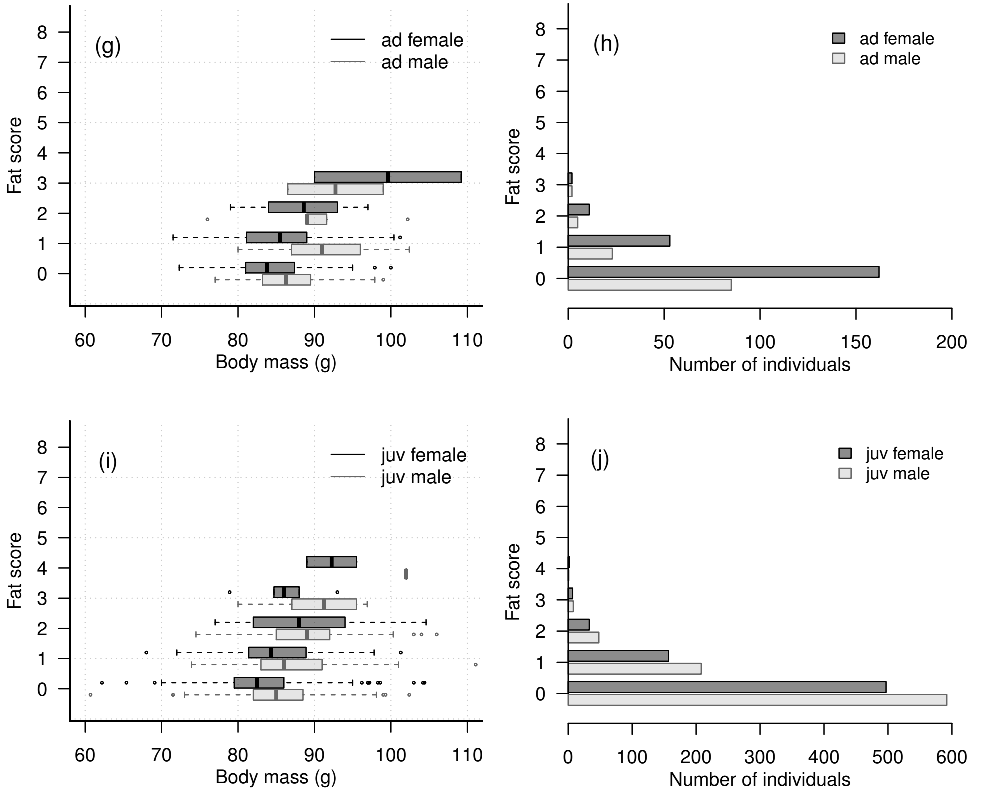


Figure 9. Boxplots of body mass according to fat score, and fat score frequencies in spring (a–b) in the breeding period (c–f) and in autumn (g–j)

9. ábra A testtömeg boxplot-ja zsírkategóriánként és a zsírkategóriák gyakoriságai tavasszal (a–b), a költési időszakban (c–f) és ősszel (g–j)

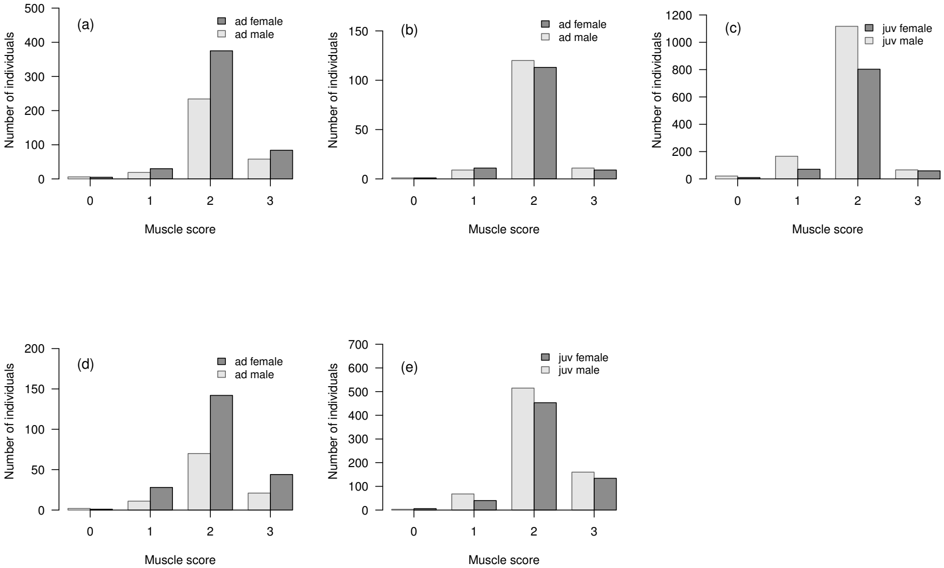


Figure 10. Muscle score frequencies in spring (a) in the breeding period (b–c) and in autumn (e–f)
10. ábra Izom kategória gyakoriságok tavasszal (a), a költési időszakban (b–c) és ősszel (e–f)

Discussion

Although, the Blackbird is one of the most numerously ringed bird in the northern countries (Wozniak 1997, Bønløkke *et al.* 2006, Fransson & Hall-Karlsson 2008, Klvaňa 2008, Bairlein *et al.* 2014, Valkama *et al.* 2014), we have only two recoveries from Russia, Slovakia, and some birds ringed in Hungary were recaptured in Slovakia, the Czech Republic, Poland, Lithuania, and one probably disoriented bird in the Netherlands *(Figure 1)*. This geographical area looks special to this species, since there were only two recoveries in the Czech Republic from Poland and Sweden, and there were only one Polish, one Lithuanian and one disoriented Belgian recovery in Croatia (Klvaňa 2008, Budinski 2013). It seems, that the Carpathians are some kind of a barrier for the northern Blackbirds resulting that the migration fly-ways avoid the Carpathian Basin. Birds ringed in the breeding period have been recovered in a relatively limited range in the Central Mediterranean, where the birds ringed during passage have been recovered in a much wider range. Perhaps these birds originated from eastern regions, where the ringing activity is poor. Birds ringed in the eastern parts of Hungary have been recovered further east (Csörgő & Gyurácz 2009, BirdLife Hungary 2017). Among the European populations the Hungarian is the most dependent on the Appenine Peninsula in winter (Csörgő & Gyurácz 2009).

Apparently, there is considerable variation in inter-annual capture frequencies during all seasons. In general, more birds were captured per season in the second half of the study period *(Figure 2)*. Blackbirds migrate early in the season (March), when ringing activity was less intensive prior to 2005, therefore this pattern is caused by the bias in ringing effort and not by the changes in the behaviour of birds.

Overall, far more adult birds are captured in spring than in autumn suggesting loop migration of the trans-migrant population at the Ócsa Bird Ringing Station *(Figure 3 a,c)*. The overwintering birds do not necessarily breed here, but a remarkable part of the migrants breed at the study site *Figure (3 b,d)*. There are relatively few new birds during the breeding period *(Figure 3 a,c)*. There are far more females than males *(Table 1)*.

There is no substantial difference between the timings of the age and sex groups, except that males desert from the nests earlier than females *(Table 1)*. The number of captured juveniles in autumn is not outstandingly large compared to the trans-migratory birds in spring *(Figure 3 a,c,e,g, Table 1)*. The recapture rate seems to be higher among the adults than among the juveniles, probably due to the higher dispersion rate of the juveniles *(Figure 3 a,c,e,g)*.

The stopover duration of adult males is seemingly longer and the recapture rate is higher than that of the females' in spring *(Table 1–2)*.

While the spring migration timing of the adults appears to be shifting earlier in the second half of the study period *(Figure 4 a)*, the autumn timings of both age groups appear to be slightly delaying *(Figure 4 b,c)*. Timing of all age and sex groups are rather similar in the autumn *(Figure 4 c–f)*. The distributions of arrival timing of adults are seemingly bimodal in both seasons *(Figure 4 b,d)*.

Considering morphometrics, there is a definite indication of sexual (males are larger than females), and age related (adults are larger than juveniles) dimorphism *(Figures 5–7 b,h,j, Table 3–5)*, but no indication of change can be seen in these parameters within the study period *(Figures 5–8 a,g,i)*.

Body mass is is similar in the sexes, but it is the largest in the adult male group in autumn *(Table 6)*. Fat scores are apparently higher in spring *(Figures 9 b,h,j)*, although body masses are similar.

Our results show that comprehensive exploratory analyses may reveal intriguing patterns, which may be investigated in more detail in the future. However, we emphasize that although the temporal extent of the data reported here is considerably large, all information presented here derives from a single location and thus has to be interpreted accordingly. Nonetheless, we hope that our results will help researchers conducting comparative or meta-analyses with baseline data and may also encourage others to report their data in a similar fashion. We also seek cooperation with interested parties and are willing to share all data reported here. Please contact the corresponding author for details.

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