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The status of the European Stonechat *(Saxicola rubicola)* in Hungary: a review

Tibor Csörgő[1*], József Gyurácz[2], Péter Lovászi[3], Zsolt Karcza[4], Tibor Szép[5] & Andrea Harnos[6]

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Abstract In 2021, the European Stonechat *(Saxicola rubicola)* became the 'Bird of The Year' in Hungary, which makes it very timely to summarise our knowledge about the status of the species in the country and to emphasise conservation priorities.

In Hungary, the species is a common, widespread breeder of dry roadside grass strips, abandoned ploughlands, bushy slopes and vineyards. It is most likely in the arid habitats between the Danube and Tisza and east of the Tisza. The largest populations also breed in these regions. The Hungarian population was estimated at 195,000–210,000 pairs between 2014 and 2018. The breeding population halved between 1999 and 2018, though it was stable until 2004. The breeding period begins from late March to early April and lasts until the end of July. First males arrive in February, and spring migration peaks in early March. Autumn migration peaks in late September. Few may overwinter. The number of birds ringed in Hungary since 1951 is 13,484, of which 1,401 were juvenile. Three birds ringed in Hungary were found abroad (Italy 2, Greece 1), and two specimens marked abroad (Croatia, Italy) were found in Hungary. The oldest bird was recaptured 1679 days after its ringing day in Hungary. The average body mass of juveniles increased significantly for both sexes by an average of 0.9 grams over 22 years. In the case of all age and sex groups, the average body mass increased during the autumn season. The average wing length of adults also increased during the autumn. The arrival time of either sex during spring migration did not change significantly between 1999 and 2020. In the case of all age and sex groups, the arrival time shifted later in autumn migration. The European Stonechat belongs to the red list category Near Threatened in Hungary.

Keywords: trend of populations, ringing results, migration, dispersion, conservation

Összefoglalás A cigánycsukot *(Saxicola rubicola)* 2021-ben „Az év madarának" választotta a Magyar Madártani és Természetvédelmi Egyesület. Ezen alkalomból jelen írás összefoglalja a cigánycsuk földrajzi elterjedésére, állománynagyságára, fészkelésére, vonulására, valamint természetvédelmi helyzetére vonatkozó lényeges ismereteket, kitekintve más országok fontosabb kutatási eredményeire is.

Magyarországon száraz út menti gyepsávok, felhagyott szántók, cserjés lejtők és szőlőültetvények gyakori, elterjedt fészkelője. Leggyakrabban a Duna–Tisza közén, valamint a Tiszántúl száraz élőhelyein fordul elő, legnagyobb fészkelő állományai is ezeken a vidékeken találhatók. A hazai populációt 2014–2018 között 195 000–210 000 párra becsülték. A költő madarak száma 1999–2018 között felére csökkent, bár 2004-ig lényegesen nem változott. A költési időszak március végén, április elején kezdődik és július végéig tart. Az első hímek februárban érkeznek, a tavaszi vonulás március elején tetőzik. Az őszi vonulás csúcsidőszaka szeptember vége. Kis számban át is telelhetnek. Magyarországon 1951 óta a gyűrűzött madarak száma 13 484, ebből 1401 fióka. Három Magyarországon gyűrűzött madár került meg külföldön (Olaszország 2, Görögország 1), kettő külföldön jelöltet (Horvátország, Olaszország) pedig Magyarországon fogtak vissza. A legidősebb madár 1679 nappal a gyűrűzés után került ismét kézre. A fiatal madarak átlagos testtömege mindkét nem esetében jelentősen, átlagosan 0,9 grammal nőtt a vizsgált 22 év során. Mindkét kor- és ivarcsoport esetében a madarak átlagos testtömege nőtt az őszi vonulás során. Az adult madarak átlagos szárnyhossza is nőtt az őszi vonulási időszak vége felé. 1999–2020 között a hímek és a tojók érkezési ideje sem változott lényegesen a tavaszi vonulási időszakban. Valamennyi kor- és ivar-

csoport érkezési ideje az őszi vonulás során későbbre tolódott. Hazánkban a cigánycsuk a veszélyeztetettséghez közeli vörös listás kategóriába tartozik.

Kulcsszavak: költőpopuláció változása, madárgyűrűzési eredmények, vonulás, diszperzió, természetvédelem

[1] Department of Anatomy, Cell- and Developmental Biology, Eötvös Loránd University, 1117 Budapest, Pázmány Péter sétány 1/c, Hungary
[2] Department of Biology, Eötvös Loránd University, Savaria Campus, 9700 Szombathely, Károlyi Gáspár tér 4., Hungary
[3] MME/BirdLife Hungary, 1121 Budapest, Költő utca 21., Hungary
[4] Hungarian Bird Ringing Center, MME/BirdLife Hungary, 1121 Budapest, Költő utca 21., Hungary
[5] University of Nyíregyháza, 4401 Nyíregyháza, Sóstói út 31/b, Hungary
[6] Department of Biomathematics and Informatics, University of Veterinary Medicine, 1078 Budapest, István utca 2., Hungary
** corresponding author, e-mail: tibor.csorgo@ttk.elte.hu*

Introduction

The European Stonechat has been generally considered conspecific with the Siberian Stonechat and African Stonechat, lumped together as Common Stonechat *Saxicola torquatus* (Cramp & Simmons 1988, Collar 2005). Using mtDNA cytochrome *b* sequences and nuclear DNA microsatellite fingerprinting evidence strongly supported the separation of Northern Eurasian taxa of the *S. torquatus* into distinct species (European Stonechat – *S. rubicola*, Siberian Stonechat – *S. maurus* and Stejneger's Stonechat – *S. stejnegeri*) (Urquhart & Bowley 2002, Wink *et al.* 2002, Zink *et al.* 2009, Opaev *et al.* 2018, Gill *et al*. 2021). The *S. rubicola* has two races: *S. r. rubicola* and *S. r. hibernans*. In Hungary, the *S. r. rubicola* race occurs (Hadarics & Zalai 2008).

The European Stonechat was the "Bird of The Year" in Hungary in 2021, which provides us with an exceptional opportunity to summarise the information about the distribution, population size, breeding ecology, migration and the nature conservation status in Hungary. Though this review focuses on the characteristics of the Hungarian population but also summarises the major research results from other parts of Europe as well.

Geographical distribution

The European Stonechat is a widespread species in Europe but less common in the northern part of its range (nearly absents from Fennoscandinavia, the Baltic States, Belorussia, southern and north Russia) (Small 2005, Hornman 2020). The breeding area of the *S. r. rubicola* race is from Northwest Africa, West, Central and South Europe to Southwest Russia and North Turkey, *S. r. hibernans* race is from Ireland, Britain, Northwest France to West Iberia and Southwest Norway (Helm *et al.* 2006, Gill *et al*. 2021). Over the past two decades, its distribution area at its northern border (Denmark, north Poland and Lithuania) has grown markedly (Hornman 2020).

Habitats

European Stonechats are usually found in lowlands, from sea level up to 400–500 m. In smaller numbers, it breeds up to 700–800 m in central and eastern Europe, exceptionally occurring up to 1,850 m (Italian Alps) or 2,230 m (Greece). This species prefers open natural or extensively cultivated areas with perches used as hunting and singing posts. It breeds in heathlands, moorlands, coastal dunes and rough grasslands with scattered small shrubs and bramble, open gorse, tussocks or heather, grassy hillsides, bush-studded pastures, roadsides and railway margins, and vineyards. Also prefers low manufactured structures such as fence lines, stone walls, and electric wires (Lardelli & Molnár 1997, Urquhart & Bowley 2002, Collar 2020).

It is a common nesting species in Hungary. Its most specific breeding sites are dry ditch banks, grass strips along dirt roads, abandoned arable lands with weeds, bushy hillsides, vineyards and afforestation, where there are bushes, paths and stalks protruding from the vegetation (Haraszthy 2019). During the breeding season, rarely, during migration, it occurs more often in wetlands (Gyurácz & Csörgő 2021).

Country-wide standardised data collection in the frame of the Hungarian Bird Atlas project (Szép *et al.* 2021) during 2014−2018 with detailed modelling of the probability of occurrence, relative density and its changing with environmental data showed that nesting is not expected only in the middle mountains covered with contiguous forest and in the area of larger cities (Gyurácz & Csörgő 2021). It is most likely in the arid habitats between the Danube and Tisza and east of the Tisza *(Figure 1)*. Based on the models, its occurrence is

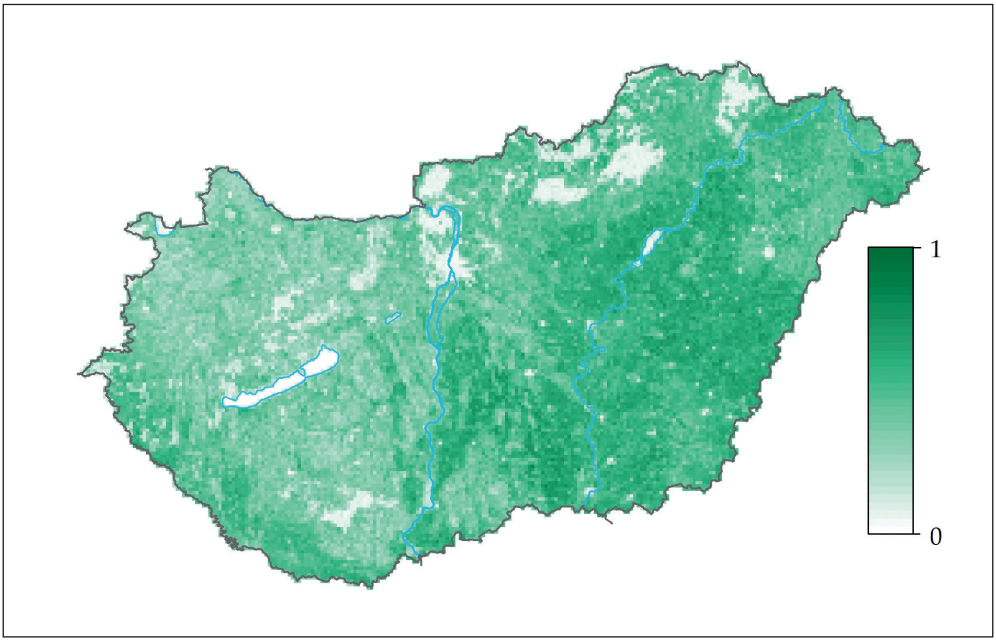


Figure 1. Probability of occurrence in the breeding season in Hungary (Gyurácz & Csörgő 2021)
1. ábra Előfordulási valószínűség a fészkelési időszakban (Gyurácz & Csörgő 2021)

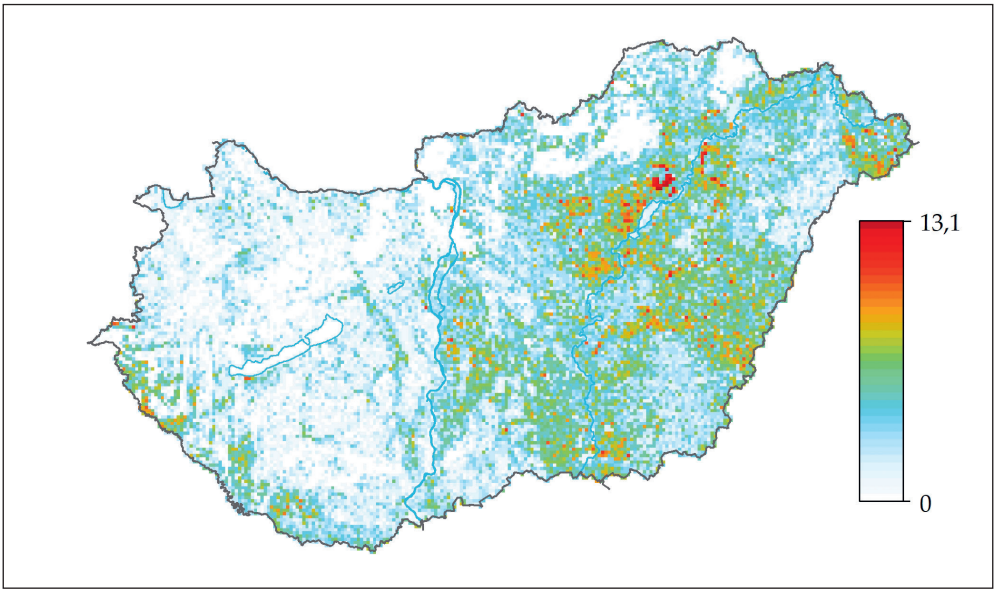


Figure 2. Predicted relative density in the breeding season in Hungary (Gyurácz & Csörgő 2021)
2. ábra Relatív egyedsűrűség a fészkelési időszakban (Gyurácz & Csörgő 2021)

positively correlated to arable lands, a kind of herbaceous vegetation, wetlands rich in soft-stemmed plants, alkaline grasslands, closed grasslands, and dirt roads (Gyurácz & Csörgő 2021). It is significantly less likely to occur in habitats above 200 metres above sea level (Gyurácz & Csörgő 2021).

Based on the modelling of the density of the breeding population, its largest populations are in the northern part of the Danube-Tisza area and east of the Tisza region (Gyurácz & Csörgő 2021) *(Figure 2)*. Its occurrence is positively influenced by paved roads, especially ditches and weeds along public roads (Gyurácz & Csörgő 2021).

Breeding

European Stonechats first breed when they are one year old. Monogamous during the breeding season but do not pair for life (Cramp & Simmons 1988). Interesting that male-female pairs defend territories also in winter quarters, the paired birds change partners regularly and pairs mostly split before leaving the area in spring (Gwinner *et al*. 1994, Rödl 1994, 1999).

Birds adapt flexibly to nesting conditions depending on their condition and remain long when conditions are right (Flinks *et al.* 2008). In Hungary, the first ones arrive in late February, mid-March usually occupies nesting sites, and nest building starts in late March, or early April. Egg-laying of the first clutch is from early April (Haraszthy 2019). Based on the reported observations of probable nesting in the frame of the Hungarian Bird Atlas project, the breeding period begins in mid-March and lasts until the end of July *(Figure 3)* (Gyurácz & Csörgő 2021).

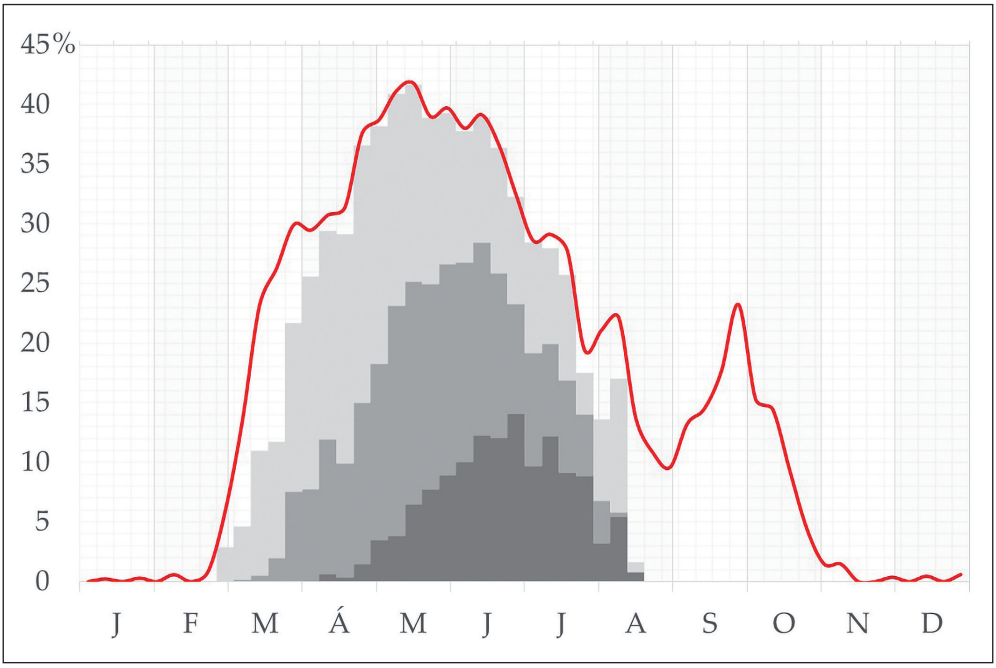


Figure 3. Frequency of observation probability (red line) and breeding evidence (possible – light grey, probable – grey, confirmed – dark grey) (Gyurácz & Csörgő 2021)

3. ábra Észlelési (piros vonal) és fészkelési valószínűség (világos szürke – lehetséges fészkelés, szürke – valószínű fészkelés, sötétszürke – biztos fészkelés) (Gyurácz & Csörgő 2021)

The incubation period is 13−14 days, the mean fledgling period is 13.5 days. Incubation is done by females only, but fledglings are cared for and fed by both parents (Cramp 1998).

According to Raess (2006), European Stonechats lay up to three clutches per season. In Hungary, it usually breeds twice a year, but rarely can third and additional breeding occur (Haraszthy 2019). It has a longer breeding season with the potential for rearing three broods compared to the long-distance migrant Whinchat *(S. rubetra)*. The greater productivity of the European Stonechat might compensate for higher winter mortality (Fuller & Glue 1977).

European Stonechats from Austria usually lay 5.0 to 5.6 eggs per clutch, and the estimated means were 5.09 eggs (Gwinner *et al.* 1995).

In Hungarian egg collections from the early and mid-20th century, clutches consist of 4 (4 cases), 5 (44), 6 (53) or 7 (3) eggs (Haraszthy 2019). Molnár (1986) found 5.4 eggs in 44 nests built on sloping canal banks, 5.4 eggs in 33 nests built on flat areas and 4.3 eggs in holes. The hatching rates were 73, 69, and 51% in the different nest types.

Clutch size decreases from first to second clutches in Slovakia. The clutch size of the third clutches increases again, indicating that only high-quality parents initiate a third seasonal breeding attempt or that a strategy of terminal investment is involved (Raess 2006). A Slovakian breeding pair produces about seven fledglings per season (Raess 2006).

Breeding population

The European population is 5,800,000–9,300,000 pairs (BirdLife International 2021).

In Hungary, Farkas (1958) mentioned it as a widespread but uncommon breeder, and according to Keve (1960, 1984), it was a quite common breeding bird in dry, bushy areas nationwide. The Hungarian population was estimated to be 200,000–400,000 pairs in the 1990s (Magyar *et al.* 1998), 390,000–515,000 pairs between 1999 and 2002 (Hadarics & Zalai 2008), 360,000–434,000 between 2000 and 2012 (Magyar Madártani és Természetvédelmi Egyesület – BirdLife Hungary 2019), 195,000–210,000 pairs between 2014 and 2018, based on the relative population density model (Gyurácz & Csörgő 2021). Modelled relative density is up to 13.1 individuals/km^2 (Gyurácz & Csörgő 2021).

Regional checklists from the last two decades also mention it as a common breeder. It was a common breeder near roads, on pastures, bare hillsides and weedy ditchshores in Nógrád County (northern Hungary) (Drexler 1997). It is a sporadic breeder on grasslands with scattered trees, weedy ditchshores and uncultivated arable lands in Vas County (western Hungary) (Gyurácz & Kóta 2020). A widespread breeder at the Hortobágy (eastern Hungary) and on the surrounding agricultural fields, the maximum density is 0.04–0.07 pairs/ha on abandoned paddy fields (Ecsedi & Kovács 2004).

Modelled relative density in Hungary is lower than the density found in optimal habitats on waste grounds (150–250 pairs/ha) in the Netherlands, 33 pairs/km² in Spain (Asturias), 31.5 pairs/km² on coastal cliffs in Britain, 8–12 pairs/km² in Rheinland grassland in Germany, or 2.8–9.6 pairs/km² on inland heathland in Britain (Collar 2020).

Population trends

The European population trend between 1989 and 2013 was stable (EBCC 2015). The EU27 population decreased by no more than 25% in 10 years (BirdLife International 2021), but for example, in Germany, the species has increased over the last two decades (Bairlein *et al.* 2014). The Pan-European Common Bird Monitoring Scheme reported a stable population between 1989 and 2017 (PECBMS 2021).

The population of the UK is probably fluctuating, with no long-term trend. Despite several former declines and range contractions, the population seems to be recovered (Woodward *et al*. 2020).

On the basis of the Hungarian Common Bird Monitoring (MMM, Szép *et al.* 2012), the Hungarian nesting population has a significant decreasing trend between 1999 and 2021 (-52.1%, CI = -59.2% – -43.8%, $P < 0.01$) *(Figure 4)*. It was still relatively stable until 2004, after which it gradually decreased until 2013, by more than 50% compared to 1999. Since 2013, the population index fluctuate and did not show a marked decline *(Figure 4)*. This trend was mainly a characteristic of Transdanubia, the North Central Mountains, and most Danube-Tisza areas. In most of the Trans-Tisza region, in Jászság and Borsodi-Mezőség, the number of nesting pairs was stable or slightly increasing (Gyurácz & Csörgő 2021) *(Figure 5)*.

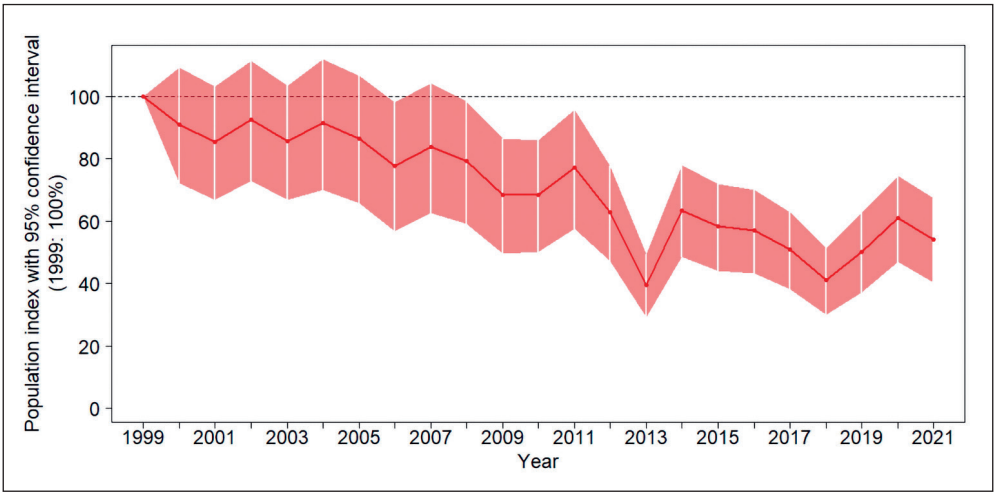


Figure 4. Population trend in the breeding season between 1999 and 2021 on the base of MMM data
4 ábra Állományváltozás a költési időszakban 1999–2021 között az MMM adatok alapján

Regional data are available from the Hortobágy region, where the species was only a passage migrant formerly. First breeding was found in 1976. Since 1984, the species gained ground in the national park area and became a common breeder by the late 1990s. According to the authors, the weeding of pastures due to decreasing grazing intensity helped spread the species countrywide (Ecsedi & Kovács 2004).

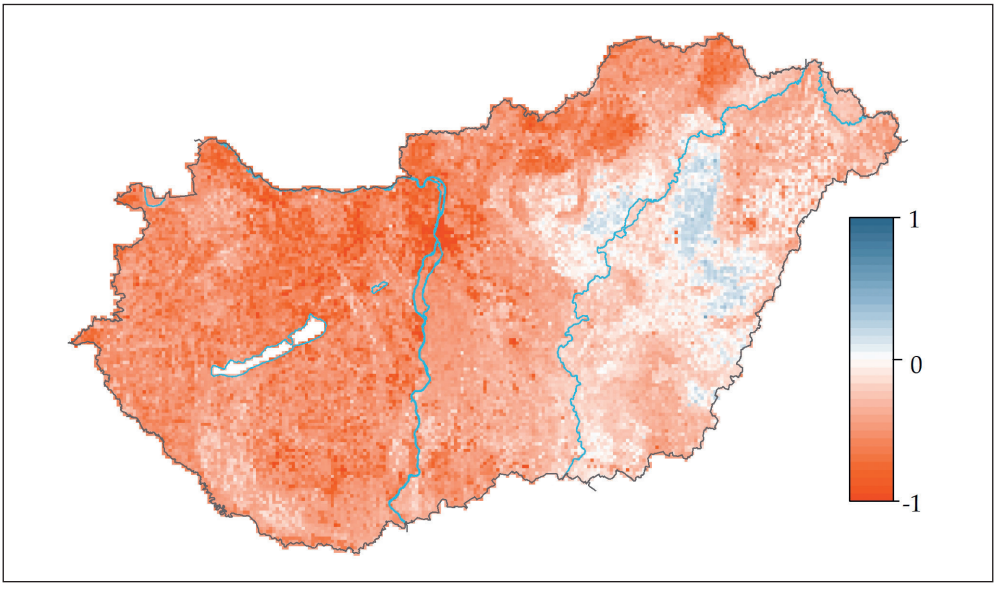


Figure 5. Trend index map in the breeding season in Hungary for the 1999–2018 period (Gyurácz & Csörgő 2021)
5. ábra Az állományváltozási index térképe a költési időszakban az 1999–2018 időszakban (Gyurácz & Csörgő 2021)

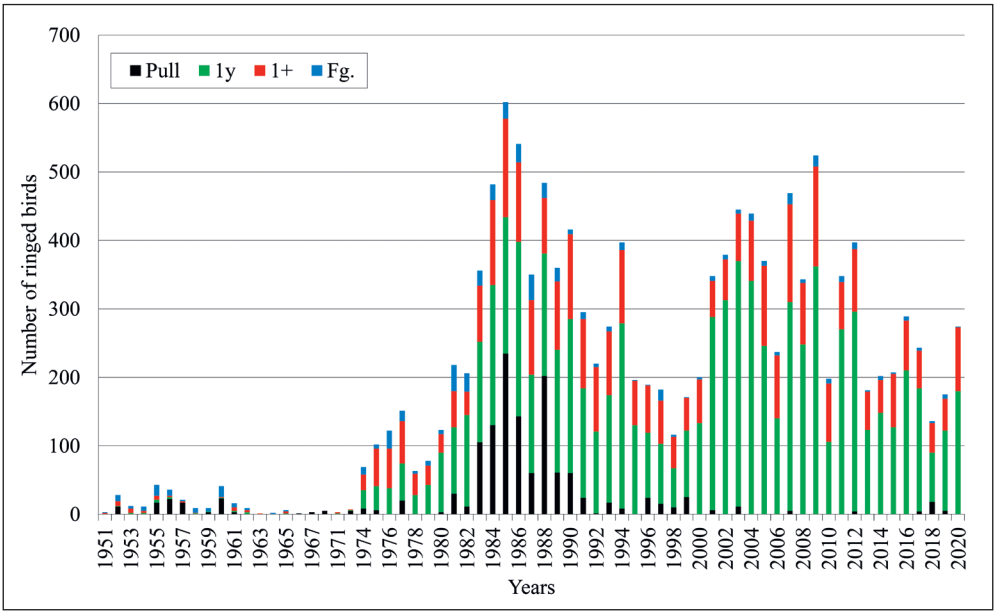


Figure 6. The number of European Stonechats ringed annually in Hungary
6. ábra Az évente gyűrűzött cigánycsukok száma Magyarországon

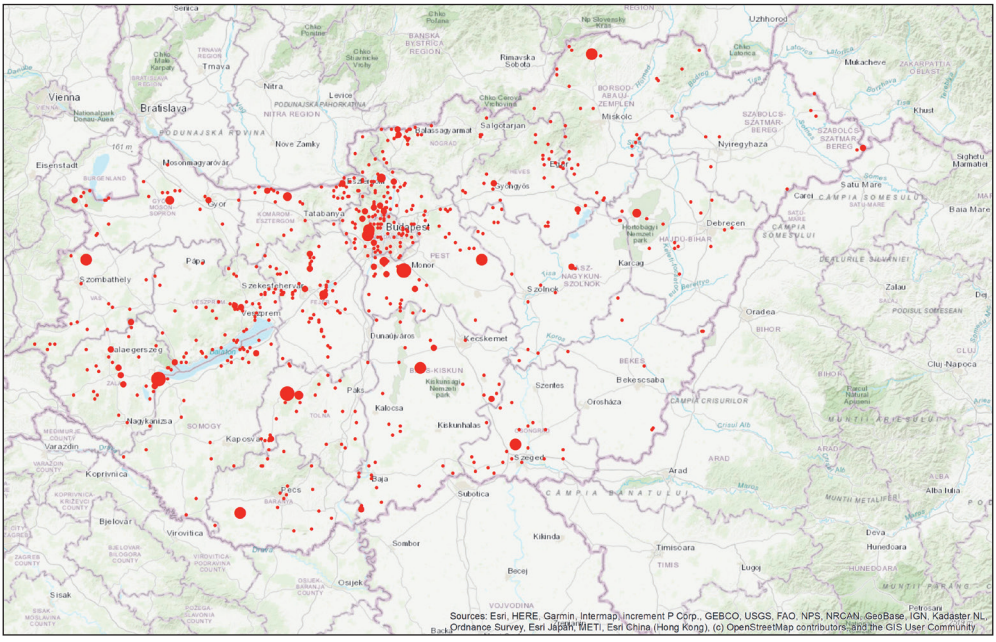


Figure 7. The locality of ringing sites of European Stonechats in Hungary (the symbols are proportional to the number of ringed birds at that location)
7. ábra A cigánycsuk gyűrűzési helyei Magyarországon (a szimbólumok arányosak az adott helyen jelölt madarak számával)

The population decline was smaller in areas characterised by high relative density. The larger population decrease occurred mainly in the areas where the sand content of the soil is higher (e.g. Kiskunság) and in the hills and mountains (Gyurácz & Csörgő 2021) *(Figure 5)*.

Hungarian ringing results

The intensive ringing of the species began at the time of the formation of the MME (BirdLife Hungary) – and within that with the establishment of the ringing department. It peaked in the mid-1980s, reaching a low point in the late 1990s. It was followed by another wave, which peaked in the mid-2000s, followed by another decline *(Figure 4, 6)*.

There have been ringing all over the country. Most birds were ringed in the Actio Hungarica (network of bird ringing stations) sites *(Figure 7)*.

The number of birds ringed in Hungary between 1951 and 2021 is 13,484, of which 1,401 were juvenile. Of these, 655 specimens (4.86%) were re-found in 826 cases at the place of marking or within 5 km (0–5 km). From a greater distance (> 5 km), only 15 birds (0.11%) with 17 cases were recaptured. Despite the small number of recoveries, it has high site fidelity (databank of BirdLife Hungary Bird Ringing Centre).

Three birds ringed in Hungary were found abroad (Italy 2, Greece 1), and two specimens marked abroad (Croatia, Italy) were recaptured in Hungary. The maximum distance between the ringing and the recapture sites is 1,125 km (Hungary-Italy) *(Figure 8)*.

Figure 8. Foreign recoveries related to Hungary of European Stonechats (red – ringing data, blue – recovery data)

8. ábra A cigánycsuk külföldi vonatkozású visszafogásai (piros: gyűrűzési adat, kék: megkerülési adat)

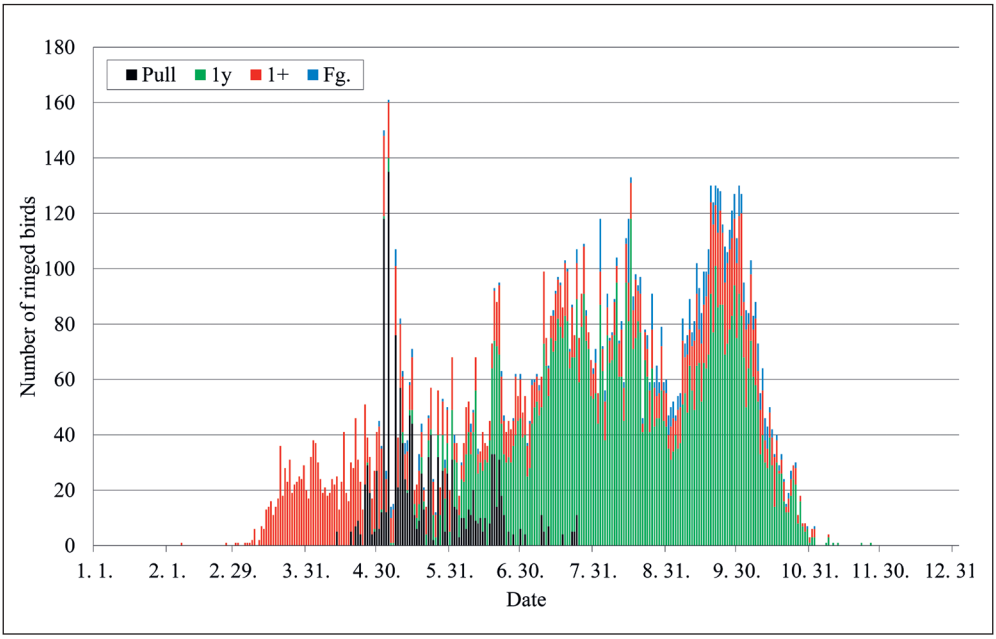


Figure 9. Daily captures of European Stonechats
9. ábra A cigánycsuk napi fogási mintázata

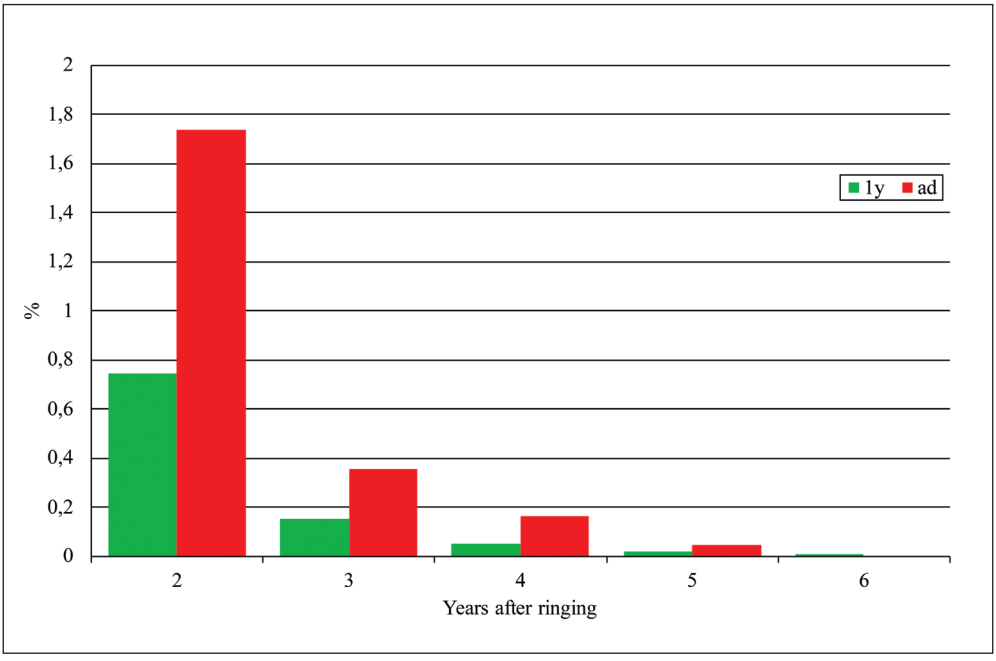


Figure 10. Recapture rate of European Stonechats in the year following their capture
10. ábra A visszafogott cigánycsukok aránya a gyűrűzést követő években

The catch pattern outlines the spring migration, dispersion, and autumn migration periods *(Figure 9)*.

According to return rates of banded birds, adult European Stonechats in Western Europe show annual mortality rates of 64% and 69% at most (Glutz von Blotzheim & Bauer 1988). In Western Europe, the overall proportion of 0.56% of birds was recovered (746 of 135,599). Recovery was lowest in Germany (0.42%) and highest in the Netherlands (1.30%) (Helm *et al.* 2006). In Hungary, 0.75% of the first-year birds (1y) were recaptured in the year following their capture, and the recapture rate declined rapidly in subsequent years. The recapture rate of adults (1+) in the year following their capture is almost two and a half times (1.74%) that of juveniles (1y), but it is also declining sharply from the second year after their capture *(Figure 10)*.

The oldest (8 years 10 months) European ringed bird was found dead in Germany (Fransson *et al.* 2017). Hungary's most prolonged period between ringing and recapture was 1679 days (4 years 7 months 6 days). The specimen was ringed as a first-year (1y) bird.

Morphological measurements

Wing length means (mm) of *S. r. rubicola* race in European countries, Netherland, Belgium, Central France and northern Italy: male 66.4±1.31 (64.0–68.0), female 65.4±1.33 (63.0–68.0), northwestern Africa: male 67.7±1.47 (66.0–70.0), female 67.2±1.20 (65.0–68.0), southern Balkan and Turkey: male 64.8±1.44 (63.0–69.0), female 63.9±1.24 (62.0–66.0) (Cramp 1998), Ukraine: 65.3±1.2 (59.0–68.0) (Opaev *et al.* 2018), Hungary: male 66.1±1.6, (1y male 66.14±1.55, 1+ male 65.94±1.86), female 64.9±1.6 (1y female 65.00±1.54, 1+ female 64.74±1.70).

In northwestern Germany between 1990 and 2012, the wing lengths were increasing and tail lengths mostly decreased (Salewski *et al.* 2014).

The biometric data was collected in Hungary in different locations from 1999 to 2020. We used the records of 2,745 European Stonechats (76 males and 89 females in spring, 461 adult males and 237 adult females, 1,086 juvenile males and 557 juvenile females in autumn). We present data for spring, breeding and autumn migratory seasons separately; birds caught after the 60th and before the 100th day of the year were considered to be spring migrants and birds caught after the 230th and before the 310th day

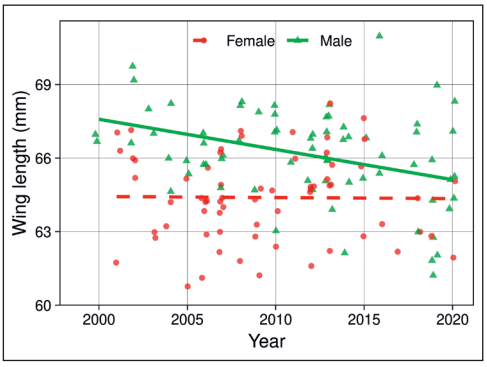


Figure 11. Wing length of male and female European Stonechats during the spring season between 1999 and 2020. The continuous line highlights the significant decrease, while the dashed line shows the non-significant change of average wing length over the years

11. ábra A hím és tojó cigánycsuk egyedek szárnyhossza a tavaszi időszakban 1999–2020 között. A folytonos vonal a szignifikáns átlagos szárnyhossz csökkenést, a szaggatott a nem szignifikáns változást mutatja az évek során

of the year were considered to be autumn migrants. The time interval of the spring and autumn migration waves was determined on the basis of the daily catch numbers. First calendar year birds (juveniles) were distinguished from adults (Svensson 1992). All birds were measured according to the same methodology. The wing length was measured with 1 mm accuracy, using a ruler in the case of birds where feather abrasion was low. The body mass was measured with 0.1 g accuracy. Linear mixed-effects (LME) models were used to detect the changes in the timing of migration and morphology. Sex, age and their interaction were included in the models. We put the year as a random factor in all models. We gave 95% confidence intervals (CI) for the estimated changes based on the models. We used the 'nlme version 3.1-152' R package (Pinherio *et al.* 2021). We added a small amount of noise to the figures' data to prevent overplotting. We set the significance level to 0.05. All statistical analyses were done in R 4.1.1 (R Core Team 2021).

While we found a 2.6 (95% CI: 0.7–4.4) mm average decrease in the wing length of males during spring migration (P = 0.0067), the wing length of females did not change significantly (P = 0.7214) *(Figure 11)*.

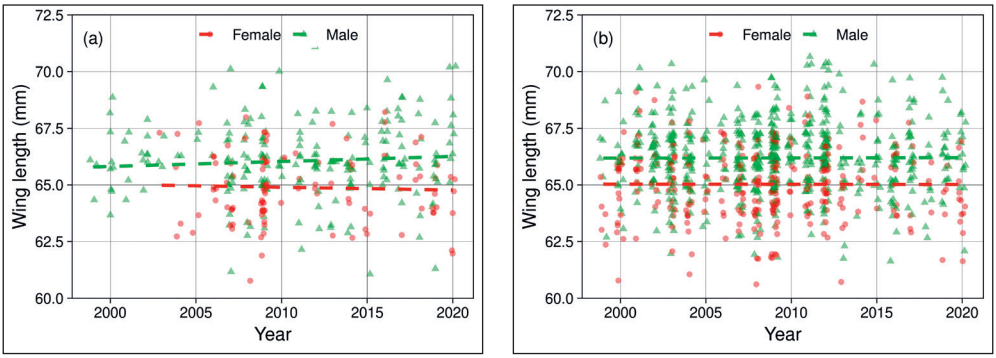


Figure 12a and b Wing length of adult (a) and juvenile (b) male and female European Stonechats between 1999 and 2020 in the autumn season. The dashed lines highlight the non-significant change of average wing length over the years

12a és b ábra Az öreg (a) és fiatal (b) hím és tojó szárnyhosszak az őszi vonulási időszakban 1999–2020 között. A szaggatott vonalak mutatják, hogy a változás nem szignifikáns az átlagos szárnyhossz esetén az évek során

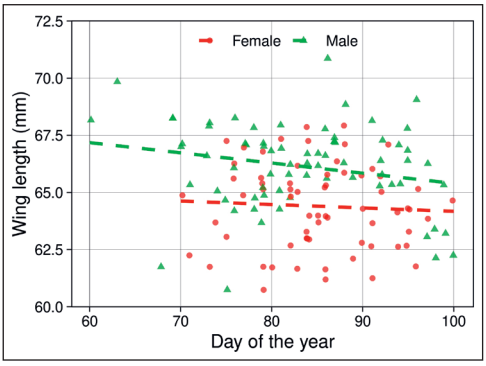


Figure 13. Wing length of male and female European Stonechats during the spring season (Day 1: 1st of January). The continuous line highlights the significant, and the dashed line highlights the non-significant decrease in average wing length over season

13. ábra A hím és tojó cigánycsuk egyedek szárnyhossza tavaszi időszakban. A folytonos vonal a szignifikáns, a szaggatott a nem szignifikáns átlagos szárnyhossz csökkenést mutatja a szezon során

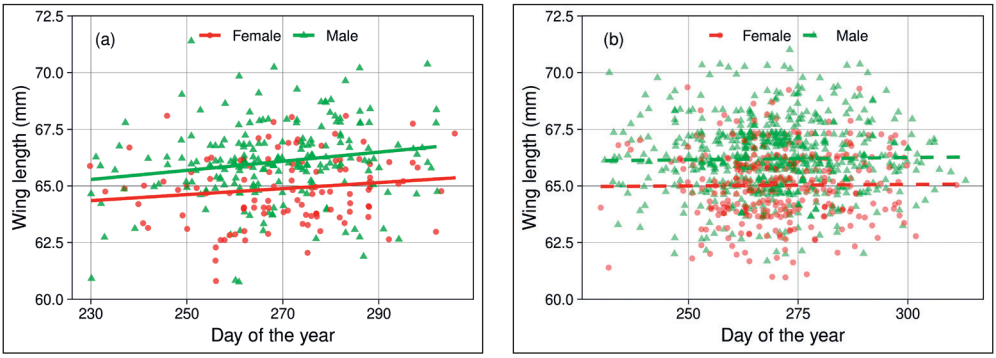


Figure 14a and b Wing length of adult (a) and juvenile (b) male and female European Stonechats during the autumn season (Day 1: 1st of January). The continuous lines highlights the significant, the dashed lines the non-significant increase of average wing length over season

14a és b ábra Az öreg (a) és fiatal (b) hím és tojó szárnyhosszak az őszi vonulási időszakban. A folytonos vonalak a szignifikáns, a szaggatott vonalak a nem szignifikáns átlagos szárnyhossz növekedést mutatják a szezon során

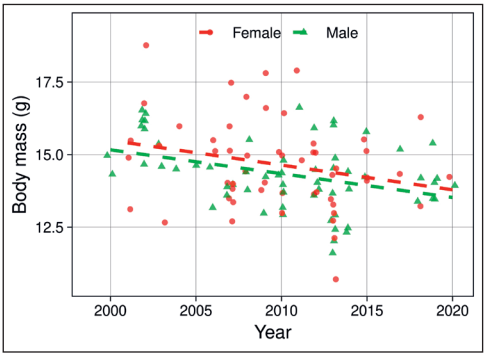


Figure 15. Body mass of male and female European Stonechats during the spring season between 1999 and 2020. The dashed lines highlight the non-significant decrease of over the years

15. ábra A hím és tojó cigánycsuk egyedek testtömege a tavaszi időszakban 1999–2020 között. A szaggatott vonalak a nem szignifikáns változást mutatják az évek során

The autumn wing length did not change significantly (P = 0.2681) during the 22 years in any age and sex group. The males have longer wings on average. The mean difference is 1.2 (95% CI: 1–1.4) mm *(Figure 12)*.

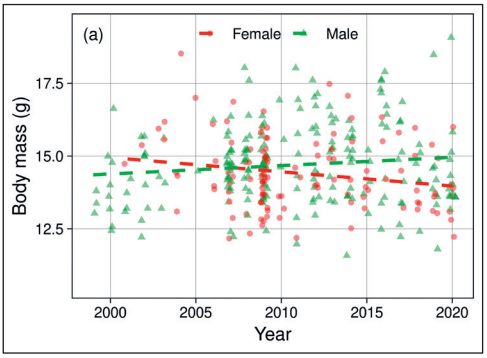
In spring, no significant changes in wing length were observed in any of the sexes (males: P = 0.1139, females: P = 0.6355) *(Figure 13)*.

In the case of adults, the average wing length increased by 1.6 (95% CI: 0.6–2.6) mm during the autumn (P = 0.0019). In the case of juveniles, the wing length did not change on average (P = 0.6879) *(Figure 14)*.

Body mass means of *S. r. rubicola* race in European countries varies between 13.7–16.5g (Cramp & Simmons 1988). In Hungary the mean body mass of males 14.4±1.3 g (n = 1172) and females 14.4±1.4 g (n = 591).

In spring, the body mass did not change significantly (P = 0.0816). There was no significant (P = 0.1048) difference between the sexes *(Figure 15)*.

There were no significant changes in the body mass of adults during the autumn season during the years. There is also a non-significant difference between the age groups.



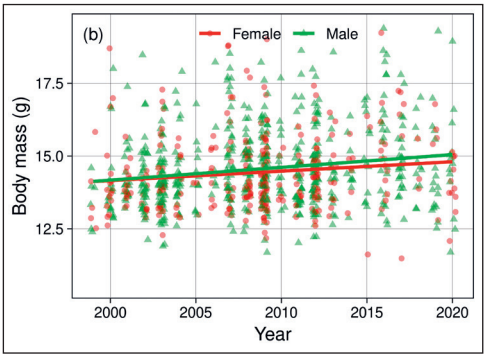


Figure 16a and b Body mass of male and female adult (a) and juvenile (b) European Stonechats during the autumn season between 1999 and 2020. The solid lines highlight the significant increase, the dashed lines the non-significant change over the years

16a és b ábra Az öreg (a) és fiatal (b) hím és tojó cigánycsuk egyedek testtömege az őszi időszakban 1999– 2020 között. A folytonos vonalak a szignifikáns növekedést, a szaggatott vonalak pedig a nem szignifikáns trendet mutatják az évek során

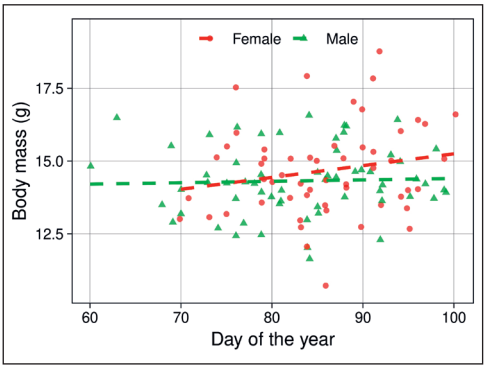
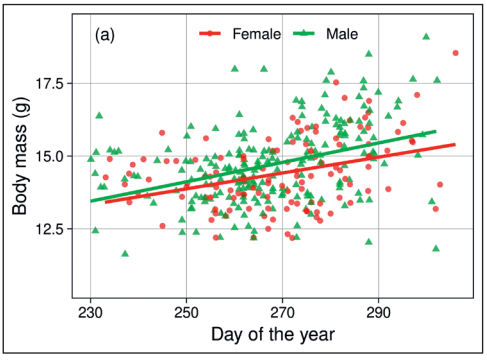


Figure 17. Body mass of males and females during the spring season. The dashed lines highlight the non-significant changes in average body mass over season

17. ábra A cigánycsuk hím és tojó egyedek testtömege a tavaszi időszakban. A szaggatott vonalak a nem szignifikáns átlagos testtömeg változást mutatják a szezon során



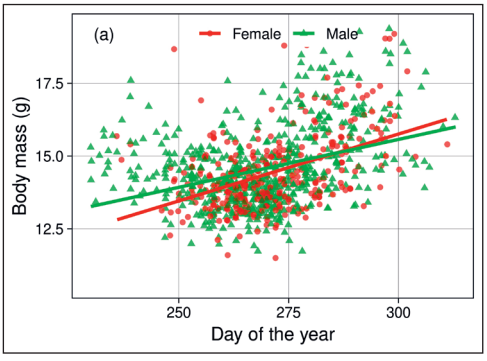


Figure 18a and b Body mass of male and female adult (a) and juvenile (b) European Stonechats during the autumn season. The solid lines highlight the significant increase during the season

18a és b ábra Az öreg (a) és fiatal (b) hím és tojó cigánycsuk egyedek testtömege az őszi időszakban. A folytonos vonalak a szignifikáns növekedést mutatják a szezon során

The average body mass in the juvenile group increased significantly for both sexes (P = 0.001) by an average of 0.9 (95% CI: 0.4–1.3) grams over 22 years *(Figure 16)*.

There was no significant change in the average body mass during the spring season (P = 0.3967) *(Figure 17)*.

In the case of all age and sex groups, the average body mass increased during the autumn season (P < 0.0001). In the case of adult females: by 2.5 (95% CI: 1.3–3.7 grams, in the case of adult males: by 3.2 (95% CI: 2.2–4.1) grams, in the case of juvenile females: 4.1 (95% CI: 3.2–5.1) grams, in the case of juvenile males: by 3 (95% CI: 2.4–3.6) grams *(Figure 18)*.

Timing of migration

In northwestern Germany, based on first and last sightings, males tended to arrive slightly earlier (5 days) and depart slightly later (4 days) than females between 1991 and 2005 (Flinks *et al.* 2008).

In Hungary, the timing of either sex during spring migration did not change significantly (P = 0.56), and the difference in timing between the sexes was also not significant (P = 0.1392) *(Figure 19)*.

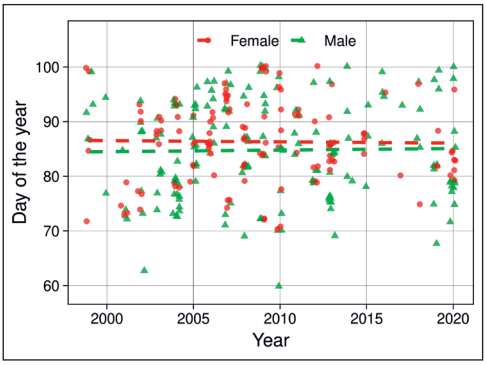
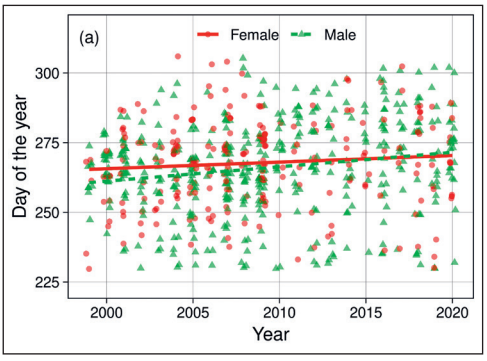


Figure 19. Spring arrival times of male and female European Stonechats between 1999 and 2020. The dashed lines highlight that the change was not significant over the years

19. ábra A cigánycsuk hím és tojó egyedek tavaszi érkezési ideje 1999–2020 között. A szaggatott vonalak a nem szignifikáns trendeket mutatják



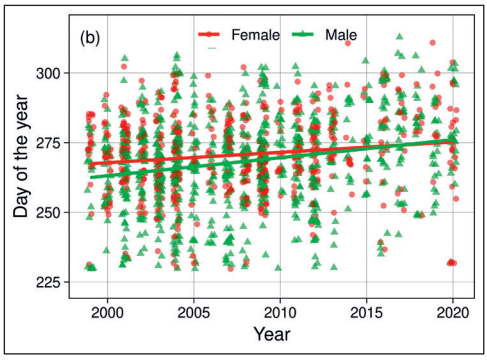


Figure 20a and b Autumn arrival times of adult (a) and juvenile (b) male and female European Stonechats between 1999 and 2020. The solid lines highlight the significant delay in timing over the years

20a és b ábra Az öreg (a) és fiatal (b) hím és tojó cigánycsuk egyedek őszi érkezési ideje 1999–2020 között. A folytonos vonalak a szignifikáns későbbre tolódást mutatják

The shift between age groups during the autumn migration is significant, juveniles migrate on average 3.2 (95% CI: 1.8–4.6) days later ($P < 0.0001$).

In the case of females in both age groups, the migration shifted on average 8.1 (95% CI: 3.3–13) days later ($P = 0.001$). In the case of males, the migration shifted on average 13.8 (95% CI: 9.9–17.8) days later in both age groups ($P < 0.0001$). The change was significantly ($P = 0.0265$) greater in males *(Figure 20)*.

Migration and dispersion

European Stonechats are predominantly migratory, but partial migration and summer movements seem surprisingly plastic. Mediterranean populations are apparently resident. Breeders of the northernmost parts of Europe winter primarily in the British Isles, the Mediterranean and oases of the Sahara (Cramp & Simmons 1988, Urquhart & Bowley 2002, Small 2005). Benelux Stonechats were fully migratory, just as their German conspecifics. British Stonechats were partially migrants; according to conservative estimates, almost half (42.1%) of the British Stonechats migrated. Stonechats belonging to the subspecies *S. r. rubicola* are considered resident in South Europe and obligate short-distance migrants in central and East Europe, the *S. r. hibernans* is thought to be a partial migrant. They were classified as 'basically sedentary' in Britain (Thomson 1956, Van Hecke 1965b, Johnson 1971, Lack 1986), although regular movements to North Africa were observed (Zink 1973). During winter, the range of both subspecies extends southwards as far as the desert fringes in North Africa (Callion 2002). Northern birds often move to mild, predominantly coastal regions, resulting in graded winter densities (Helm *et al.* 2006). The European Stonechats from East Europe are short-distance migrants that travel about 1,500 km. Ringing recovery data suggests that many of them pass the Mediterranean Sea on their way (Raess 2006). This species is an obligate short-distance migrant in Central Europe, including Hungary (Flink *et al.* 2008, Magyar 2009).

Directions of Benelux and German Stonechats were mostly oriented towards southwest and northeast, those of British Stonechats towards southeast and northwest. The vector of British migrants was outside the confidence limits of Benelux and German populations, which in turn oriented in almost identical directions (British 158.6°, Benelux 204.6°, German 203.6°. Central and East European Stonechats moved in southwesterly directions, except for a Hungarian nestling captured in Greece in November 1987. For a closer analysis of North African winter quarters, sample sizes were small, suggesting more easterly wintering of East European Stonechats (Helm *et al.* 2006).

In Italy, the peak in ringing numbers is recorded in March (Spina & Volponi 2009). In Northeast Ukraine (Kharkiv Region), the mean date of the arrival of the Stonechat between 1993 and 2008 was 27th March (13th March – 6th April; the median was 31st March). Though most early spring records were of presumably lone males (60%), 38% of the first records in spring were those of already paired birds, and the difference between arrival dates of both sexes was non-significant. Apparent protandry was not found. The mean interval between the first sightings of male and female Stonechats was circa two days (Banik 2019). Studies of Zugunruhe – the 'migratory restlessness' behaviour of captive birds – protandry in spring,

although Stonechats winter in heterosexual pairs (Van Doren *et al.* 2017). The first males in Hungary return to their breeding grounds in February. The peak of the spring migration is the first half of March (Molnár 1986, Magyar 2009).

In Germany, the autumn migration is most pronounced from late August to late October and peaks between mid-September and mid-October (Bairlein *et al.* 2014). In the Czech Republic, the departure and autumn migration occur from the second half of September till late October; however, single birds may be observed as late as November and in the first half of December (Pudil & Jelinek 2008). In Italy, the peak in ringing numbers is recorded in September-October (Spina & Volponi 2009). In Malta, migrants arrived in October and November, with about a quarter staying for the winter (Helm *et al.* 2006).

In Hungary, the autumn migration begins at the end of August, the peak period is the last week of September. In October, the majority of the birds leave the country, but some specimens may overwinter in mild winters (Magyar 2009, Gyurácz & Csörgő 2021).

The Mediterranean is an important wintering area for the species (Spina & Volponi 2009). Birds of known origin from all parts of Europe were recorded in North African winter quarters. Local overwintering was only observed in Britain, France, Spain and Italy (Helm *et al.* 2006). Benelux Stonechats were clearly migratory. The origin of wintering birds thus remains obscure (Helm *et al.* 2006). The number of birds overwintering in Belgium is significantly correlated with temperature in the previous winter (Dhondt 1983). The number of wintering birds is increased in Germany (Bairlein *et al.* 2014).

From the birds ringed in Germany, most birds spend the winter in Algeria and Morocco; some may stay in Spain or southern France and more and more are overwintering in Germany (Bairlein *et al.* 2014). From the Czech Republic, the birds have the southwestern direction of migration to wintering grounds in northern Algeria and Tunisia. Single birds are sometimes found in the Czech Republic during winter, mainly in southwestern Slovakia (Pudil & Jelinek 2008).

On average, 27% of the Stonechats banded in one season in Israel returned the following winter (in four seasons) (Rödl 1999), but only 1.95% of c.1,850 ringed birds on Malta for at least one (up to four) additional migration periods. Adults are dominated among returning migrants (Helm *et al.* 2006).

In Hungary, it may overwinter in small numbers; there are few observations from the winter months each year (birding.hu 2022). Observations became regular in the second half of February. The peak of spring migration is the first half of March. Most individuals were found from mid-April to mid-June (probably due to the highest visibility of singing males and feeding parents). Autumn migration starts at the end of August, peaks in late September, and goes down by late October *(Figure 3)* (Gyurácz & Csörgő 2021).

Conservation

The species' population size is extremely large, and the population trend appears to be stable. For these reasons, the species is evaluated as Least Concern. The moderate decrease was mainly due to the intensification of agriculture, the postponement of the harvest time and the cutting of bushes and tree lines in nesting sites (del Hoyo *et al.* 2020, BirdLife International 2021).

In Hungary, it belongs to the red list category Near Threatened (Nagy *et al.* 2019). As a result of weeding due to the decrease in grazing intensity, it became a common nesting ground in the Great Plain by the end of the 20th century. By eliminating the felling of tree lines and shrubs during the breeding period and reducing excessive grazing, the destruction of nestlings can be significantly reduced. Its habitats are also threatened by the spread of certain invasive plants, such as the spread of the goldenrod (*Solidago* spp.), and common milkweed *(Asclepias syriaca)* (Ecsedi 2004, Gyurácz & Csörgő 2021).

The main mortality factors of brood are weather (several days of rain, thunderstorms) and predators (domestic dogs, cats, snakes *Natrix* spp.) (Molnár 1986).

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