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Breeding, dispersal, migration and conservation of the Black-winged Stilt *(Himantopus himantopus)* in Hungary

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Abstract The Black-winged Stilt was the bird of the year in Hungary in 2019. The population of the species increased from 20–25 breeding pairs to 550–680 pairs from 1980s to the present. 75–85% of the Hungarian population bred on effluent pools for pigs and settling pools at sugar beet factories in the first half of 1990s. There were significantly more breeding pairs in Hungary in 1999 compared to previous years, and finally 871 breeding pairs of Black-winged Stilts were documented in 2000 and the Hungarian population was estimated at 940–960 pairs. There were 550–680 breeding pairs in Hungary between 2015 and 2017. Significantly more clutches had more than five eggs in the sampled colonies during the influx in 2000 than in the egg collections before 1971 or in the sampled colony in 2008 as well. First arrivals reached Hungary between 5 and 20 March (median: 15 March) between 2005 and 2019. These arrival dates fall approximately a month earlier than the former arrival dates in mid-April during the 1980s. 470 Black-winged Stilts were observed in a single flock during post-breeding dispersal, this flock was the largest ever documented in Hungary. Stilts left Hungary by the first half of September in the 1980s, and in contrast, they left Hungary between 27 August and 4 January (median: 19 October) between 2005 and 2019. Recently, the most departure dates fall one and a half to three months later compared to the departure dates in the 1980s. Black-winged Stilts marked in Hungary disperse in the Carpathian Basin during their post-fledging/post-breeding dispersal. Based on ring readings of two individuals, they start to migrate southwest with stopover sites in Italy, but their wintering areas are unknown. Stilts hatched in Portugal (one individual) and France (two individuals) bred in Hungary during the large influxes in 1999 and 2000. Five Black-winged Stilts hatched in Italy were observed later in Hungary and are supposed to be breeders in Hungary in most cases. Furthermore, one individual captured as an adult in Spain and two trapped in Italy were observed in Hungary. The Hungarian population of Black-winged Stilt is threatened by predation on eggs and chicks, drainage of wetlands, and also by human-induced flooding of artificial wetlands (e.g. fishponds). Stilts regularly occupy artificial breeding islands the first years after habitat restoration. The Hungarian population of Black-winged Stilts is increasing due to habitat management with grazing animals, especially with Mangalica ‘Woolly’ Pigs and Water Buffalos.

Keywords: influx, joint clutch, habitat shift, habitat management with grazing, wetland management

Összefoglalás 2019-ben a gólyatöcs volt az év madara Magyarországon. Ennek a fajnak az állománya az 1980-as évektől elkezdett emelkedni, ennek eredménye, hogy 20–25 párról napjainkra 550–680 párra nőtt. Az 1990-es évek első felében a hazai állomány 75–85%-a sertéstrágya-szikkasztókon vagy cukorgyári ülepítőtavakon fészkelt. 1999-ben jelentősen több gólyatöcs fészkelt Magyarországon, mint korábban, 2000-ben pedig 871 pár költését dokumentáltuk, a hazai állományt pedig 940–960 párra becsültük, 2015 és 2017 között pedig 550–680 páros volt. Magyarországon a 2000-ben tapasztalt invázió alatt szignifikánsan több volt az öttojásosnál nagyobb fészkek aránya a mintaterületeken, mint az 1971 előtti tojásgyűjteményekben és a 2008-as mintaterületen. A gólyatöcsök 2005 és 2019 között március 5. és március 20. közötti időszakban érkeztek vissza Magyarországra, ami körülbelül egy hónappal korábbi érkezést jelent, mint az 1980-as évek közepére jellemző április középi érkezés. A fészkelést követő gyülekezés alatt 470 példány volt a legtöbb, amit egy csapatban láttak. Az 1980-as években a gólyatöcsök szeptember elejére elhagyták Magyarországot, ezzel szemben 2005 és 2018 között a faj utolsó példányait augusztus 27. és január 4. között észlelték, így az utolsó észlelési adatok többsége másfél – három hónappal esik későbbre, mint az 1980-as években. A hazai jelölésű gólyatöcsök a fészkelést követően a Kárpát-medencében kóborolnak, majd délnyugatra vonulnak; két egyed megfigyelése alapján megállóhelyeik Olaszországban vannak, de a pontos telelőhelyeket nem ismerjük. A fészkelési invázió alatt 1999-ben és 2000-ben két Franciaországban és egy Portugáliában fiókaként jelölt egyed fészkelt Magyarországon. Későbbi években további öt Olaszországban kikelt gólyatöcsöt figyeltek meg Magyarországon, egy részüknél feltételezhető volt, hogy fészkelnek. Egy Spanyolországban és két Olaszországban, kifejlett madárként, színes gyűrűvel jelölt gólyatöcsöt azonosítottak hazánkban. A gólyatöcs magyar állományát egyes területek kiszáradása veszélyezteti, de komoly gondot jelenthet még a mesterséges vízállások (pl. halastavak) elárasztása, vagy a predáció is. A gólyatöcs az élőhely-rekonstrukciók során kialakított mesterséges szigeteken az első években rendszerint fészkel. Jelentős részben a legeltetéses élőhely-kezelésnek köszönhető, hogy a hazai gólyatöcs-állomány emelkedik, különösen a mangalicákkal és bivalyokkal megvalósított legeltetéseknek van pozitív hatása a faj megtelepedésére.

Kulcsszavak: invázió, összetojás, élőhely-váltás, legeltetéses élőhely-kezelés, vizesélőhely-kezelés

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Introduction

The five subspecies of Black-winged Stilt *(Himantopus himantopus)* have a vast combined range so that this species is a truly cosmopolitan bird: the species can be found in Europe, Asia, Africa, Australia as well as in North and South America, however, several studies consider two to five distinct species based on recent splits from the nominate race of the Black-winged Stilt (Oláh 2008, del Hoyo & Collar 2014). In spite of the highly complex taxonomy of the species, five subspecies are accepted worldwide. The nominate race *H. h. himantopus* is distributed in Europe, Africa and the majority of Asia: while its westernmost range within Europe is found in France and the Iberian Peninsula, the southern breeding areas are located in sub-Saharan Africa and Madagascar; furthermore, breeders of this subspecies can be found also east to Central Asia and the central part of northern China, in the Indian subcontinent, Sri Lanka, Indochina and Taiwan (del Hoyo & Collar 2014). Northern populations are migratory, while other populations are dispersive or residents under warmer climatic conditions (Cramp & Simmons 1983).

Black-winged Stilts feed on invertebrates, mainly aquatic insects and their larvae – including Coleoptera, Trichoptera, Hemiptera, Odonata and Diptera – spiders, crustaceans, molluscs, worms, amphibian tadpoles and eggs, small fish and rarely some plant materials (Cramp & Simmons 1983).

The Black-winged Stilt is a strictly protected bird species of key conservation importance in Hungary since 1982 (Bankovics 1984). Similarly to Pied Avocet *(Recurvirostra avosetta)* and Kentish Plover *(Charadrius alexandrinus),* the Black-winged Stilt is considered as a characteristic breeding bird of the unique soda pans of the Carpathian Basin (Boros & Ecsedi 2013).

The Black-winged Stilt was the bird of the year in Hungary in 2019, which provides us an exceptional opportunity to summarize our knowledge on this species in Hungary and to emphasize the future research and conservation priorities.

Breeding population in Hungary

Only limited information is available on the breeding number of Black-winged Stilts in Hungary before the 1970s (Cramp & Simmons 1983, Oláh *et al.* 2003). Chernel (1899) described this species as a bird with a declining population in Hungary at the end of the 19th century due to human-induced drainage of wetlands. Molnár (1986) described four large breeding areas of Black-winged Stilt in Hungary until the middle of 1980s: 1.) the area of Lake Fertő (Neusiedler See) and Hanság, 2.) the area of Lake Balaton and Lake Velence, 3.) the area between the river Danube and the River Tisza, 4.) and finally, the area between the river Körös and the river Maros. Beside Kentish Plover and Pied Avocet, the Black-winged Stilt was usually mentioned as one of the character species of the nesting bird communities on soda pans in Hungary before the 1980s (Bankovics 1983).

During the 1980s, 20–30 breeding pairs of Black-winged Stilt were estimated in Hungary (Bankovics 1984, Bankovics *et al.* 1990), and this population size was the lowest for the Hungarian breeding population (Oláh *et al.* 2003). The cause of decline until the 1980s were thought to be complex: 1.) drainage of natural lakes and marshes by intensive canalisation, 2.) decline of ground-water level due to general canalisation and arid years during the 1980s, 3.) the establishment of fishponds on breeding areas of the species and 4.) egg collecting until the early 1970s (Molnár 1986, Oláh *et al.* 2003, Oláh 2014, Pereszlényi *et al.* 2019). Former soda pans of Homokhátság at Bócsa (e.g. Szappanos-szék), Bugac (e.g. Szekercés-szék) and Fülöpháza (e.g. Kondor-tó, Hattyú-szék) were regular breeding areas for Black-winged Stilts when supplied with sufficient quantities of water. However, as soon as those lakes lost their water supply most waterbirds – including Black-winged Stilts – deserted them by the end of 1980s and breeding was no longer observed there (Bankovics 1979, Molnár 1986, Máté & Pigniczki 2015, Pereszlényi *et al.* 2019).

The recovery of the Hungarian Black-winged Stilt population started from the mid-1980s and it became obvious by the 1990s, due to the significant habitat shift of the species: they moved from natural wetlands to artificial habitats (Molnár 1986, Boros 1998, Oláh *et al.* 2003, Oláh 2014). The Hungarian population was estimated at approximately 100–150 pairs during the 1990s (Boros 1998, Nagy 1998). Due to this habitat shift, the Black-winged Stilts started to breed in effluent pools for pigs (Molnár 1986, Bod 1993, 1994, Kotymán 1996), settling pools at sugar beet factories (Ecsedi 1994), fishponds (Berdó 1994, Nagy 1994, Pigniczki 2001), old clay-pits (Kotymán 1996), paddyfields (Oláh 1996), artificially flooded areas and artificial islands of habitat restoration areas (Boros & Pigniczki 2001, 2013). A sizeable part (57–93 pairs) of the Hungarian population bred at effluent pools for pigs near Szentes in 1990–1994 (Bod 1994). Approximately 75–85% of the Hungarian population bred on effluent pools for pigs and settling pools at sugar beet factories in the first half of the 1990s (Oláh *et al.* 2003). Similarly, the Black-winged Stilt became a more regular breeder in Transdanubia by the 1990s (Nagy 1998). No general estimation is available for the whole of Hungary, but it was clear that there were more breeding Black-winged Stilts in 1999 than in the previous years (Oláh *et al.* 2003).

A large influx of Black-winged Stilts was observed in 2000 in Hungary, probably due to the extreme extension of flooded areas in the Great Hungarian Plain: 871 breeding pairs were reported, and the Hungarian breeding population was estimated at 940–960 pairs in that year (Oláh *et al.* 2003). Interestingly, it was found that the majority (51.0%) of Black-winged Stilts bred again on soda pans, while the breeding population at effluent pools for pigs and settling pools at sugar beet factories was less important, as only 11.3% of the breeding pairs were found in such habitats in 2000. A substantial part of the population bred in flooded areas (17.8%) and flooded agricultural lands (16.3%), while only a small part of the population bred in old clay-pits (3.3%) and paddyfields (0.3%) (Oláh *et al.* 2003). The breeding population of Black-winged Stilts increased quite suddenly in 1999 and 2000. This population growth could not be explained by a mere increase of the Hungarian (or even the Pannonian) local population estimated during the second half of the 1990s. Additionally, several colour-marked individuals were observed in 1999 and 2000, indicating that one individual came from Portugal and two from France (Oláh *et al.* 2003).

As no systematic survey was conducted on the entire Hungarian population of Black-winged Stilts after 2000, the range of estimations show a high variance (depending on

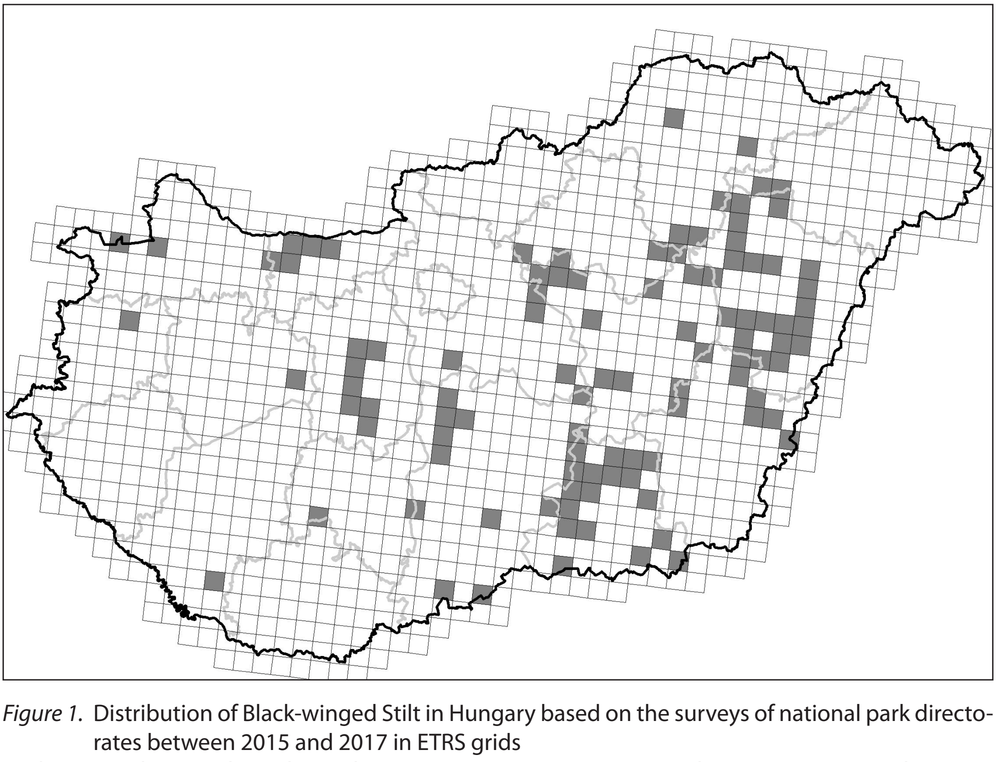

Figure 1. Distribution of Black-winged Stilt in Hungary based on the surveys of national park directorates between 2015 and 2017 in ETRS grids

1. ábra A gólyatöcs elterjedési térképe Magyarországon 2015–2017 között a nemzeti park igazgatóságok felmérései alapján, ETRS-hálózaton bemutatva authors, 180–950 or 200–1000 pairs) for the breeding populations found during the 2000s and 2010s, noting that there were fewer breeding pairs during the arid years, in contrast to the wet years (Bankovics 2008, Oláh 2014). The staff of Hungarian national park directorates and the members of Hortobágy Environmental Association provided good quality data on the Hungarian breeding population: they reported 628 pairs in 2015, 515 pairs in 2016 and 553 pairs in 2017; based on those records, the total Hungarian population was estimated at 550–680 breeding pairs during 2015–2017. Stilts breed mainly on the Great Hungarian Plain, but they occupied habitats in Transdanubia, too *(Figure 1).* Breeding Black-winged Stilts were found in a new artificial habitat type, namely in the gravel pits at Ács in 2017 (unpublished data, database of Ministry of Agriculture).

The density (number of breeding pairs/area in hectares of suitable habitat) of breeding pairs of Black-winged Stilts was studied in the soda pans and fishponds of Kiskunság: 13 pairs were observed at Kelemen-szék in 1994, which meant 0.085 pairs/ha density (Boros 1994, Pigniczki 2001). Stilts did not breed at Kelemen-szék in 1995 (density: 0.0 pairs/ha), because that year was dry (Pigniczki 2001). Pigniczki (2001) estimated the density of breeding Black-winged Stilts at 1.146 pairs/ha in 1999 in a fishpond at Akasztó (55 pairs), 0.389 pairs/ha in Kelemen-szék (90 pairs), 0.133 pairs/ha in Fehér-szék (7 pairs) and 0.246 pairs/ha in Zab-szék (32 pairs) in 2000 (Pigniczki 2001).

Breeding biology in Hungary

Most Black-winged Stilts start to form pairs from the second half of April, and generally had full clutches in Hungary between 29 April and 30 June, based on data available from egg collections (Haraszthy 2019a). Field observations indicate that some pairs may start to incubate their eggs even earlier [e.g. one pair incubated eggs on 22 April 2010 and another pair on 24 April 2014 at Pusztaszer and two pairs on 14 April 2005 at Kistelek (T. Nagy unpublished data)]. These data indicate that breeding starts earlier nowadays than it did several decades ago (Haraszthy 2019a).

Black-winged Stilts may build nests using plant materials or only scrape nests into the soil. If their nests are built in shallow water, they are able to mitigate the effect of rising water levels by raising their nests even higher above water levels. They breed colonially in most cases, often together with other species like Pied Avocet, Kentish Plover, Northern Lapwing *(Vanellus vanellus)*, and occasionally they join other species, such as Black-tailed Godwit *(Limosa limosa)*, Common Redshank *(Tringa totanus)*, Little Ringed Plover *(Charadrius dubius)*, Black-headed Gull *(Chroicocephalus ridibundus)* and Common Tern *(Sterna hirundo)* (Haraszthy 2019a, Cs. Pigniczki unpublished data).

Black-winged Stilts lay 3–5 eggs, averaging four eggs most frequently. Nests including less than three eggs are probably incomplete or robbed, while nests with more than five eggs are most likely joint clutches of at least two females (Cramp & Simmons 1983, Snow & Perrins 1998). Clutches collected in Hungary during 1896–1971 contained 8×3, 62×4, 3×5, 3×7 and 1×8 eggs (Pereszlényi *et al.* 2019, L. Haraszthy *pers. com.*) *(Figure 2).* Joint clutches were found occasionally during the 1990s: 6×7 eggs were reported from

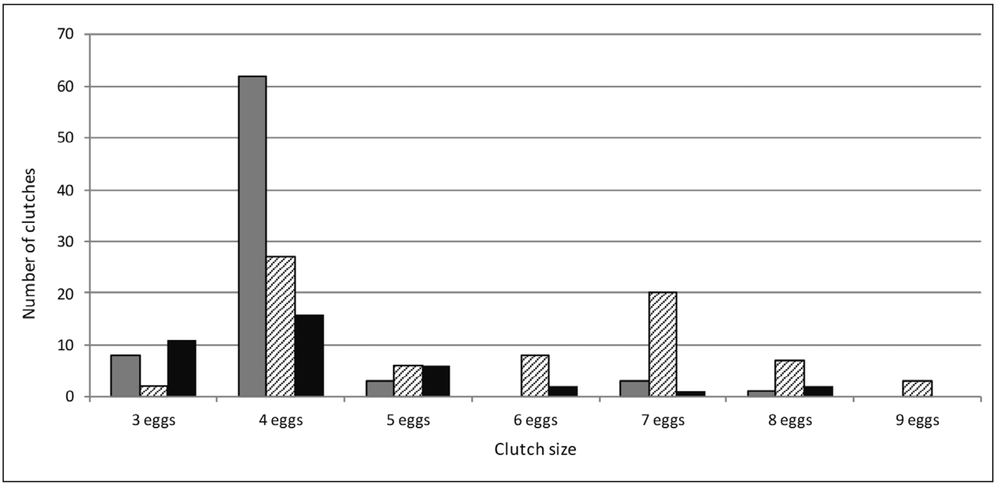

Figure 2. Comparison of clutch sizes of Black-winged Stilts found in egg collections and collected until 1971 (grey) (Pereszlényi *et al.* 2019), observed during the influx in 2000 (striped) (Oláh *et al.* 2003) and observed in 2008 (black) (Haraszthy 2019b). The number of joint clutches with more than five eggs was the highest during 2000 among the three periods

2. ábra Gólyatöcsök fészekalj-méretének összehasonlítása 1971 előtt, tojásgyűjteményekben fellelhető fészkek alapján (szürke) (Pereszlényi *et al.* 2019), a fészkelési invázió alatt 2000-ben (sávozott) (Oláh *et al.* 2003) és 2008-ban (fekete) (Haraszthy 2019b). 2000-ben az összetojásos, ötnél több tojást tartalmazó fészkek aránya magasabb volt, mint a másik két vizsgált időszakban

different locations of the Great Hungarian Plain (Berdó 1994, Bod 1994, Ecsedi 1994, Oláh *et al.* 2003). Interestingly, several joint clutches were detected in the Great Hungarian Plain, during the influx of Black-winged Stilts in 2000: in the case of the four studied colonies 5×1, 2×2, 2×3, 27×4, 6×5, 8×6, 20×7, 7×8 and 3×9 eggs were reported from nests (Oláh *et al.* 2003) *(Figure 2).* Therefore, while there were only four joint clutches with more than five eggs (5.2%) among 77 collected nests during 1896–1971, there were at least 38 joint clutches with more than five eggs (52.1%) among 73 nests (not calculating with clutches with one or two eggs/nest) in 2000. In this case, there were significantly more joint clutches with more than five eggs during the influx in 2000 than during the period 1896–1971 (chi-square test: $\chi^2 = 40.817$, df = 1, $p < 0.0001$). Haraszthy (2019b) reported nests of Black-winged Stilts built in the marsh of Dinnyés-Fertő in 2008 with the following clutch sizes: 3×1, 7×2, 11×3, 16×4, 6×5, 2×6, 1×7, 2×8 eggs *(Figure 2)*, amounting to a proportion of 13.2% (N = 5 out of 38; nests with one or two eggs/nest excluded) of the nests had joint clutches with more than five eggs. Nests with five eggs were documented in this study as joint clutches due to two different groups of eggs in the same clutch (Haraszthy 2019b). Statistically, there were significantly more joint clutches with more than five eggs in the studied colonies during the large influx in 2000 than in 2008 (chi-square test: $\chi^2 = 15.932$, df = 1, $p < 0.0001$). There was no significant difference between the number of normal nests and joint clutches with more than five eggs if we compared nests documented in 1896–1971 and 2008 (chi-square test: $\chi^2 = 2.2366$, df = 1, $p = 0.135$). Indeed, a Japanese study suggests that joint clutches of Black-winged Stilts may occur, when the population is female biased, and females are not able to find single males, therefore unpaired females are also able to breed, if they form bigamous trios including a male and another female and have 1.) a joint clutch or 2.) two simultaneous nests or 3.) several nests successively (Kitagawa 2009, 2011). Haraszthy (2019a, 2019b) treated joint clutches in Hungary as a result of intraspecific nest parasitism. Unfortunately, no data is available on the sex ratio of Black-winged Stilts in Hungary during the influx in 2000, and neither on the exact parental behaviour in case of joint clutches during incubation (including the number of parents incubating a particular joint clutch), therefore, more fieldwork is needed to analyse the role of joint clutches in Hungary. Our results indicate that during the influx of Black-winged Stilts, the number of joint clutches was extremely high (Haraszthy 2019a).

The chicks are precocial (Cramp & Simmons 1983). Bod (1992, 1993) estimated the fledging success at 3.0 and 3.6 fledged juveniles/pairs in two colonies in 1990 and 2.1 fledged juveniles/pairs in 1992 on effluent pools for pigs at Szentes.

Dispersal and migration

Field observations

The Black-winged Stilts arrived back to Hungary approximately on 7–8 April at the end of the 19th century (Chernel 1899). Stilts returned during the first half of April during the

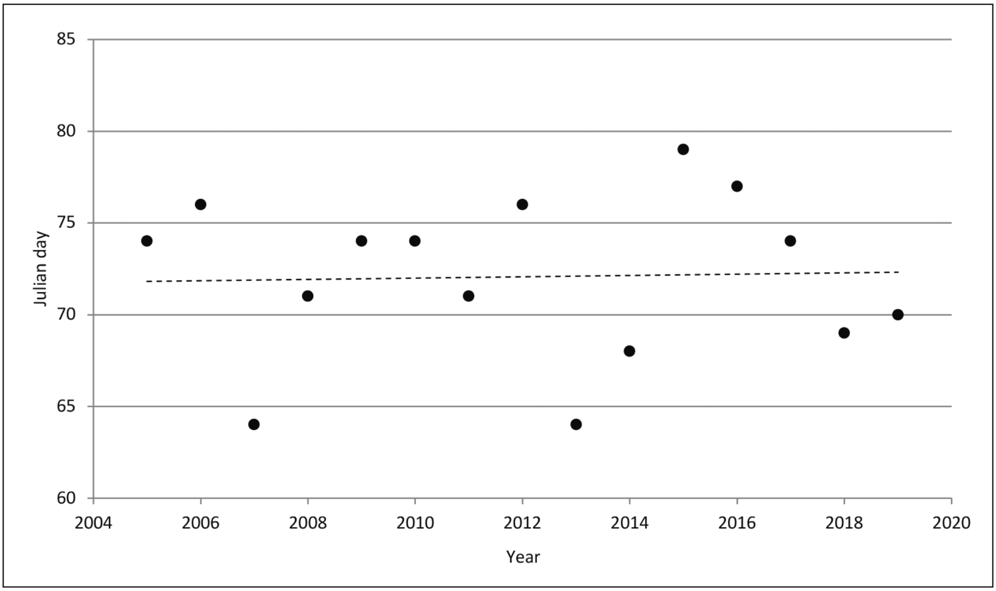

Figure 3. Arrival date of Black-winged Stilts to Hungary between 2005 and 2019 (based on data available from http://map.mme.hu and www.birding.hu)

3. ábra Gólyatöcsök érkezése Magyarországon 2005 és 2019 között (http://map.mme.hu és www.birding.hu adatbázisok adatai alapján)

1980s (Bankovics 1984, Bankovics *et al.* 1990). During the late 1990s and 2000s, the Black-winged Stilts arrived back to Hungary between the end of March and the beginning of April (Oláh *et al.* 2003, Bankovics 2008). The first Black-winged Stilts arrived back to Hungary between 5 March and 20·March during the period between 2005 and 2019 *(Figure 3)* (www.birding.hu, http://map.mme.hu). The median day of first arrival was 74 Julian day (15 March), and the mean and standard deviance of first arrival was found to be 72.1 (13 March) ± 4.5 Julian day. From this it can be inferred that Black-winged Stilts arrived back to Hungary a month earlier by 2010s than during the 1980s. Earlier arrivals could be the result of climate change in the Hortobágy area (Végvári *et al.* 2010). We did not detect a shift in the case of arrival dates of stilts to Hungary between 2005 and 2019 (linear regression: b > 0.001, df = 13, p = 0.9999).

The Black-winged Stilts tend to form large flocks in July and early August, during post-breeding or post-fledging dispersal periods. Large flocks with more than 200 individuals became increasingly regular in Hungary from 1999. The first larger flock was documented in Hungary during the 1990s on the Böddi-szék (near Dunatetétlen): it contained 218 individuals on 16 July 1999 (Pigniczki 1999). The largest flock observed in Kiskunság contained 251 individuals: this flock was observed at Partos-szék (near Fülöpszállás) on 9 July 2000, but only 119 stilts were seen on 15 July 2000 (Cs. Pigniczki unpublished data). The settling pools at a sugar beet factory at Kaba held 237 Black-winged Stilts on 18 July 2004 (J. Oláh in www.birding.hu). The largest flocks ever documented in Hungary were observed

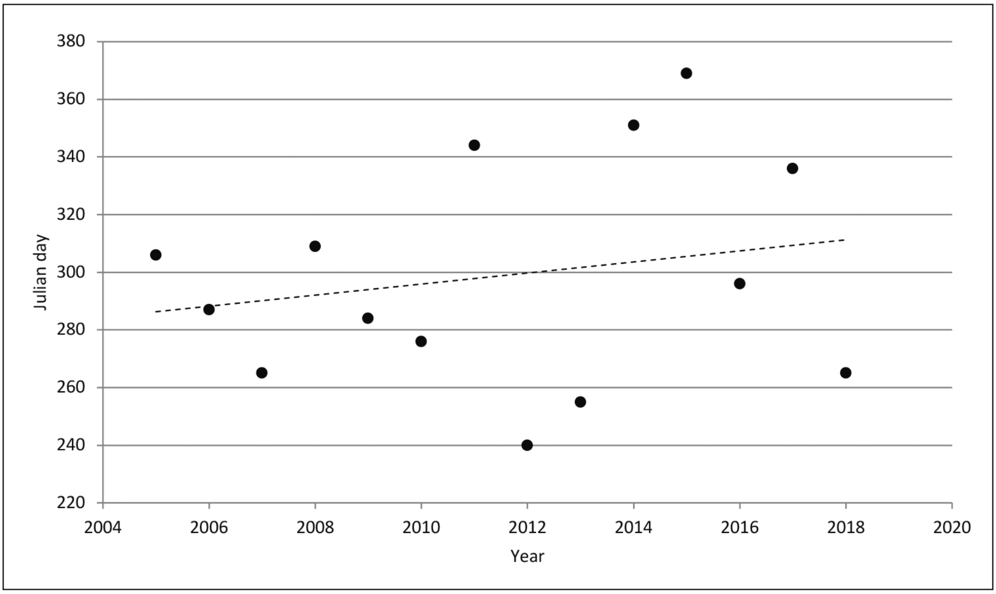

Figure 4. Departure date of Black-winged Stilts from Hungary between 2005 and 2018 (based on data available from http://map.mme.hu and www.birding.hu). The last observation of the season 2015 happened on 4 January 2016, that date was treated as 369 Julian day

4. ábra Gólyatöcsök utolsó megfigyelése Magyarországon 2005 és 2018 között (http://map.mme.hu és www.birding.hu adatbázisok adatai alapján). A 2015-ös szezon utolsó megfigyelése 2016. január 4-én történt, ezt a 369-es julián napként kezeltük

Table 1. First and last observation dates of Black-winged Stilt individuals in Hungary between 2005 and 2019 (based on data available from http://map.mme.hu and www.birding.hu).
** The last observation of the 2015 season occurred on 4 January 2016.*

1. táblázat Gólyatöcsök legkorábbi és legkésőbbi adatai a 2005–2019-ből (http://map.mme.hu és www.birding.hu adatbázisok adatai alapján).
**A 2015-ös szezon utolsó adata 2016. január 4-én került megfigyelésre*

Season	**First data**	**Last data**
2005	15 March	2 November
2006	17 March	14 October
2007	5 March	22 September
2008	11 March	4 November
2009	15 March	11 October
2010	15 March	3 October
2011	12 March	10 December
2012	16 March	27 August
2013	5 March	12 September
2014	9 March	17 December
2015	20 March	4 January 2016*
2016	17 March	22 October
2017	15 March	2 December
2018	10 March	22 September
2019	11 March	not available

on the 95 ha large habitat complex of Vesszős-szék and Hatvani-csatak (near Pusztaszer): 470 Black-winged Stilts were counted on 26 July and 6 August 2015, 380 individuals on 12 July 2016, and 417 on 21 July 2018 (T. Nagy unpublished data). Sárkány-tó (near Sárkeresztúr) is also an important soda pan for Black-winged Stilts, where 370 individuals were seen on 26 July 2013 and 268 birds on 4 July 2018 (N. Kovács in www.birding.hu).

Black-winged Stilts may appear in unusual habitats during their movements. For instance, a group of maximum six individuals fed on the Csukás-ér, a nine-meter wide sewage-water ditch next to the town of Kecskemét in 2018 and in 2019 (Cs. Pigniczki unpublished data).

The last Black-winged Stilts left Hungary by the beginning of September during the 1980s (Bankovics 1984, Bankovics *et al.* 1990). Most Black-winged Stilts leave Hungary during August, however, a few individuals stay in Hungary and they start their autumn migration in September, and the last ones were observed in October and rarely even in November and December in Hungary during the 1990s and the first years of the 2000s (Nagy 1992, Oláh *et al.* 2003, Bankovics 2008). Interestingly, 2 individuals were observed on 21 December 1990 (Nagy 1992). The last Black-winged Stilts were observed in Hungary between 27 August and 4 January during the period between 2005 and 2018 *(Figure 4)* (www.birding.hu, http://map.mme.hu). The median value of the last observation in Hungary was 291.5 Julian day (19 October). The mean and standard deviance of the last observation was 298.8 ± 39.0 Julian day (26 October). Currently, the last Black-winged Stilts leave Hungary one and a half to three months later than during the 1980s, with a substantial inter-annual variance. We found that the departure date of stilts changed, they left Hungary later by the end of the period between 2005 and 2018, but it was not significant statistically (linear regression: b = 1.919, df = 12, p = 0.4804).

Observations of individuals marked in Hungary

345 Black-winged Stilts were marked in Hungary between 1951 and 2018, 285 (82.6%) of them were captured as chicks. Colour marking of the species started in 2015 in Hungary, which resulted in 46 (13.3%) colour-ringed individuals between 2015 and 2018.

Some information is available on the dispersal *(Figure 5)* and the migration *(Figure 6)* strategies of Black-winged Stilts due to colour-ringing. An individual marked at Kis-rét at Szabadszállás in the Kiskunság on 3 June 2015 was observed 54 days later at the Austrian part of Lake Fertő (Neusiedler See), 209 km away from its natal area. Another individual captured at Sós-tó at Bácsalmás on 6 July 2016 was seen 36 days later at Sárkány-tó at Sárkeresztúr, which covered a distance of 116 km. An adult female captured at Seregélyes, in the vicinity of Lake Velence on 2 July 2018 moved 143 km and was observed between 26 July and 10 August 2018 at the Hungarian part of Lake Fertő (Neusiedler See). These ring readings indicate that both juvenile and adult Black-winged Stilts can cover larger distances, while they move from one wetland to another in the Carpathian Basin, during their post-fledging or post-breeding dispersal. On the other hand, a chick captured on 11 July 2017 used the same location around Lake Fertő (Neusiedler See) for a long period, and was observed there eleven times until 3 September 2017. This example suggests that individuals can stick to a suitable site for a long time.

Only one record is known from autumn migration of Black-winged Stilts: a colour-ringed juvenile marked as a chick at Mocsa (Hungary) was observed at Sentina in Italy on 24 August 2018. Another individual captured as juvenile (likely to have hatched in the Carpathian

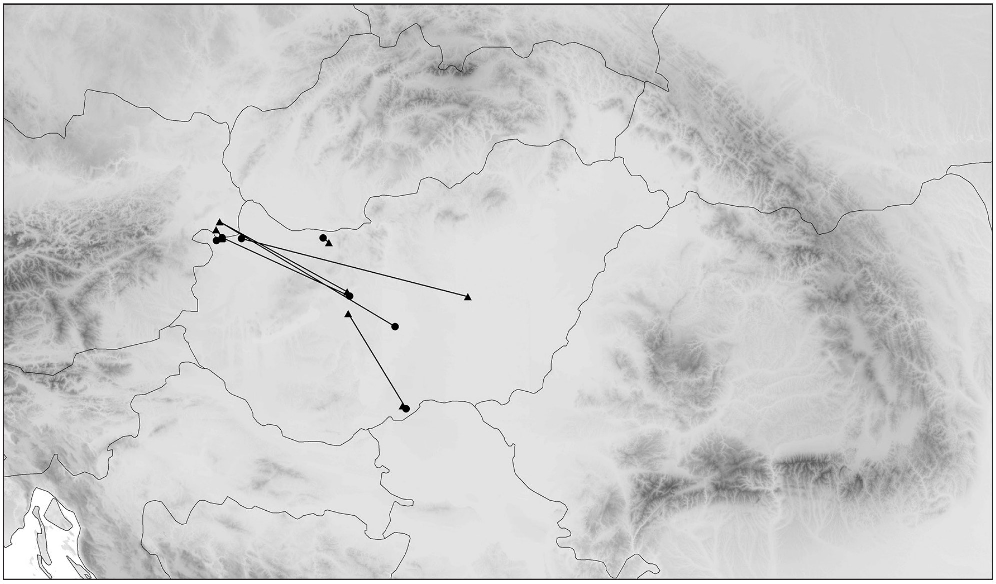

Figure 5. Dispersal of Black-winged Stilts in the Carpathian Basin based on birds marked in Hungary. Circles indicate the location of captures, while triangles show the location of observations

5. ábra Gólyatöcsök diszperziója a Kárpát-medencében a magyar gyűrűs madarak megfigyelési adatai alapján. A körök a befogás, a háromszögek a megfigyelés helyét jelölik

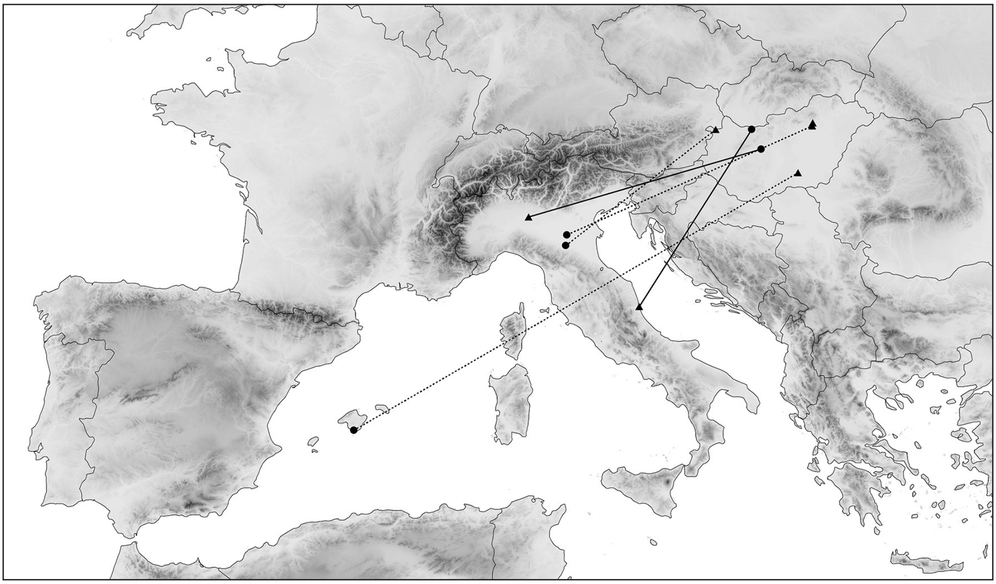

Figure 6. Migration of Black-winged Stilts related to Hungary. Circles indicate the location of captures, while triangles show the location of observations. Movement of stilts captured in Hungary are indicated by continuous lines, while interrupted lines show the movement of birds marked abroad

6. ábra Gólyatöcsök magyar vonatkozású vonulási adatai. A körök a befogás, a háromszögek a megfigyelés helyét jelölik. A Magyarországon gyűrűzött madarak elmozdulását folytonos vonal, a külföldön gyűrűzöttekét szaggatott vonal mutatja

Basin) was observed at Crema in Italy on 26 March 2010 during spring migration *(Figure 6)*. These two records are very limited but suggest that Black-winged Stilts may move southwest from Hungary to their wintering areas. It seems that telemetry-based studies and colour-marking projects are needed to identify the key wintering areas and migration routes of this species. We suppose that at least a part of Black-winged Stilts hatched in Hungary follow similar migration routes as individuals hatched in Italy: three birds with Italian origin crossed the Sahara and moved to Mali to winter there (Spina & Volponi 2008).

Observations of individuals marked abroad

Ring readings of colour-ringed Black-winged Stilts marked abroad indicate connection between the Carpathian Basin and southwestern Europe: two ringed as chicks in France, one captured as chick in Portugal, one marked as adult in Spain and finally seven individuals – two captured as adults and five as chicks – from Italy were observed in Hungary.

Black-winged Stilts captured in Italy in late March and early April as adults could be individuals returning to the Carpathian Basin in their spring migration *(Figure 6)*. One of those birds was captured in Italy in 2010 and was observed in Hungary in 2016 and 2019 as well, and we suppose that it was an individual breeding around Mezőkövesd and Mezőszemere. The adult bird trapped in Spain in May 1993 was most likely a local breeder there, and a year

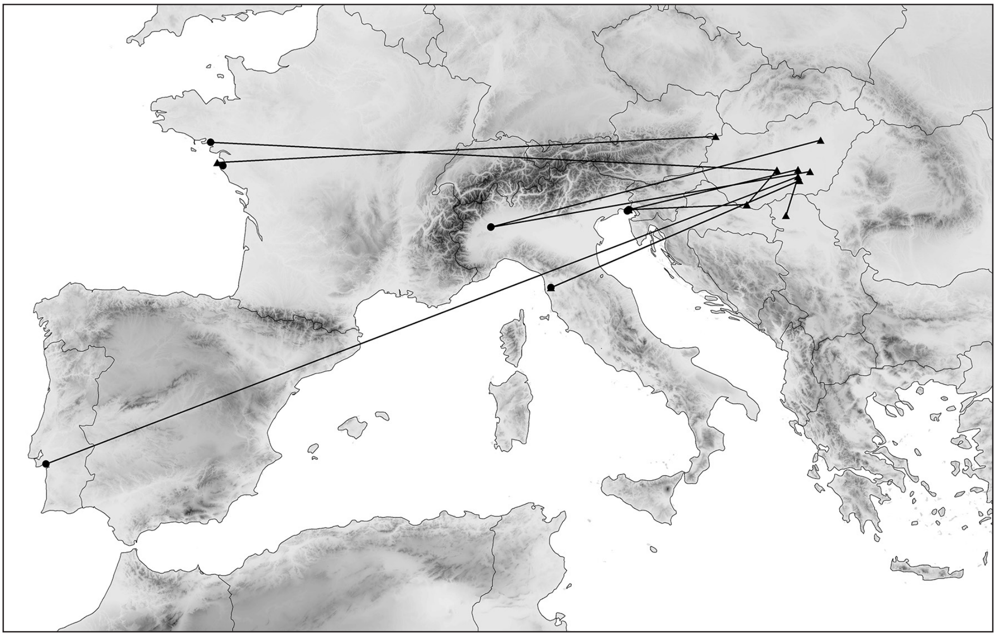

Figure 7. Origin of Black-winged Stilts captured as chick outside Hungary and observed later in Hungary during breeding period. Circles indicate the location of captures, while triangles show the location of observations

7. ábra Gólyatöcsök származási helye, melyeket külföldön, fiókaként fogtak be és Magyarországon költési időben figyeltek meg. A körök a befogás, a háromszögek a megfigyelés helyét jelölik

later was observed in Hungary on 28 July 1994 during post-breeding dispersal, however, it is not known where that individual bred *(Figure 6)*.

We know the natal area of eight Black-winged Stilts marked abroad, all of which were observed in Hungary during breeding season (between 24 April and 16 July) *(Figure 7)*. Interestingly, two individuals hatched abroad were identified in Hungary during the first influx in 1999 and another one during the large influx in 2000. Therefore, the ring recoveries proved that not only the local individuals, but also some Southwest and West European stilts started to breed in Hungary, and provided strong evidence for the origin of birds when the Hungarian breeding population increased suddenly. Similar connections were found and a similar influx was observed in the case of Pied Avocets, a close relative of stilts during extremely wet years: three avocets, including one hatched in Italy and two hatched in Spain, bred later in Hungary (Boros & Lengyel 2009).

Black-winged Stilts with foreign natal area were observed at Hortobágy, Szentes, Gátér, Pusztaszer, Fülöpszállás (2 individuals) and Sarród during breeding season. The largest distance between the natal area and Hungary was 2507 km (Vaia, Portugal – Gátér, Hungary). The mean distance (± s.d.) between natal areas and supposed breeding sites was 1163.4 ± 634.2 km, while the median distance was 978 km.

A bird hatched in Portugal was observed at Lake Fehér at Gátér with chicks on 7 July 1999, and four years later that bird was observed on a nest at Kula in Serbia on 17 May 2003.

This is an indication that this individual became a breeder of the Carpathian Basin *(Figure 7)*. A bird with Italian origin marked in 2006 was observed on 13 August 2010 at Páprád, Hungary, and a year later it was seen at Kelemen-szék at Fülöpszállás, Hungary on 20 June 2011, as a potential breeder *(Figure 7)*. There is an example for breeding dispersal: a bird hatched in the Atlantic area of France in 1992 nested two years later 19 km away from her natal area but she was observed three times in the Hungarian part of Lake Fertő (Neusiedler See) at Sarród between 24 April and 31 May 1999 *(Figure 7)*.

Conservation in Hungary

The population of Black-winged Stilts in Hungary largely depends on water conditions in its habitat, therefore, dry years and human-induced drainage of natural habitats could prevent many pairs from breeding in Hungary.

Black-winged Stilts and other shorebirds may start to breed on drained fishponds or other drained artificial wetlands. In these cases, it is necessary to provide enough time for these birds to incubate the eggs and lead their chicks away before refilling the fishponds (Molnár 2019).

Loss of breeding sites due to overgrowth with marsh vegetation on the shoreline and in the water-course of lakes and the growth of trees, especially *Eleagnus angustifolia* on breeding islands and in the vicinity of soda pans prevent the breeding of shorebirds (Ecsedi & Boros 2013).

Eggs and chicks are threatened by predators: several species of predators were documented and observed regularly in the colonies of Black-winged Stilts in Hungary while the predators were looking for eggs and chicks, like Western Marsh Harriers *(Circus aeruginosus)*, Caspian Gulls *(Larus cachinnans)*, Hooded Crows *(Corvus cornix)*, Rooks *(Corvus frugilegus)*, Magpies *(Pica pica)*, Red Foxes *(Vulpes vulpes)*, Golden Jackals *(Canis aureus)*, Dogs *(Canis lupus familiaris)*, Badgers *(Meles meles)* and Wild Boars *(Sus scrofa)* (Ecsedi & Boros 2013, Cs. Biró pers. com., Cs. Pigniczki unpublished data). It was observed on the habitat restoration area of Lake Kolon at Izsák, that a swimming chick of Black-winged Stilt was preyed on by a Northern Pike *(Esox lucius)* (Cs. Biró pers. com.).

Habitat management

Black-winged Stilts use a wide variety of wetlands with shallow water, both for breeding and foraging.

Breeding islands created for waterbirds during habitat restorations were often occupied by Black-winged Stilts during the first years after the interventions. For example, a pair of Black-winged Stilts together with 35 pairs of Pied Avocets bred on the island of Fehér-szék at Fülöpszállás in 1999, in the second year followed by works on that area (Boros & Pigniczki 2001, 2013, Pigniczki 2001).

Lake Kolon is a large peat bog area with a huge reedbed. Open water surfaces were created in the reedbed, and an island was built from soil by the autumn of 2011. There was a breeding pair of Black-winged Stilts in 2012, eleven pairs in 2013, four pairs in 2014 but no pair during the following years (Cs. Biró pers. com.). Generally, Black-winged Stilts occupy islands during the first years after the earthworks of habitat restorations.

Grazing of livestock (e.g. Hungarian Grey Cattle, Hungarian Flecked Cattle, Water Buffalo, Mangalica 'Woolly' Pig, Racka Sheep, Goat, Donkey and Horse, etc.) on Hungarian wetlands is a very important tool to control marsh vegetation and to create suitable breeding and foraging areas for many species of waterbirds, including Black-winged Stilts (Ecsedi & Boros 2013, Pigniczki *et al.* 2013).

Habitat management in Pusztaszer Landscape Protection Area is an example of the important role that grazing by Water Buffalos can play in removing reedbeds and thus creating lakes with open water for breeding shorebirds. The Vesszős-szék at Pusztaszer was used as a domestic duck and goose farm for a long time, and that soda pan was overgrown by marsh vegetation, therefore, Vesszős-szék was not suitable for breeding shorebirds anymore (Tajti 2013). The grazing of the first twelve buffalos started on a 60 ha area of Vesszős-szék in 2004 (0.2 grazing animal/ha), and the number of buffalos increased to 41 individuals by 2006. A spectacular habitat change took place in Vesszős-szék and Hatvani-csatak from 2007, when 110, and later 130 buffalos grazed on a 120 ha area. Due to this grazing management, the density of marsh vegetation became scarce and finally disappeared from the area by the end of 2009, when buffalos grazed on a 160 ha area, including the marsh of Büdös-szék. However, *Typha latifolia* reappeared in the Vesszős-szék in 2010 due to extremely wet conditions, but 150 individuals of grazing buffalos were able to control the vegetation. The open water surface of Vesszős-szék and Hatvani-csatak was stable between 2011 and 2019, due to the grazing of 120–160 buffalos and the marsh of Büdös-szék started to be opened. Black-winged Stilts occupied the opened habitat and 19 pairs started to breed in 2006, and their number increased from zero in 2005 to 20.5 ± 17.0 pairs (mean ± SD) in the

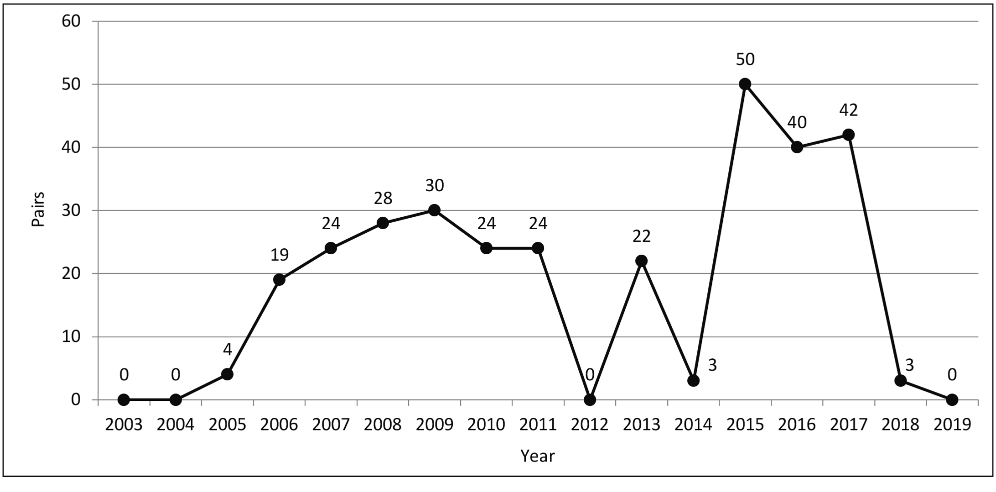

Figure 8. Breeding population of Black-winged Stilts in Vesszős-szék and Hatvani-csatak at Pusztaszer, during grazing of Water Buffalos

8. ábra A gólyatöcs állományának alakulása a pusztaszeri Vesszős-széken és Hatvani-csatakban, bivalylegeltetés mellett following years; 0–50 breeding pairs *(Figure 8)*, depending on the winter precipitation of the particular year (Tajti 2013, T. Nagy unpublished data). Vesszős-szék and Hatvani-csatak are important for Black-winged Stilts during post-breeding/post-fledging dispersal as well with a maximum of 470 individuals on the study area (T. Nagy unpublished data). Buffalos started to graze in the marsh of Büdös-szék at Pusztaszer in 2009, and the first breeding of Black-winged Stilts in that area was documented a year later there (T. Nagy unpublished data). Habitat management with a similar grazing method of buffalos was implemented at Lake Nagy-Széksós at Mórahalom, its result was a maximum of 28 breeding pairs of Black-winged Stilts in the area (Krnács 2013, Gy. Krnács pers. com.). Cattle are also able to create similar areas for shorebirds: 55 breeding pairs of stilts bred at Bába-szék at Dunatetétlen in 2018 (S. Kovács pers. com.).

Another example indicates the importance of Mangalica 'Woolly' Pigs for shorebird habitat management in the Hortobágy area. The Nagy-Vókonya wetland was a degraded part of the Hortobágy National Park, where the original steppe habitat was destroyed by the creation of a rice field system in the 1950s. That area was also used later for domestic goose farming during the 1980s. The Hortobágy Environmental Association carried out a Life Project in the area (LIFENAT02/H/8638). In the frame of the project, a total of 100 km of paddyfield dykes was eliminated, and due to this activity, several temporary spring wetlands were created in the steppe habitat. Furthermore, a 200 ha semi-permanent wetland was formed and an ecologically high level of grazing was introduced to the area employing mixed livestock. The livestock included Hungarian Grey Cattle, Mangalica 'Woolly' Pig, Racka Sheep and Donkey (Pigniczki *et al.* 2013). Throughout the project, a minimum of 0.8 grazing animal unit/ha grazing level was introduced. If the grazing effect of an adult cattle or buffalo means 1.0 grazing animal unit, then compared to that value the rate of grazing effect of a sheep or goat is 0.15, in the case of a pig is 0.3–0.5 and in the case of a donkey is 0.6 (Borza *et al.* 2017). Some years after the project, the grazing density was raised to 1.2 grazing animal unit/ha. The original base survey for breeding shorebirds revealed almost no breeding shorebirds in the area before the project. This changed significantly after the project especially for Lapwing, Common Redshank and Black-tailed Godwit, moreover, Black-winged Stilt, Pied Avocet and Common Snipe *(Gallinago gallinago)* became regular breeding shorebirds in Nagy-Vókonya. As soon as the 200 ha wetland was flooded for the first time in 2004, immediately 7 pairs of Black-winged Stilts bred in the area. Stilts were the first species that colonized that area, although the Hortobágy population was small in those years. In the following years, an increasing number of stilts was seen foraging in the area. Stilts only became regular breeders after 2010 with a peak of 72 pairs in 2013 *(Figure 9)*. It was found that an ecologically high level of grazing was essential to maintain the right balance of open water surface, short grass, and muddy or open-soiled habitat. Anything above 0.8 grazing animal unit/ha was beneficial for shorebirds. In the case of Nagy-Vókonya Mangalica 'Woolly' Pigs were used for entering and feeding in deeper water.

The impact of grazing in landscape-scale on the breeding population of Black-winged Stilts can be followed in the example of the Hortobágy. Generally, the Hortobágy had an insignificant breeding population of Black-winged Stilts until 1999, and the first important year in the case of the Hortobágy population of this species was noted in 1999 with 30

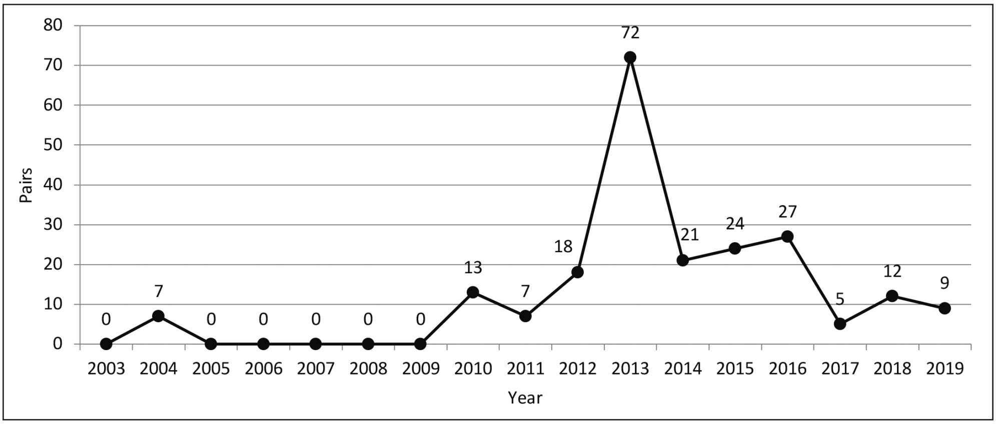

Figure 9. Breeding population of Black-winged Stilts in Nagy-Vókonya at Hortobágy during grazing of Mangalica 'Woolly' Pigs
9. ábra A gólyatöcs állományának alakulása a hortobágyi Nagy-Vókonyán, a mangalicatartás mellett

pairs (Borza *et al.* 2017), but with no documented breeding attempt during the large influx in 2000 (Oláh *et al.* 2003). The majority of habitat recreation and rehabilitations occurred in the late 1990s and the early 2000s and by 2010 there were several suitable breeding habitats for the species where both ecologically high level of grazing and suitable water cover were maintained. The number of breeding pairs of Black-winged Stilts reached a hundred pairs during the 2010s in Hortobágy (Borza *et al.* 2017). This increase of the species was the result of changing habitat due to intensive grazing activity in the Hortobágy: grazing livestock opened shallow lakes covered by vegetation, mainly by *Phragmites australis*, *Typha latifolia*, and *Bolboschoenus maritimus*, and created wetlands with open water surfaces, which are important not only for Black-winged Stilts but also for other breeding shorebirds. The effect of grazing activity was the most spectacular on the breeding population of shorebirds

Table 2. Breeding population of Black-winged Stilts between 2009 and 2019 in the northeastern part of Hortobágy (HEA, unpublished data)
2. táblázat Az Északkelet-Hortobágyon fészkelő gólyatöcsök állománya 2009 és 2019 között (Hortobágy Természetvédelmi Egyesület, nem publikált adatok)

	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Nyárijárás & Nyírő-lapos	0	4	0	4	4	1	0	4	0	40	0
Magdolna-puszta	1	0	0	0	0	2	1	53	4	1	0
Daru-Karinkó-puszta	0	0	0	0	0	0	0	2	0	0	0
Kerek-fenék	0	3	2	0	0	0	0	9	2	0	0
Nagy-szik	0	0	9	16	16	8	0	21	76	4	3
Nagy-Vókonya	0	13	7	18	72	21	24	27	5	12	9
Total/Összesen	1	20	18	38	92	32	25	116	87	57	11

if at least 1.5 grazing animal units of livestock were in 1 ha area (Borza *et al.* 2017). Due to intensive grazing activity on Nagy-szik, the breeding population of Black-winged Stilts increased from 0–4 breeding pairs to 8–21 pairs, and they breed regularly in that area, and their population is stable with some fluctuation (Ecsedi *et al.* 2017). The increase of the breeding Black-winged Stilts in the Northeast Hortobágy area *(Table 2)* (HEA database, unpublished data) coincide with habitat restorations and increased level of grazing. Especially, those wetlands were important where either Water Buffalos or Mangalica 'Woolly' Pigs were used for habitat management because both can forage on the shore and in the water as well, where they are the best type of livestock for creating breeding habitat for shorebirds. In the case of Black-winged Stilt, these types of livestock did not only create important mudflats for foraging, but also turned the vegetation more tussocky, with clusters of vegetation interspersed with patches of water, hence perfect for the breeding stilts.

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The mystery of *Anser neglectus* Sushkin, 1897. Victim of the Tunguska disaster? A Hungarian story

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Abstract The well-known Russian ornithologist Prof. Peter Sushkin described it as a distinct species from Bashkortostan (Bashkiria) in 1897, a highly acclaimed discovery. However, its breeding grounds never been discovered. Since then, there has been a long-standing debate over the taxonomic position of *Anser neglectus*. Taxonomists have argued that *Anser neglectus* belongs to the group of *A. fabalis* Lath. because of its close resemblance with *A. f. fabalis*.

At the beginning of the 20th century, large numbers of the Sushkin's goose were observed in three winter quarters: on two lakes in the Republic of Bachkortostan, in the surroundings of the town of Tashkent in the Republic Uzbekistan, and in the puszta Hortobágy in eastern Hungary. It is a pity that taxonomists did not thoroughly compare the Russian and Hungarian ornithological papers concerning the former presence of *Anser neglectus* in these areas, because these rich sources refer to characteristics that would cast serious doubt on the classification of *Anser neglectus* as a subspecies, an individual variation or mutation of *A. f. fabalis*.

Sushkin's goose, though a typical Taiga Bean Goose, distinguished itself from other taxa of the Bean Goose by its plumage, its field identification, by its specific "Gé-gé" call, the size of its bill, and by its preference for warm and dry winter haunts. *A. neglectus* should therefore be considered a separate, fully distinct species, *sensu* Stegmann (1935) and Stegmann in Schenk (1931/34), if we follow the established criteria in bird systematics of Tobias *et al*. (2010).

Between 1908 and 1911, an estimation of up to 150.000 individuals of *A. neglectus* wintered in the Hortobágy puszta. Approximate counts for both other winter quarters are not available. The last living birds were seen in the zoological garden of Budapest in 1934. Since then, *A. f. fabalis* and *A. s. rossicus* "Type *neglectus"* (i.e. *A. f. fabalis* and *A. s. rossicus* with a color of the bill and the legs, similar to the former *A. neglectus*) have been observed sporadically on the breeding grounds and in the winter quarters of both taxa. However, the true *A. neglectus* seems to be extinct. Its sudden disappearance may be related to the Tunguska event, the catastrophe in 1908 that may have caused genetic mutations. This hypothesis is considered to be the most likely, among other available hypotheses about its extinction.

Keywords: *Anser neglectus*, extinction, mystery, Tunguska event, Hortobágy puszta, Republic of Bashkiria, Tashkent

Összefoglalás A Shushkin-ludat *(Anser neglectus)* az orosz ornitológus, Prof. Peter Shushkin különálló fajként írta le 1897-ben Bachkortostanból, amelyet jelentős felfedezésnek tekinthetünk. Azonban a faj költőterületét sohasem sikerült megtalálni. Azóta hosszas vita folyik az *Anser neglectus* taxonómiai helyzetéről. A taxonómusok álláspontja szerint az *Anser neglectus* az *A. fabalis* Lath. csoportjába tartozik az *A. fabalis*hoz való hasonlatossága alapján.

A 20. század elején nagy mennyiségben figyeltek meg Shushkin-ludakat három telelőterületen: a Bachkortostani Köztársaság két taván, az Üzbég Köztársaságban található Taskent szomszédságában és a Hortobágyon. Sajnos a taxonómusok nem vetették össze alaposan az *Anser neglectus*nak az ezen területeken való korábbi megfigyeléseire vonatkozó orosz és magyar cikkeket, ugyanis ezen gazdag források olyan jellemzőkre térnek ki, melyek alapján komolyan kétségbe vonható az *Anser neglectus*nak az *A. f. fabalis* alfajaként, egyedi variációjaként vagy mutációjaként való besorolása.

A Shushkin-lúd, bár tipikus tajgai vetési lúd típusú, a vetési lúd más formáitól jól elkülönül tollazata, terepi határozóbélyegei és jellegzetes "gege" hangja, csőrmérete, illetve meleg és száraz telelőterületek irányába mutató élőhely preferenciája révén. Ennél fogva az *A. neglectus*t önálló fajként kell tekintenünk Stegmann (1935) és

Stegmann (in: Schenk 1934) meghatározásai alapján, ha a Tobias *et al.* (2010) által megfogalmazott madárrendszertani kategorizálást követjük.

1908 és 1911 között a Hortobágyon becslések szerint 150 ezer *A. neglectus* is telelt. A másik két telelőhelyre vonatkozóan ebből az időszakból nem ismertek állománybecslések. A. utolsó élő példányokat a budapesti állatkertben 1934-ben látták. Azóta az *A. f. fabalis* és az *A. s. rossicus “neglectus”* **típusú (azaz** *A. f. fabalis* és *A. s. rossicus*, *A. neglectus*ra emlékeztető láb- és csőrszínnel) egyedeket szórványosan figyeltek meg mindkét taxon fészkelő- és telelőterületein.

A valódi *A. neglectus* kihaltnak tűnik. Váratlan eltűnése kapcsolatba hozható a Tunguszka-eseménnyel, vagyis az 1908-ban bekövetkezett, genetikai mutációkat eredményező katasztrófával. Ez a hipotézis tűnik a legvalószínűbbnek a kihalást magyarázó hipotézisek közül.

Kulcsszavak: *Anser neglectus*, kihalás, rejtély, Tunguszka-katasztrófa, Hortobágy, Bashkiria, Taskent

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Introduction

Anser fabalis sp. inhabits large parts of the Palearctic tundras and taigas in Europe and Northern Asia: from Scandinavia in the West to the basin of the river Anadyr, Kamchatka and Okhotsk in the East (Stepanyan 1990, 2003). The actual taxonomic classification of the Bean Goose species-complex after IOC World Bird List Version 9.2 (Gill & Donsker 2019) is the following:

Taiga Bean Goose *Anser fabalis* (Latham, 1787)
– *A f. fabalis* (Latham, 1787)
– *A f. johanseni* Delacour, 1951
– *A. f. middendorffii* Severtsov, 1873
Pink-footed Goose *Anser brachyrhynchus* Baillon, 1834
Tundra Bean Goose *Anser serrirostris* Gould, 1852
– *A. s. rossicus* Buturlin, 1933
– *A. s. serrirostris* Gould, 1852.

Taiga Bean Geese have a larger body size and shape, a long bill and neck, whereas Tundra Bean Geese are smaller in shape and have a shorter bill and neck (a.o. Emel’yanov 2000, Koblik *et al.* 2006). This classification is not the result of research done by ornithologists but is based on an age-old division known to indigenous people from Northern Siberia (Middendorff in Buturlin 1934).

However, the morphology of the Taiga and Tundra Bean Geese does not always correspond to the geographic position of their breeding sites. Earlier research (Alphéraky 1905, Buturlin 1934, Tugarinov 1932, 1941) stated that Taiga Bean Geese can be found breeding within the tundra belt. This was recently confirmed by Morozov (2016), who found *A. f. fabalis* breeding in the south of the Bolzhemelskaya tundra (North-East Russian Europe) among nesting *A. f. rossicus*. Also Rozenfeld *et al*. (2018) recently found nests of *A. f. fabalis* in the tundra belt of the Yamal Peninsula (North-West Siberia) with a density of 0.01 till 0.04 breeding pairs per km of river length.

From the first half of the 19th century onwards, many studies have been devoted to the taxonomy of the Bean Geese. The effort has proven to be a challenge due to the fact that the Bean Geese show a large morphological variability, as well as the fact that taxonomic decisions were made based on the examination of only a restricted number of individual birds. As a result, the description of species or subspecies such as *A. carneirostris*, *A. curtus, A. anadyrensis* were not confirmed by later research.

During the winter of 1891/92, P. P. Sushkin observed a new goose on two lakes in Bashkiria (East European Russia) and identified it as a new species: *Anser neglectus* or Sushkin's Bean Goose (later SBG) (Sushkin 1897a, 1897b). This eminent Russian scientist was unaware at the time that the SBG would go down in history as a mysterious bird that disappeared for unknown reasons off the face of the earth and of which the breeding sites remained unknown. Sushkin found this specimen of the SBG in a flock of nine birds. They belonged to the category of 'Great Been Geese', and could therefore not be classified as a Pink-footed goose *A. brachyrhynchus*. They had a pink or flesh-coloured bill band and legs, instead of orange-yellow.

Since then, many researchers have confirmed the existence of this new taxon. However, the position of the SBG within the taxonomy of the Bean Geese quickly became a matter of discussion. Numerous reviews gave very different results in the systematic position of SBG. This goose soon gained three vernacular names in the Russian language: the Ufimski Gumennik (named after Ufa, the capital of Bashkirian Republic), the Tonkoklyuvii Gumennik (Thin Bill Bean Goose) and the Tonkonosii Gumennik (Thin Nose Bean Goose). Of these three, the latter became the most common.

During migration time and in winter, large numbers of the SBG visited three haunts: the Hortobágy puszta (East Hungary), the Republic of Bashkiria, and the surroundings of the town of Tashkent (Republic of Uzbekistan). These observations were made at the end of the 19th – beginning of the 20th century, but from 1911 onwards the SBG disappeared quickly from these haunts.

After 1945, Hungarian and Russian literature concerning SBG was not easily accessible to ornithologists in the West. They were seldom compared with each other. Most researchers consulted either the Russian or the Hungarian literature, the latter often as large summaries in German translation. It was rare to find a synthesis that took all sources into account. Though Grote (1930a, 1930b, 1932), Dementieff (1936) and Johansen (1945) were all well aware of the literature from both countries.

Furthermore, a lot of the literature concerning the SGB contained only limited references to the earliest publications by these eminent ornithologists from the end of the 19th and the first half of the 20th century: Buturlin (1901, 1907, 1908, 1934, 1935), Chernel (1902, 1907, 1917, 1918), Madarász (1899, 1900, 1909), Nagy (1907, 1924, 1934), Schenk (1929, 1930, 1930, 1934), Sushkin (1897a, 1905, 1938), G. and L. Szomjas (1916, 1917, 1922, 1926, 1934), Zarudniy (1888, 1910a, b) and others. Also, the papers of Alphéraky (1905, 1907), Grote (1920, 1930a, 1930b, 1934, 1932), Hartert (1921, 1932), Stegmann (1935) and Stresemann (1922, 1929, 1930, 1934), discussing the results of these first papers, remained underrepresented in later research.

Studying the existence and former distribution of *A. neglectus* is not easy for two reasons:

Firstly, early research made a distinction between the Western Taiga Bean Goose *(A. f. fabalis)* and the Western Tundra Bean Goose *(A. s. rossicus)*. Later on, this distinction was no longer made in a large part of the Palearctic, which made the study of *A. neglectus* more difficult (Roselaar 1977, Huyskens 1986).

Secondly, a serious confusion has occurred over the course of years between the earliest occurrences of the 'true' *A. neglectus* and a colour deviation found in all subspecies of *A. fabalis* sensu lato, called *A. fabalis* 'Type *neglectus*' (Danilov 1930, Danilov in Dementieff 1936, Tugarinov in litt. in Grote 1934). The 'true' A. *neglectus* has for a long time been mistaken for this pseudo – *A. neglectus*.

At this time, the fate of *Anser neglectus* has been shrouded in mystery. Hartert wrote in 1932 that the final word has not been spoken about *A. neglectus*. Schenk (1929) wrote "How is it possible that the population of a species had decreased so catastrophically within only two decades, that only a few birds remained of the thousands of birds that used to occur on the Hortobágy puszta?" Also, Voous *(in litt.* dd. 12.03.1974) refers to the occurrence of large numbers in Hungary. The fact that these birds were recognizable by their call is a fascinating story, he wrote. The Bean Goose specialists G. Huyskens, P. Maes and others, who were aware of the former Hungarian ornithological literature, were convinced that SBG has been an independent taxonomic unit. Huyskens (1986) refers to the fact that thousands of birds suddenly disappeared, as one of the most outstanding ornithological phenomena that occurred in 20th century Europe. Or in the words of Bauer and Glutz von Blotzheim (1968) in their Handbuch: "the marked instability in the occurrence of *A. neglctus* remains an unsolved problem. From about 1899 to 1911, this goose wintered in Hungary in very large numbers but from the 1920s, it only appeared in small numbers".

This paper will render a faithful account of the earlier studies by the Hungarian and Russian ornithologists about the presence and the taxonomy of the SBG, as well as an objective review of later taxonomical research. It will try to repeat historic writings of the most eminent ornithologists from Russia, Hungary and Germany as accurately as possible. It will try to respect and discuss the opinions of the original observers and those who processed the systematics of *A. neglectus* later, as objectively as possible. It will suggest that SBG was an independent species and that the location of its breeding area was never identified with certainty, and that the whole large population potentially fell victim to the Tunguska catastrophe.

Synonyms:

Anser neglectus Sushkin, 1897
Sushkin (1897a, b), Oates (1899), Madarász (1900), Karamzin (1901), Zhitkov & Buturlin (1901), Menzbir (1902), Alphéraky (1905), Chernel (1918), Huyskens (1986).
Melanonyx neglectus (Sushkin)
Buturlin (1901), Alphéraky (1907), Zarudniy (1910a), Bianki 1922).
Anser fabalis neglectus (Sushkin)
Tugarinov *in litt. in* Grote (1934).
Melanonyx fabalis neglectus (Sushkin)
Tugarinov (1932), Sushkin (1938).
Anser fabalis fabalis (Latham, 1787)

Dementieff (1936), Tugarinov (1941), Dement'yev & Starostinits (1952), Dement'yev & Gladkov (1952), Dolgushin (1960), Dement'ev *et al.* (1967), recent authors (see later).
Anser segetum Gmelin, 1789
Bogdanov (1871).
Anser arvensis Brehm, 1831
Bogdanov (1871).
Anser rhodorhynchus Buturlin, 1901
Buturlin (1901).

Nomenclature in other languages:

Denmark: Sushkingans
France: Oie de Sushkin
Germany: Suschkingans, Dunnschnäblige Saatgans, Gé-gé gans; Rotfussgans
Great Britain: Sushkin's Bean Goose
Hungary: Gé-gé-lúd, Sushkin-lúd; Suskin-lúd
The Netherlands: Sushkinsgans, Sushkin's Rietgans
Russia: Tonkonosii Gumennik, Tonkoklyuvii Gumennik, Ufimski Gumennik
Serbia and Herzegovina: Tankokljuna Guska

Material and Methods

We followed the systematic classification of the Bean Geese, proposed by Emel'yanov (2000) and by Koblik *et al.* (2006), that does not comply with the IOC World Bird List v. 9.2. The following subspecies of the Bean Goose were mentioned in this study:

- The Western Taiga Bean Goose, *Anser fabalis fabalis* (Latham, 1787) (formerly *A. arvensis* Brehm, 1831)
- The Siberian Taiga Bean Goose, *Anser f. middendorffii* Severtsov, 1873 (formerly *A. sibiricus* Severtsov, 1873 and *Melanonyx sibiricus* Alphéraky, 1904)
- The Western Tundra Bean Goose, *A. f. rossicus* Buturlin, 1933 (formerly *A. segetum* Gmelin, 1789)
- The Eastern Tundra Bean Goose, *A. f. serrirostris*. (For synonyms, see Alphéraky 1905)

In the chapter "Measurements" we only used data acquired from initial Russian researchers, to exclude data who may relate to *A. f. fabalis/rossicus* "Type *neglectus*".

Results and Discussion

Field characters of *Anser neglectus*

According to all the original authors *A. neglectus* was a typical Bean Goose which could easily be distinguished from other Bean Geese, in hand as well as in the field (Sushkin

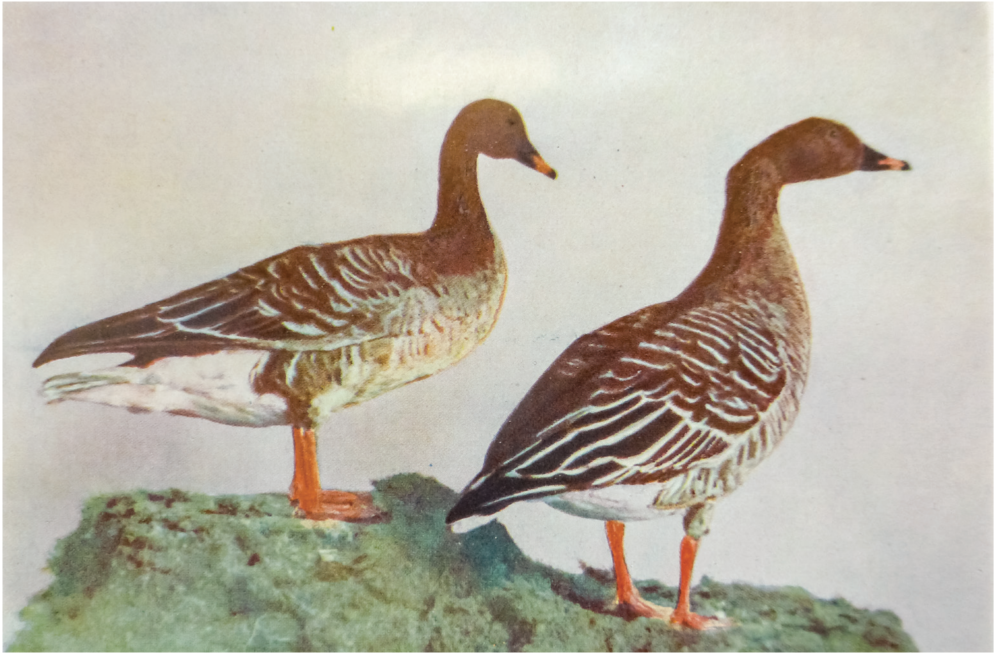

Figure 1. *Anser neglectus*. Adult (right) and juvenile bird (left). Shot resp. on 4 March 1923 and 23 December 1928, puszta Hortobágy (Photo: L. Szomjas in J. Schenk, 1929)
1. ábra *Anser neglectus*. Öreg (jobbra) és fiatal madár (balra)

1897a, 1897b, Sushkin in Alphéraky 1905, Nagy 1907, Schenk 1929, 1934, Buturlin 1934, Tugarinov 1941). She belonged to the Taiga Group of Bean Geese (Hartert 1932, Dementieff 1936, Tugarinov 1941, Johansen 1945, Dement'yev & Gladkov 1952, Roselaar 1977, Mayr & Cottrell 1979, Huyskens 1986) *(Figure 1, 2)*.

It was a large goose, significantly larger in the field than *A. f. rossicus,* with the approximate stature of *A. f. fabalis*, and had a long neck, a narrow unusually slender bill ("rostro longiore et graciliore") *(Figure 3, 4)*, and the nail of the bill was more oval shaped than in other taxa of the Bean Goose. It had a straight lower mandible, without a sign of a bump (Sushkin 1897a, 1897b, Sushkin in Alphéraky

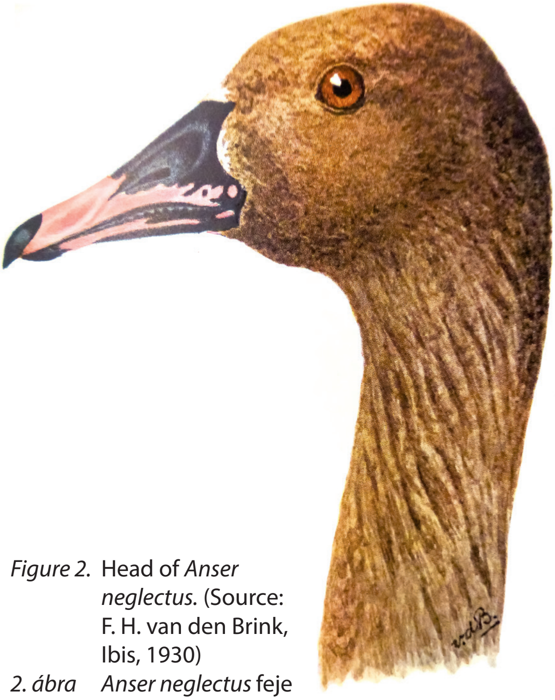

Figure 2. Head of *Anser neglectus.* (Source: F. H. van den Brink, Ibis, 1930)
2. ábra *Anser neglectus* feje

1905, Salvadori 1905, Stresemann 1922, Dementieff 1936). Some birds showed a ring of white feathering around the base of the upper mandible and the width was variable (e.g. Sushkin in Alphéraky 1905). This description corresponds to that of a typical Taiga Bean Goose.

A. neglectus, whose head, neck and sides of the neck, as well as back and belly had a warmer brown tone than in the other Bean Geese *(Figure 1).* The head could have a reddish or a soot-coloured tone. The feather edges of the upperparts and the flanks also had a browner colour (Madarász 1900, Sushkin in Alphéraky 1905, Schenk 1929, 1930, Kamner 1932, Tugarinov 1932, 1941, Sterbetz 1980). According to Tarján (1926), the dark colours made the SBG easily recognisable, even when the bird was in flight. Unfortunately, this dark colour is not shown in F. W. Frohawk's drawing (in Alphéraky 1905).

The main characteristic, which distinguished this goose from all the other Bean Geese, was the pink colour of the bare parts, which ranged from yellow pink to dark pink. This applied to the bill band, located between the nail of the bill and the nostril, as well as the legs. In the other Bean Geese, they are yellowish to a deep orange yellow. The width of the bill band was quite variable. It was usually limited to the area between the nostril and the nail of the bill, whereas in other cases the entire or almost the entire upper bill was pink coloured. These pink colours were a consistent feature. In Budapest Zoo in the early 1930s there were three *A. neglectus* and about ten *A. fabalis*. They were checked regularly by reliable ornithologists, including M. Vasvári and J. Schenk himself. They never noticed any change of the orange-yellow colour of the bare parts in any of the *A. neglectus* and *A. fabalis*. At first sight both taxa were distinctly different (Schenk 1934). Berry (1934) wrote the following about the leg colour: "when observing a group of wild geese, and all the geese have the same leg colour, it certainly attaches great credibility to this field characteristic".

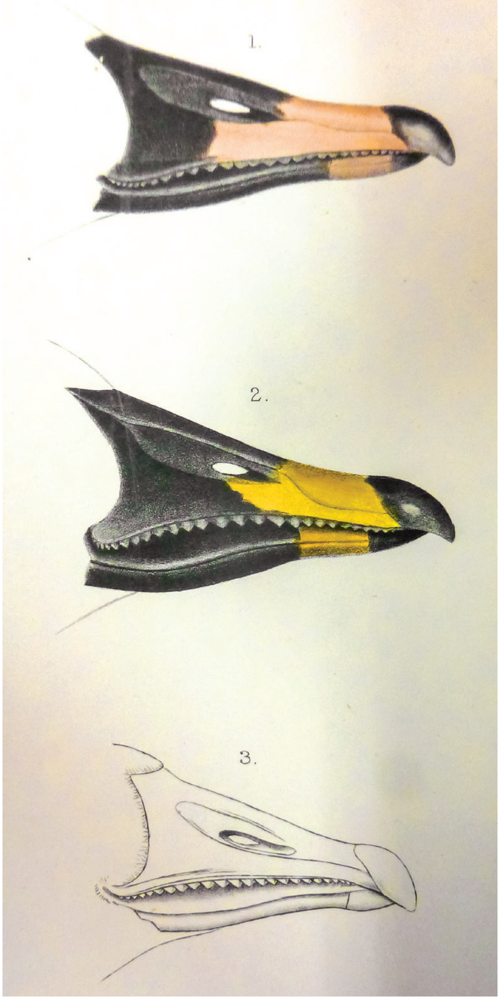

Figure 3. Bill of *Anser neglectus* (above), *A. f. rossicus* (middle) and *A. brachyrhynchus* (below). (After original drawings of P. P. Sushkin, Ibis 1897).

3. ábra *Anser neglectus* (felül), *A. f. rossicus* (középen) *és A. brachyrhynchus* (alul) csőre

Figure 4. Two bills belonging to *Anser neglectus*. Slender (above) and more curved (below). (Picture of T. Csörgey in J. Schenk, 1929).

4. ábra *Anser neglectus* csőre karcsú (fent) és hajlott (alul)

It was generally known that within just a few hours, but usually some days after death, this pink colour of the bill band and legs turned into a reddish colour and in a stuffed bird or a dried skin this colour would become a reddish brown (Madarász 1900, 1909, Buturlin 1934, Nagy 1934).

We are not well informed about the appearance of the juvenile (= first year) plumage in the field. Sushkin in Alphéraky (1905) makes a distinction between the plumage of young and adult birds which is only applicable in birds examined in hand. However, it appears from Madarász' writings (1909) that the young *neglectus* could easily be recognized among adult birds in the field.

The differences in field characteristics between the SBG and other representatives of the Bean Geese were also confirmed by anatomical studies. Szalay (1902) conducted a comparative anatomical study of the glenohumeral joint in *A. neglectus* and *A. f. fabalis/rossicus* in a series of 34 different osteological measurements. Out of these, five were more distinct than in a comparative osteological study between the glenohumeral joint in the Black-headed Gull *Larus ridibundus* and the Common Gull *L. canus.* Szalay (1902) then decided that *A. neglectus* should not be considered a species but a subspecies of *A. fabalis*. The well-known Hungarian palaeontologist K. Lambrecht (*in litt. in* Schenk 1929) also conducted research on the degree of pneumatization of the glenohumeral joint of *A. neglectus* and found that there was a higher rate of occurrence of pneumatization in *A. f. fabalis/rossicus* than in the SBG (also see Schenk 1929).

According to Stegman (in Schenk 1934) no hybrids had been identified between *A. neglectus* and other representatives of the Bean Geese. However, a hybrid pair was described in Moscow Zoo *A. neglectus* x *A. f. fabalis*. This pair gave birth to six young, two of which reached maturity. The bill band and legs were orange in one bird and pink in the other (Buturlin & Dement'yev 1935, Dementieff 1936). Heinroth (1929) also described hybridisation among birds in captivity between *A. fabalis* and the Domestic Goose *(A. a. forma domestica)* of which the offspring clearly resembled *A. neglectus*. This statement seems rather improbable considering the enormous shape of the bill of the Greylag Goose *A. anser*, as well as the high prevalence of *A. neglectus* in at least three important areas and their rapid disappearance (see below).

Here we quote Sushkin (1897a) and Sushkin (in Alphéraky 1905), in his meetings with the SBG in Bashkiria:

"From my hide-out, armed with a pair of binoculars, I could probably examine hundreds of geese. Only once or twice did I see Bean Geese with orange bill bands and legs among them, all the others were *A. neglectus*, except for a few Greylag Geese, which appeared as lost birds among the Bean Geese. These Bean Geese with flesh-coloured legs and bill bands were well known to the local population, the Bashkirs and the Tatars. I showed them a goose with an orange bill band and legs *(A. f. rossicus)*, they claimed that it was a rare or unknown goose to them. Also, the local hunters, who were familiar with the wild geese, consistently spoke of a pink colour".

The voice of *Anser neglectus*

Anser neglectus had an unusual call which could easily be distinguished from the call of the other representatives of the genus *Anser*.

Nagy (1907) visited the Hortobágy puszta in April 1907 and came across not only *A. albifrons*, but also *A. f. fabalis, A. f. rossicus* and *A. neglectus.* At that time the Hungarian ornithologists had been able to distinguish both subspecies of the Bean Goose in the field (Lakatos in Vertse 1967). Nagy described the call of *A. albifrons* as "Gli gli gli" and that of both Bean Geese as "Taddadat". The call of *A. neglectus* consisted of a very typical "Gé-gé" (Chernel 1907, 1917, Tarján 1926, Csörgey 1928, Buturlin 1934, Schenk 1929, 1934, Kamner 1932). Hence the Hungarian vernacular name of the SBG: "Gé-gé lud". The call of this new goose had already been in use before 1904 (Chernel 1907, 1917, Csörgey 1928, Schenk 1929, Kamner 1932). In the Hungarian vernacular this call also sounds like "Gé-gé" (L. Megyery, oral comm.). Sushkin (1897a) and Sushkin in Alphéraky (1905) also drew our attention to a melodious call with a double note which was heard in Bashkiria.

This unusual voice, transcribed in the International Phonetic Alphabet (IPA) as: "ɣe-ɣe", was immediately recognized by hunters and non-ornithologists in Hungary, which, according to Chernel, Tarján and others, made the "Gé-gé" goose so well known (Chernel 1907, 1917, Tarján 1926, Csörgey 1928, Schenk 1929, 1930). The story of Chernel (1917), who was made aware of the presence of *neglectus* by their call while out in the field and could only discover the goose later from his hiding place, is typical. Schenk (in Sterbetz 1980) observed that among the other wild geese which foraged on the puszta in the company of *A. neglectus*, only this goose responded to the SBG's alarm call.

Dutch and Belgian expert field observers of wild geese (G. Huyskens, P. Maes, G. Bulteel, J. De Ridder, W. Suetens, L. van den Bergh, H. van Deursen, H. Voet) had never heard such a “Gé-gé” call made by *A. f. fabalis* or *A. f. rossicus*. In the previous century hundreds of both taxa wintered in the southern Netherlands. Nor does this call agree with the call made by *A. f. middendorffii,* which is described as deeper than that of both western subspecies, but the syllables are identical (Parslow-Otsu 2010). The heavy call of *middendorffii*, which sounds very deep and nasal to the human ear, was also confirmed in the manuals consulted (Brazil 2009, Ayé *et al.* 2012, Robson 2015). This unique call can also be heard on the Xeno-canto site where Anon Torimi (2015/18) reproduces several sound recordings which were sourced in the Kohoku Wild-Bird Center, Shiga Prefecture (Japan).

Measurements of *Anser neglectus*

It is rather difficult to interpret the measurements of Bean Geese in the literature because the consulted material did not always make a distinction between the Taiga and the Tundra types of *A. fabalis* (Roselaar 1977, Huyskens 1986).

According to Buturlin (1934) *A. neglectus* can most certainly be distinguished from other taxa of the Bean Geese by the slender bill, the reduced height of the lower mandible and the more oval-shaped nail of the bill. *Table 1* is taken from Alphéraky’s (1905) and Buturlin’s (1908, 1934) original data. The data give the length of the wing, tarsus and bill for four taxa of *A. fabalis: neglectus, fabalis, middendorffii* and *rossicus*. Alphéraky gave the measurements of several individual birds (n), which enabled the calculations of mean and standard deviation (σ) of each measurement. The values of n and σ could not be distilled from Buturlin’s works (1908, 1934). Based on different sources we may assume that his measurements concerned at least 12 individual birds.

In Alphéraky’s (1905) series of measurements, the average bill length of *neglectus* (n = 11) was statistically shorter than that of *fabalis* (n = 37): 57.7 mm to 64.1 mm ($t_N = 6.130$, $P < 0.001$).

Table 1. Length of wing, tarsus and bill (in mm) in *A. neglectus*, *A. f. fabalis*, *A. f. middendorffii*, *A. f. rossicus* according to the data of Alphéraky (1905) (= A) and Buturlin (1908, 1934) (=B)

1. táblázat Az *A. neglectus, A. f. fabalis, A. f. middendorffii, A. f. rossicus* szárny, csüd és csőr hossza (mm) Alphéraky (1905) (= A) and Buturlin (1908, 1934) (=B) adatai alapján

Taxon	Source	Length wing	Length tarsus	Length bill	Length bill
					n/mean ±σ
A. neglectus	A.	452-485	75-79	55-63	11/57.7±2.5
	B.	411-482		54-69	
A. f. fabalis	A.	410-490	66-73	56-71.5	37/64.1±4.4
	B.	409-498		54-72	
A. f. middendorffii	A.	450-505	74-84	74-83	13/77.0 ±4.9
	B.	449-503		64-83	
A. f. rossicus	A.	410-450	74-76	57-63	
	B.	409-451		51-61	

Buturlin (1908, 1934) and Dement'yev *in* Buturlin & Dement'yev (1935) noted that the much thinner bill of *neglectus* compared to that of the Western Taiga

Bean Goose *A. f. fabalis* was due to a lower maximum height of the under mandible, if these measurements are taken when the bill is fully shut *(Figure 2, 3, 4)*. This height must not exceed the value of 6.50 mm. Ideally the age groups of juvenile and adult birds should be kept separate when carrying out this measurement.

Table 2, which was also set up using the Russian researchers' original measurements shows a clear difference in the height of the lower mandible between the taxa *neglectus* and *fabalis*.

Table 2. Maximum height of the under mandible (in mm) in Sushkin's Bean Goose *(A. neglectus)* under the condition of a completely closed bill. For comparison, this dimension was also shown for *A. f. fabalis, A. f. middendorffii* and *A. f. rossicus*

2. táblázat A Sushkin lúd *(A. neglectus)* alsó állkapcsának maximum magassága (mm) teljesen zárt csőr esetén, összehasonlítva a *A. f. fabalis, A. f. middendorffii* és *A. f. rossicus* állkapcsának méreteivel

Author	***A. neglectus***	***A. f. fabalis***	***A. f. middendorffii***	***A. f. rossicus***
Alphéraky (1905)	6.0-6-5	7.0-8.5	9.0-12.0	7.5-11.0
	5.5 in a young female			
Buturlin (1908)	adult: 5.8-6.3	6.8-8.1	8.4-11.4	8.4-9.4
	juvenil: 5.6	rarely 5.8	rarely 11.9	
Buturlin (1934)	all ages: 5.5-6.7	6.0-8.5		8.0-9.5
Buturlin	adult: 6.0-6.7	adult: 7.0-8.5	adult: 8.4-11.4	in older birds up to till 10.0
in Buturlin & Dement'yev (1935)			sometimes up to 12.0	very rarely 10.5
	juvenil: 5.5-6.0	juvenil: 6.0-8.0	juvenil: from 8.0	
Dementieff (1936)	5.5-7.0		7.0-10.5	
	mean: 6.0			
Tugarinov (1941)	5.0-6.7		7.0-10.5	
	mean: 6.3			

The place of *Anser neglectus* within the systematics of *A. fabalis*

Overview of the assessments

Over the years, many ornithologists have studied the systematic position of *Anser neglectus*. The different opinions are given in *Table 3*.

Table 3. An overview of the systematic position of *Anser neglectus* through time
3. táblázat Áttekintés a faj rendszertani besorolásáról

<table>
<tr><td colspan="2">Species:
Sushkin 1897a, Sushkin 1897b, Madarasz 1899, 1900, 1909, Oates 1899, Menzbir 1900, 1902, 1934, Buturlin 1901, Zhitkov & Buturlin 1901, Karamzin 1901, Alphéraky 1905, 1907, Salvadori 1905, Buturlin 1907, 1908, 1931/34, Chernel 1918, Hartert 1921, Stresemann 1922, 1929, 1930, 1934, Hartert <i>in</i> Klein 1927, Schenk 1929, 1934, Stuart Baker 1929, Vasvári 1929, Peters 1931, Stegmann <i>in litt</i>. <i>in</i> Schenk 1934, Buturlin <i>in</i> Buturlin & Dement'yev 1935, Stegmann 1935.

Subspecies:
Szalay 1902, Chernel 1902, Tugarinov 1932, Tugarinov <i>in</i> Hartert 1932, Tugarinov <i>in litt</i>. <i>in</i> Grote 1934, Grote 1934, Sushkin <i>in</i> Nagy 1934, Sushkin 1938, Niethammer 1938, Keve-Kleiner 1943, Johansen 1945.

Species or subspecies:
Csörgey 1927–28.

No strong opinion:
Hartert 1932, K. H. Voous <i>in litt</i>. 12.03.1974, Roselaar 1977, Johansen 1962, Alex & Shergalin 2013.</td></tr>
<tr><td>Authors with other opinions:</td><td>Opinions:</td></tr>
<tr><td>Dementieff 1936.</td><td>Individual variation of <i>A. f. fabalis</i></td></tr>
<tr><td>Buturlin & Dement'yev 1935,
Uspenski 1965</td><td>Most probably individual variation of North European and West Siberian forms of <i>Anser fabalis</i></td></tr>
<tr><td>Arrigoni degli Oddi 1929, Tugarinov 1941, Dement'yev & Gladkov 1952, Mayr & Cottrell 1979.</td><td>Synonym of <i>A. f. fabalis</i></td></tr>
<tr><td>Matvejev & Vasič 1973.</td><td>Synonym of Bean Goose</td></tr>
<tr><td>Hachler 1944, Johansen <i>in litt</i>. <i>in</i> Delacour 1951, Delacour 1951, 1954, Johansen 1959,
Vaurie 1965, Ali & Ripley 1968</td><td>Colour phase</td></tr>
<tr><td>Voous <i>et al</i>. 1973, Bauer & Glutz von Blotzheim 1968, Cramp & Simmons 1977.</td><td>Mutation</td></tr>
<tr><td>Sangster & Oreel 1996, Ruokonen & Aarvak 2011.</td><td>"Typological thinking" of former authors has been the source of a wrong classification (see below)</td></tr>
</table>

The existence of *A. neglectus* was no longer mentioned in several major works: Ivanov *et al*. 1951, Johansen 1962, Eck 1996, Danilov *et al.* 1984, Ilichyov & Fomin 1988, Stepanyan 1990, 2003, del Hoyo *et al*. 1992, Koblik *et al*. 2006, Ryabitsev 2008, Johnsgard 2010, Mitropol'skiy 2012, Koblik & Arkhipov 2014, Gill & Donsker 2019.

Comments on this overview

It appears from the different opinions that the systematic position of the SBG was often modified over the years. It broadly ranged from species to subspecies and later to a denial of the existence of this goose. The last authors, who considered *A. neglectus* a species, were noted between 1931–1935: Menzbir (1934), Stresemann (1934), Buturlin and Dement'yev (1935), Stegmann (1935). From 1936 (however, see Huyskens 1986), the SBG became an individual variation, a colour phase, a deviation in plumage or a synonym of the North European or West Asian subspecies of *A. fabalis.* This opinion was defended by expert

systematists, e.g. Dementieff (1936), Dement'yev (1941), Tugarinov (1941), Mayr & Cottrel (1979), Dement'yev & Gladkov (1952). It is striking that prominent systematicians changed their opinions in a short period of time: Hartert, 1921 by 1932, Tugarinov, 1932 by 1941, Johansen 1945 by 1959.

1. In a comprehensive work by Zhitkov (1912), 26 individuals, which did not have the typical orange colour of the bill band, were among his collected Bean Geese from the Yamal peninsula. The replacement pink colour of the bill band turned out to be unstable. Zhitkov wrote (p. 352) that in the deeper parts of the pink bill colour there was a sulphur yellow colour and he gives some examples. Furthermore (p.353), he claimed that subjective, unstable, superficial colours were present, which blended with colours of a collection of skin pigments further down. Zhitkov (1912) wrote in his Bean Geese study that he had only observed an unstable pink colour of the ring around the bill but he barely mentions an unstable pink colour of the legs. Moreover, the researcher writes that a different, unstable bill colour should not be a reason to determine the existence of a new taxon. These findings caused Zhitkov to doubt the existence of *A. carneirostris* Buturlin 1901. Later, many researchers considered the Buturlin's Bean Goose *A. carneirostris* to be a colour variation of the Bean Goose sensu lato (e.g. Alphéraky 1905, Buturlin 1935).

It also appears from Sushkin's (in Alphéraky 1905) and Buturlin's works (1908, 1934) that Zhitkov did not examine a 'real' *A. neglectus*. If the 26 Bean Geese of Zhitkov had been *A. neglectus*, their average maximum height from the lower mandible with a closed bill should not exceed the value of 6.50 mm. All 26 birds examined by Zhitkov showed a value for this measurement > 6.50 mm. Dementieff (1936) also mentions that in 1908 Zhitkov collected a pair of Bean Geese, of which one partner had an orange bill band and the other a pink one, which does not suggest a 'real' *A. neglectus* either.

Zhitkov's work apparently had a significant impact on later research into the systematic position of *A. neglectus.* Later authors generalised the results of his work (Dementieff 1936, Tugarinov 1941). They also took Zhitkov's deviant Bean Geese for the 'real' *A. neglectus*. The years 1936–1941, therefore, had a decisive impact on the history of the systematic position of *A. neglectus*. Since then, only a few researchers have considered the SBG a separate entity. The ‘real’ *neglectus*, described by Sushkin in 1897, was not studied by Zhitkov. At the time of Zhitkov’s research the SBG was there as a Taiga Bean Goose amidst thousands, as a migrating bird or as a winterer in Bashkiria, in the Hortobágy puszta and in the surroundings of Tashkent. It is about two entities which are unrelated: the Sushkin ‘real’ *A. neglectus* and a Zhitkov *A. f. rossicus*, “Type *neglectus”* (1912).

In publications by Alphéraky (1907) and Danilov (1930) it appeared that rare individuals with the pink coloured ring around the bill and pink legs also occurred in the breeding areas and in the winter quarters of the eastern subspecies of the Bean Goose, *A. f. middendorffii* and *A. f. serrirostris*. This view was shared by many authors, among them Nagy (1934), Hartert (1932), Buturlin and Dement’yev (1935), Dementieff (1936), Cramp and Simmons (1977) and Ruokonen and Aarvak (2011). A different colour of the bare parts for the wintering Pink-footed Goose *A. brachyrhynchus* was also described by Payne-Gallwey in Alphéraky (1905), Berry (1934) and Scott (1956). Scott found one bird with an orange ring around the bill and an orange leg colour among 377 wintering Pinkfeet in southern Scotland instead of the characteristic pink colour for this taxon (also see Delacour 1951, Barthel & Frede 1989).

2. The opinion that *A. neglectus* was a synonym of *A. f. fabalis* seems unlikely, when reading and comparing the texts that originate from the original Hungarian and Russian ornithologists. The facts that very large numbers of ‘real’ *neglectus* were confirmed by all observers without exception, that the deviant plumage and the distinct call were so identifiable, speak against the existence of a synonym.

3. According to Sangster and Oreel (1996), *A. neglectus* was wrongly classified as a separate taxon at the time, because at the beginning of the twentieth century the discoverers of *A. neglectus* and other researchers had applied “typological thinking” to this classification. In their assessment, Sangster and Oreel (1996) refer to Mayr’s book (1976), which contrasted typological thinking with “population thinking”. Ruokonen and Aarvak (2011) also adhered to Sangster and Oreel ‘s view (1996) and believed that the species has been named wrongly historically, such as *A. neglectus*, *A. mentalis*, *A. oatesi, A. fabalis johanseni* and others were the result of outdated and incorrect “typological thinking”.

However, the literature tells us (Mayr in Sober 2006) that typological thinking had already been abandoned by the end of the 19th century. Haffer (2003) is very rigid about this. ‘Population thinking’ started in the years 1850–1880 and this author gives the names of the systematicians who started “population thinking”. Series of specimens of the same species were built to determine the range of a measurement. All the eminent ornithologists, such as Buturlin, Madarász, Nagy, Schenk, Sushkin and Zarudniy, the original observers of *Anser neglectus*, and the immediate followers of the writings of the original observers, especially Alphéraky and Grote, were among the top researchers in the world of ornithology in their time. All these researchers were very aware of the variations that may occur within the measurements of a taxon. We have already discovered in Sushkin (in Alphéraky 1905) in the original description of the measurements of the SBG, grouped in a table, that “the attached table shows there are connections between the measurements of individual birds”. And furthermore, “knowledge of a higher number of measurements, would undoubtedly give a greater fluctuation than the one we have now observed. Therefore, we are currently unable to pass a judgement on the extreme measurements of *A. neglectus*". Zarudniy also described new subspecies, for which he used 50 to 150 specimens in his series of prepared bird skins (Alex & Shergalin 2015a, b).

4. No author who observed or captured *A. neglectus* in a free and wild state has ever reported characteristics of hybridisation between this taxon and other taxa of *A. fabalis* sensu lato. The pink, instead of the orange-yellow colour of the bill band and legs of *A. neglectus* and the dark colour of the head and neck, indicates that interspecific colour variations very probably minimised the risk of hybridisation (Wallace 1889, Dobzhansky 1941, Huxley 1942, Mayr 1942, 1963, Grant 1975, Lack 1968, 1971).

5. Based on intensive morphological investigations and studies of mitochondrial DNA, Ruokonen and Aarvak (2011) decided to deny the existence of *A. neglectus*, because these authors could not find any evidence for accepting taxa other than those already known: they must therefore be the subspecies *fabalis, middendorffii, rossicus* and *serrirostris*. Ruokonen & Aarvak (2011) investigated five specimens of *A. neglectus* in their study. It is a pity that these researchers did not measure the height of the lower bill. Among these five, four had origins which did not match the distribution of the 'real' *A. neglectus*. After all, two were from Novaya Zemlya, where the SBG as a typical Taiga Bean Goose, may well not have bred. One bird came from Denmark in 1920 and one from China in 1921. The former was again determined to be a *rossicus* by these authors and the latter a *fabalis*. As explained earlier, in both cases it was most likely an *A. f. fabalis/rossicus* of the '*neglectus* type', that does not show any affinity with the 'real' *A. neglectus*. The fifth specimen came from Samara (Southeast European Russia) and was collected in the year 1906. This was again determined by Ruokonen and Aarvak (2011) to be an *A. f. fabalis*. Only this bird could possibly match the 'real' *A. neglectus* because the 'real' SBG visited this region at the beginning of the 20th century (see below). Ruokonen and Aarvak's research material (2011) therefore seemed too thin for us to conclude that *A. neglectus* did not exist.

6. The opinions that *A. neglectus* was an individual variation, a colour phase or that they were Bean Geese with an aberrant plumage is quite unlikely, considering the original descriptions of the 'true' *A. neglectus*. According to Alex & Shergalin (2013), "the mass presence of the SBG until the end of the 1920s goes against the status of individual variation".

Was *Anser neglectus* a species or a subspecies?

Due to the results obtained by molecular research, non-molecular researchers sometimes remained in a state of uncertainty because the results of the molecular and classical research did not always appear to agree (e.g. Omland *et al.* 1999, Kondo *et al.* 2004, 2008, Irwin 2009, Winker 2010, Martens 2012, Päckert *et al.* 2012, Randler *et al.* 2012). This was one of the reasons why Tobias *et al.* proposed a new direction in the research of systematics, intending to judge whether an unknown taxon could be considered a species (Tobias *et al.* 2010). This new direction, which takes less account of the results of the DNA-research, closely matches the idea of the upgrade of the Biological Species Concept.

Tobias's criteria had already been applied when preparing the work "Checklist of the Birds of the World", Vol. 1. Non-passeres (del Hoyo & Collar 2014). This work explains why the characteristics of both the phenotype and the distribution of the taxon under investigation are considered. Since the location of the breeding area of *neglectus* was never determined with certainty, we cannot answer the question about distribution. Only the phenotypical characters remain open for research. Reference was made to del Hoyo and Collar's work (2014) for the method of awarding points.

If points are awarded strictly, the taxon to be examined will be given:

- a completely different call: this gives a minimum of ten points according to the Tobias *et al*. (2010) criteria, which attach great importance to the voice. Because the required spectrographic analysis of the voice of the taxon to be examined is missing, we will randomly reduce these ten points to four;
- the browner colour of the head, neck and sides of the neck than in other representatives of the Bean Goose *Anser fabalis* sensu lato: we will award one point based on this minor difference;
- the pink instead of orange-yellow bill band and legs can be considered a medium difference and be awarded at least two points;
- the lower height of the lower bill in *neglectus* compared to *fabalis fabalis* (see Alphéraky 1905, Buturlin 1908, 1934) is a minor difference and is given half a point;
- the taxon to be examined was a Taiga Bean Goose which was mainly or exclusively crossing over and wintered in dry steppic areas (P. Maes *in verbis*; Sterbetz 1980): Tashkent and surroundings, the lakes Asly-Kul' and Shungak-Kul' in Bashkiria and the Hortobágy puszta. This does not correspond with the well-known wintering biotopes of *A. f. fabalis* and *A. f. rossicus* (Van Impe 1980, van den Bergh 1985, Huyskens 1986), nor with those of *A. f. middendorffii* (Cao *et al.* 2008, 2010, Kim & Park 2011, Jia *et al.* 2016). In accordance with the criteria of Tobias *et al.* (2010) *neglectus* is also awarded at least one point for this deviation.

If points are awarded strictly, we reach a total of at least seven points, which allows the taxon under examination to be awarded a full species status, based on the criteria laid down by Tobias *et al*. (2010) and del Hoyo and Collar (2014).

Finally, we will provide some literature data, which point to the existence of *A. neglectus* as an independent taxon:

Stegmann (1935) and Stegmann *in* Schenk (Schenk 1934) wrote: "To me it sounds out of the question that *A. neglectus* would be a subspecies of *A. fabalis*. For me, *A. neglectus* is an independent species. This is a logical decision. If at first sight any animal species is immediately unequivocally recognized as belonging to a single form, there is no reason to doubt the independence of that species. Up to now no transitional forms between the SBG and the different races of the Bean Geese are known, which usually does not justify a degradation of this species to subspecies. The uncertainty, which still exists regarding the location of the breeding area, is no reason to doubt an independent species". According to S. Eck (*in verbis*, 23.9.1982) Stegman was one of the most skilled systematics Russia has ever known.

Here we also quote Sushkin (1938):

"Until now, the Ufimskiy Gumennik (= *A. neglectus*) has been a mystery in the fauna of the Palearctic area. Undoubtedly it belongs to the *fabalis* group. It distinguishes itself from the other Bean Geese with rather static, recurrent characteristics, although they are not important. At the X° International Zoological Congress in Budapest (1927), I was privileged to show my colleagues round the garden of the Zoological Park, among them Lord Rothschild, Dr. Hartert and Dr. Stresemann, to observe the *Melanonyx neglectus* and *M. fabalis fabalis* living there. After a thorough inspection my colleagues recognized that without a doubt it was the species I had described".

The presumed breeding area of *Anser neglectus*

The Tunguska catastrophe

On 30th June (17th June on the old-style Julian calendar) 1908 there was a catastrophe in the eastern part of the Krasnoyarsk province, about 37 mi (60 km) north and 12 mi (20 km) west of the current village of Vanavara, near the Podkamennaya Tunguska river, an eastern tributary of the Yenisei (60°54'07" N, 101°55'40" E) *(Figure 5)*. Later it was estimated that the energy released by the catastrophe (15 megatons) was approximately equal to the power of the American 'Castle Bravo' thermonuclear bomb dropped on 1st March 1954 over the Bikini atoll (Marshall Islands).

The catastrophe took place in an extremely sparsely populated and inhospitable taiga region. For this reason, the first scientific expedition to the region led by Prof. Leonid A. Kulik could not take place until 1927, 19 years after the catastrophe. The disaster was the subject of hundreds of scientific publications, in which Russian and Italian researchers played an important role. By 1995, 35 international scientific expeditions to this region had been carried out. Despite thorough research, we do not quite understand today which physical mechanism occurred at this site. Several hypotheses were put forward. The reports on the impact of the disaster, drawn up by Kulik and collaborators and later researchers, exceeded our imagination beyond credulity. It appeared that all the vegetation of the taiga was

Figure 5. Geographical position of the Tunguska catastrophe
5. ábra A Tunguszka katasztrófa földrajzi helye

destroyed over an area of 830 square miles (2150 km^2), which left large areas with more than 80 million flattened trees looking like a "telegraph pole" forest. According to eyewitnesses, this catastrophe was the immediate cause of the deaths of thousands of Reindeer *Rangifer tarandus sibiricus*. No form of radioactivity was observed, and potential results remained unconfirmed. The greatest mystery surrounding this disaster consisted of later findings of chromosomal abnormalities and mutations. After the disaster, genome aberrations in the xylem of trees and plants happened quite quickly and were also identified later. This disaster was probably also responsible for morphometric aberrations observed in the Wood ant colonies *Formica fusca*. The same applies to abnormalities in the blood groups of certain families of the Evenki population. These too were probably due to the consequences of the Tunguska catastrophe (Vorontsov & Lyapunova 1984, Andreev 1991, Serra *et al.* 1994, Andreev & Vasilyev 1995, Hartmann 2000, Gasperini *et al.* 2001, Longo *et al.* 2001, Habeck & DeSmedt 2002, Vasilyev *et al.* 2002, Vaganov *et al.* 2004, Vasil'ev 2004, Silagadze 2005, Rubtsov 2009, Rychkov 2000 in Rubtsov 2009, Lombry 2015, Ol'khovatov 2018).

Probable breeding area

The breeding area of the SBG has never been found and has remained unknown until today. Stegmann (1935) and Sterbetz (1980) were the last of the earlier succession of researchers to point out this gap.

At the beginning of the 20th century many researchers (including Alphéraky 1905, Schalow 1917, Buturlin 1934) assumed that the breeding areas of *neglectus* were probably located in Arctic and High Arctic regions as the Pechora delta, the Yugor peninsula and the islands Kolguyev and Novaya Zemlya. In a detailed overview of his monumental work, Pleske (1928) reported that breeding in these very northern areas was difficult to accept, as there were not enough objective data available to support this breeding. It is indeed unlikely that *A. neglectus*, a typical Taiga Bean Goose, which in appearance and measurements was close to *A. f. fabalis*, would have settled in these regions. These High Arctic regions had already been well researched by many ornithological expeditions at the time of Pleske, and the particularly high numbers of *A. neglectus*, which were observed in at least three winter quarters (see below), do not agree with this supposition.

The *A. neglectus* found in these arctic regions most probably belonged to the series of the "*neglectus* type" of *A. f. fabalis* and *A. f. rossicus*. They were most likely local tundra-breeding birds with a deviant pink colour of the bill band and perhaps of the legs, as described by Zhitkov (1912). More recently, *rossicus*-Bean Geese of the "*neglectus* type", a very rare breeding bird, were found on the Yugor peninsula (Grichik 1995) and by Kalyakin (2001) on the southern island of Novaya Zemlya and also during migration on the Yugor peninsula.

It can be assumed that there were probably also 'real' *A. neglectus* during the moulting period, who had come from the taiga, their breeding area, still unknown to us. In more recent times moulting in High Arctic regions was found in the Taiga Bean Goose *A. f. fabalis* by Strøm *et al.* (1994) and by Syroechkovsky and Kalyakin (1996) (also see Roselaar 1977).

Hartert (1932), Stegmann (1935) and Dementieff (1936) were convinced that the breeding areas of *A. neglectus* could no longer be found, because in their time, all potential breeding sites of this goose had already been thoroughly investigated. Buturlin (*in* Tugarinov 1941) thought that the breeding areas of *neglectus* could be found in the taiga region between the rivers Pechora and Ob. Johansen (1945) was thinking of the northern taiga of the Ural Mountains and according to Stegmann (1935) the SBG would have a separate breeding area, where no other Bean Geese were to be found.

However, in the days of these researchers, there were still many potential breeding areas for *neglectus*, which had never been studied ornithologically before, such as the vast taiga belt of Western and Central Siberia, with the Podkamennaya Tunguska river and its vast surrounding area. Ornithologically, this inhospitable area remained one of the least known in the whole of Russia (Naumov 1985, Zhukov 2006). As far as research into wild geese is concerned, Rogacheva and Syroechkovsky (2015) called the entire taiga region of Central Siberia a *terra incognita*, where geese populations migrated in the past and their migratory routes remained virtually unknown. This potential breeding area for *neglectus* was discovered late, many years after 1908. This observation is supported by the work of the famous ornithologist A. Ya. Tugarinov, whose ornithological research of the Yenisei river area was one of his life works. In his publications (Tugarinov 1910, 1912, 1927, 1932, Tugarinov & Buturlin 1911), the area stretching far beyond and around the Podkamennaya Tunguska is not mentioned as the breeding area of a Taiga Bean Goose. In his following work, Tugarinov (1941) mentions only the combined upper reaches of this river as a breeding area. Also I.N. Zhukov, who visited various regions between Ob and Yenisei, such as the Nishnyaya Tunguska river, around 1925 does not mention the Podkamennaya Tunguska in his works (Beresovikov 2018). Dement'yev and Gladkov (1952), Syroechkovsky Sr. (1959), Dement'ev *et al.* (1967) and Rogachëva (1988, 1992) were apparently the first to mention the entire basin of the Podkamennaya Tunguska as the breeding area of a Taiga Bean Goose.

We now know that the taiga east of the Yenisei river is inhabited by the Siberian Taiga Bean Goose *A. f. middendorffii* (Stepanyan 1990, 2003, Emel'yanov 2000, 2004, 2012, Burskiy *et al*. 2003, Ryabitsev 2014). Its population has declined significantly over the last decades (e.g. Syroechkovskiy Jr. 2006, Emel'yanov & Savchenko 2015, Emel'yanov *et al.* 2018).

The late research in a sparsely populated region, which was very difficult to investigate, shows that if *A. neglectus* had bred here in 1908 and before, no ornithologist could have known about the breeding. For the time being we suggest that the taiga region of the Podkamennaya Tunguska, or a wide area around this river, were the only ways to locate the unknown but assumed breeding area of the 'real' *A. neglectus*. This vast region was hit by the Tunguska catastrophe in 1908.

Even if this assumption can be confirmed by further investigation, many questions remain unanswered. Did *neglectus* breed on the western bank of the Yenisei? Did *A. f. middendorffii* occupy the breeding area of the vanished *A. neglectus* or had it already settled there, beside *A. neglectus*? And if *A. f. middendorffii* was already present in this region, were the breeding areas of both taxa, *neglectus* and *middendorffii* sympatrically (which seems unlikely), parapatrically or allopatrically located in relation to each other?

The knowledge of the distribution of the breeding areas in Siberia of both Taiga Bean Geese, the Western and the Siberian, has grown significantly in recent years, thanks to the work of many researchers: Zabelin (1996), Vartapetov (1998), Emel'yanov (2012, 2013, 2014), Ryabitsev and Ryabitsev (2015) (with many sources from the literature); Emel'yanov and Savchenko (2016). Therefore, the chance seems extremely small, if not non-existent, that a large, contiguous population of thousands of Taiga Bean Geese, which also corresponds to Sushkin's first description, can ever be found in the future.

Distribution in winter of *Anser neglectus*

Early records

Even before Sushkin described *A. neglectus* as a new species in 1897 (Sushkin 1897a, b, Sushkin in Alphéraky (1905), there were indications that this new goose had already been identified before in Russia. This made Sushkin think of Eversman, who had found many *A. f. fabalis* and *A. f. rossicus* in the region around Orenburg 40 years before him. He thought that Eversman would not have been able to find a *neglectus* in this location, due to poor weather conditions. In confirmation, Zarudniy (1888) also mentioned large numbers of Bean Geese around this city in an ornithological overview of the region. Sushkin himself visited Bashkiria for the first time in the 1891/92 winter (Sushkin 1897a, b, Sushkin in Alphéraky 1905) and saw A. *neglectus* there that winter.

According to literature data, at the time, very large numbers of *A. neglectus* were found in three regions: in the Hortobágy puszta in eastern Hungary, by two lakes in the Republic of Bashkiria and around the city of Tashkent (Uzbekistan).

Former presence in the Hortobágy puszta

The current area of 494,000 acres (200,000 ha) makes the Hortobágy puszta (41°36' N, 21°09' E) one of the largest grass plains in Western and Central Europe. According to Nagy, the field characters of *A. neglectus* at this location could easily be compared to that of *A. f. fabalis* and *A. f. rossicus* (Nagy 1907).

According to Schenk, *A. neglectus* was first determined by Csörgey, Linder and Schenk at a wildlife trader's in 1899. It was soon recognized as a new species of geese in that country (Schenk 1930), based on Sushkin's descriptions (1897a, 1897b). Madarász, Kamner and Schenk reported that the numbers of this new goose gradually increased between 1899 and 1911; a maximum was reached between 1908 and 1911 (Madarász 1909, Kamner 1932, Schenk 1930). In this short period, Sushkin's Bean Geese accounted for 40 to 50% of the total number of wild geese in the Hortobágy puszta (Schenk 1929, 1930). This was confirmed by Tarján (1921, 1926), who examined several hundreds of wild geese for several days mid-November 1911, half of which were *A. neglectus*. This observation is also repeated by Stresemann (1929). According to him Tarján examined 66 wild geese which had been captured in a few days on 21. November 1911; half of them were SBG. After 1911 only a small number of *A. neglectus* was present (Szomjas 1916, 1917, Schenk 1930), although in December 1920 their number in the Hortobágy puszta was estimated at 3% of the total number of wild geese present and since the autumn of 1922 at 2% (Nagy 1924, Tarján 1926).

Between 1924–1928 they only managed to collect one to two specimens per season and in the autumn of 1929 only a very small number of *neglectus* was represented in the puszta (Schenk 1929, 1930). Nagy (1934) no longer recognised the call of the 'Gé-gé goose' and attributed the previously so familiar call to old male geese.

Sushkin's Bean Goose stayed on the puszta from the end of September until the end of April (Madarász 1909, Szomjas 1926). Here are the most recent confirmed observations of *A. neglectus* in Hungary and in (before 1919) Great Hungary. It covered the entire Carpathian Basin, it was three times larger as the current area of Hungary.

- On 21. March1932 a young male SBG was shot near Sibiu (now Romania) from a group of six geese. The description of this bird is convincing (Kamner 1932);
- On 30. November 1932 Szomjas (1934) shot another bird on the Hortobágy puszta with the 'Gé-gé' call (also see Schenk 1934);
- On 19. November 1934 a bird was also shot by Szomjas (1934) in Tiszalök and it was given an accurate description;
- In Budapest Zoo there were still three *A. neglectus* present around that time and an additional description was made of one of these birds on 26. May 1934 (Schenk 1934).

The cause of the sudden decrease in the numbers of SBG remained an unanswered question to all the experts and hunters of geese, even though their presence was actively sought during many successive winters (Schenk 1929, 1930).

It is very likely that at the time of Nagy (1934) *A. f. fabalis* and *A. f. rossicus* "Type *neglectus*" may also have been present on the Hortobágy puszta within the groups of 'real' *neglectus*. The author is clear. He found a family of the SBG where the parents had a pink bill ring and legs, but their young still had the standard yellow-orange leg colour. Nagy called this family "a fragment of an *A. neglectus* family". Later, after the disappearance of the SBG in the three main regions, these goose families were also found in the Netherlands (Van Impe 1988, van den Bergh 2004). In all probability, this was a pseudo – *A. neglectus* or an *A. fabalis* sensu lato type *'neglectus'*.

Former presence in Bashkiria

Sushkin, the SBG describer, is virtually the only source, nonetheless invaluable, of the former presence of this mysterious goose in Bashkiria (Sushkin 1897a, 1897b, Sushkin in Alphéraky 1905). His observations were made around the lakes Asly-Kul' and Shungak-Kul' (Asly-Kul' 54°18'46" N, 54°34'38" E, surface area 9 mi^2 23.5 km^2; Shungak-Kul', 54°24'36" N, 55°14'00" E, surface area 0.7 mi^2, 2.4 km^2). Sushkin (1897a, b) and Sushkin in Alphéraky (1905) wrote that the numbers of these Bean Geese, most of which were *A. neglectus*, were such that they obscured the sun over both lakes. When he looked over the fields in the morning, the geese were sitting so close together that it made the fields look black as if they had been ploughed during the night. His writings show that both lakes were visited by thousands of wild geese, although it was more likely to have been tens of thousands. The SBG did not present itself in pure groups, but in the company of *A. f. rossicus*. Among the first birds collected by Sushkin (1897a, b) there were 10 *A. neglectus* and only one *A. segetum* (= *A. f. rossicus*). Perhaps these concentrations were also mixed with *A. f. fabalis*, because 40 years before Eversman (in Sushkin 1897a and in Alphéraky 1905) had seen large groups of these two taxa in Orenburg. The incredible numbers of Bean Geese mentioned in Sushkin (1897a) and by Sushkin in Alphéraky (1905) were confirmed in Karamzin's work (1901). In 1895 he visited Lake Asly-Kul' and ascertained much damage to the cereals wreaked by the Bean Geese. Karamzin (1901), however, does not mention *A. neglectus.*

The SBG appeared by both lakes in spring and autumn. The geese's spring migration was between 28. April and 15. May (Gregorian calendar). In 1891 Sushkin observed autumn migration after 4. October (idem), and a maximum on 05. October. By 13. October (idem) their number had fallen sharply, and the latest observations of migration were on 16. October (idem). The Greylag goose was also seen here in small numbers, but *neglectus* generally appeared in the autumn when the Greylag had already disappeared (Sushkin 1897a, Sushkin in Alphéraky 1905).

Anser f. fabalis/rossicus has become an unusual migrant bird in the entire southern Ural region (Il'ichyov & Fomin 1988; Zakharov 2006). Valuev (2010) conducted extensive research around Lake Asly-Kul' in the years 1987, 2001, 2004 and 2010, without seeing a single Bean Goose. The only positive news for the Republic of Bashkiria has come from around the city of Krasnokamsk, (58°05' N, 55°41' E), where about 200 Bean Geese stay every winter (Podmaryov 2010). The current presence of Bean Geese in small numbers only also applies to the surrounding republics and governments: Republic of Tatarstan (As'keev & As'keev 1999), Chelyabinsk Government (including Korovin 1997, Popov 2015, Tarasov & Grachov 2016) and Perm Government (including Lapushkin & Kazakov 2000, Naumkin 2005, Kazakov *et al.* 2016).

Former presence in Uzbekistan

Zarudniy (1910b) was the only original source to be found on the previous appearance of *A. neglectus* in Uzbekistan. The places visited were located on the Syr-Darya river near the capital Tashkent. As for the two previous places, the Hortobágy puszta and Bashkiria, this author mentions the appearance of numerous gatherings. The first birds were seen on 5–7 December 1906 (Gregorian calendar). Here Zarudniy (1910b) observed several groups of *neglectus* on the right bank of the Syr-Darya. He collected eight geese from among them. At the same location on 17 and 18 October of the following year, he collected two birds from two groups, which both consisted of about 50 birds.

Zarudniy (1910b), Schenk (1930) and Grote (1930a, b, 1932) write that there was a similarity between the presence of *neglectus* in Tashkent and the one in the Hortobágy puszta. After 1911 the numbers of the species decreased at both locations, and rather abruptly in the Hortobágy puszta. Schenk (1930) also writes that according to Zarudniy, *neglectus* was still prolific in Uzbekistan in the years 1906–1909, but in 1918 it had also become a rarity. After 1918 only one *neglectus* was collected in the surroundings of Tashkent to 100 *A. fabalis/ rossicus* (Zarudniy in Grote 1930a).

Today *Anser fabalis s*ensu lato is a winter visitor in small numbers in Uzbekistan, with an exceptional sighting of 270 specimens in the whole region in December 1990 (Poslavskiy *et al.* in Rustamov & Kovshar 2007). However, the same work and Meklenburtsev *et* *al.* (1987) mention the prolific presence of Bean Geese at the end of the 19th and beginning of the 20th century and refer to Zarudniy's work (1910b). Other works do not mention *Anser fabalis* at all (Kreuzberg-Mukhina 2006, Spisok Ptits Uzbekistana, 2017, Mitropol'skiy 2012, Filatova & Lanovenko 2012).

In the three former regions of migration and wintering (Hortobágy puszta, Bashkiria and the surroundings of Tashkent) there have been no more sightings of the 'real' *A. neglectus*.

How many *Anser neglectus* were present in the Hortobágy puszta at the time?

Several authors pointed out that it would be very difficult to make an estimate, considering the vastness of the terrain and that access was very difficult to at the time. Both factors made it difficult to have a clear picture of the accuracy of the estimates (e.g. Nagy 1924).

However, we are well informed about the percent composition of the entire population of geese in several of L. Szomjas' and T. Tarján's communications. It was generally accepted that in a winter season with average temperatures, the population of wild geese in the Hortobágy puszta would consist of 75 to 90% of *A. albifrons*, approximately 5 to 15% of *A. erythropus* and the approximate remaining 10% was shared between *A. f. fabalis/rossicus, A. neglectus* and *A. anser,* in approximately equal proportions (Nagy 1924, Szomjas 1926, Tarján 1926, Schenk 1929). As aforementioned, only *A. neglectus* was an exception to this rule between 1908 and 1911.

Nagy (1924) estimated the total number of geese present at 300,000 (also see Sterbetz 1967). But this estimate only related to the Pentezug region, which is a mere part of the Hortobágy puszta (Anonymus 1973), so that Nagy (1924) estimated that the number of wild geese for the whole Hortobágy puszta was several hundreds of thousands (Sterbetz 1967). Udvardy (1941) confirmed this estimate in his book about the birds of the Hortobágy. Moreover, eastern Hungary may still have had major wintering places for wild geese which were unknown at the time of the mass presence of *A. neglectus* in the Hortobágy. E.g. Biharugra (46°58' N, 21°36' E), where L. Nagy estimated the number of wintering wild geese between 40 and 50,000 in the years 1950–53 (Sterbetz 1967). According to Sterbetz (1975) there used to be as many wild geese in this region as in the Hortobágy puszta.

Let's assume that there were 300,000 wild geese present in the entire Hortobágy puszta, which is a minimum assessment. For example, for the ratio 1/3 of 10%, there were approximately 10,000 *A. neglectus* present in the puszta in normal winters. During the peak years 1908–1911, we assume that the population of *A. neglectus* was probably 120,000 to 150,000 individuals. In this calculation we assume that the number of *neglectus* geese that was shot was a reliable representation of the number of living *neglectus* present in the Hortobágy puszta.

The numbers of wild geese decreased sharply in Hungary in the previous century (Sterbetz 1975, 1967, 1977, 1978, Vertse 1967, Lebret & Philippona 1968, Horváth & Szabó 1981, Faragó 1994, 2016, Faragó & Gosztonyi 2009), especially since the early 1950s (Keve & Sterbetz 1964). This enormous decline in the populations of Bean Geese is consistent with the findings in the two other habitats of the Bean Geese and *A. neglectus*, Bashkiria and the surroundings of Tashkent.

Some notes on ecology of *Anser neglectus*

During migration and in winter, *A. neglectus* stayed in three very dry regions: the two steppic lakes Asly-Kul' and Shungak-Kul' in Bashkiria, near Tashkent and in the Hortobágy puszta, as a typical Taiga Bean Goose. According to Köppen's climate classification, these three regions have a decidedly continental climate. The biotope of these regions of migration and wintering differs greatly from the former wintering areas of the Western Taiga Bean Goose *A. f. fabalis*, which we then identified in the Netherlands (1958–1980) and the current wintering areas of this nominate race in northern Germany (G. Huyskens, P. Maes *oral communication*; Van Impe 1980, Huyskens 1986). According to Sterbetz (1980), the preference for these dry regions was typical for *A. neglectus.*

In the Hortobágy puszta and on both lakes of Bashkiria, *A. neglectus* foraged among puszta-vegetation as well as on cultivated land (Sushkin 1897a, Sushkin in Alphéraky 1905, Nagy 1924, Szomjas 1926). Unlike the White-fronted Goose, which preferred to forage on the puszta itself, the Bean Geese would stay on the banks of the river Tisza, where they mainly foraged crops on the edges of the steppic lakes (Nagy 1924, Szomjas 1926).

According to den Hollander (1947), the Wheat *Triticum* sp. and *Zea mays* were almost the only crops available on the Hortobágy puszta. Except for rice *Oryza sativa*, which was not cultivated in the pusztas at the beginning of the 20th century, we may assume that *A. neglectus*' diet at the beginning of the 20th century, did not differ much from that of *A. f. rossicus* during the years of Sterbetz' research. This researcher accurately tabled the food choice of *A. f. rossicus* on the Hungarian pusztas during the years 1952–1967 (Sterbetz 1977, 1978). The diet of the Tundra Bean Goose consisted mainly of leaves of Wheat varieties, Gramineae sp. and False sheep's fescue *Festuca pseudovina*. The most suitable seeds were: Maize, Wheat species, Common barnyard grass *Echinochloa crus galli*, Green Foxtail *Setaria viridis* and Knotweeds, *Polygonum* sp.

The disappearance of *Anser neglectus* Sushkin, 1897

It may be concluded from this literature review that the 'real' SBG has not existed since 1934, or maybe a few years later, when the last birds died in Budapest Zoo.

No study has ever shown that this goose was the subject of excessive shooting in the winter quarters or was more susceptible to hunting pressure than other species of wild geese. No study has ever indicated that in 1908 *neglectus* would have fallen victim to infectious diseases such as Pasteurellosis or Bird Influenza, which can kill large numbers of wild animals in a short time. In their works Schenk and others were very worried about the absence of *A. neglectus* and in one of his studies he even deeply deplores the situation (Schenk 1929).

What were the causes of the disappearance of Sushkin's Bean Goose? Three 20th century Hungarian waterfowl experts were asked for advice: P. Beretzk (1894–1973), A. Keve (1909–1984) and I. Sterbetz (1924–2012). All three were convinced that *A. neglectus* wintered in the Hortobágy puszta at the beginning of the last century and most probably still did in large numbers in other pusztas of eastern Hungary. The Hungarian ornithologist T. Csörgey (1875–1961) shared their opinion. He knew the 'Gé-gé' goose in his youth and he had often spoken to the young Keve about the ‘Gé-gé-gus’ (Keve, A. *oral communication*). According to Dr. Keve, the disappearance of the SBG was due to *(in litt.* 26.03.1971):

1. Changes within the puszta. In 1971 it was no longer the flat steppe it had been forty years previously. Since then there has been a significant increase in developments and forestation;

2. Hunting rights were leased and currently they shoot from a greater distance. Now the geese tend to spread out over a large area along the river Tisza;

3. Today, hunters are no longer interested in ornithology and do not send their catch, which might be ornithologically interesting, to the owners of zoological collections;

4. A change in the direction of migration should be considered regarding *A. neglectus* (also see Tarján 1926, Csörgey 1928).

These considerations may lead to a reduction or a local disappearance of a species (as happened for example to *A. f. fabalis* in the south east of the Netherlands and to *A. f. rossicus* in northern Spain), but they could not lead to the collapse of a large population. Currently the Tunguska catastrophe seems to be one of the only remaining hypothesis that might explain the disappearance of *A. neglectus*. We assume that there probably was a connection between this catastrophe and the disappearance of *A. neglectus*:

– The Tunguska catastrophe occurred in June 1908. It caused severe forest fires, which according to reindeer farmers killed thousands of reindeer at once (Habeck & DeSmet 2002, Lombry 2015);
– In 1908, in the first autumn after the catastrophe, Madarász (1909) could not find a single juvenile *A. neglectus* among the winter birds in the Hortobágy puszta. In the spring of 1909, he found only one young bird which had been collected on the Lower Danube in Hungary;
– The number of Sushkin’s Bean Geese reached a maximum on the Hortobágy puszta between 1908 and 1911. This sudden increase was a great mystery to all Hungarian ornithologists and hunters. According to Tarján (1926) and Csörgey (1928) the sudden increase after 1908, the year of disaster, was the result of a different migration route;
– Silagadze (2005) demonstrated that the genetic abnormalities that occurred after the Tunguska catastrophe could be due to the presence of electrophonic meteors, which would have triggered an electrophonic radiation. During their orientation, birds are subjected to electromagnetic fields (Kimchi & Terkel 2001, Wiltshko & Wiltshko 2005, Prato *et al.* 2013). The first two research teams also found that the presence of light is not a prerequisite for magnetoreception, which facilitates an immediate impact of the magnetic field on orientation. Electromagnetic radiation, even a low frequency, can affect the central nervous system (Marino & Becker 1977), it can kill mice and cause physiological stress (many authors). Could those electromagnetic waves have been responsible for a change in orientation in *A. neglectus?* Many studies indicate that this possibility may be considered (e.g. Brent *et al.* 1993 Repacholi 1998, Hardell & Sage 2008);
– It was a mystery in the Hortobágy puszta when the numbers of *neglectus* declined abruptly and inexplicably after 1911. Several researchers reported that genetic disorders could be caused by the Tunguska catastrophe, e.g. Nesvetajlo 1998, Rychkov 2000, Vasil’ev 2004, Silagadze 2005);

– As already mentioned, there was a parallelism between both the increase and decrease in the numbers of *A. neglectus* on the Hortobágy puszta and in the surroundings of Tashkent. According to archaeological research, *A. neglectus* was not the only goose species that has become extinct on the Siberian mainland in recent times. Zelenkov (2008) and Zelenkov and Kurochkin (2014) described *Anser djuktaiensis* sp. nov. which originated from the Upper Pleistocene of Yakutya (Sakha Republic, far eastern Siberia). This species was larger than *A. anser* and morphologically it clearly resembled this bird and *A. fabalis*. Panteleev and Potapova (2000) described a Bean Goose from the Holocene in the vicinity of the town of Salekhard (North West Siberia). The distribution of the width of the proximal and the length of the distal epiphysis of the femoral bones and the length and the width of the *tibiotarsus* were smaller in these skeletons than those of the current *A. fabalis/rossicus*. Maybe this Bean Goose was also a new species or subspecies?

From *Anser neglectus* to *Anser fabalis sensu lato* "Type *neglectus*"

During the period in which very high numbers of the SBG occurred at the three locations mentioned (eastern Hungary, Bashkiria, Tashkent), the presence of *A. neglectus* was still observed in several governments of European Russia and present-day Ukraine: Moscow, Kharkov, Penza, Poltava, Pskov, Ryazan, Samara, and in the Republic of Kazan, where birds were collected on the Volga river (Karamzin 1901, Sushkin in Alphéraky 1905, Zarudniy 1910a, Polyakov 1910, Artobolevskiy 1924, Sushkin 1928 *in litt. in* Schenk 1930, Gavrilenko 1929, Schenk 1929, 1930, Grote 1930 a, 1930b, 1932, Tugarinov 1932, 1941, Hartert 1932, Perschakow in Grote 1932, Dement'yev in Buturlin & Dement'yev 1935). In each case it was a matter of observations of small numbers. Considering the similarity with the large invasions of the SBG, these records may be regarded as mainly referring to the 'true' *A. neglectus.*

Although the descriptions were not always complete, sightings of *A. neglectus* were also noted in the following countries/regions:

Albania, Lake Skadar (Reiser in Stresemann 1922, Schenk 1930)
Apulia, (Arrigoni degli Oddi 1929)
Bulgaria (Klein 1927)
Croatia near Trilj (Kolombatovič *in* Stresemann 1922)
Denmark (Schiöler 1921, Ringleben 1953)

Germany, four records in Stresemann (1922, 1929, 1930, 1934). The 1929 work contains a complete description of the 'real' *A. neglectus*

Great Britain, according to F. W. Frohawk, an authority (in Witherby & Ticehurst 1908), SBG occurred also in the United Kingdom

The Netherlands (van den Brink 1930)

Two dates from Scotland do not relate to *A. neglectus*, but do relate to *A. carneirostris* (Berry 1934).

Provided all these observations coincide with the mass appearance of the 'real' SBG in the three main regions mentioned, we may reasonably assume that the observations cited also referred to the 'real' *neglectus*.

The records of *A. neglectus* in the Altai Mountains, India (Assam), China and Japan are a different matter (Stuart Baker 1929, Zarudniy in Grote 1930a, 1934, Kamner 1932, Hartert 1932, Tugarinov 1932, Dement'yev in Buturlin & Dement'yev 1935, Sushkin 1938, Johansen 1959, Ali & Ripley 1968, Ruokonen & Aarvak 2011). Several authors, e.g. Sushkin in Alphéraky (1905), Schenk (1929) and Grote (1934) thought that the 'real' *A. neglectus* was also found in all these locations and that the SBG would therefore have had a large area of distribution. However, the studies by Alphéraky (1907), Danilov (1930) and Dementieff (1936) showed that the *A. neglectus* identified in these regions, far away from the usual migration and wintering areas, could be considered as colour variations of the eastern subspecies, *middendorffii* and *serrirostris*. These colour variations of bill bands and legs, which have also been identified in the other subspecies *fabalis* and *rossicus,* are completely unrelated to the 'real' *A. neglectus.*

Since 1934, the year of the last confirmed observations of *A. neglectus* in Hungary, there have been regular, although rare, sightings of *A. fabalis* and *A. f. rossicus* "Type *neglectus"* in many countries of Central and Western Europe. Without a shadow of doubt, the colour of the bill band and legs of all these birds was as described for the 'real' *A. neglectus.* But neither their dark plumage nor their call corresponded to the original description by Sushkin (1897a, 1897b). All cases involved individuals or families (e.g. Hachler 1944, Nagy 1961, Voous 1963, Voous *et al.* 1973, Klafs & Stübs 1987, Van Impe 1988, Königstedt 1990, Perco 2012). Only the observations of groups in the Netherlands (concentration of up to 38 birds) are an exception to this rule (van den Bergh 2004) and therefore deserve confirmation.

The mystery of *Anser neglectus* is not resolved and further research is needed. As stated formerly, a lot of questions still arise. Further genetic studies on existing museum specimens are highly recommended. Although the detrimental effects of the Tunguska event cannot be excluded, researches for isotopes unique for the Tunguska environment will be welcome in the future (T. Csörgő *in litt.*).

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Automatic bird song and syllable segmentation with an open-source deep-learning object detection method – a case study in the Collared Flycatcher *(Ficedula albicollis)*

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Abstract The bioacoustic analyses of animal sounds result in an enormous amount of digitized acoustic data, and we need effective automatic processing to extract the information content of the recordings. Our research focuses on the song of Collared Flycatcher *(Ficedula albicollis)* and we are interested in the evolution of acoustic signals. During the last 20 years, we obtained hundreds of hours of recordings of bird songs collected in natural environment, and there is a permanent need for the automatic process of recordings. In this study, we chose an open-source, deep-learning image detection system to (1) find the species-specific songs of the Collared Flycatcher on the recordings and (2) to detect the small, discrete elements so-called syllables within the song. For these tasks, we first transformed the acoustic data into spectrogram images, then we trained two deep-learning models separately on our manually segmented database. The resulted models detect the songs with an intersection of union higher than 0.8 and the syllables higher than 0.7. This technique anticipates an order of magnitude less human effort in the acoustic processing than the manual method used before. Thanks to the new technique, we are able to address new biological questions that need large amount of acoustic data.

Keywords: bird song, deep-learning, object detection, Collared Flycatcher, automatic segmentation

Összefoglalás Az állati bioakusztikai kutatások jelentős mennyiségű digitalizált hangfelvételt produkálnak, így hatékony automatikus feldolgozási módszerekre van szükség a felvételek információtartalmának kinyerésére. Kutatásunk középpontjában az örvös légykapó *(Ficedula albicollis)* énekének viselkedésökológiai szempontból történő vizsgálata áll. Az elmúlt 20 évben több száz órányi hangfelvételt készítettünk a faj természetes élőhelyén, és ezek feldolgozására automatikus módszereket kerestünk. Tanulmányunkban egy nyílt forráskódú, mélytanulású (deep learning) képdetektálási módszert használtunk az örvös légykapó (1) énekének hangfelvételen belüli megtalálására, és (2) az éneket felépítő egységek, a szillabusok megkeresésére. Mindkét esetben az énekeket spektrogrammá alakítottuk, és két külön modellt tanítottunk be a detektálási feladatokra. Mindkét feladat esetében a módszer ígéretesnek tűnik, jelentősen csökkentve a feldolgozáshoz szükséges emberi időt, ami lehetővé teszi minőségileg új, bioakusztikával kapcsolatos kérdések vizsgálatát.

Kulcsszavak: mélytanulás, örvös légykapó, automatikus szegmentálás, madárének

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Introduction

Bird song is an important model for study the ontogeny and evolution of signals and sexual selection (Catchpole & Slater 2008, Vellema *et al.* 2019), therefore it attracts great interest from behavioural ecologists. Furthermore, many faunistic, applied and conservational researches are based on bird song (Laiolo 2010, Borker *et al.* 2015, Zachar *et al.* 2019). Many of these investigations need to collect large amount of acoustic data, where the processing of the recordings may be challenging. Usually, the main steps of the processing are the search of the vocalization of the focal species on the recording, the segmentation of the signals, the extraction of the acoustic features of interest, and the clustering or classification of the elements (Hopp *et al.* 1998). To find automatic processing for all these steps are at the centre of the interest of current research programs (Priyadarshani *et al.* 2018).

One of the most time-consuming steps is the search for the signals in long recordings. Several computer programs were developed to help the researchers to make the manual search easier (Bioacoustics Research Program 2014, Zsebők *et al.* 2018a). Also, several automatic solutions were published based on amplitude or combined amplitude and other acoustic variables like Sound Analysis Pro (Tchernichovski *et al.* 2000) developed for laboratory studies or Luscinia (e.g. Lachlan *et al.* 2018) used in many field studies. Other direction is to use one example of targeted sound and use spectrographic cross-correlation e.g. monitoR package in R (Hafner & Katz 2017). A more sophisticated solution is to build models based on many samples of the targeted vocalization. One of the most promising directions is the deep-learning method based on artificial neural networks, used successfully to detect bat sounds (Mac Aodha *et al.* 2018), identify individuals by their vocalization (Stowell *et al.* 2018), and many models were published in the framework of Bird song Detection Challenge (Stowell *et al.* 2019) to recognize the bird song independently of the species. However, several studies focus only on one species where all the signals have to be found, therefore researchers have to develop a one-species detection method. It can be especially challenging when the vocalization is largely variable like in bird species with large repertoire.

Here, we show how a deep-learning framework can be easily used and tailored by the researchers for one-species detection with complex signals. We chose a ready-made object detection program called 'You Only Look Once' (YOLO) that is developed for object detection in images and videos (Redmon *et al.* 2016, Redmon & Farhadi 2018). YOLO uses deep-convolutional network method, where the dimensions of the input layers can be tailored to the input image size and the characteristics of the network layers can be adjusted to the difficulty of the object detection problem. The idea behind the framework is that the acoustic recordings can be represented as spectrogram images and these images can be fed into the input of YOLO.

Our model species is the Collared Flycatcher *(Ficedula albicollis)* of which vocalization is intensively studied (Haavie *et al.* 2004, Garamszegi *et al.* 2007, 2008, 2012, 2018, Zsebők *et al.* 2017, 2018b). The song is diverse and variable, constitutes of small elements called syllables *(Figure 1)*. Males express 20–90 syllable types (based on 20 songs sampled), and there are large individual differences in the repertoire of syllables (Garamszegi *et al.* 2012). Finding both the songs in the recordings and segmenting the syllables within the songs are time-consuming processes that demand the search for automatic solutions for these steps.

In this study, our objectives were to build separate models with the YOLO object detection method to identify (1) the songs in the raw acoustic recordings and (2) the syllables within the songs, and evaluate the performance of the two models. We also provide the computer programs that ease the use of YOLO: scripts transforming the sound into images for teaching and testing, extracting the results from the output of the YOLO, and an interactive segmentation tool to verify and correct the mistakes.

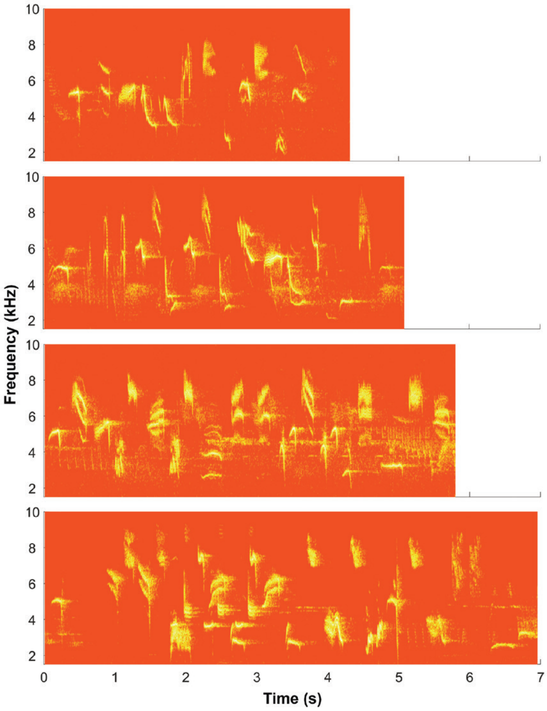

Figure 1. Spectrograms of Collared Flycatcher songs from four different individuals

1. ábra Az örvös légykapó négy különböző egyedétől származó énekének spektrogramja

Materials and methods

Recordings were obtained in the Pilis-Visegrádi Mountains, Hungary (47°43' N 19°01' E), during the mating period (April–May) between 1999 and 2015. For detailed protocol, see Garamszegi *et al.* (2012). We manually cut the songs out from the recordings and segmented the syllables with the Ficedula Toolbox (Zsebők *et al.* 2018a). We stored the start and end time positions of the songs in the recording file, and the start and end position, minimum frequency and maximum frequency of the syllables within the song file. Altogether we used 3275 songs from 146 recordings for the song database, and 9200 syllables from 9342 songs for the syllable database from our Collared Flycatcher sound library.

We also included sound recordings to our song and syllable database from different bird species frequently appeared during sampling: *Poecile palustris, Cyanistes caeruleus, Parus* *major, Phylloscopus collybita, Sylvia atricapilla, Certhia familiaris, Certhia brachydactyla, Turdus philomelos, Turdus merula, Erithacus rubecula, Fringilla coelebs, Emberiza citrinella.* These recordings were originated from the online sound library of Xeno-canto (xeno-canto.org). The list of sound files and their recorders are provided in the Supplementary *(Table S1)*. Altogether, 390 recordings were used 30 recordings by species.

We built two image libraries, one for the song and another one for the syllable segmentation. For both image libraries, we calculated the spectrograms with 512 FFT (Fast Fourier Transformation) window and 50% overlap. The images contained the spectrograms between 1.5 kHz and 10 kHz frequency, and the resulted images were 300 pixels wide and 150 pixels high.

For the song image library, the images contained 5 s long parts from the recordings. The flycatcher recordings were sampled in a way that the images contained at least 0.1 sec long part of song. The xeno-canto recordings were sampled continuously from the beginning of the recordings by 5 seconds (maximum 10 samples per recordings) without knowing the time information when the given species was vocalized but serving as negative samples without Collared Flycatcher songs. The song image library contained 6831 images, 56% of them contained Collared Flycatcher songs.

The syllable image library contained 1 s parts of the recordings. The images of the flycatcher songs contained at least 1 syllable. The xeno-canto recordings were sampled continuously from the recordings by 1 sec (maximum 50 samples per recording). The syllable image library contained 41229 images, 56% of them contained Collared Flycatcher syllables.

The time information of syllables and songs were provided only for the Collared Flycatcher images. 90% of the images were used as training and 10% as test samples. For the song detection, YOLO model contained 15 layers, and for syllable detection, 31 layers. The learning rate was 0.001 for both models. For the detailed description of the models, see the supplementary files. The models were trained on a GPU (Nvidia GeForce GTX 1080 Ti) in a cluster housed in Wigner GPU Laboratory in the Wigner Research Centre for Physics, Hungarian Academy of Sciences.

The performance of the models was evaluated based on the cross-validation output of the YOLO program, well-known measures in machine learning: recall, average loss and the intersection over union (IOU) (Redmon *et al.* 2016). The calculation of the final mean and standard deviation (SD) of these measures were based on the last 1000 epochs.

All the programs for generating the image library and evaluating the models were written in R environment (R Core Team 2018) with the help of the Seewave package (Sueur et al. 2008). The source codes are freely available on GitHub (https://github.com/zsebok/YOLO).

Results

Both the song and the syllable detection models showed fast learning based on the curves of loss function and IOU *(Figure 2)*. In song detection, in 40,000 epochs, the average loss reached 0.050 ± 0.005 (mean ± *SD*), the recall was 0.978 ± 0.024, and the IOU was 0.809 ± 0.020. In syllable detection, after 80,000 epochs, the average loss was 0.287 ± 0.019, the

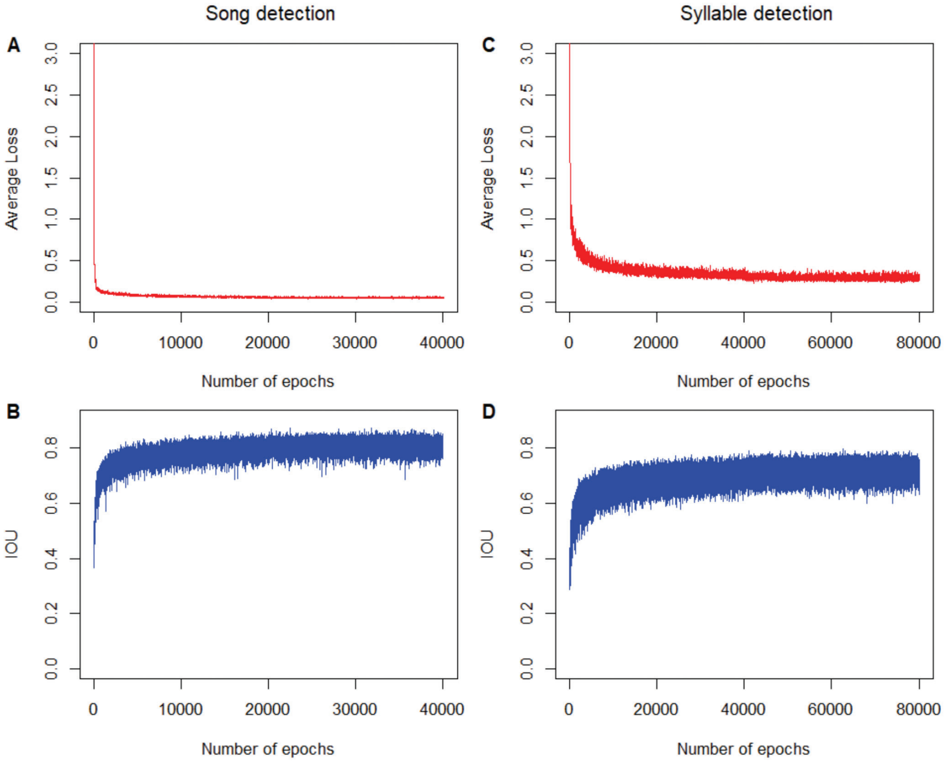

Figure 2. Evaluation of the song (A, B) and the syllable (C, D) detection models through the learning process

2. ábra Az ének (A, B) és szillabus (C, D) detektáló modellek tanulási görbéi

recall was 0.906 ± 0.035, and the IOU was 0.722 ± 0.025. After the training, the visual inspection of the segmentation rectangular seemed acceptable at both the detected songs and syllables on test sounds *(Figure 3, 4)*.

Discussion

According to the visual inspection of the object detection results, the song and syllable segmentation looks promising showing no large error. However, in the syllable segmentation, the mean IOU that is lower than the human inter-observer IOU (0.84 ± 0.17, unpublished results) seems sufficient to identify the syllables and perform automatic measurements on them. In general, IOU over 70% is taken as good performance in object detection (Rahman & Wang 2016, Redmon *et al.* 2016), and both song and syllable detection reached that limit.

In line with the previous publications (Mac Aodha *et al.* 2018, Stowell *et al.* 2019), we also found that the deep-learning technique with convolutional layers can cope with the highly variable acoustic signals and indicate a promising method for segmenting the acoustic recordings to significantly decrease the processing time by the human observers. The disadvantage of

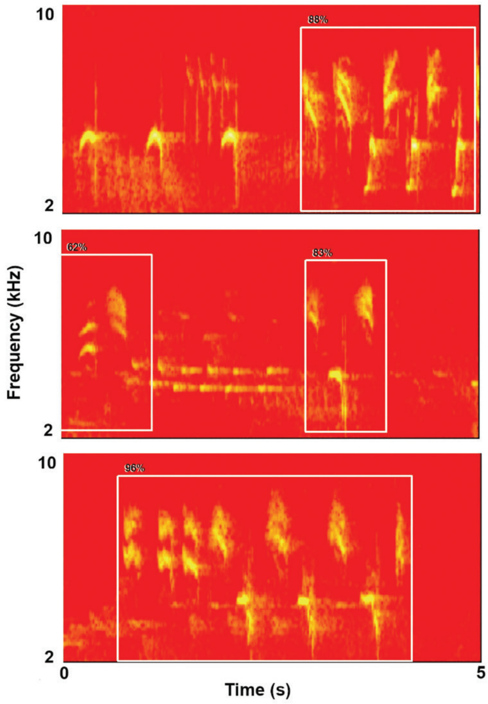

Figure 3. Example images of the song detection. The numbers above the detected songs are representing the Intersection Over Union values

3. ábra Spektrogramon ábrázolt példák az énekdetektálás bemutatására. A detektált énekek fölötti számok az IOU értéket mutatják

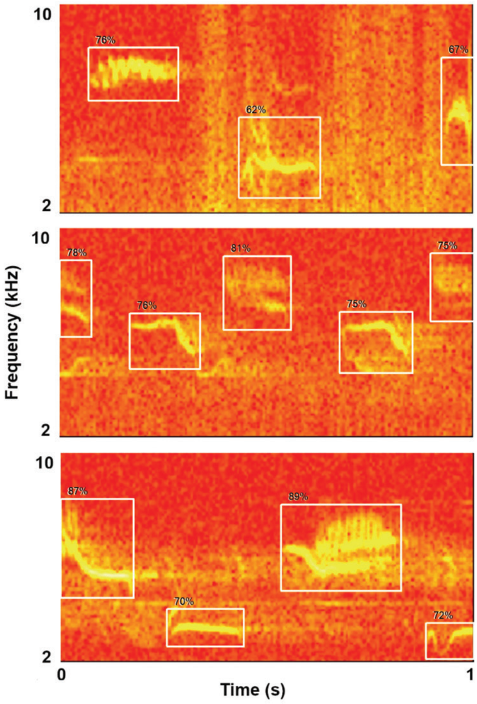

Figure 4. Example images of the syllable detection. The numbers above the detected syllables are representing the Intersection Over Union values

4. ábra Spektrogramon ábrázolt példák a szillabus detektálás bemutatására. A detektált szillabusok fölötti számok az IOU értéket mutatják

using deep-learning method is the need of huge amount of previously segmented recordings to train and test the models. It can be feasible, like in our research program, where long-term or broad-scale investigations can already provide such data. However, large acoustic libraries (like xeno-canto.org) can be a great help in the start of building such datasets.

Here, we showed that for a one-species recognition, a free and open-source object detection program like YOLO developed for image and video processing can be used effectively. With the scripts written in R and provided as a supplementary to this paper, a user without much knowledge is able to build acoustic bird detector for specific species. It is worth to mention that YOLO is able to detect objects belongs to multiple classes (Redmon *et al.* 2016), thus our suggested framework can be broaden to multiple species in birds and other animals.

To further increase the general usefulness of our models for the detection of Collared Flycatcher and other bird species' songs and syllables, it is worth to apply data augmentation technique by using artificially prepared recordings with different background noises (Stowell *et al.* 2018). Also, to use such models on more broad geographical range, further recordings from other populations are needed in the training phase of the process.

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Supplementary material

Table about the used sound recordings downloaded from xeno-canto.org (available on the homepage of Ornis Hungarica)
Táblázat a xeno-canto.org oldalról letöltött hangfelvételekről (elérhető az Ornis Hungarica honlapjáról)

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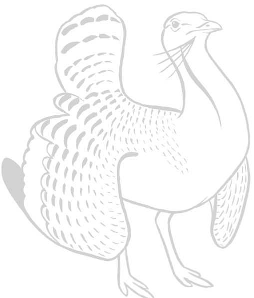

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Biometric data of North African Blackbird *Turdus merula*: are there many subspecies?

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Abstract During the past two centuries, few studies have been conducted on biometrics of North African Blackbirds. Several of these studies were carried out during the latter part of the 19th and in the early 20th centuries. As a result, two subspecies were recognized namely *Turdus merula algira* inhabiting northern regions of North Africa and some localities in southwestern continental Europe and *T. m. mauritanicus* inhabiting central western Morocco and southern Algeria and Tunisia (to the end of arid climatic regions). In this study we provide morphological data from the northeastern Algerian population of Blackbird. Results reveal no differences between sexes in any of the measurements (small sample size). Comparison of morphological data of specimens collected in the northern region of North Africa and from the southern region of Maghreb countries (Algeria, Tunisia and Morocco) show morphometric differences only in wing length. These results are consistent with the existence of multiple subspecies in North African populations of Blackbird. Our findings support the assumptions of previous researchers in considering *T. m. algira* as typical of northern areas of Maghreb countries and *T. m. mauritanicus* typical of southern areas of the region.

Keywords: North African Blackbird, morphological characteristics, subspecies, *Turdus merula mauritanicus*, *Turdus merula algira*

Összefoglalás Az elmúlt két évszázadban csak kevés tanulmány foglalkozott az észak-afrikai fekete rigók biometriájával. Ezen vizsgálatok többsége a 19. század második felében, valamint a 20. század elején készült. Két alfajt különböztettek meg: a *Turdus merula algira* Észak-Afrika legészakibb területeit, és Európa délnyugati részét, valamint a *T. m. mauritanicus* közép-nyugat Marokkó, Algéria és Tunézia deli részét (a sivatagi klímazónáig) népesíti be. Ebben a tanulmányban a fekete rigó északkelet-algériai populációjának morfológiai vizsgálatát közöljük. A jelen tanulmányban is rögzített testméretek, eredmények alapján nem lehet jelentős különbséget tenni a nemek között. Az Észak-Afrika északi részéről, valamint a Maghreb államok (Algéria, Tunézia, Marokkó) déli régióiból származó adatok összehasonlításakor is csak a szárnyhosszban mutatkozik eltérés. Azonban ezek az eredmények megerősítik a leírt alfajok elkülönítését az észak-afrikai fekete rigó populációkban, miszerint korábban a Maghreb államok északi területeiről leírt *T. m. algira* és a deli régiókban megtalálható *T. m. mauritanicus* valóban különálló alfajoknak tekintendőek.

Kulcsszavak: alfajok, észak-afrikai feketerigó, morfológiai tulajdonságok, *Turdus merula mauritanicus*, *Turdus merula algira*

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Introduction

The morphological characters of birds are one of the factors reflecting their physiological processes, life history traits, behavior and ecological functions (Dunning 1993, Gaston *et al.* 2001). Biometric data are of great interest in the study of biogeography and the evolution of species (Guillaumet *et al*. 2005, Svensson 2015).

In the 19th and early 20th centuries, the interest was focused on the description of new species (Hounsome 1993). Several studies had demonstrated that biometrics was one of the most important characteristics, which facilitates the detection of a subspecific or population-level differences, which were later often confirmed by phylogenetic technics. In the occidental Palearctic (especially Maghreb countries), these studies were represented by the identification of: Atlas Pied Flycatcher *Ficedula speculigera* described as morphologically different subspecies (Svensson 1992, Sætre *et al*. 2001a) and identified later as a species (Sætre *et al*. 2001b); Streaked Scrub Warbler *Scotocerca inquieta* (Bergier *et al.* 2013); two major lineages were genetically identified within Crested Larks *Galerida cristata* (Guillaumet *et al*. 2008) to describe a new endemic species to North Africa, namely Maghreb Crested Lark *Galerida macrorhyncha* (Sangster *et al*. 2016) and finally, the *Saxicola* complex which is still under revision concerning the two species occurring in North Africa, the European Stonechat *S. rubicola* and African Stonechat *S. torquatus* (Zink *et al*. 2009, Gill & Donsker 2018).

The Blackbird *Turdus merula* is one of the most common birds in the Palearctic region (Isenmann 2002, Collar 2005) including the southernmost areas where the species is present in various habitats from coastal to semi-arid conditions (Isenmann & Moali 2000). It is one of the most successful species judged by its ability to adapt to a wide range of environments including woodland, farmland and urban habitats (Mac Arthur & Mac Arthur 1961, Ludvig *et al*. 1994, Isenman 2002). Møller (2008) and Ciach and Fröhlich (2017) have related the response of some bird species (including Blackbird), which become very abundant in urban areas, to increasing food availability and night lighting in these ecosystems. One of the oldest colonizers of urban areas, the North African Blackbird *T. merula* constitutes the only breeding thrush species in urban ecosystems in northeastern Algeria (pers. unpub. data).

The seven actually recognized subspecies of Blackbird are distributed over the Palearctic region (Gill & Donsker 2018). Despite the consideration of two subspecies of North African Blackbird in the 19th and early 20th century (Hartert 1902, Madarász 1903), only *T. m. mauritanicus* have been retained for North Africa in the updated list of Gill & Donsker (2018). In the case of the Tibetan Blackbird *T. m. maximus*, for example, an investigation into the phylogenetic and biogeographic status of the subspecies led researchers to classify it as a separate species *T. maximus* (Collar 2005).

Previously, using morphological differentiation, Witherby (1905) have distinguished two races for North African Blackbird namely: Algerian Blackbird *T. m. algira* (Madarász 1903) and Moroccan Blackbird *T. m. mauritanicus* (Hartert 1902). These subspecies were evidently distinguishable by wing length, and based on the measurements, it has been concluded that the smaller Algerian Blackbird inhabited the northern areas of Great Maghreb (Aïn Mokra, Annaba; Hammem Meskoutine, Guelma; Akbou, Béjaïa), while the other one was

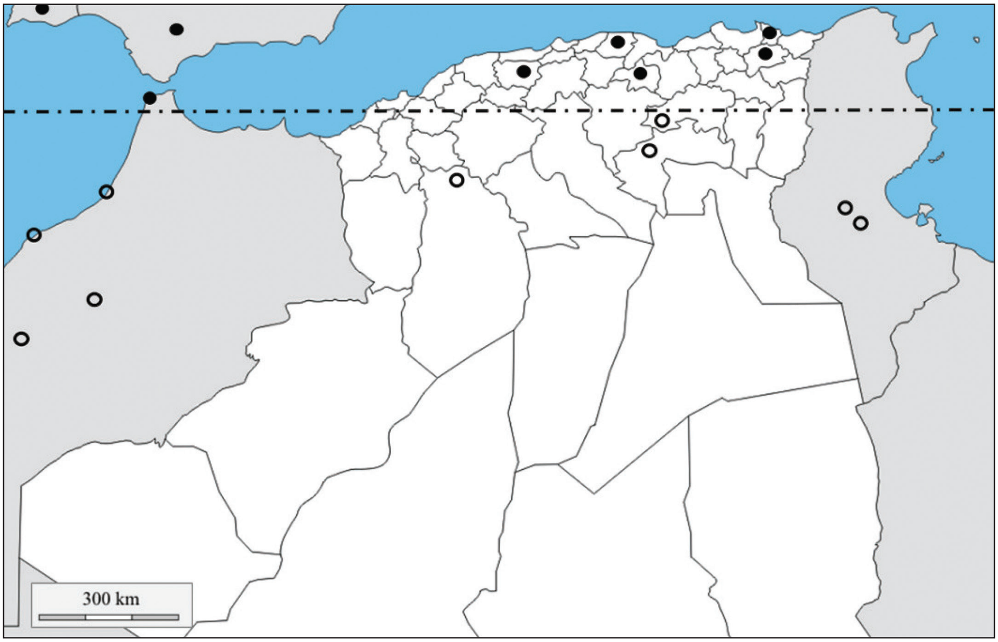

Figure 1. Supposed distribution of North African subspecies *T. m. algira* and *T. m. mauritanicus* across Maghreb and south Europe (● *T. m. algira*, ○ *T. m. mauritanicus*, overlapping area)

1. ábra A *T. m. algira* és a *T. m. mauritanicus* alfajok vizsgálatainak földrajzi elhelyezkedése a Maghreb régióban és Dél-Európában (jelölések: ● *T. m. algira*, ○ *T. m. mauritanicus*, átfedő területek határa)

Table 1. Geographic localities of Blackbird specimens presented in *Figure 1.*

1. táblázat Az összehasonlításra felhasznált fekete rigó egyedek földrajzi eredete (lásd 1. ábra)

Locality	**Source**
Aïn Defla	Jordans 1950
Casa Blanca	Cottrell *et al*. 1964
Djbel Mekter	Rothschild *et al*. 1914
Monchique	Ticehurst & Whistler 1933
Tilatou	Ménégaux 1914
Tiffrit	Rothschild & Hartert 1912
Berrahel	Rothschild *et al*. 1911
El Kantara	
Hammem Meskoutine	
Azrou	Rothschild *et al*. 1923
Rabat	
Rif	
Rhamna	
Safi	
Tanger	
Tazoult	

present in the arid region of the Maghreb countries (El-Kantara, Biskra; Tazoult, Batna; Djebel Mekter, El Bayadh) (Rothschild *et al.* 1911, Ménégaux 1920) *(Figure 1)*. The same biogeographical differentiation of the two subspecies was noted in Morocco, where *T. m. algira* was observed in Tanger (Rif) and *T. m. mauritanicus* was identified in the central-west of the country in Mazagan, Casablanca (Rothschild *et al*. 1923) *(Table 1, Figure 1)*. Other observations were recorded in southern Portugal

(Monchique) and in South and Central Spain, where the subspecies was described as belonging to the Algerian Blackbird *T. m. algira* (Stenhouse 1921, Ticehurst & Whistler 1933). In addition, it was found that a continental Palearctic population fraction (extreme northwestern Africa and extreme southwestern Europe) of Blackbirds presented three divergent lineages of haplotypes (Rodrigues *et al*. 2016). This implies that the northern Mediterranean population of Blackbird would belong to North African subspecies.

According to Wysocki (2002), defining the differentiation among populations is possible using morphological parameters. Over a century, knowledge on the Blackbird populations inhabiting the northern regions of North Africa was insufficient and the question of differentiation has been seldomly studied. Consequently, only two studies had reported superficially morphological data of North African Blackbird (Cramp 1988, Selmi 2004). Although the Blackbird *T. merula* has thoroughly been studied, the subspecific variation of the North African populations is still not completely known. In our study, we aim to present morphometric parameters of a North African Blackbird *Turdus merula* population. We compare these traits with other studies (notably certain from North Africa). Using comparison, we will discuss a previously described existence of intra-species variability (morphological traits) that is still unconfirmed.

Materials and methods

This study was conducted throughout the breeding season of 2015 on a resident urban population of North Africa (*Turdus merula* spp.), in the Christian cemetery of Bône (Algeria). The study site is a 6 ha large, old downtown cemetery belonging to the historic, colonial district of the city (36° 54’41”N/ 7° 45’24”E) *(Figure 2)*. The cemetery comprises an area of evergreen and deciduous vegetation, with low undergrowth managed once a year. The built parts (vaults and chapels) and pedestrian ways divide the site to different patches covering the most important surface of the cemetery.

We captured adult Blackbirds using mist nets during the breeding season (February to early July). We measured the biometrics of individuals according to Svensson (1992): weight (g), tarsus, bill, tail and wing lengths (mm). A 0.02 mm precision caliper was used to measure the tarsus length of captured birds. For weight measurement, we used a digital scale to the nearest 0.01 g. Wing parameters were measured with a metal ruler, also with 0.02 mm nearest precision. Colored and numbered metal rings were attached to the legs of all captured individuals before release. Additional specimens were captured from Algiers province exactly in “Bebezzouar university campus”.

Adult wing length of Balckbirds *Turdus merula merula* collected from Denmark, Poland, France and Hungary (Møller 1995, Wysocki 2002, Grégoire 2003, Csörgő *et al.* 2017) were used for comparison with North African ones (Rotschild 1921, Vaurie 1955, Selmi 2002, present study). Furthermore, we compared Blackbirds (museums data *Table 1*, *Figure 1*) from Maghreb countries to support the differentiation between subspecies using morphometric parameters of individuals. Including present study data, we used older specimens (Hartert, collected from northeastern Algeria) and another recent one from southern Tunisia

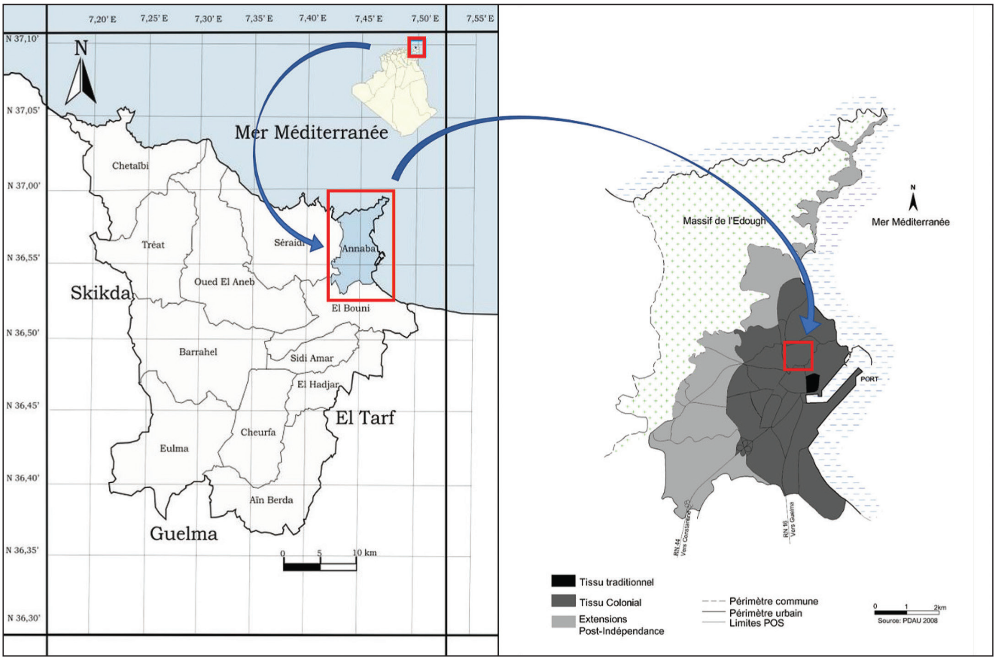

Figure 2. Study area (Traditional tissue: built before 1830; Colonial tissue: built during the colonial epoch 1830–1962 and post-independence extension: after 1962)

2. ábra A vizsgálati terület elhelyezkedése (eredeti terület: 1830 előtt építve; gyarmati időszak: 1830 és 1962 között építve; a felszabadulás utáni terület: 1962 után)

(Op. cit) to assure North African population analyses. These data represent the most southern range of the species.

First, we compared North African Blackbirds (without specified subspecies) and then revealed the difference within North African supposed subspecies. Welch's T test for two independent samples and an ellipses principal component analyses (PCA) were used to highlight morphologic variation and overlapping geographic distribution of North African subspecies. In the last comparison, only specimens of known locality were used. Analyses were carried out in R 3.4.0 (R Core Team 2017).

Results

For this study 26 adult individuals were captured (17 males and 9 females). No difference between males and females was found for any biometric measurement because of the small sample size ($p < 0.05$), *(Table 2)*. Although, marginally significant difference in wing and tail ($p = 0.06$ and 0.07, respectively) would reflect probable changes if the sample size will be enlarged.

First, we compared wing length of European Blackbirds *T. m. merula* (125.8 ± 5.22 mm, ranged 113–132 mm, n = 15) with North African *T. m. mauritanicus* (121.83 ± 5.86 mm, 112–135 mm, n = 104), which measurements significantly differed ($t = –2.70$, df = 19.46,

Table 2. Morphological characteristics of North African Blackbird *Turdus merula* spp. from Annaba city
2. táblázat Annaba város fekete rigóinak (*Turdus merula* spp.) morfológiai jellegei

Measurements	**Range**	**Sex**	**Mean ± SD**	**t**	***p***
Wing (mm)	114.4 – 124.8	Males	120.82 ± 3.63	2.058	0.0603
	111.8 – 124	Females	117.28 ± 4.29		
Tail (mm)	100.9 – 112.9	Males	105.54 ± 4.83	1.940	0.0707
	96.7 – 109.1	Females	103.11 ± 4.55		
Tarsus (mm)	34.6 – 42.7	Males	38.94 ± 1.63	0.744	0.4651
	36.3 – 40.1	Females	38.49 ± 1.23		
Bill (mm)	29.2 – 31.9	Males	30.76 ± 0.85	1.317	0.2132
	28.2 – 31.7	Females	30.07 ± 1.33		
Weight (g)	73 – 95.9	Males	83.76 ± 11.04	0.795	0.437
	58.7 – 95.5	Females	80.17 ± 9.83		

$p < 0.05$). This result was based on the current subspecies inhabiting North Africa in which formerly described separation was pooled. Repeating the comparison without the data of the supposed *T. m. algira* as part of *T. m. mauritanicus*, the wing length did not reveal any evident difference (t = 0.43, df = 19.39, *p* = 0.67). Of 68 North African Blackbird measured,

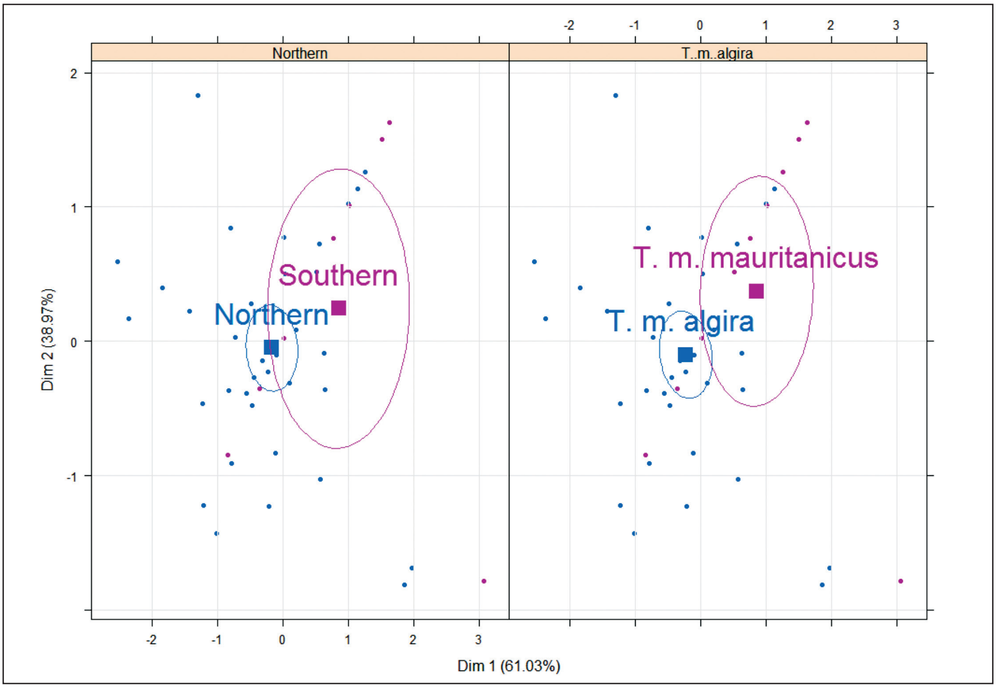

Figure 3. Ellipses PCA of subspecies traits (Wing and Tail) distributed in North Africa and Southern Europe
3. ábra Az alfajok jellemzőinek (szárny és farok) főkomponens elemzése Észak-Afrikában és Dél-Európában

wing length was 120.83 ± 4.79 mm (range 112–135 mm). This trait revealed a significant difference ($t = -5.38$, $df = 40.47$, $p < 0.05$) when data were separated according to old trinomial nomination *T. m. algira* (119.19 ± 4.24 mm, n = 48 (present study data included) and *T. m. mauritanicus* (124.75 ± 3.71 mm, n = 20).

According to wing and tail lengths PCA, despite weak sample size of *T. m. mauritanicus*, the supposed smaller *T. m. algira* was associated to *T. m. mauritanicus* traits. The latter, sometimes collected outside its "described" distribution area, has a larger wing length (126.8 ± 6.51 mm, range 115–135 mm, n = 10) contrary to *T. m. algira* (120.35 ± 4.90 mm, range 112–131 mm, n = 39). *T. m. mauritanicus* is mostly present in positive side of the Dim 1. According to the presence of *T. m. algira* individuals in the positive and negative sides of both axes, subspecies traits would overlap because of the presence of some long-winged specimens of this subspecies. However, distribution of the two subspecies overlaps contrary to traits *(Figure 3)* because some authors attributed *T. m. mauritanicus* to several long-winged specimens.

Discussion

We had marked an unbalanced sex ratio (captured individuals) which follows general tendencies within the species as the number of captured adult males was mostly important compared with this of females (Cresswell 1999, Wysocki 2002, Selmi 2004, Scheifler *et al.* 2006). It was showed that capture probabilities were male-biased in birds (Donald 2011) and precisely within Blackbirds (Lovász *et al.* 2018). Within studied population (sampled during breeding season), these results could reflect behavioral response to predation risk (Ibáñez-Álamo & Soler 2012, 2017) where females spend more time in nest and males guard the territory. There was a single exception from the population of central France (Dijon) where females were more likely to be captured than males (Faivre *et al.* 2001).

Contrary to our results, in northern populations of Blackbird, weight presented significant variation (Cresswell 1999, Macleod *et al.* 2005). As well as weight, wing, tarsus and tail lengths are the most used characters showing dimorphism in Blackbirds (Cramp 1988, Selmi 2004). These differences were not observed within our population which would reflect an absence of sexual dimorphism in morphological terms *(Table 2)*. However, marginal difference detected in wing and tail lengths would explain a hidden difference if the sample size was increased.

Parallel to the fact that some populations/subspecies of the Blackbird is short-distance migrant (Isenmann 2002) and, the probability of the occurrence of the species in a given habitat is strongly linked to its presence in the nearest neighboring habitat (Selmi 2003), we could confirm the observation of the North African subspecies in southern Europe (Portugal, South and Central Spain (Stenhouse 1921, Ticehurst & Whistler 1933)). In addition, our results state the absence of difference (at least in wing length) between *T. m. merula* and *T. m. mauritanicus* (only southern described area in *Figure 1*), which supports the geographic belonging of the supposed *T. m. algira*. Rothschild *et al.* (1911) did not give an average of wing length of both supposed subspecies but he presented ranges of this character. He had confirmed that *T. m. algira* was smaller (118–120 mm) than *T. m. mauritanicus* (118–128, mostly above 120 mm) following geographical division of subspecies. Later in 1955, Vaurie reported that wing length of *algira* ranged between 119 and 131 mm for thirteen specimens whereas *mauritanicus* measured 122–135 mm with an average of 128 mm.

Tarsus length in South Tunisia revealed a clear sexual dimorphism (Selmi 2004). Our individuals may present a longer tarsus compared to southern Tunisian (supposed *T. m. mauritanicus*) and European populations *T. m. merula* (Wysocki 2002, Selmi 2004). Although we do not know what was the length of the tarsus of *mauritanica*, our Blackbirds would be *algira* with longer tarsus. This supports the hypothesis of presence of another subspecies of North African Blackbirds mentioned in the last century as *algira*. It seems that a longer tarsus would be a morphological character which has not been reported before.

Within Forest Thrush *Turdus lherminieri* populations (Guadeloupe), a strong micro-geographic differentiation was found for a body-size descriptor (Arnoux *et al.* 2013). Because of the strong endemism related to Mediterranean basin species and insular environments all around notably Balearic Islands, the same body-size descriptor may explain the presence of differentiation within North African Blackbird. Beside Africa, other specimens (according to authors belong to *algira*) were captured in other continental localities, notably Portugal. Captured specimens' wings measured 115 and 117 mm, respectively for females and a male which were different of north Portugal specimen (from Vizeu) with 124 mm wing length (Ticehurst & Whistler 1933). In addition, Vaurie (1955) had reported that several authors had referred the populations of the Balearic Islands, southern Portugal, and central and southern Spain to *algira* (he did not mention authors see "Bird notes from southern Spain, 1921") following genetic facts presented from Azores islands (Rodrigues 2016).

Morphological characters of Blackbirds do not differ only in size but also in colorations (feathers and bill), which reflect, according to different authors, immunity, health and reproductive performance of individuals (Faivre *et al*. 2003a, b, Préault *et al*. 2005, Tomiałojć & Bursell 2006).

We confirmed the presence of a morphological differences at least in wing lengths of North African Blackbirds (Hartert 1902, Rotschild 1911, 1912, 1914, 1923, Ménégeaux 1914, Ticehurst & Whistler 1933). In fact, we would consider that Blackbirds collected during our study are smaller than southern Tunisian ones (Selmi 2004), and also European ones (Op. cit). This agreement follows results combined from those found during the 19th and 20th centuries. Although, Gill and Donsker (2018), described *T. m. mauritanicus* as a unique subspecies geographically belonging to northwestern Africa (from Morocco to Tunisia). Considering subspecific level of North African Blackbirds described previously and confirmed by morphological data in the present paper we would class current study collected specimens as *T. m. algira* until the genetic confirmation.

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Reproductive performance of the Middle Spotted Woodpecker *Dendrocoptes medius* around Yasouj city (South Western Iran)

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Abstract In the spring of 2018, 18 nests of the Middle Spotted Woodpecker *(Dendrocoptes medius)* were surveyed in a 300 hectare area of the forest region in the south and north of Yasouj. Egg-laying began in late March. Clutch sizes were between three and seven (mean: 4.29 ± 1.25, median: 4, N = 8). The incubation period varied from 11 to 13 days (mean: 12.4 ± 0.89 days). The number of eggs that hatched in successful nests (N = 8) ranged from 2 to 5 (mean: 3.75 ± 0.89). Hatching percentage (N = 7) was 90%. Duration of the nestling period was 23–25 days (median: 24 days). Fledging dates ranged from Apr 28 to June 10, and most chicks (77%) fledged in the first ten days of May. Number of fledglings from successful nests (N = 17) ranged from 1 to 5 (mean: 3.58 ± 0.71), whereas the mean number of fledglings from all nests (N = 18) was 3.39 ± 1.09. The percentage of successful nests (at least one fledged young, N = 17) was 94.4%. The overall duration of breeding varied from 39 to 43 days (mean: 40.8 ± 1.48 days).

Keywords: breeding, primary hole nesters, hatching success, fledging, nesting success

Összefoglalás 2018 tavaszán 18 közép fakopáncs *(Dendrocoptes medius)* odút vizsgáltak 300 hektárnyi erdőterületen, Yasouj városától délre, illetve északra. A tojásrakás március végén kezdődött. A fészekaljméret három és hét tojás között változott (átlag: 4,29 ± 1,25, medián: 4, N = 8). A kotlási időszak 11–13 napig tartott (átlag: 12,4 ± 0,89 nap). A sikeres fészkekben (N = 8) 2–5 fióka kelt ki (átlag: 3,75 ± 0,89). A tojások kikelésének aránya 90% volt (N = 7). A fiókanevelési időszak 23–25 napig tartott (medián: 24 nap). A kirepülések április 28. és június 10. között zajlottak, és a legtöbb fióka (77%) május első tíz napjában repült ki. Az odúnként kirepült fiókák száma (N = 17) 1 és 5 között volt (átlag: 3,58 ± 0,71). Mindemellett, az összes fészek esetében a kirepült fiókák átlagos száma (N = 18) 3,39 ± 1,09 volt. A költések 94,4%-ban bizonyultak sikeresnek (legalább egy kirepült fióka/fészek, N = 17). A költés teljes időtartama 39 és 43 nap között változott (átlag: 40,8 ± 1,48 nap).

Kulcsszavak: költés, elsődleges odúköltők, kikelési siker, kirepülés, költési siker

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Introduction

Middle Spotted Woodpecker *(Dendrocoptes medius)* depends on old, deciduous forests. Current knowledge of the reproductive biology of the species is based on only a few studies (Pettersson 1985, Pasinelli 2001, Kosenko & Kaygorodova 2003, Kosiński & Ksit 2006), but none of them has previously examined breeding behavior and performance of this species in Iran. The Middle Spotted Woodpecker breeds in the Zagros forests in West and Southwestern Iran and to a lesser extent also in the Alborz forests in Northwest Iran.

Reproductive biology, along with other demographic parameters, has been suggested as a superior estimator of habitat quality (Pasinelli 2001, Williamson *et al*. 2016). One of the most pivotal decisions in single-brooded birds is the timing of egg-laying that can greatly affect important parameters such as clutch size and other reproductive outputs (Klomp 1970, Perrins 1970, Daan *et al.* 1988). Numerous factors, which differ among bird species, affect reproductive success in birds (Newton 1989), such as the age of the breeding birds (Saether 1990) or food, predators, climatic conditions during the breeding period (Wiktander *et al.* 1994, Kosiński & Ksit 2006).

Another such out-of-human-control factor is rainfall, which is affecting breeding performance of Middle Spotted Woodpeckers (Pasinelli 2001). Therefore, determining and knowing reproductive performance and its numerous affecting factors is of great importance to take appropriate conservation measures and to assess their suitability.

Here, we report on different aspects of breeding performance of the Middle Spotted Woodpecker in Southwestern Iran. This study expands our knowledge about the biology of this species in Iran and our results are compared to the ones yielded from previous studies from other localities.

Materials and Methods

The study took place in an area of 300 hectare of the forest region in the south and north of Yasuj city in Southwestern Iran (31°35'N, 51°38'E) at 2000 meter above sea level with an average annual temperature and rainfall of 14 ºC and 817 mm, respectively. The vegetation consists of shrubs of the genera *Acantholimon, Astragalus* and *Amygdalus*, as well as various species of trees including mostly Persian oak *(Quercus brantii var. persica)* and rarely ash *(Fraxinus angustifolia)*, mount atlas mastic *(Pistacia atlantica)*, dotted hawthorn *(Crataegus puntica)* and honeysuckle *(Lonicera nummularifolia)*.

From early March to mid-May of 2018, surveys of woodpeckers were conducted by 2–3 people on foot (4–6 hours per day, often afternoon) to identify the approximate territory boundaries and to locate nests, which resulted in finding 18 active nests of Middle Spotted Woodpecker. Different approaches were used for this purpose. These include listening to the sound of birds excavating cavities, observing scratches and signs of cavity excavation, entering and/or leaving the cavity by woodpeckers, and finding wood chips under the tree on the ground. It must be noted that playbacks were not used as a potential way to find active birds. Later in the season, active nests were found by checking for eggs inside cavities and by listening for begging calls of chicks. For each active nest, a number of variables were recorded *(Table 1)*. To prevent nest abandonment, recording of these variables (i.e. nest structure characters) were done after fledging of the nestlings or when a nest was depredated or abandoned. Nest contents were checked using a Borescope (Extech BR300).

To assess breeding performance, the following variables were recorded for each nest: date of laying of first and last eggs, clutch size, incubation period, hatching rate (eggs laid divided by hatchlings), number of nestlings, number of fledglings (when the muscles and

Table 1. Breeding phenology and parameters of the Middle Spotted Woodpecker
1. táblázat A közép fakopáncs költési fenológiája és paraméterei

Breeding parameter	**Range**	**Mean ± SD**	**Median**	**n**	**%**
Beginning of laying date	March 21 to May 3				
Beginning of fledging date	Apr 28 to June 10				
Duration of breeding season (days)	39–43	40.8 ± 1.48	41		
Clutch size	3–7	4.29 ± 1.25	4	7	
Number of hatched nestlings in total nests	2–5	3.75 ± 0.89	4	8	
Number of fledglings in a successful nest	2–4	3.58 ± 0.71	4	17	
Number of fledglings in a failed brood	0–4	3.39 ± 1.09	4	18	
Incubation phase (days)	11–13	12.4 ± 0.89	13	5	
Nestling phase (days)	23–25	24 ± 0.71	24	5	
Hatching success					90
n eggs				30	
n nestlings				27	
N nests				7	
Nesting success (all nests)					94.4
n successful broods				17	

feathers are developed enough to leave nest), duration of the nestling period, and fate of each nest (successful, if at least one fledgling hatched, or unsuccessful otherwise). Duration of the breeding season was defined as the time interval between the day on which the first egg was laid in the earliest nest until the day on which the last nestling of the latest nest fledged. The incubation period was calculated for individual nests as the time interval between the day on which the last egg was laid to the day before the first nestling hatched. The length of the nestling period was calculated as the time interval between the day of first egg hatching to the day on which the first nestling fledged (Pasinelli 2001, Kosiński & Ksit 2006, Michalczuk & Michalczuk 2016). Nesting success was defined as the ratio of the number of nests with at least one fledged young to the number of nests in which eggs or nestlings were found (Kosiński & Ksit 2006, Michalczuk & Michalczuk 2016). We checked all the nests every 2–3 days during the study period to record the breeding parameters. To figure out if the nests contained any unhatched eggs or dead chicks, we did a final check on all the nests after fledglings left the nests (Michalczuk & Michalczuk 2016). Based on Michalczuk and Michalczuk (2016), we monitored all the nests during egg-laying period, treated those with destroyed eggs or abandoned as incomplete clutches.

Statistical calculations were performed using the SPSS software V.18. The relationships between variables were analyzed by the Kendall's tau correlations. The significance of relation between hatching success and nesting success was investigated by Fisher's exact test. A significance level of 0.05 was employed for all statistical tests.

Results

Nesting activities of Middle Spotted Woodpeckers began from mid to late March. Egg-laying started on March 21st and continued to May 3rd. In most of the nests, egg-laying date was in the last ten days of March *(Figure 1)*. Clutch size ranged from 3–7 eggs ($\overline{x}$ = 4.29 ± 1.25 SD, median = 4, N = 8) *(Table 1)*. 71.4% of the nests had four eggs *(Figure 2)*.

Incubation period varied from 11 to 13 days ($\overline{x}$ = 12.4 ± 0.89, median: 13). Number of hatchlings averaged 3.75 ± 0.89 (range = 2–5, median = 4) in all nests (N = 8) *(Table 1, Figure 2)*. Most of the nests had four chicks (62.5%). Overall hatching rate was 90% (N = 7).

The duration of the nestling period was 23–25 days, with median of 24 days (N = 5). The earliest and latest fledging dates were April 28 and June 10, respectively, and most chicks (77%) fledged in the first ten days of May *(Figure 3)*. Length of the breeding duration ranged from 39 to 43 days ($\overline{x}$ = 40.8 ± 1.48, median = 41).

Mean number of fledglings was 3.58 ± 0.71 (range = 2–4) in successful nests (N = 17) and 3.39 ± 1.09 in all active nests (N = 18) *(Table 1)*. No chicks were fledged only in 1 out of 18 nests. The most frequent number of fledglings per nest was four (70.6%, number of successful nests = 19) *(Figure 3)*. There is a tendency towards increasing the hatching success (τ = 1.00, P = 0.0001) as the clutch size increases. The relationship between both of clutch size and nesting success (τ = 0.071, P = 0.84) and clutch size and the number of fledglings in successful nests (τ = 0.091, P = 0.81) are not significant. There is no significant correlation between number of nestlings and fledglings (τ = 0.091, P = 0.81), as well as nestling and nesting success (τ = 0.07, P = 0.84).

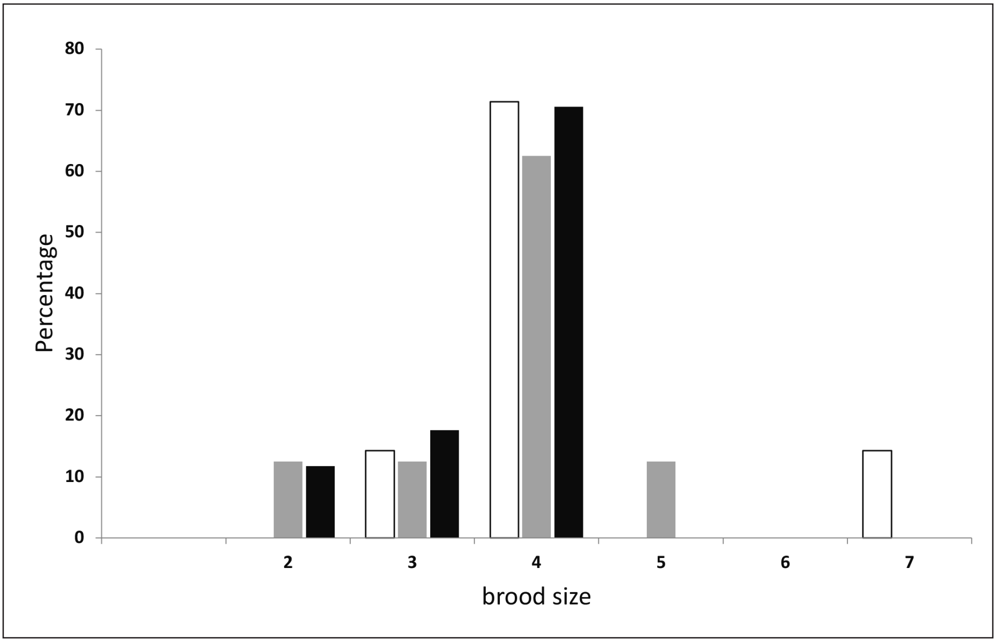

Figure 1. Egg laying date in Middle Spotted Woodpeck
1. ábra A közép fakopáncsok tojásrakási időpontjai

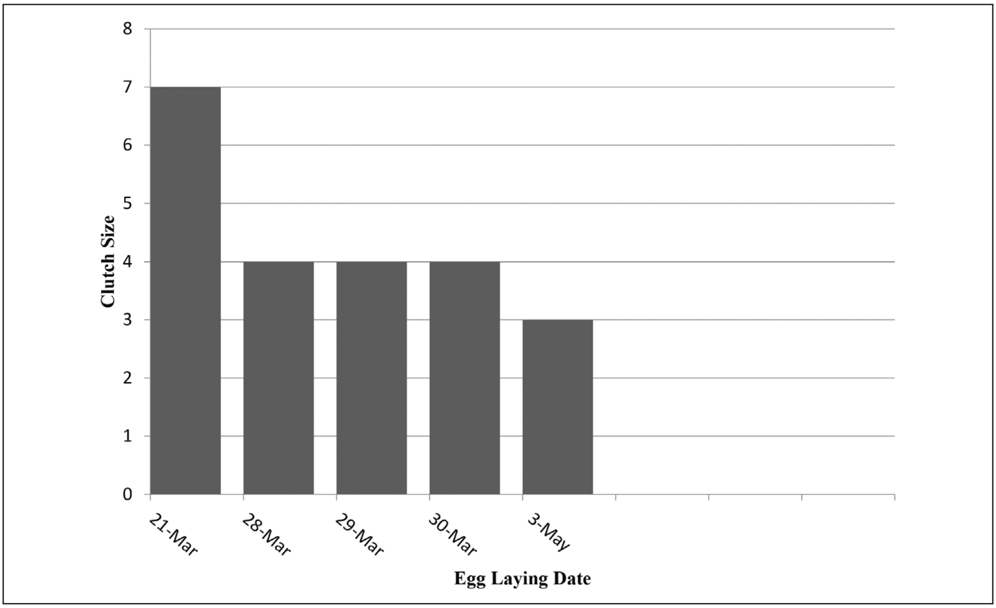

Figure 2. Distribution of Middle Spotted Woodpecker brood sizes. White bars show clutch size (N = 7), gray bars indicate number of hatched nestlings (N = 8), and black bars give number of fledglings (N = 17) in successful nest

2. ábra A közép fakopáncsok fiókaszámának eloszlása. A fehér oszlopok a fészekalj méretet (N = 7), a szürke oszlopok a kikelt fiókák számát (N = 8), a fekete oszlopok a kirepült fiókák számát (N = 17) mutatják a sikeres költésekben

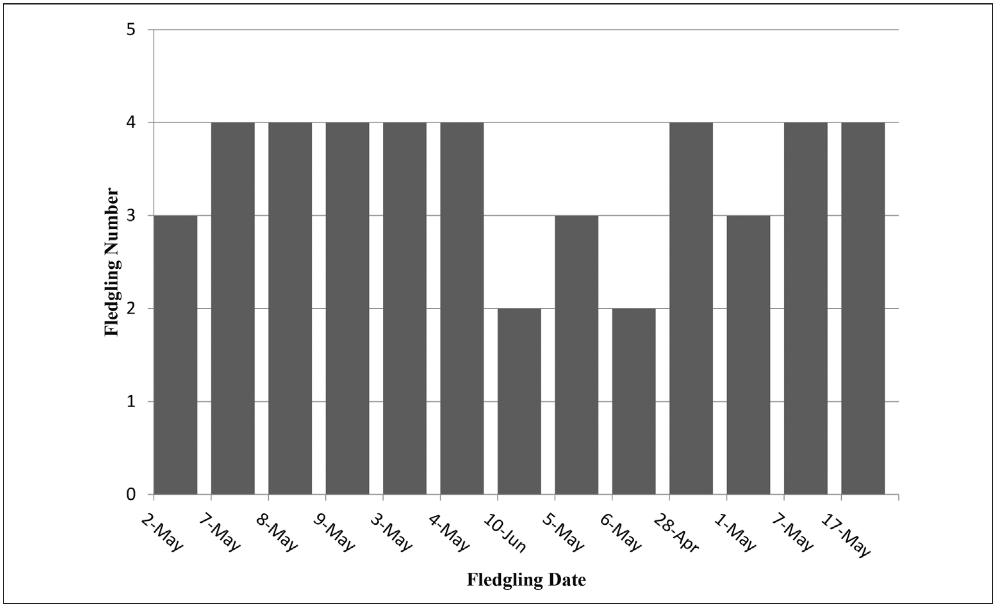

Figure 3. Fledgling date in Middle Spotted Woodpecker

3. ábra A közép fakopáncsok kirepülési időpontjai

The percentage of successful nests (at least one fledged young) (N = 17) was 94.4% *(Table 1)*. Applying Fisher's exact test, there is no significant relationship between hatching success and nesting success ($P = 0.8$).

Discussion

Egg-laying dates of some Palearctic Woodpecker species have repeatedly been studied. For example, the time of egg-laying primarily occurs in late April to early May in the Middle Spotted Woodpecker (Pasinelli 2001 (in Switterland), Kosinksi & Ksit 2006 (in Poland)), in the last week of April in the Great Spotted Woodpecker *(Dendrocopos major)* (Mazgajski 2002), from April 24th to May 3rd in Syrian Woodpecker *(Dendrocopos syriacus)* (Michalczuk & Michalczuk, 2016), and from 27th March to 21st May in Black Woodpecker *(Dryocopus martius)* (Van Manen 2012). The results of this study indicated that egg-laying begins in late March. The general timing of breeding period in birds is controlled by photoperiodicity (Immelmann 1971). The onset of egg-laying was earlier in our study area compared to above-mentioned regions, most likely explaining by the differences in elevation and maybe availability of food resources in these study areas. Our study was carried out at an elevation of 2200 m a.s.l, while previous studies (i.e. Pasinelli 2001, Kosinksi & Ksit 2006) had been done in lower elevations. The beginning of egg-laying may vary from year to year, being earlier in warmer springs (Pasinelli 2001, Mazgajski 2002). It has been shown that the timing of woodpecker breeding in temperate forests is synchronized with the time of caterpillar peak abundance (Török 1990, Pasinelli 2001, Wiktander *et al*. 2001, Kosenko & Kaygorodova 2003). For example, Kosenko and Kaygorodova (2003) suggested that the caterpillars appear a few days prior to commence of the hatching period. The young of Middle Spotted Woodpeckers are primarily fed by caterpillars (Török 1990), and since the appearance of caterpillars are associated with the appearance of the leaf buds (Van Balen 1973, Buse *et al.* 1999), it is very likely that the beginning of egg-laying in Middle Spotted Woodpeckers are somehow regulated by the commence of vegetation growth. An important factor in determining the timing of breeding is the availability of food resources (Daan *et al.* 1988, Pasinelli 2001). Another factor that seems to affect the breeding performance of the Middle Spotted Woodpecker is weather conditions during the nestling phase (Pasinelli 2001).

Many studies have provided valuable data on clutch sizes of woodpecker species (e.g. Wiktander *et al.* 1994, Michalek *et al.* 2001, Mazgajski 2002, Pasinelli 2003, Kosinski & Ksit 2006, Pasinelli 2006, Vierling & Lentile 2006, Van Manen 2012, Zhu *et al*. 2012, Michalczuk & Michalczuk 2016). The average number of eggs differ for different species or even within the same species, e.g. for Middle Spotted Woodpecker 6.4 eggs (Pasinelli 2006), 6.5 eggs (Kosinski & Ksit 2006), and 5.6 in Hungary and Vienna (Michalek *et al.* 2001, Pasinelli 2003); for Great Spotted Woodpecker 5.4 eggs (Mazgajski 2002), 5.6 eggs (Michalczuk & Michalczuk 2016); for Syrian Woodpecker 5 eggs (Van Manen 2012); for Black Woodpecker 3.8 eggs (Wiktander *et al.* 1994); for Lesser Spotted Woodpecker *(Dendrocopos minor)* 5.9 eggs; for Lewis's Woodpecker *(Melanerpes lewis)* 5.00 eggs (Zhu *et al*. 2012, Vierling & Lentile (2006); and for Red-headed Woodpecker *(Melanerpes erythrocephalus)* 5.4 eggs.

In our study, clutch sizes ranged from 3 to 7, with an average of 4.29. This was lower than findings of other studies. In Central and Eastern Europe, clutch sizes ranged from three to ten (Pasinelli 2001, Kosenko & Kaygorodova 2003, Kosiński & Ksit 2006), although, Pasinelli (2003) has reported that 10-egg clutches are extraordinary in the Middle Spotted Woodpeckers. The low clutch size in the current study is probably due to reduced rainfall, poor vegetation and food shortages in the study year.

In the Middle Spotted Woodpecker, duration of the incubation period has been reported to range from 7 to 12 days (Pasinelli 2001). In our study, incubation lasted from 11 to 13 days, with an average of 12.4 days, which is consistent with prior studies. Moreover, duration of the nestling period ranged from 23 to 25 days, with an average of 24 days which is also similar to the results of other studies such as Pasinelli (2001).

In this study, the percentage of hatched eggs was 90%, which is much higher than the studies of Pasinelli (2001) with 71% and Kosiński and Ksit (2006) with 70%. In our study, the average number of fledglings from successful nests was 3.58, which was different from those in Poland with 4.5 (Kosiński & Ksit 2006), in Switzerland with 3.2 (Pasinelli 2001), and in Southwest Russia with 5.4 fledglings (Kosenko & Kaygorodova 2003).

Nest success in woodpeckers typically varies between 70% and 100% (Winkler *et al.* 1995, Pasinelli 2006). Nest success in this study was 94.4%, which was much higher than Pasinelli (2001) with 74.3%, Kosiński and Ksit (2006) with 83.1%, but closer to Michalek and Winkler (2001) with 89.5 and Kosenko and Kaygorodova (2003) with 89.7%. In our study, only one nest failed for unknown reasons.

One of the reasons for the difference in the results of the same parameters in various studies is the negative impacts of weather and rainfall. Pasinelli (2001) and Mazgajski (2002) have previously reported these negative effects during the breeding period on breeding success of Middle and Great Spotted Woodpeckers. According to Pasinelli (2001), mortality of nestlings increase in cold and humid weather conditions, because parents barely find enough food to feed chicks. In another study, Wiebe (2011) figured out that there was a direct relationship between clutch size and warmer temperatures in nest cavities; nevertheless, this parameter (cavity temperatures) has no affect on hatching and fledging success.

It has noted that territory quality is one of the affecting factors of breeding success in birds (Stacey & Ligon 1987, Catchpole & Phillips 1992, Pasinelli 2001, Nappi & Drapeau 2009). In woodpeckers, measuring the availability of hole-trees (Walters, 1990) or the densities of dead stems and deciduous trees is important (Carlson 1998). The most population densities of Middle Spotted Woodpecker are found in mature deciduous forests with many old Oak stems (e.g. Muller 1982, Schmitz 1993, Winkler *et al.* 1995) with few exceptions (see: Gunther & Hellmann 1997). Finally, habitat quality affects the reproductive performance of this species on the landscape level (Pasinelli 2001).

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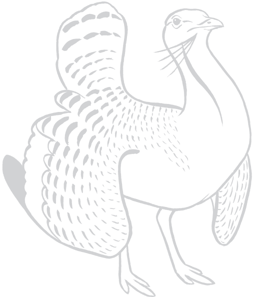

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Migration and wintering of Fieldfare *(Turdus pilaris)* in southeastern Hungary

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Abstract The Fieldfare is a bird species widely distributed in the Palearctic region. In Hungary, the species is considered as a rare breeder and common, sometimes abundant migrant in autumn and spring, and also as winter visitor. It is prone to invasion, since northern breeding populations leave the breeding sites in large numbers only when the available food is inadequate or inaccessible to the birds. Most populations follow a southern-southwestern migration pattern, and in the course of their movement they also migrating through the Carpathian Basin. In this study, we examined the migration and wintering of the species in an area of southeast Hungary between 2004 and 2019. Data were collected between the beginning of October and the middle of April and during that period we saw Fieldfares a total of 416 times. In addition to the description of migration, the effect of weather on bird numbers was also investigated. According to our results, the species appears in the area in October and disappears in late March and the first half of April. The individuals that migrate in October are likely belonging to the Central European breeding population, while from November the Scandinavian birds can be seen. The maximum number of birds observed during the different years showed significant differences, as did the patterns of movements within the seasons. The relationship between the local weather and the number of birds has been demonstrated over several seasons, which is typical of species with an escape migration.

Keywords: invasion, wintering, escape movements, introduced plants

Összefoglalás A fenyőrigó az északi területek elterjedt énekesmadara, amely Magyarországon kisszámú fészkelő és gyakori, olykor tömeges őszi és tavaszi átvonuló, illetve téli vendég. Egyike a tipikus inváziós madárfajoknak, ugyanis az északon fészkelő populációk csak abban az esetben hagyják el nagy számban a költőhelyeket, ha a rendelkezésre álló táplálék mennyisége nem elegendő, vagy az nem hozzáférhető a faj számára. A legtöbb populáció déli-délnyugati vonulási irányt követ, és ezen mozgásuk során érintik a Kárpát-medencét is. Jelen dolgozatban egy délkelet-magyarországi területen vizsgáltam a faj vonulását és telelését a 2004 és 2019 közötti időszakban. Az adatgyűjtés október eleje és április közepe között zajlott, és összesen 416 alkalommal láttam fenyőrigókat. A vonulás leírása mellett az időjárásnak a madarak mennyiségére gyakorolt hatását is vizsgáltam. Eredményeim szerint a faj ősszel, októberben jelenik meg a területen és március végén, április első felében tűnik el. Az októberben átvonuló egyedek minden bizonnyal a közép-európai költőállományhoz tartoznak, míg novembertől már a skandináv madarakat lehet látni. Az egyes vizsgálati évek során megfigyelt maximális példányszámok jelentős eltéréseket mutattak, mint ahogy a madarak szezonon belüli mozgási mintázata is különböző volt az évek között. A lokális időjárás és a madarak száma közötti összefüggést több szezonban is sikerült igazolni, ami tipikusan jellemző a szökő vonulást mutató fajokra.

Kulcsszavak: invázió, szökő vonulás, telelés, betelepített növények

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Introduction

The Fieldfare *Turdus pilaris* has an extremely large breeding range with a total of 24,100,000 km^2 area (BirdLife International 2019). It breeds from North and Central Europe, East through Central Siberia, North Kazakhstan, Altai and Sayan Mountains to Aldan Basin and Transbaikalia (Collar 2019). It breeds in several European countries since the mid-20th century, including Serbia (Stanković 2018), Italy (Spina & Volponi 2009), Croatia (Budinski 2013) and the British Island (Wernham *et al.* 2002). Monotypic (Collar 2019), however, birds wintering in the Upper Volga region of West Russia, described as race *glacioborealis*, differ from local breeders in morphology and plumage, but further researches are needed (Lastukhin 2005). It winters in West and South Europe, North Africa and Southwest Asia (Collar 2019), but some breeding areas (i.e. South Scandinavia, Germany, Czech Republic and Hungary) have a considerable overlap with autumn/winter areas (Milwright 1994). Vagrants have occurred in Arabia, China (Kansu), Japan, North America and India (Clement & Hathway 2000, Banerjee & Inskipp 2013).

Fieldfares typically breed in birch, alder and pine forests mostly near rivers, marshes and creeks, but at lower widths they can be found in mixed forests too (Collar 2019). The Fieldfare's preferred diet, in summer at least, is invertebrates, particularly earthworms. In autumn they switch to fruits, and in severe winter weather, when the ground is frozen, a considerable number of Fieldfares may enter orchards to feed on apples (Norman 1994, 1995).

The species migrates from the northern breeding areas to south-southwest, however, there are differences among breeding populations. Compared to the closely related Song Thrush *T. philomelos* and Common Blackbird *T. merula*, the connectivity between the breeding and wintering grounds is very small (Huttunen 2004, Csörgő *et al.* 2017a, b). In the case of Redwing *T. iliacus* that breeds also in the northern areas, there is also very small connectivity (Huttunen 2004). Birds breeding in Finland have mostly southwestern migration direction and winter almost in Italy and France, but there are data from 30 different countries (Valkama *et al.* 2015). Similar pattern can be observed in Sweden and Denmark, but a part of the Swedish local breeding birds moves first to Norway, and then turns to south. They winter in a very broad area from Spain to Azerbaijan (Bønløkke *et al.* 2006, Fransson & Hall-Karlsson 2008). The birds re-captured in Germany originate almost from North Fennoscandia and winter in South-Southwest Europe, but some individuals are from Russia to the 87° longitude and there are recoveries from the eastern Mediterranean too (Bairlein *et al.* 2014). The foreign recoveries in Italy, which is one of the most important wintering countries of the species, originating particularly from Finland, Germany and Russia. The Baltic accounts for a large part of the overall sample, together with Central-eastern Europe and there is a connectivity of Italy with the United Kingdom too (Spina & Volponi 2009). The Siberian and the central Russian birds go to the Po, Rhone and Gironde rivers, so these populations have a southwestern migratory direction. This migration route passes the Carpathian Basin, which can be used for a refuelling stop if necessary, and enters the Po from the east. This is the only direction (other than via the Adriatic Sea), which avoids crossing the Alps (Milwright 1994). This was considered by a bird that has been ringed in Hungary and later has recovered in Siberia (Csörgő & Gyurácz 2009a). Their migration speed is fast, most likely depending on the favourable winds (Milwright 1994).

The Scandinavian birds leave the breeding areas from October, then the recoveries in November are already concentrated in Central Europe (Fransson & Hall-Karlsson 2008, Bairlein *et al.* 2014, Valkama *et al.* 2015). The earliest foreign ringed Fieldfares reach Italy in mid-September and increase in frequency in October, while the highest numbers are reached between the second decade of November and the first of December (Spina & Volponi 2009). The first individuals reach the Central European breeding grounds from early-March (Schröpfer 2008), while the Scandinavian birds arrive in April (Fransson & Hall-Karlsson 2008, Valkama *et al.* 2015).

The species is not faithful to its wintering sites year after year (Ashmole 1962, Norman 1994), and, additionally, has no fidelity to an area, even within a winter season. For example, birds ringed during winter in the United Kingdom, Belgium and The Netherlands have been found in Croatia in subsequent winters (Budinski 2013). Furthermore, birds from the same brood, in subsequent winters may occur in entirely different areas (Simms 1978). Some individuals have been found in successive winters at areas up to several thousand kilometres (Ashmole 1962, Bairlein *et al.* 2014). Studies in Germany show that the individual wintering sites can be spread over 3000 kilometres over the years (Bairlein *et al.* 2014). These irregularities can be explained by drifting during migration (Alerstam 1975), movements during hard weather (Lack 1960), or intense nomadic behaviour to exploit variable berry crops (Norman 1994). Wintering birds from Britain, Denmark and Germany move to the southeast during a winter season (Milwright 1994). However, the examination of the ringing record shows that some individuals, and possibly some populations, are faithful to winter sites (Milwright 1994). At one ringing site in eastern England, out of 910 birds, 11 (1.2%) were trapped again in later winters, also, of the 278 British and Irish ringed birds which have been recovered anywhere during a winter subsequent to that of their ringing, 15 (5.4%) were recovered within 20 km from their ringing site (Milwright 1994). Besides, Thy (1986) found that Fieldfares wintering in eastern England have a flexible social structure ranging from highly gregarious to near-territorial according to their food supply. In experiments using apples, previously-gregarious Fieldfares established large exclusive territories and spent more time on aggression and eating experimental apples and less time on hunting invertebrates than non-territorial birds did. However, important to note, that the birds wintering in Britain might show a different habit due to the temperate, mild climate is different from the Central European conditions.

The Fieldfare is a typical irruptive species. The results of Tyrväinen (1970) in Finland shows, that a significant part of the breeding population did not migrate in the autumn when the berry crop of the mountain ash was exceptionally good and, moreover, when the autumn was very mild, and the snow cover delayed. Emigration only started when the food supply was exhausted. The species shows marked invasion tendencies in relation to the supply of rowanberries (Alerstam 1993). Svärdson (1957) found that every third or fourth winter, Scandinavia is invaded by huge masses of Fieldfares originating from the northern breeding grounds. Irruption species seem to have an extra ability of locating food. In this way, Fieldfares, which move along fairly high in the air, could direct their further flight according to sign-stimuli reaching them from perhaps almost as far as the horizon. Their search would thus be a random one, but not a search like that of a foraging party of tits, working its way through the trees; instead, it would be an optical search over a really wide range (Svärdson 1957). Birds are often capable of staying during a period of harsh winter conditions in rowanberry or apple trees and to maintain themselves on remaining berries or rotten fruits (Berthold 1996).

In Hungary, the species breeds in small number, but it is a common, sometimes abundant migrant in autumn (September-October) and spring (March-early March), and visitor in winter (October-March) (Hadarics & Zalai 2008). Although occasional breeding is known from the early 20th century (Hadarics & Zalai 2008), the number of breeding pairs increased from the 1980's (Béres & Béres 1983, Béres & Petrovics 1984), possibly due to the extension of the species' distribution area (Tiainen *et al.* 1997, Schmidt 1998). The knowledge related to the movements of the local population is insufficient (Csörgő & Gyurácz 2009a).

Based on the Hungarian ringing records, most of the birds that migrate through and winter in the Carpathian Basin are from Scandinavia (mostly Finland). However, there are recaptures from Belgium and Russia too, and birds that had been ringed in Hungary have been recovered from southern France to Turkey (Csörgő & Gyurácz 2009a).

In this study, the migration and wintering of Fieldfare were examined in Southeast Hungary. The main goal was to describe the autumn and spring migration of the species in the study area and to examine the connections between weather and the movements of the Fieldfares.

Material and methods

The study was carried out in the area of Kevermes and Lőkösháza in the southeastern part of Hungary *(Figure 1)*. I considered the administrative boundaries of the two villages with an 80 km^2 total area as the boundaries of the territory of my research (Hevesi 2005). The landscape is dominated by agricultural lands with some planted forests, artificial lakes, canals and steppes (for details see Bozó 2017). The core area was the surroundings of Fenyves-forest, with an approximate 50 ha total area. This area included the lake gravel pit (open water surface with dense lakeside vegetation), the forest of the former pheasant station (oleaster *Elaeagnus angustifolia* plantation), the Fenyves-forest (common hackberry *Celtis occidentalis*, common oak *Quercus robur*, acacia *Robinia pseudoacacia*) and a poplar (*Populus* spp.) plantation.

The study seasons covered the period between 1 October and 15 April in every year from 2004 to 2019 with a total of 416 observation records. The data collection was based on field observations with binocular. During the 2006/07 and 2009/10 seasons, the data collection was started later and finished earlier, therefore from these periods the earliest and latest observations cannot be published. The situation was the same in the cases of the latest records during the 2008/09, 2010/11 and 2015/16 seasons. For the description of migration periods and winter movements, I only considered the data from 2012 to 2019, when the intensity of data collection was similar. During this period, we visited the study site on 501 different days and we have seen the species on 344 different days. Detailed information of weather

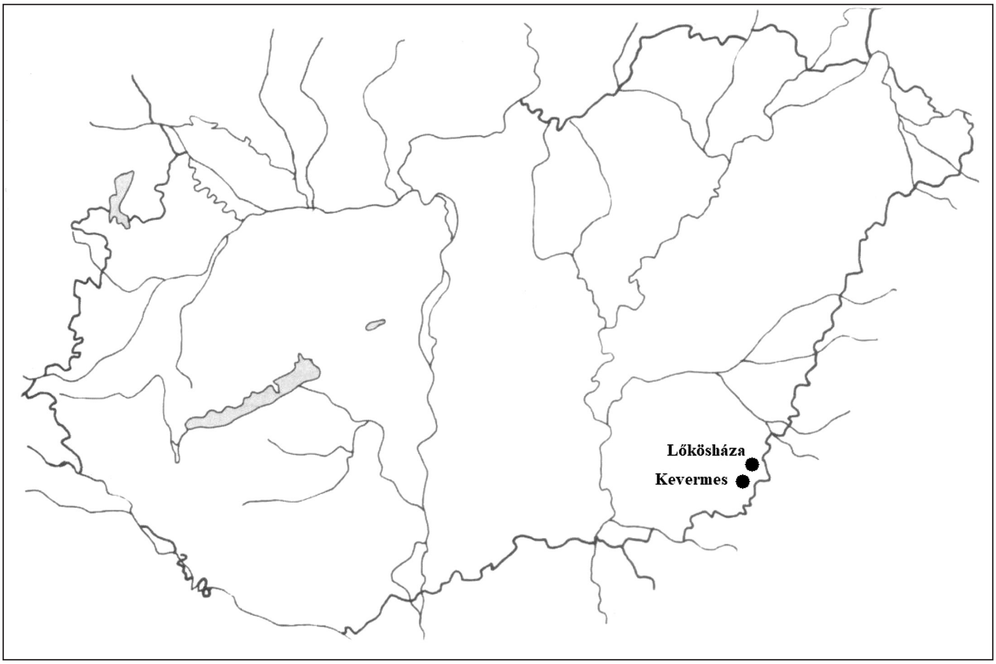

Figure 1. The location of the study area in Hungary
1. ábra A vizsgálati terület elhelyezkedése Magyarország területén

(minimum and maximum temperature values, snow thickness values) is available only from 2012, therefore to analyse the impact of temperature and snow coverage on the number of birds, I used data set from 1 October 2012 to 15 April 2018. To analyse the relationship between the number of birds and the temperature data of the current week, I used Pearson's product correlation test with the software R version 3.2.4 (R Development Core Team 2016). I also analysed the impact of the temperature values of the previous week on the number of birds in every season. To test the impact on the number of birds in the study area, the peak values of the different seasons were compared to the monthly temperature values of Helsinki, South-Finland. Microsoft Excel 2013 was used to create graphs and tables. The temperature data are from the website of the World Weather Online (www.worldweatheronline.com).

Results

The average movement pattern for 2012–2019 is characterized by three major peaks (mid-December, early-February, and late February to early March). The number of birds increases in October and the first half of November, high between late-November and early-March, and decreases from the second half of March *(Figure 2)*.

Taking the complete database into account, the earliest autumn data are from 4 October 2012, while the latest spring observation was on 15 April 2017. Based on data from 10

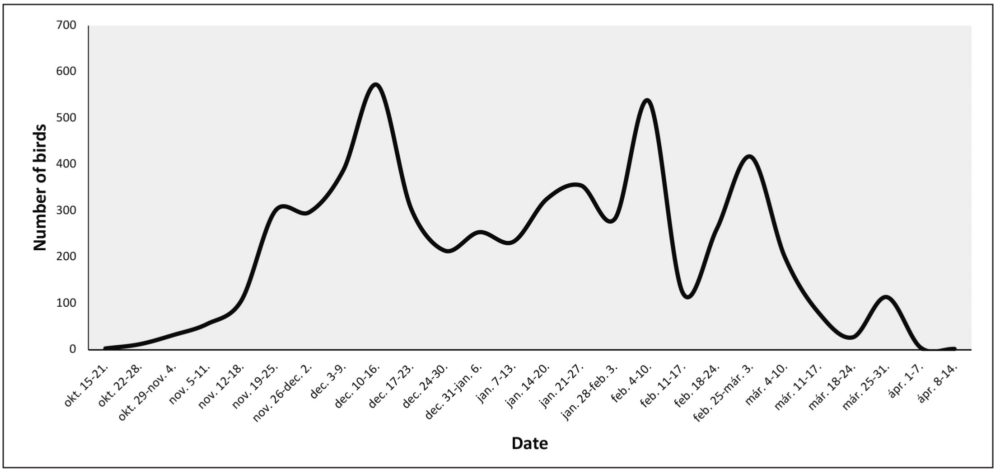

Figure 2. Seasonal distribution of Fieldfare's data between 2012–2019. Number of birds was averaged based on weekly averages over the seven seasons

2. ábra A fenyőrigó adatok szezonon belüli (október 15. – április 14.) eloszlása 2012–2019 között. A példányszámok a hét szezon hetenkénti átlagai alapján lettek számítva

Table 1. The earliest and latest observation data, the dates of the seasonal peaks and the number of birds observed at that time, and the number of days elapsed between the earliest and latest observation data per season

1. táblázat A legkorábbi és legkésőbbi megfigyelési adatok, a szezonális csúcsok időpontjai és az abban az időpontban megfigyelt példányszám, valamint a szezononkénti legkorábbi és legkésőbbi megfigyelési adatok között eltelt napok száma

Season	Earliest data	Latest data	Peak day	Number of birds on peak day	Days spent in the area
2004/05	2 Nov.	12 Mar.	09 Jan.	n.a.	131
2005/06	12 Nov.	18 Mar.	29 Dec.	600	127
2006/07	n.a.	n.a.	10 Feb.	150	n.a.
2007/08	23 Oct.	21 Mar.	01 Dec.	600	150
2008/09	23 Oct.	n.a.	23 Jan.	400	n.a.
2009/10	n.a.	n.a.	17 Dec.	300	n.a.
2010/11	02 Nov.	n.a.	23 Dec.	1500	n.a.
2011/12	14 Oct.	26 Mar.	04 Dec.	400	164
2012/13	04 Oct.	9 Apr.	04 Feb.	2000	188
2013/14	02 Nov.	23 Mar.	23 Jan.	200	142
2014/15	26 Oct.	1 Apr.	14 Dec.	500	158
2015/16	22 Oct.	n.a.	12 Dec.	400	n.a.
2016/17	15 Oct.	15 Apr.	16 Jan.	1000	183
2017/18	16 Oct.	29 Mar.	27 Nov.; 16 Dec.	400	164
2018/19	17 Oct	7 Apr	24 Feb	1200	172

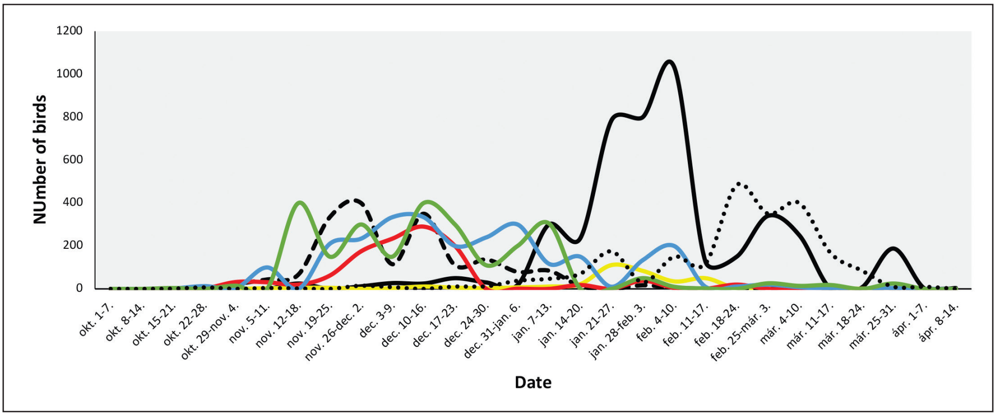

Figure 3. Seasonal distribution of Fieldfare's data (cumulative values). Different lines indicates the different study seasons (black solid line: 2012/13, yellow solid line: 2013/14, black dashed line: 2014/15, red solid line: 2015/16, blue solid line: 2016/17, green solid line: 2017/18, black dotted line: 2018/19)

3. ábra A fenyőrigó adatok szezononkénti eloszlása (kumulatív értékek). A különböző vonalak a különböző vizsgálati szezonokat jelzik (fekete folytonos vonal: 2012/13, sárga folytonos vonal: 2013/14, fekete szaggatott vonal: 2014/15, piros folytonos vonal: 2015/16, kék folytonos vonal: 2016/17, zöld folytonos vonal: 2017/18, fekete pontozott vonal: 2018/19)

seasons, Fieldfares spent an average of 157.8 days in the area (SD = 20.5). The shortest period (127 days) was spent in the 2005/06 season and the longest period (188 days) in the 2012/13 season *(Table 1)*.

Compared to the average pattern, seasonal migration curves show significant differences between 2012 and 2019 *(Figure 3)*. It had the highest number of birds in the 2012/13 season and the lowest number in the following season. In four seasons, the most birds were present between the beginning of November and the end of December, and after that period, their numbers decreased significantly. Conversely, during three seasons, there were few

Table 2. Correlations between the number of birds observed and the temperature data for the current week by season

2. táblázat A megfigyelt madarak száma és az aktuális hét hőmérsékleti adatai közti összefüggések szezononként

Season	**Minimum temperature**			**Maximum temperature**			**Average temperature**		
	t	**p**	**R**	**t**	**p**	**R**	**t**	**p**	**R**
2012/13	-1.7511	0.0917	-0.3248	-2.0253	0.0532	-0.3691	-1.9174	0.0662	-0.3520
2013/14	-2.9695	0.0063	-0.5033	-3.3775	0.0023	-0.5522	-3.2263	0.0034	-0.5347
2014/15	-1.4258	0.1658	-0.2693	-1.8956	0.0692	-0.3485	-1.6985	0.1014	-0.3160
2015/16	-1.4734	0.1526	-0.2776	-1.4247	0.1661	-0.2691	-1.4523	0.1584	-0.2739
2016/17	-3.3404	0.0025	-0.5480	-3.6993	0.001	-0.5872	-3.5408	0.0015	-0.5704
2017/18	-0.7193	0.4784	-0.1397	-1.2790	0.2122	-0.2433	-1.0135	0.3202	-0.1949
2018/19	-1.0072	0.3231	-0.1937	-0.5306	0.6001	0.1035	-0.7460	0.4623	-0.1448

Table 3. Correlations between the number of birds observed and the temperature data for the previous week by season
3. táblázat A megfigyelt madarak száma és az azt megelőző hét hőmérsékleti adatai közti összefüggések szezononként

Season	Minimum temperature			Maximum temperature			Average temperature		
	t	p	R	t	p	R	t	p	R
2012/13	-1.8145	0.0812	-0.3353	-2.2598	0.0324	-0.4052	-2.0680	0.0487	-0.3758
2013/14	-2.2224	0.0352	-0.3995	-2.6547	0.0134	-0.4618	-2.4873	0.0196	-0.4384
2014/15	-0.3887	0.7007	-0.0760	-0.7591	0.4546	-0.1473	-0.5982	0.5550	-0.1165
2015/16	-1.0875	0.2868	-0.2086	-1.0500	0.3034	-0.2017	-1.0724	0.2934	-0.2058
2016/17	-3.3320	0.0026	-0.5470	-3.5932	0.0013	-0.5760	-3.4718	0.0018	-0.5628
2017/18	-0.6446	0.5248	-0.1254	-0.9580	0.3469	-0.1847	-0.8006	0.4306	-0.1551
2018/19	-1.4366	0.1627	-0.2711	-1.0651	0.2966	-0.2044	-1.2390	0.2264	0.2361

Table 4. Correlations between the number of birds and the snow cover by season
4. táblázat A madarak száma és a hóborítottság közötti összefüggések szezononként

Season	t	df	p	R
2012/13	1.7105	65	0.0919	0.2075
2013/14	4.3919	80	<0.0001	0.4408
2014/15	-0.9929	73	0.3240	-0.1154
2015/16	-0.8253	104	0.4111	-0.0807
2016/17	3.6074	67	0.0006	0.4033
2017/18	-1.1060	57	0.2734	-0.1449
2018/19	-0.8020	73	0.4252	-0.0934

Fieldfares in the area in autumn and the first half of the winter and their number peaked between late-January and late-February.

In the 2013/14 and 2016/17 seasons, the number of birds is negatively correlated with both minimum, maximum, and average temperatures. There was also a negative correlation between maximum temperatures and the number of birds in the 2012/13 season *(Table 2)*.

Examining the relationship between the weekly average number of birds and the temperature one week earlier, there was a negative correlation between the maximum temperature data and number of birds in the 2013/14 and 2016/17 seasons, while a negative correlation between minimum and average weekly temperatures was found for 2012/13, 2013/14 and 2016/17 seasons *(Table 3)*.

There was a positive correlation between the number of birds and snow cover in the 2013/14 and 2016/17 seasons *(Table 4)*.

There was no significant relationship between the average monthly mean temperatures in southern Finland and the seasonal peaks in Kevermes ($r = -0.20728$, $p = 0.477$), but in two of the seasons when the seasonal peak was above 1000 specimens (2010/11 and 2012/13) were characterized by extremely low temperature values in the breeding area.

Discussion

Table 5. Average monthly mean temperatures in southern Finland in the months when we recorded seasonal maximum numbers in Kevermes

5. táblázat Az átlagos havi középhőmérsékleti értékek Dél-Finnországban azokban a hónapokban, amikor Kevermesen a szezonális maximum példányszámokat regisztráltuk

Season	Average monthly temperature (S-Finland)	Peak day
2005/06	-2.2	29 Dec.
2006/07	-7.9	10 Feb.
2007/08	2.3	01 Dec.
2008/09	-2.8	23 Jan.
2009/10	-3.6	17 Dec.
2010/11	-7.5	23 Dec.
2011/12	3.3	04 Dec.
2012/13	-1.8	04 Feb.
2013/14	-5.9	23 Jan.
2014/15	0.1	14 Dec.
2015/16	3.3	12 Dec.
2016/17	-1.9	16 Jan.
2017/18	1.8	27 Nov.; 16 Dec.
2018/19	-7.1	24 Feb.

In the case of partial migratory species nesting in northern Europe and Siberia, the breeding success (density) and the autumn-winter weather (amount and availability of food) determines the rate at which the birds remain at the breeding grounds or migrate to the south (Svärdson 1957, Jenni 1987). In case of Fieldfare, a good breeding season followed by poor late summer weather, would lead to large bird populations with a poor northern food supply. Such a case would bring forth years when very large influxes of Fieldfares appear in wintering areas early in the autumn (Milwright 1994). Fieldfare is one of the irruptive species, and while the migration direction is essentially southwest, some populations use different migration directions, routes, and wintering grounds. In addition, usually, even within a winter season, they travel considerable distances in search of food (Csörgő & Gyurácz 2009a). On the other hand, migration of closely related thrushes is much more regulated. The connectivity between nesting and wintering sites is much stronger, but there are also differences between populations. Different subspecies of Song Thrush *T. philomelos* and Common Blackbird *T. merula* exhibit various migratory strategies (resident, partial or obligate migrant) (Lundberg 1985, Csörgő *et al.* 2017a, b, Németh 2017). The general direction of autumn migration of Song Thrush is in a large angle from southwest to southeast, however, the migrants mainly winter in southwest Europe (Milwright 2006), while Common Blackbirds from Fennoscandia, British Isles, Denmark and Germany migrate to south-southwest and there is a clear tendency, that birds from more eastern origin migrate to the south (Ashmole 1962). Hungarian populations of Song Thrushes and Common Blackbirds winter in a relatively limited range in the Central Mediterranean (Csörgő *et al.* 2017a, b, Csörgő & Gyurácz 2009b, c). It seems that the Carpathians are some kind of a barrier for the northern Common Blackbirds and Song Thrushes (Csörgő *et al.* 2017a, b). This results in the migration flyways avoiding the Carpathian Basin. The populations of Redwings *T. iliacus* are obligate or partial migrants and overwinter in a wide area from Iceland to the Black Sea (Huttunen 2004). The migration and winter movement of the species is very similar to that of the Fieldfare: birds do not have strong wintering site fidelity and their movement is determined by the amount of available food (Andreotit *et al.* 2001, Milwright 2002, 2003). Northern populations typically migrate southwest (Milwright 2002, 2003), similar to other thrush species discussed so far. The east-west movements for *Turdus* species seem to be important, also in an evolutionary sense. In a recent study, Nagy *et al.* (2019) found that the most likely ancestral area of genus Turdus located in East Asia, followed by colonization of the western Palearctic, Africa and emerged and repeated trans-Atlantic events. In addition, some species distributed in Siberia, like Naumann's Thrush *T. naumanni* and Black-throated Thrush *T. atrogularis* can be also occur in Western and Central Europe during their westward vagrancy (Hadarics 2014, 2016). The Fieldfare does not breed in the southeastern part of Hungary, however, it is a common migratory and wintering species (Bozó 2017). Breeding in Hungary takes place between April and July, mainly on wet meadows, pastures and floodplains (Haraszthy 2019). There are no extensive pastures, meadows and apple orchards in the area, which are essential foraging sites for the species. Feeding flocks appear every year on the Turai lawn and Tulkán lawn (which are wet lawns) in Lőkösháza, but they only stay there for a short time, presumably due to the lack of suitable resting trees (Bozó 2017). However, the Fenyves Forest and the surrounding forests provide an adequate food supply for the species (oleaster, common hackberry). Birds typically spend the night there, but in mild weather and on snow-free days, during the morning they divide into smaller groups and feed on the surrounding fields. In the absence of ringing-recapture data, it is not known whether these birds come back overnight or move to another area. Both options are likely to occur, as in some cases the number of birds is approximately the same at two morning outings, others are significantly different. In case of cold weather and thick snow cover, birds will not leave the food-rich forest during the day. In addition to the fruits available even with thicker snow cover, the watering places in the area are of great importance. For this purpose, in the case of long-lasting colds below –15 °C, birds use the close gravel pit and the puddles that are broken by traffic. The availability of water is likely to be a very important factor for the movement of birds during the season. In the winter of 2005/06, due to the extremely thick (sometimes 50–60 cm) snow cover, Fieldfares appeared in much larger numbers in the village than usual. At that time, their flocks appeared in the only apple orchard of the village and also in bird feeder sites.

Summarizing the data from the past 16 years, the first birds arrive in the second half of October in autumn, but in one case they arrived in the area at the beginning of the month. Because individuals of northern European populations typically reach the northern areas of Central Europe only by November (Fransson & Hall-Karlsson 2008, Valkama *et al.* 2015), these birds are likely to be members of the Central European breeding population. Following sporadic occurrences in October, migration will intensify in November, which is likely to indicate the arrival of Scandinavian birds. The movement pattern observed thereafter changes from year to year. Although the dates of the seasonal peaks do not coincide with the coldest winter temperatures in the North, two out of the four coldest winters in Finland overlapped with the highest numbers of Fieldfares observed in Kevermes. The data show a peak in mid-December and then a peak in late January/early February, supported by the time distributions of the maximum number of birds observed in the 16 study years.

Significant differences between years can be explained by species-specific invasion patterns and low wintering site fidelity. In the more southern areas, they appear more abundantly when food in the northern areas is scarce and/or inaccessible, e.g. because of a heavy snowfall. This can be especially significant if the breeding success was high in that year. This is true not only for the Fieldfare but also for the closely related species, the Redwing and the Common Blackbird (Snow 1966, Andreotit *et al.* 2001, Milwright 2002, 2003, Bairlein *et al.* 2014), but also in other species with similar migration habits, e.g. Two-barred Crossbill *Loxia leucoptera* (Svärdson (1957) and Brambling *Fringilla montifringilla* (Jenni 1987)).

While Blackbirds are unlikely to perform hard-weather movements in Britain (Snow 1966), some individuals may exhibit weather escape movements in Germany (Bairlein *et al.* 2014) and also in Hungary, where the males show hard-weather escape equalising the sex ratio on lower altitudes (Csörgő & Kiss 1986, Ludvig *et al.* 1991). The Song Thrush (Ashmole 1962) and the Common Blackbird (Ioalè & Benvenuti 1983) are also characterized by strong wintering site fidelity.

Only two invasions occurred during the study period, when the maximum numbers of birds were over 1500 individuals. It shows very well the seasonal variability in the number of wintering individuals, that after the invasion in the season of 2012/13, we observed the least birds in the following season.

Fieldfares have low wintering site fidelity. They are characterized by an escape movement, which occurs when the weather conditions become unfavourable or when food sources are exhausted. In our study, the correlation between the local weather and the number of birds shows that with the decrease in temperature, the number of birds has increased statistically significantly in certain seasons. It was the strongest among the current weekly numbers and the previous week's weather values. Three out of the six seasons showed significant correlation. There was a significant positive correlation between the snow cover and the number of birds in two seasons. All in all, this indicates that the local movement of birds is mainly influenced by the weather of the previous week. It encourages birds to seek new food sources in adverse weather conditions. Because of the thickening of the snow cover, birds cannot feed on the soil. In this case, the role of woody vegetation increases, as the berries and fruits are still available.

The fact that the birds spend 127–188 days in the study site, raises conservation issues. The species is extensively hunted in southern Europe (Spina & Volponi 2009), while in most parts of the continent, due to specific human activities and climate change, the extent of pastures and wetlands is decreasing. As a result, changes may occur in species overwintering in the continental Mediterranean. For example, Németh (2017) found that the Common Blackbird is wintering even more northward. According to ringing-recapture data, the bird bycatch distance has decreased significantly (5.9 km/year) over the years. The migration of Fieldfare is much less regulated than the Common Blackbird's, and it is able to react to changes much easier. It is therefore likely that the Carpathian Basin will become an increasingly important wintering area for the species. Since, like many other bird species, it consumes mainly crops (oleaster, common hackberry) in the winter, their role may also increase. This is especially true in the woodless plains of the Great Plain, where forests consisting of native tree species have been almost completely eliminated (Bozó 2018), so bushes and wooded areas of alien species can be appreciated from a nature conservation point of view.

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Leucistic Woodcock (*Scolopax rusticola* L.) occurrences in Hungary from the second half of the 19th century to the present day

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Abstract Publications about curiosities are known in the Hungarian and international ornithological literature since the 1800s. Although studies explaining the processes of pigmentation dysfunctions have been known since the mid-nineteenth century, these specimens still appear only as curiosities in the professional press and the terminology used to specify them is generally incorrect. The analysed genetic abnormalities causing white colour varieties in Woodcock (albinism, leucism, Ino) are due to mutations. By briefly describing the biological background of the defects, this work helps detect colour changes. In this article, we provide a broad overview of partially or completely white Woodcocks (n = 23 expl.) found in international (8 countries) and Hungarian literature. We have supplemented the literature background with our own studies. The large-scale analysis of the variability of colours and patterns was made possible by the countrywide wing sample collection within the biometric module of Woodcock Monitoring, which has been running under the coordination of the Hungarian Hunting Conservation Association since 2010. Within this framework, 12,078 samples were analysed between 2010–2018. We found that pigment deficiency occurred in the sample set only with a proportion of 0.01%. Based on the Hungarian literature and our own samples, we presented the known occurrences on maps of the state territory with boundaries before and after 1921, indicating the causes of patterns of occurrence by migration and frequencies of occurrence.

Keywords: Woodcock, *Scolopax rusticola*, curiosity, colour change, albinism, leucism, pigmentation

Összefoglalás A magyar és a nemzetközi ornitológiai szakirodalomban már az 1800-as évekből ismertek kuriózumokra vonatkozó közlések. Ugyan a XIX. század közepétől már megjelentek a pigmentációs diszfunkciók folyamataira magyarázatot adó tanulmányok is, ennek ellenére a kuriózumok továbbra is csak mint érdekességek tűnnek fel a szaksajtóban, és e fehér példányok megnevezésére használt terminológia általában hibás. A dolgozatunkban tárgyalt fehér erdei szalonka színváltozatokat eredményező genetikai rendellenességeket (albinizmus, leucizmus, Ino) mutációk okozzák. E színelváltozást okozó defektusok biológiai hátterének rövid ismertetésével e munka segíti a színelváltozások felismerését. Cikkünkben széleskörű áttekintést szerettünk volna adni a nemzetközi (8 ország) és magyar szakirodalomban fellelhető részben vagy teljesen fehér erdei szalonkákra (n = 23 pld) vonatkozóan. A fent említett irodalmi hátteret saját vizsgálatainkkal egészítettük ki. A szín- és mintázatbeli változatosság nagy mintaszámokon alapuló kutatási lehetőségét az Országos Magyar Vadászati Védegylet koordinálásával 2010-től működő Erdei Szalonka Monitoring biometriai vizsgálati modulja országos léptékű szárnyminta-gyűjtési lehetőséggel alapozta meg. Ennek keretében 12 078 példány mintáját vizsgáltuk 2010 és 2018 között. Megállapítottuk, hogy a mintában 0,01%-os részesedéssel fordultak csak elő pigmenthiányos példányok. A hazai szakirodalmi adatok és saját mintáink alapján a Királyi Magyarországra vonatkozóan, valamint a jelenlegi országhatárokon belül térképeken ábrázoltuk az ismert megkerüléseket utalva az előfordulási mintázat vonulási sajátságokban rejlő okaira, valamint a megkerülési gyakoriságokra.

Kulcsszavak: erdei szalonka, *Scolopax rusticola*, kuriózum, színváltozatok, albinizmus, leucizmus, pigmentáció

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Introduction

Birdwatchers and dedicated Woodcock hunters have always been keen on finding special-coloured Woodcock specimens. However, there are only a few historical reports of specimens showing abnormal colour in the Hungarian hunting- and scientific literature, which is no coincidence, since unique coloured specimens of this species occur only very rarely. As with other wild birds, the most common colour mutation in Woodcock is the lack of pigmentation to varying degrees till completely white feathering. The possibility to investigate colour mutations in Woodcock surfaced in 2012 following the occurrence of a specimen with partially missing pigmentation. Research on Woodcock at the Institute of Game Management and Vertebrate Zoology at the University of Sopron has been running for several decades, until 2010, however, it was not possible to study the variety of colours and patterns nationwide, on the basis of a large number of samples. The large-scale analysis of the variability of colours and patterns was made possible by the countrywide wing sample collection within the biometric module of Woodcock Monitoring, which has been running under the coordination of the Hungarian Hunting Protection Association since 2010. The Hungarian and international literature and our own results may provide an explanation for the questions about the rarely occurring pigmentation disturbances in Woodcock. Another goal is to clarify the special terminology, which is often used incorrectly until now.

Material and Methods

Our investigations are based on historical ornithological literature and wing samples (n = 12,078) collected during the Woodcock Monitoring from 2010 onwards. As part of the description of the Woodcock curiosities the following international (8 countries) and national scientific literature were analysed from 1825–2019:

England (UK): Yarrell (1843) (Url. 1), Norfolk Accredited Museum (Url. 4), Rothschild Zoological Museum (Url. 5), Anonymus (1842), Anonymus (1874), Frohawk (1900) (Url. 2).

Germany: Anonymus (1864)

Romania: Anonymus (1890)

India: Anonymus (1897)

France: Goduon (2002), Boidot (2003a, b), Boidot (2004), Boidot (2006), Bruyére (2007), Cauquil (2007), Fulchic (2007), Boidot (2008a, b), Boidot (2009), Boidot (2010), Boidot (2012b), Boidot (2013a, b), Lapasset (2017), Pascal (2019)

Italy: Pennacchini (2013), (Url. 6)

Czech Republic: (Url. 3)

Russia: Anonymus (2015), Anonymus (2018a).

Hungary: Anonymus (1870), Anonymus (1872a, b), Inkey (1873), Anonymus (1878), Dittrich (1878), Madarász (1884), Lakatos (1887), Buda (1900), Lakatos (1904), Anonymus (1906), Donászy (1907), Bodnár (1908), Szilárd (1910), Egervári (1912), Veress (1912) Szakáll (1921), Csík (1924), Karakosevic (1927), Bélaváry (1943), Szakács (1994), Iváncsics (2002), Márok (2004), Szabó (2013), László *et al.* (2013), Bende & László (2017a)

The investigations on pigmentation disorders are based on the countrywide wing sample collection within the biometric module of the Woodcock Monitoring of the Hungarian Hunting Protection Association since 2010. During sampling in spring, one wing of at least 25%, from 2011, 40% of the hunted birds were prepared, cut off at the elbow, opened to 130-160 degrees and sent by the data provider to the research. The samples served primarily to determine the age, but the resulting photographic databases offer an excellent opportunity to study the colour and the pattern based on a large number of elements in Hungary.

Results

The first mention in the literature about a Woodcock in partial white special colour, comes from an unknown author from the year 1870 (Anonymus 1870). Afterwards, in the period before the First World War (until 1921), white-feathered specimens (n = 17) from 11 counties were known hunted in the territory Kingdom of Hungary *(Figure 1)*.

Based on the published curiosities it can be stated that such specimens are known – following the distribution pattern of all killed specimens in the study area (Faragó 2009) – in Transdanubia (Somogy) and in the Central Hungarian region along the Danube (counties: Bács-Bodrog Csongrád, Pest-Pilis-Solt-Kiskun, Fejér and Komárom). In addition, the region of Northern Hungary (counties: Szabolcs, Zemplén, Borsod) was crucial and from

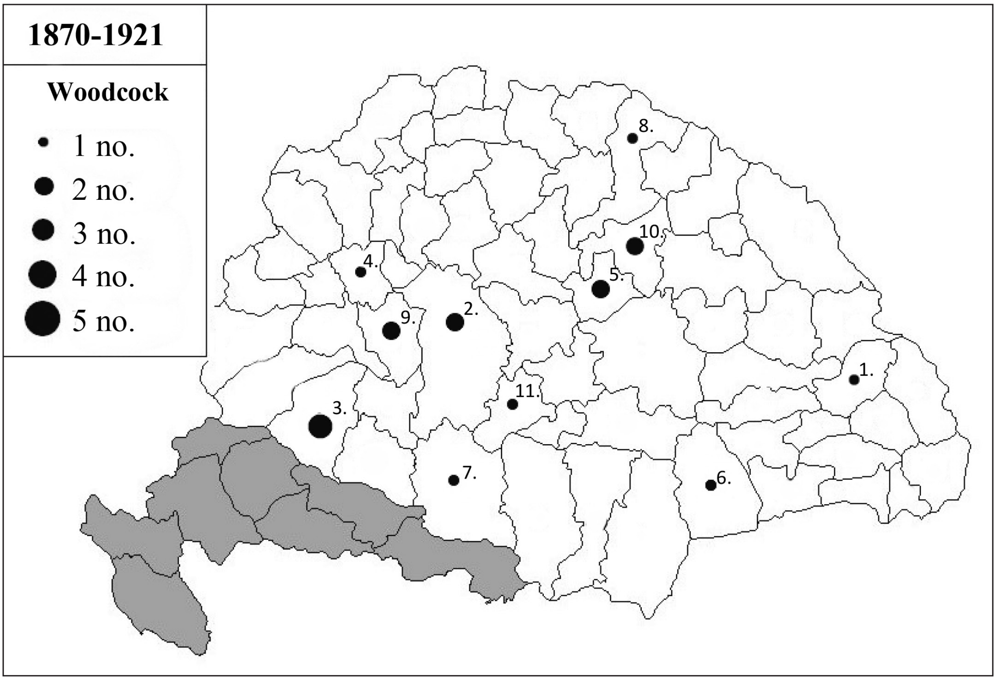

Figure 1. Occurrence of white Woodcocks in the territory Kingdom of Hungary until 1920
1. ábra Fehér szalonkák megkerülése a Királyi Magyarország területén 1920-ig

the eastern counties of Transylvania (Hunyad, Maros-Torda) are also known published data on curiosities.

These records are concentrated in the counties of the Kingdom of Hungary, where according to Faragó (2009) the largest proportion of Woodcock has been shot.

For the period from 1870 to 1921, the following literature data for the unique white-coloured Woodcock are available by County *(Figure 1).*

1. Maros-Torda County: 1870 – Görgényszentimre, Anonymus (1870),

2. Pest-Pilis-Solt-Kiskun County: 1872 – Páty, Anonymus (1872a*)*, 1872 – Budai-Mountain, Anonymus (1872b), 1878 – Royal Estate of Gödöllő, Kis-Baghi forest, Anonymus (1878),

3. Somogy County: 1873 – Somogytarnócza, Inkey (1873), 1906 – The exact location is unknown, Anonymus (1906),

4. Komárom County: 1884 – The exact location is unknown, Madarász (1884),

5. Borsod County: 1897 – The exact location is unknown, Anonymus (1897), 1908 – Révleányvár Bodnár (1908), 1921 – The exact location is unknown, Szakáll (1921),

6. Hunyad County: 1900 – Retyezát, Buda (1900),

7. *Bács-Bodrog* **County:** 1908 – Vajszka, Szilárd (1910),

8. Zemplén County: 1912 – Gálszécs*,* Veress (1912),

9. Fejér County: 1920 – Guttamási, Szabó (2013), 1920 – Lovasberény, Szabó (2013),

10. Szabolcs County: First two decades of the 1900s – Tikos Puszta, Szakáll (1921),

11. Csongrád County: 1921 – Révleányvár, Fridli (1921).

Considering the spatial distribution of the exceptional specimens within our present-day borders after the First World War (since 1921), it is obvious, that the known sites are

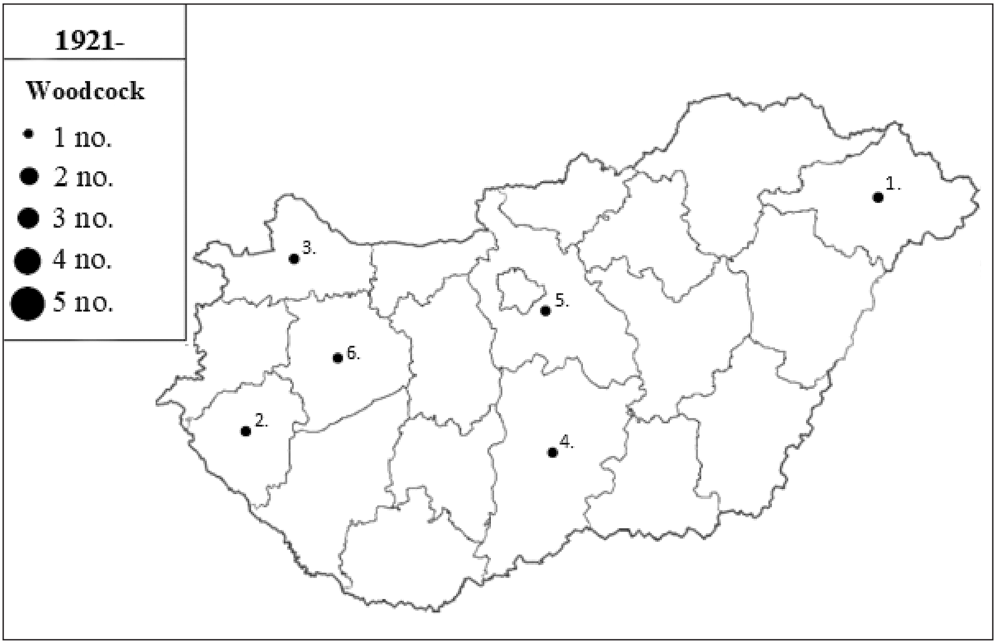

Figure 2. Occurrence of white Woodcocks in the territory of Hungary after 1921
2. ábra Fehér szalonkák megkerülése Magyarország területén 1921. után

concentrated in the counties along the main migration routes. Therefore, they are of crucial importance, similar to the territorial distribution in Kingdom of Hungary *(Figure 2).*

For the period 1921–2019 the following literature data are available for unique white-feathered Woodcock, based on *Figure 2*:

1. **Szabolcs-Szatmár-Bereg County:** 1994 – Tiszakerecseny (Szakács 1994),
2. **Zala County:** 2002 – Csöde, Iváncsics (2002),
3. **Győr-Moson-Sopron County:** 2004 – Himod (Márok 2004),
4. **Bács-Kiskun County:** 2010 – The exact location is unknown (Faragó *et al.* 2013, Bende & László 2014),
5. **Pest County:** 2012 – The exact location is unknown László *et al.* (2013, 2014),
6. **Veszprém County:** 2018 – Noszlop (Bende & László 2019).

As already mentioned, the importance of Transdanubia (Zala, Győr-Moson-Sopron, Veszprém counties) with regard to the location of white specimens remains unchanged, but the Danube-Tisza region (Pest, Bács-Kiskun counties), and the region of northern Hungary (Szabolcs-Szatmár-Bereg County) is also important. There are no data from the counties of the Tiszántúl region because of the low forest cover and consequently small hunting bag.

According to the Woodcock harvest from the period 2010–2014, it is apparent that the curiosity sites – despite the few data of exceptionally brightly coloured specimens – are tied to the three main migration routes representing by the amounts of hunted specimens (Faragó *et al.* 2012a, b, 2014, 2015, 2016).

Discussion

Colour and pattern determining pigments

In Woodcock, the correct designation of the white colour mutations and the various disturbances leading to white feathers is generally difficult, which is why incorrect terminology is often found in ornithological literature. In order to correctly identify these colour mutations, it is important to know the process of normal pigmentation, and which pigments play a role in the development of species-specific colour and pattern of feathers. The so-called classic "wild dominant" colour of Woodcock is determined by two types of melanin eumelanin and pheomelanin. In feathers containing both forms of melanin, eumelanin is primarily located in the middle of the feathers, while pheomelanin at the edges, creating the species-specific pattern. Melanin is produced through a multistage chemical process known as melanogenesis, where the oxidation of the amino acid tyrosine is catalysed by the tyrosinase enzyme. Melanin polymer molecules are oxidized during the process. However, the degree of oxidation can vary, and thus the intensity of the colour produced. Black is the most oxidized form, while brown indicates a weaker oxidation state (Mason 1953, Rawles 1953, Lubnow 1963). Process of pigmentation may be disturbed due to malfunctions in genetic and physiological processes. Any disturbance in the formation of melanin or other pigments, as well as in the transport and incorporation of pigment granules, can potentially affect the bird's colour. Among the above, the most common anomalies in Woodcock are the disruption of melanoblast spreading and the incomplete or completely inhibited uptake of pigments into the feather cells. The uneven spread of the pigment may depend on the partial lack of melanin or on the dysfunction of the cells responsible for pigmentation (Pennacchini 2013). The disruption in the production of the pigmentation enzyme, tyrosinase, may also inhibit the normal process of melanin production and thereby the pigment synthesis. The disruption in the production of the pigmentation enzyme, tyrosinase, may also inhibit the normal process of melanin production and thereby the pigment synthesis. The pheo- and eumelanin-producing melanocytes are formed by melanoblasts that develop in the embryonic spinal cord at an early embryonic stage and then spread to the skin and feather follicles. This process is genetically determined and in case of disruption the spread is hindered. This means that no pigment grains can be added to the feather cells as the feathers grow, because the producing melanoblasts are missing in the feather follicles and certain areas remain unpigmented. The white colour due to a hereditary pigment disorder occurs early and does not change with age. The feather pigmentation can also be inhibited by disorders of melanin synthesis or pigment transport (van Grouw 2013). According to international and Hungarian literature, a pigmentary lack in the most bird species, as well as in Woodcock is most common on the wings, especially on the flight feather (Bende & László 2014, 2017a, b, 2018a, b, 2019). Each part of the body can develop this lesion, which often shows bilateral symmetry. The reason for this is due to the early stages of embryonic development described above, because most often affected by leucism is the plumage of body parts furthermost of the vertebral canal. These processes can lead to lower or fully missing pigmentation in some feathers.

Albinism and leucism

In the Hungarian and international ornithological and hunting literature there are often repots of birds with different pigment deficiencies called "***albino***" (Anonymus 1864, Anonimus 1906, Donászy 1907, Bodnár 1908, Fridli 1921, Szakáll 1921, Iváncsics 2002, Szabó 2013, Anonymus 2018a), or "***partial albino***" (Karakosevic 1927, Rollin 1964, Buckley 1982, 1987, Ogilvie 2001, Márok 2004, Anonymus 2015). We must admit that it is wrong.

From the second half of the 19th century and the beginning of the 20th century, we find some observations on the colour and pattern variation of Woodcock (Lakatos 1887, Donászy 1907, Bodnár 1908, Csík 1927).

These papers usually report on pigment-deficient birds (white, grey, possibly completely white), which often have a faint pattern on their feathers. In addition to the generally white-feathered specimens with few dark patterns, there are also reports of so-called "colourful" Woodcock with spotty lack of pigmentation. However, these names are not explicit and in many cases contradictory. Bodnár (1908) first emphasizes how important it is to understand the physiological factors that cause colour deviations in Woodcock. Fox and Vevers (1960) defined albinism as the complete absence of both melanins not only in the feathers, but in the iris and the skin, due to a congenital tyrosinase deficiency, which is why not only the plumage (white), but also the feet, claws and eyes are pigment-free. Real albino individuals are very rare in wild birds because of the stereo blindness of their pigment-free eyes (van Grouw 2006). Until now, no real albino Woodcock specimen was reported. In the published specimens with white feathers, the eyes, the skin and the unfeathered horny formations were always pigmented, accordingly, these partially pigment-deficient individuals are not albinos in the correct terminology, but leucistic mutations, which means white, with some pigmentation in some places. The common terminology for these "white-varicoloured" birds is "partial albinism", which is by definition not interpretable. Individuals lacking colour to varying degrees are not partial albinos, but so-called leucistic birds (Anonymus 2018b). Leucism is characterized by the presence of the tyrosinase enzyme, so that these birds produce melanin, and the colouring deficiency occurs only in feathers. The developing plumage is partially or completely white, but the eyes are always dark and the beak, legs and claws are also pigmented (van Grouw 2006). The white feathers of leucistic birds are not completely pigment deficient, as there are also Woodcocks known with almost entirely white feathers. On closer examination, however, the plumage is slightly brown or silvery, and the pattern of normal birds is partially or completely recognizable. These specimens are not albinos, as the colouring melanins are present, but their abnormal quality or even lower quantity can lead to an almost completely white feather. The very low concentration and strong dilution of the colouring agents in the plumage result in a very pale whitish colour. This disorder is called "melanin dilution", of which many types are also known in Woodcock (e.g. pastel, Isabella, etc.). In extreme cases, this lesion can also be resulted in an almost white feathering. There are also known mutations in which the amount of melanin remains unchanged, but not in quality, which in extreme cases leads to hardly coloured feathers. This change is known in the literature as "brown mutation". In fact, albinism is much less common than most ornithologists thought. By now it is well known that white discolouration in nature is rarely caused by albinism, but by any kind of leucism or by a non-hereditary reason such as disease, malnutrition (van Grouw 2013).

The Ino mutation

The Ino mutation is a strong qualitative reduction of eumelanin and pheomelanin. This phenomenon is often confused with albinism in bright Ino individuals. The mutation is based on a single gene linked to the sex chromosome in each species (van Grouw 2013). The affected specimens do not develop species-specific colour due to the quantitative reduction and deficient oxidation of eumelanin and pheomelanin, resulting in spectacular colour loss. The oxidation degree of melanin varies, so that black eumelanin can be dark to very light brown, whereas reddish-brown pheomelanin is always very pale or even barely visible. The plumage has a faint pattern, particularly at higher levels of eumelanin, which is typically noticeable in species where the feathers usually contain white parts, like the feathers of Woodcock *(Figure 3).* The mutant Ino bird has reddish eyes, although the iris pigments are not absent, but melanin is in a slightly oxidized state. Due to the available pigment materials, these birds have much better sight than an albino. It is to claim that the red-eyed white birds registered under natural conditions are certainly Inos and not albinos. This recessively inherited mutation occurs only in females (van Grouw 2013). Some publications (Boidot 2003a, 2014) with contradictory statements are known in France about the Ino mutation. Boidot (2003) refers in his article to a very white Woodcock, described as a pastel in a photo published by

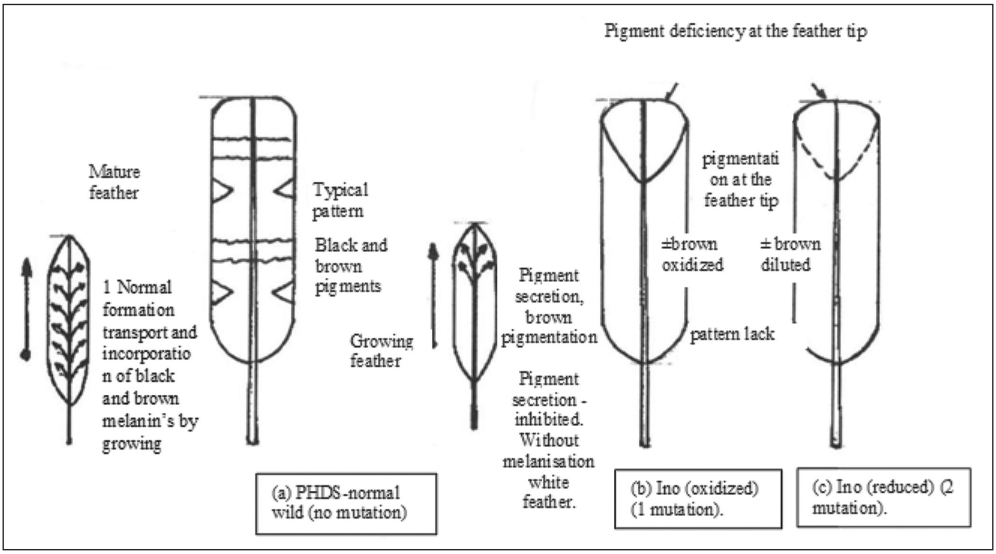

Figure 3. Pigmentation of normal wild dominant and Ino mutant plumage during feather development (following Boidot 2003a)

3. ábra A normál vad domináns és az Ino mutáns tollazat pigmentációja a toll fejlődése során (Boidot 2003a nyomán)

(a): Normal wild dominant plumage (PHDS) („PHDS" = Plumage Habituel el à Dominante Sauvage):
Regular allocation of pigments during feather growth
Both black and brown melanins are present developing colour and pattern characteristical for Woodcock.
Irregular allocation of pigments – Ino mutation:
Inhibited melanisation after beginning of feather growth: black melanin disappears
(b): only slightly oxidized brown eumelanin or **(c):** only diluted brown eumelanin is present (Boidot 2003a)

M. Bernard Laoue. However, according to the author, the plumage of this specimen can be classified as Ino. Boidot (2014) also points to a specimen previously described as an Isabella mutant, where the Ino mutation is considered to be a realistic possibility, but the misdescription of colour in the earlier description cannot be excluded. However, no reliable literature on the occurrence of this mutation in the Woodcock is known. The publications contain photographs of preparations in which the characteristics of the mutation (such as eye colour, limbs, skin pigmentation, etc.) are not clearly identifiable. Another difficulty in describing the mutation is the lack of a sexual dimorphism, which makes it impossible to determine the sex of the Woodcock based on morphological characteristics.

International review

One of the first uniquely coloured specimen reported in **England** in 1825 was published in the ornithological journal "*The Natural History of British Birds*". This colour graphic depicts an almost completely pigment-deficient Woodcock (Url. 1). Both collections of the Norfolk Accredited Museum (Url. 4), and the Rothschild Zoological Museum (Url. 5) exhibit each a leucistic, pure white Woodcock specimen. In the year 1842, the Regélő Pesti Fashion Magazine (Regélő Pesti Divatlap) informs the readers about observing a real curiosity. This specimen had been breeding in the same nest for five years. Finally, the special bird was shot and stuffed (Anonymus 1842). In 1874, a white coloured Woodcock flushed during a driven hunt near Waterford was reported in Hunter and Competition Magazine. The cited Field noted that white-spotted Woodcock is not that rare, but the pure white is a real *„rara avis"* (rare bird, weiße Krähe) (Anonymus 1874). Frederick William Frohawk, a British naturalist, published in 1900 a scientific drawing of a heavily underpigmented specimen entitled "Study of a white Woodcock" (Url. 2).

A curiosity bagged in **Germany** can be read in the Hunter's Magazine of 1864: "*White Woodcock shot near Duisburg this year*," is written to the "Jagdzeitung" from Düsseldorf. Count Spee's hunter killed the special bird on the evening courtship flight (Anonymus 1864). In **Romania**, near Crajova (today Craiova), a completely snow-white Woodcock was shot, and it was taken to the museum in Brasov, is written to a German Hunting Magazine (Anonymus 1890). Some recent literature from **Russia** is also known: An article on albinism reports about a white leucistic curiosity, partially dotted with brown pattern (Anonymus 2018a). On October 15, 2015, a hunter shot a Woodcock with pigment deficiency in the Aleksandrovsky district (Vladimir region). Pigment deficiencies appeared on the right and left wings for some flight feather and coverts (Anonymus 2015).

In the Hunter's Magazine an unknown Hungarian hunter reports on his hunting experiences in **India** in 1897. He was watching his prey of nearly 70 Woodcocks when he noticed the following phenomenon: 5 specimens of the hunting bag were of an abnormal colour. Two of them had white flight feathers and coverts on their wings (Anonymus 1897).

The richest knowledge of the colours of the Woodcock was published in **France**. French experts distinguish three categories based on varying levels of pigment deficiency of Woodcock (Boidot 2012a):

1. category: Less than 10% of the plumage is white.
2. category: 10–50% of the plumage is white.
3. category: More than 50% of the plumage is white.

Pigment deficiency can occur anywhere on the body but the wing feathers are the most affected. Thus, in most publications refer on birds to greater or lesser extent pigment deficient on the wing, but there are also reports of white discoloration varying degrees on different feathers on the body (Goduon 2002, Boidot 2003a, b, 2004, 2006, Bruyére 2007, Cauquil 2007, Fulchic 2007, Boidot 2008a, b, Boidot 2009, 2010, 2013a, b, Lapasset 2017, Pascal 2019).

Photos about some partially white specimens are also known from **Italy** (Pennacchini 2013). Among the reference materials of taxidermist Stefano Panfili (Url. 6) is a photo about a Woodcock with pigment deficiency in the head and neck, while on the body white feathers are only scattered.

In the **Czech Republic**, on October 27, 2011, a young Woodcock with a white flight feather on the left wing was caught at the Červenohorském Sedle. The specialty of this bird is that it is the only known pigment-deficient specimen which was caught by bird ringers and not shot during hunting (Url. 3).

Pigment deficient Woodcocks in the Hungarian hunting literature

From the mid-20th century to the First World War, articles on curiosities appeared relatively frequently in the hunting press, later, such reports are rarely to read. One of the first published reports of a white specimen in Hungary came from an October hunt in 1870 in Görgényszentimre. The special bird was shot by Tivadar Bormenissza (Anonymus 1870). Subsequently, a special coloured bird was shot in the vineyards near Páty. Its breast and mantle were completely white, the plumage pattern ashy-gray instead of brown, only the tail was slightly coloured (Anonymus 1872a). Also, in the Buda Hills in the year 1872, Councillor Schwartzer shot a special-coloured Woodcock that was completely white with the exception of three black tail feathers and some normal coloured breast feathers. According to the description, the bird had yellow, so pigmented beak and legs (Anonymus 1872b). In 1873, Count István Erdődy shot a white Woodcock on the estate of Count Ferenc Széchenyi in Somogytarnóca (Inkey 1873). In March 1878, Joseph Manhalt, a forest keeper in the royal estate of Gödöllő, in the Kis-baghi forest successfully hunted a Woodcock with partially white plumage. According to the description, the body feathers had normal colour, while the wings were completely white except for a flight feather. The special bird was immediately sent to Vienna, to the ornithological collection of Crown Prince Rudolf (Anonymus 1878, Dittrich 1878). A white Woodcock is also known from Komárom County that was shot in 1884. This bird was exhibited in the collection of the Hungarian National Museum together with a whitish pale exemplar of unknown origin (Madarász 1884). In 1897, a hunter named J. Nagy sent a very interesting Woodcock exemplar form County Borsod to Adolf Lendl's workshop in Buda for stuffing. According to the description, the bird was completely white (Anonymus 1897). At the turn of the century, Adam Buda mentions a white Woodcock as a rare curiosity in a report on hunting in Retyezát. This bird was shot by Samuel Mátra during the autumn hunting (Buda 1900). Lakatos (1904) also refers in his book "*The Forest Snipe and its Hunting*" to some abnormally coloured, partially or completely white Woodcock exemplars prepared by Adolf Lendl taxidermist in Buda. Another completely white specimen was reported to being shot in 1906 by Count Tivadar Jankovich on his estate in Somogy County (Anonymus 1906). According to Bodnár (1908), in the collection of 272 exemplars of the Gymnasium in Hódmezővásárhely there was a plenty of ornithological specialties, as well as a multi-coloured Woodcock. Also, in 1908, a white Woodcock was shot by Countess Emilné Széchenyi in the forest near Vajszka, Bács-Bodrog County (Szilárd 1910).

On March 30, 1912, János Novák, a military officer, shot a unique Woodcock in the Kisazari forest near Gálszécs (Zemplén County). The pure white plumage of this bird had only a few dark feathers, and the flight feathers were of an abnormal light brown colour (Veress 1912). This specimen was also taken to the taxidermist Lendl's workshop for stuffing (Egervári 1912). Near Lovasberény and Guttamási, completely white Woodcocks were shot in the 1920s as well (Szabó 2013). In March 1921, a "multi-coloured Woodcock" was shot, which had two white flight feathers on both wings, two white coverts on the left and underpigmented alula on the right (Szakáll 1921). In the same report, Szakáll mentions another unpublished white Woodcock of the collection of the Gymnasium in Hajdúnánás.

On April 8, 1921 a forester Ernő Fridli, informed in the journal Hunting about an "albino Woodcock" with pigment deficiency in the first three flight feathers and the alula of the left wing and in the first flight feather of the right wing. The bird was shot by Count József Majláth (Fridli 1921).

After the First World War, news of unique coloured Woodcocks became rare in the professional journals, except for a few, but interesting records. Milivoj Karakosevic shot a unique specimen on the courtship flight on March 13, 1927. The wingtip and the alulae on both sides were snow-white (Karakosevic 1927). In 1943, a white Woodcock was observed located in the South. The bird was flushed during the autumn wild boar hunt but could not be shot (Bélaváry 1943). Unfortunately, the location of the last two records has remained unknown.

After the Second World War, news of unique coloured Woodcocks are hardly known. The frequency of colour deficiencies may not have decreased, but the reason why publication of appearance these birds was no longer considered important is unknown.

After 1943, the next announcement is from 1994. This year on March 19, Miklós Janisch shot an abnormally coloured Woodcock near Tiszakerecseny (Szabolcs-Szatmár-Bereg County), which had two white primaries and white alulae on both wings (Szakács 1994).

On March 20, 2002, Gyula Radics shot a Woodcock with white primaries in Csöde, Zala County, the partial pigment lack extended also to primary coverts (Iváncsics 2002). On the morning flight in March 2004, a very similar specimen was shot by Zsolt Gombás near Himod (Győr-Moson-Sopron County), with two snow-white primaries and alulae on both wings. The rare prey was taken to taxidermist Kálmán Geiger's workshop in Sopron (Márok 2004). In the 12 078 wing samples received in our institute as part of Woodcock Bag Monitoring, only two partially pigment-deficient curiosities occurred. In 2010, a Woodcock was shot in Bács-Kiskun County, with a single pigment deficient feather: one of the secondary coverts had a white tip and a patternless vane (Faragó *et al.* 2013, Bende & László 2014, 2017a, b, 2018a, b). Among the samples collected in 2012 came from Pest County, there was a specimen with white primaries (László *et al.* 2013, 2014).

In spring 2018, a white Woodcock was shot as part of the sampling monitoring. This ornithological rarity is almost completely pigment-free, pigmented spots were only found on the back, on the tail feathers and partly on their coverts. This immature white Woodcock was shot on March 26, 2018 by Zsolt Marton near Noszlop (Veszprém County) on a reedy, bushy terrain nearby an alder forest. According to the hunter, the bird was flying late, lonely at the end of the courtship flight.

Concluding remarks

Based on the above, it can be concluded that the literature on the colour- and pattern variability of Woodcock is poor in both national and international context, which is not accidental, as birds of extraordinary colour are rare among individuals of this species. The most common discoloration, as in other wild bird species, is the white, so called pigment deficient mutation. In the description of birds with white-varicoloured plumage commonly used terms are "albino, partial albino or showing notes of albinism", but we know, that partially pigment-deficient individuals, so-called leucistic birds are not albinos. Findings regarding the INO mutation in Woodcock are found in French literature, but no reliable occurrence of this mutation is known until now. The size of the hunting bag is not negligible in terms of curiosity occurrence. An overview of the Hungarian statistics on Woodcock hunting bag data available from 1875 to the present shows, that it makes less than 0.1% of the total bag in Europe. In the light of this small amount of data, the occurrence of a unique leucistic Woodcock carries extremely valuable information. The occurrences of these rare birds are focused in areas of the considerable hunting bags, linked to the three major migratory pathways of the species, considered both royal and present-day Hungary.

Over the past 150 years, hunting of about twenty pigment deficient Woodcock has been published by dedicated hunters of the species. The uniqueness of these findings also illustrates that in our own studies as part of the Woodcock Sampling Monitoring, in the wing samples (n = 12,078) examined between 2010 and 2018, only three individuals showed pigment deficiency. Even in the case of the most common pigment anomalies, this is only 0.03% of the Hungarian bag. Even in French or Italian hunting bags, which are much larger than our local sampling possibilities such leucistic specimens are very rare. The appearance of almost entirely white individuals is a really rare event. It would be great, also in Hungary, resurrecting the tradition of reporting about the unique bird occurrences, expanding the ornithological knowledge available on Woodcock.

Request

The knowledge of white colour varieties and the list of curiosities is incomplete, so the authors ask everybody kindly to send any further information on this subject to them.

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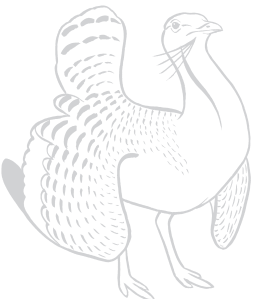

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Cases of occasional interspecific brood parasitism and egg dumping in Hungary

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Abstract There are numerous publications in the ornithological literature on mixed-species broods, i.e. on cases when a species lays some or all of its eggs into the nests of other species. This phenomenon, known as brood parasitism, has not yet been studied in Hungary. Here, I use the term brood parasitism, but I could not separate cases of egg dumping, a reproductive error by females. Based on literature and my own observations, I found evidence for interspecific brood parasitism in 28 species breeding in Hungary, not including the cases of the obligate interspecific brood parasite, the Common Cuckoo *(Cuculus canorus)*. Only one of these belongs to passerines, while in the rest of the cases, this phenomenon occurred in representatives of non-passerine families. However, cases of brood parasitism and nest parasitism have to be treated separately. The latter refers to cases when a species occupies a nest, usually a nesthole or nestbox, already containing eggs of another species, and lays its own eggs next to the foreign eggs. The present study provides data on European Roller *(Coracias garrulus)*, Northern Goshawk *(Accipiter gentilis)*, Common Kestrel *(Falco tinnunculus)*, Red-footed Falcon *(Falco vespertinus)*, Eurasian Hobby *(Falco subbuteo)*, tit species (*Parus, Cyanistes, Poecile* spp.), Eurasian Nuthatch *(Sitta europaea)* and Eurasian Tree Sparrow *(Passer montanus)*, but in all likelihood the number of species involved is much higher.

Keywords: brood parasitism, nest parasitism, egg dumping, abandoned addled egg, non-passerines, passerines

Összefoglalás A madártani szakirodalomban számos tanulmány foglalkozik a fajok közötti összetojás kérdésével, azaz az olyan esetekkel, amikor egy faj tojásainak egy részét vagy mindet másik faj fészkébe rakja. Ezt a költésparazitizmusnak nevezett jelenséget eddig Magyarországon nem vizsgálták. Irodalmi adatok és saját megfigyeléseim során 28 Magyarországon fészkelő faj esetében találtam bizonyítékot költésparazitizmusra vonatkozóan. Ezek közül mindössze egy eset kapcsolódik énekesmadarakhoz, míg a többi esetben más rendekbe tartozó családok képviselőinél fordult elő ez a jelenség. El kell azonban különíteni a költésparazitizmus és a fészekparazitizmus esetét, amikor már tojásos fészket – elsősorban odút vagy költőládát – foglal el egy másik faj, és abba rakja saját tojásait az idegenek mellé. A tanulmányban szalakót**ára**, vörös és kék vércs**ére**, cinegefélékre, csuszkára vonatkozóan közlök adatokat, de minden bizonnyal ezeknek a fajoknak a köre ennél sokkal szélesebb.

Kulcsszavak: költésparazitizmus, fészekparazitizmus, visszamaradt záp tojás, verébalakúak

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Introduction

A number of bird species are known to lay their eggs into the nests of other species so their offspring are raised by foster parents. These species are regarded as classic brood parasites. However, there are also species that lay their eggs into foreign nests only under certain conditions that are rather rare – this is known as facultative brood parasitism. This phenomenon can be either intraspecific or interspecific. It has been revealed in an increasing number of species that they lay some or all of their eggs in the nests of their conspecifics (Yom-Tov 2001, Haraszthy 2019a), and this phenomenon is called intraspecific brood parasitism or conspecific brood parasitism. It has long been known that gallinaceous birds (Galliformes) and ducks (Anseriformes) include species that may lay eggs not only into the nests of conspecifics, but also of other species. Krakauer and Kimball (2009) published data on intraspecific brood parasitism in 11 gallinaceous species, ca. 4% out of 281 species, that laid their eggs into the nests of 29 different bird species. Intraspecific brood parasitism was by far the most frequent in Common Pheasant *(Phasianus colchicus)* whose eggs were found in the nests of 19 other species. These included 6 duck species (Anatidae), 8 gallinaceous species (Phasianidae), 4 rail species (Gallidae) and one species in the snipe family (Scolopacidae) the nestlings of all of which are nidifugous.

Interspecific brood parasitism is significantly more common among nidifugous species than among species whose nestlings are nidicolous (Lyon & Eadie 1991). At the same time, there are cases when a nidifugous species, such as the Common Moorhen *(Gallinula chloropus)* lays its eggs into the nests of a nidicolous species, e.g. Little Bittern *(Ixobrychus minutus)* (Haraszthy 2018) or Yellow Bittern *(Ixobrychus sinensis)* (Ueda 1993, Ueda & Narui 2004).

In breeding colonies, the chance is always higher that the species, nesting there, lay their eggs into the nests of another species. In the USA, Cannell and Harrington (1984) found Black-crowned Night Heron *(Nycticorax nycticorax)* eggs on two occasions in Snowy Egret *(Egretta thula)* nests, and Great Egret *(Ardea alba)* eggs in a Black-crowned Night Heron nest.

In Madagascar, Werding (1970) found Cattle Egret *(Bubulcus ibis)* eggs in Black-crowned Night Heron nests on two occasions. Gonzales-Martin and Ruiz (1996) found Cattle Egret or Little Egret *(Egretta garzetta)* eggs in four Squacco Heron *(Ardeola ralloides)* nests in the Ebro Delta, Spain. (The eggs of the two species cannot usually be safely separated on sight, because both are unifom light blue and largely overlap in size (Haraszthy 2019b)). The same authors also found a certain Little Egret egg in a Squacco Heron nest. Niemczynowicz *et al.* (2015) proved interspecific nest parasitism in five colonially breeding bird species in the Biebrza Valley, Poland. In Northern Lapwing *(Vanellus vanellus)* nests, they found Common Redshank *(Tringa totanus)*, Black-tailed Godwit *(Limosa limosa)*, Black-headed Gull *(Larus ridibundus)* and Common Tern *(Sterna hirundo)* egg or eggs. They observed Northern Lapwing eggs in Common Redshank nests, Northern Lapwing, Common Redshank and Black-headed Gull eggs in Black-tailed Godwit nests, as well as a Common Redshank egg in a Common Tern nest.

In Hungary, although a number of such cases have been published in Hungarian, they are mostly in hardly accessible papers and no comprehensive study has yet been made on incidents of interspecific brood parasitism, excluding the cases of the highly-specialized, obligate brood parasitic Common Cuckoo *(Cuculus canorus)*. Although I could not distinguish between facultative brood parasitism and egg dumping (sensu Krakauer & Kimball 2009), these accicental cases of mixed broods summarised in this study, complemented with my own observations, may facilitate future studies on brood parasitism and egg dumping.

Representatives of non-passerine families

Common Quail *(Coturnix coturnix)*

In Kéménd (today Kamenín, Slovakia), in the year 1900 (undated record) a nest was found while mowing alfalfa *(Medicago sativa)*, which contained 5 Grey Partridge *(Perdix perdix)* and 3 Common Quail *(Coturnix coturnix)* eggs. A Quail was flushed from the nest, but despite this, it was definitely a Grey Partridge nest that had been parasitised by a Quail (Étter 1900). The destroyed egg collection of the Hungarian Natural History Museum contained a Western Marsh-harrier *(Circus aeruginosus)* nest collected at Ürbő on 16 May 1907 with 4 harrier eggs and a Common Quail egg (Fuisz *et al.* 2015).

Common Pheasant *(Phasianus colchicus)*
On 21 May 1970, I found 5 Common Pheasant eggs in a 20-egg Grey Partridge nest in a freshly mown alfalfa field between Budapest and Ecser. András Czwalinga collected a 7-egg Mallard *(Anas platyrhynchos)* nest on 18 June 1971 at Fülöpszállás, which also contained a Common Pheasant egg (Faragó *et al.* 2015). Between 1974–1978, László Molnár checked 20 Gadwall *(Mareca strepera)* nests in the gull colony island of Lake Csaj, and found a Common Pheasant egg among ten Gadwall eggs in one of the nests. He also found a Garganey *(Spatula querquedula)* nest with 8 duck eggs in Pusztaszer on 4 May 1978, and this nest already contained three Common Pheasant eggs on 16 May (Haraszthy 2019b). Rozgonyi (2000) also found 3 Common Pheasant eggs in a five-egg Mallard nest at Karancslapujtő on 24 April 1999. On 3 May 2000, Pál Marik observed a Common Pheasant egg in a 12-egg Northern Shoveler *(Spatula clypeata)* nest in the Tavasz Meadow next to Gyula, and on 9 May, he found another Common Pheasant egg in a 9-egg Northern Shoveler nest in the same area.

Greylag Goose *(Anser anser)*
With Elemér Futó, we found two Greylag Goose eggs next to the four eggs of a Mute Swan *(Cygnus olor)* nest in Kis-Balaton on 5 May 2005 *(Photo 1)*. On 11 April 2018, I found 5 swan eggs and 2 Greylag Goose eggs in a Mute Swan nest in the Csíkvarsai Meadow at Csákvár *(Photo 2)*. On 18 April 2018, Ádám Selmeczi Kovács and I checked a Whooper Swan *(Cygnus cygnus)* nest in the Ipoly Valley, and found a Greylag Goose egg with the 6 swan eggs *(Photo 3)*.

Common Pochard *(Aythya ferina)*
On 15 June 1959, Wolfgang Makatsch found a 9-egg Ferruginous Duck *(Aythya nyroca)* nest at Lake Fehér by Szeged, which also contained 2 Common Pochard eggs (Haraszthy et *al.* 2015b). László Molnár also observed a Common Pochard egg in a 13-egg Ferruginous Duck nest found at Lake Csaj on 4 June 1978 (Haraszthy 2019b).

Tufted Duck *(Aythya fuligula)*
On 24 May 2005, Elemér Futó and I surveyed the duck nests on an island of Kis-Balaton. We found two Gadwall nests that contained Tufted Duck eggs, distributed as follows: 11 Gadwall eggs with 3 Tufted Duck eggs and 9 Gadwall eggs with 5 Tufted Duck eggs *(Photo 4, 5)*.

Ferruginous Duck *(Aythya nyroca)*
László Máté found an 8-egg Common Pochard nest with a Ferruginous Duck egg at Rétszilas on 23 May 1951 (Haraszthy & Viszló 2015). On 4 and 8 June 1978 at Lake Csaj, László

Molnár found two 8-egg Common Pochard nests. Each had a Ferruginous Duck egg in it (Haraszthy 2019b). On 23 May 2004, the 7-egg Common Pochard nest I checked in the Sikota marsh near Dinnyés also contained a Ferruginous Duck egg *(Photo 6)*. Molnár (2000) found a Ferruginous Duck egg in each of five Gadwall nests, in a Common Pochard nest and in a Black-headed Gull nest at Lake Csaj. On 21 May 2015, I photographed 2 Ferruginous Duck eggs next to 4 Mallard eggs in a nest of the latter species at Apaj *(Photo 7)*. On 16 May 2011, I checked the gull colony island at Rétszilas, and found a probable Ferruginous Duck egg in a 2-egg Black-headed Gull clutch *(Photo 8)*. On 16 May 2017, I checked a three-egg Black-headed Gull nest on a tiny island of the Rétszilas Fishponds, and found a Ferruginous Duck egg in it, as well as another nest with two Black-headed Gull eggs and two Ferruginous Duck eggs *(Photo 9, 10)*.

Mallard *(Anas platyrhynchos)*

On 7 May 2018, a 7-egg Red-crested Pochard *(Netta rufina)* nest found in Kis-Balaton also contained two Mallard eggs *(Photo 11)*, and I also found a Mallard egg in a 9-egg Gadwall nest *(Photo 12)*.

Gadwall *(Mareca strepera)*

On 24 May 2005, Elemér Futó and I checked duck nests on an island of Kis-Balaton.
We found two Tufted Duck nests that also contained Gadwall eggs in the following distribution: Tufted Duck 8 / Gadwall 3, Tufted Duck 12 / Gadwall 6 eggs *(Photo 13, 14)*.

Great Crested Grebe *(Podiceps cristatus)*

In 2009, János Perényi photographed a Whiskered Tern clutch in Lake Tisza, which contained two tern eggs and two Great Crested Grebe eggs *(Photo 15)*.

Black-necked Grebe *(Podiceps nigricollis)*

On 16 July 1996, Levente Viszló and I checked the Whiskered Tern/Black-necked Grebe colony established in the Zámolyi Reservoir. In two of the Whiskered Tern nests, there was a Black-necked Grebe egg alongside three tern eggs *(Photo 16, 17)*.

European Turtle Dove *(Streptopelia turtur)*

In summer 1947, during his study carried out in the Gellért Hill, Budapest, Tomasz (1955) found two fresh European Turtle Dove eggs next to the two strongly incubated eggs of Eurasian Collared Doves *(Streptopelia decaocto)* in their nest. He assumed that the Turtle Dove smuggled her eggs into the Collared Dove nest, but he did not exclude the possibility that the Turtle Dove chose to lay her two eggs in an abandoned, two-egg Collared Dove nest. The latter case, however, is nest parasitism rather than brood parasitism, as the Turtle Dove occupied an abandoned nest that still contained eggs.

Spotted Crake *(Porzana porzana)*

The destroyed egg collection of the Hungarian Natural History Museum contained a Black Tern/Spotted Crake clutch, which contained one egg from each species (Fuisz *et al.* 2015).

Common Moorhen (*Gallinula chloropus)*
On 13 May 1962, the 4-egg Little Grebe *(Tachybaptus ruficollis)* nest found by László Ocsovszky at Algyő also contained a Common Moorhen egg (Haraszthy 2015). On 23 May 2004, I found 3 Common Moorhen eggs in an 8-egg Mallard nest in the Sikota marsh at Dinnyés. On 3 June 1962, Jenő Radetzky found a 3-egg Little Bittern clutch with a Common Moorhen egg (Solti 2012). On 10 June 1979, Rékási (1980) found Little Bittern nests under three of the Purple Heron nests in the marsh at Madaras, one of which contained three white Little Bittern eggs and three speckled Common Moorhen eggs. On 29 May 2005, the nest I found in the reedbelt of the Hortobágyi-Fishponds had five Little Bittern eggs and a Common Moorhen egg (Haraszthy 2018).

Eurasian Coot *(Fulica atra)*
On 18 May 2017, I checked 191 Black-headed Gull nests out of approximately 500–600 at Fülöpszállás. One of the two-egg Black-headed Gull nests also contained one Eurasian Coot egg *(Photo 18)*. At the same place, the two-egg Black-headed Gull nest that had also one Eurasian Coot egg when Mihály Nyúl had found it, I saw two gull nestlings and one Eurasian Coot egg.

Black-winged Stilt *(Himantopus himantopus)*
On 5 June 2008, in the breeding colony established on a reef of Lake Fertő at Dinnyés, I observed 3 Black-winged Stilt eggs in a 2-egg Common Tern *(Sterna hirundo)* nest *(Photo 19)*. On 11 May 2015, I checked six Black-headed Gull nests and four Black-winged Stilt nests in the vicinity of Fülöpszállás. In one of the 2-egg Black-headed Gull nests, there was also a Black-winged Stilt eggs *(Photo 20)*.

Little Ringed Plover *(Charadrius dubius)*
On 22 July 2006, a Little Tern *(Sternula albifrons)* incubated one egg of its own and two eggs of a Little Ringed Plover in a „nest” within the Little Tern colony established on a gravel reef of the Dráva River *(Photo 21),* On 5 June 2008, in the breeding colony formed on a reef of Lake Fertő at Dinnyés, there was a Little Ringed Plover egg in one of the two-egg Common Tern nests *(Photo 22)*.

Collared Pratincole *(Glareola pratincola)*
Radetzky (1927) found a two-egg Collared Pratincole nest in Ürbő, which also contained one Kentish Plover egg.

Black-headed Gull *(Larus ridibundus)*
Between 1990 and 1996, Széll & Bakacsi (1996) found 1-3 Black-headed Gull eggs on five occasions in Mediterranean Gull *(Larus melanocephalus)* nests checked in Hungary. On 11 May 2015, I checked six Black-necked Grebe nests at Fülöpszállás. In one of the 4-egg nests, I also found a Black-headed Gull egg *(Photo 23)*.

Mediterranean Gull *(Larus melanocephalus)*
On 6 May 1971, Péter Beretzk also found a Mediterranean Gull egg in a two-egg Black-headed Gull nest (Széll & Bakacsi 1996).

White-winged Tern *(Chlidonias leucopterus)*
In the destroyed egg collection of the Hungarian Natural History Museum, there was a Common Tern/White-winged Tern nest with one egg of each species. The nest had been collected at Lake Velence on 20 May, 1894 (Fuisz *et al.* 2015).

Common Tern *(Sterna hirundo)*
On 5 June 2008, in the breeding colony formed on an island of Lake Fertő at Dinnyés, there was two Common Tern egg in one of the 3-egg Black-winged Stilt nests *(Photo 24)*.

Passerine species

Song Thrush *(Turdus philomelos)*
On 30 June 1987, Novák (1989) found three Song Thrush eggs alongside the four eggs of a Blackbird *(Turdus merula)* in the nest of the latter, in County Veszprém. The Blackbirds raised four nestlings that successfully fledged: one of them was their own and three were Song Thrushes *(Photo 25)*.

Cases of apparent interspecific brood parasitism that in reality were occupations of inhabited nests

In species that breed in nestholes, nestboxes or twig nests, it may occasionally happen that after occupying the nest and laying one or more eggs, they are chased off by another species that in turn starts to breed there. In species that breed in nestholes or nestboxes, the eggs of the former occupants almost always remain in the nest, while in those that breed in twig nests, it happens more rarely that the new owners do not throw out the eggs, and just lay their own next to those of the original occupant. Such clutches often obviously consist of the eggs of two species, nevertheless, they cannot be regarded as classic cases of interspecific brood parasitism, as they are, in fact, the result of nest parasitism.

Hooded Crow *(Corvus cornix)* – **Common Kestrel** *(Falco tinnunculus)*
It has long been known that Common Kestrels have a preference to breed in nests built and finely lined by Hooded Crows. Sometimes, the crow has already laid one or a few eggs by the time the Common Kestrel pair turns up and starts to mob and chase the crows until they desert their nest. In such cases, the Common Kestrels do not always push out the crow eggs, and in nests with a deeper cup they would not even be able to do so, so they simply lay their own eggs next to them. In such nests, the greenish crow eggs with grey pattern can easily be distinguished by anyone from the reddish Kestrel eggs. These, however, are not from brood

parasitism, but from a nest takeover. Such cases occurred in the past and with all certainty happen, even though rarely but regularly, in the present. As Hooded Crows are regularly shot down, it is not known how often this happens in nests that lose their owners due to this reason, but in all likelihood it happens more frequently than the cases that come to light.

In the destroyed egg collection of the Hungarian Natural History Museum, there was a four-egg Common Kestrel clutch collected at Csömör on 4 May 1906, which also contained a Hooded Crow egg (Fuisz *et al.* 2015). The egg collection of Dezső Radetzky in the Hungarian Natural History Museum contains a four-egg Common Kestrel clutch collected by him at Tárnok on 5 May 1928, which also contains a Hooded Crow egg (Haraszthy *et al.* 2015a).

In the last decades, nestboxes have been erected for Common Kestrels throughout Hungary, as well as for Red-footed Falcons *(Falco vespertinus)* in groups large enough for colonial breeding of this latter species. Common Kestrels readily occupy solitary nestboxes as well as boxes erected in smaller groups or colonies. It happens regularly that the Kestrels lay one or more eggs and then a pair of Western Jackdaws pick out their nestbox and harass the Kestrels until they desert it. In such cases the Kestrel eggs remain in the box and the Jackdaws lay their own next to them *(Photo 26)*. If in the vicinity, sometimes just a few metres away, there is an empty box, the Kestrels often occupy that, otherwise they make another breeding attempt further away. However, the reverse may also happen, when Kestrels take over the nestbox from Jackdaws. In both cases, despite appearances, it is a takeover of the nestbox and not brood parasitism.

Long-eared Owl *(Asio otus)* – **Red-footed Falcon** *(Falco vespertinus)*

Since Red-footed Falcons start breeding rather late, instead of corvids they compete with Long-eared Owls for a good nest or nestbox. On 15 June 1988, Red-footed Falcons were breeding in a nest built by Hooded Crows on a tree by the Kösely canal near Nagyiván in the Hortobágy. The Red-footed Falcons were incubating their own 3 eggs and one Long-eared Owl egg *(Photo 27)*.

Long-eared Owl *(Asio otus)* – **Common Kestrel** *(Falco tinnunculus)*

The nestboxes erected for Common Kestrels and Red-footed Falcons are regularly occupied by Long-eared Owls, too. Sometimes, the falcons chase the owls off when the latter already have eggs or even a complete clutch and then the falcons use the box for breeding. Zsíros (2015) observed the occupation of a nestbox with a complete, three-egg clutch of Long-eared Owls by Common Kestrels. The Kestrels laid six eggs next to the owl eggs. Again, this case was not brood parasitism, but nest(hole) parasitism *(Photo 28)*.

Common Kestrel *(Falco tinnunculus)* – **Eurasian Hobby** *(Falco subbuteo)*

The Eurasian Hobby is a late breeder, and often tries to occupy already inhabited nests. It is probably successful in the large majority of cases. In 2015, a pair of Common Kestrels occupied a nestbox erected on a transmission tower near Monor. The female had already laid her first egg, when a pair of Eurasian Hobbies turned up and chased away the Kestrels in three days. They raised two nestlings from their three eggs, but the Kestrel egg had addled.

In 2016, a Saker Falcon laid an infertile egg in the same box and later abandoned it. Afterwards, Common Kestrels occupied the nestbox and the female laid three eggs, but once again, the Hobbies chased away the Kestrels (Schwartz 2019).

Common Buzzard *(Buteo buteo)* – **Northern Goshawk** *(Accipiter gentilis)*

In the Eastern Mecsek Hills on 21 April 1950, Szilárd Cseresnyés collected a clutch consisting of one egg each of Northern Goshawk and Common Buzzard (Faragó *et al.* 2015). In this case, it is not possible to determine whether the Goshawk occupied a one-egg Buzzard nest and began to lay her own eggs in it, or perhaps the Buzzard smuggled an egg into the Goshawk nest. Considering the balance of forces between the two raptors, the first version is more likely.

Eurasian Scops Owl *(Otus scops)* – **European Roller** *(Coracias garrulus)*

Nowadays, nearly 3000 nestboxes support the establishment of pairs and the successful breeding of European Rollers in Hungary (Kiss & Tokody 2017). These nestboxes, however, are suitable for other species, too, moreover, Rollers start breeding rather late, and this favourable opportunity is often exploited by Common Starlings *(Sturnus vulgaris)* and Eurasian Scops Owls. On several occasions, the Scops Owls had already laid 2-3 eggs in the box, which was at that stage occupied by Rollers and the female Roller laid her eggs, too. Rollers do not throw out Scops Owl eggs from the nestbox, but incubate them along with their own. When the eggs hatch, they cannot feed the owl chicks, which consequently die *(Photo 29)*. One occasion is also known when an abandoned Roller nest with two eggs was occupied by Eurasian Scops Owls (Haraszthy 2019b).

Common Starling *(Sturnus vulgaris),* **Eurasian Tree Sparrow** *(Passer montanus)* – **European Roller** *(Coracias garulus)*

Common Starlings and Eurasian Tree Sparrows regularly nest in Roller boxes. Although Rollers return late from their wintering grounds, these species may still be breeding then. The Rollers regularly chase away the smaller birds, throw out their nestlings and start breeding in the nestbox thus occupied. Such cases, however, are considered as nest(hole) parasitism. In 2014, a pair of Little Owls *(Athene noctua)* bred in a Roller box near Apaj. When the nestlings fledged, Starlings occupied the box, but they got thrown out by Rollers that subsequently bred there successfully (Szász 2017).

Great Tit *(Parus major)* – **Eurasian Blue Tit** *(Cyanistes caeruleus)* – **Marsh Tit** *(Poecile palustris)*

Among tits that breed in nestboxes, both genuine brood parasitism and nest(hole) parasitism may occur. In a given case, the true situation can only be unambiguously determined if the box is checked and changes in the number of eggs is recorded on a daily basis. If the number of eggs of both species grows every day, either simultaneously or with a slight time lapse, then it is clearly a case of brood parasitism. But if a mixed brood is found only in the nestling stage, there is no opportunity to determine if brood parasitism or nest(hole) parasitism has taken place.

In Hungarian nestbox schemes, Great Tits and Blue Tits have been observed several times to lay their eggs in the same box. Normally, the nestlings of both species fledge from these mixed broods, which means the adults raise the nestlings of the other species, too. In the Kamaraerdő, Budapest, on 23 May 1993, a nestbox held six Blue Tit and six Great Tit nestlings about to fledge, which were all fed by Blue Tits (Éles 1993). On 7 May 2015, Andrési (2016) found 8 Great Tit and 10 Blue Tit eggs in a nestbox at Ásotthalom; all Great Tits and one Blue Tit fledged later successfully, raised by Great Tits. Sándor Rozgonyi found a „shared" nest of Blue Tits and Great Tits with 18 eggs at Karancslapujtő on 25 April 2000, and 4 days later there were already 22 eggs in the nest. On 15 May, the nest contained 12 Great Tit nestlings with sheathed feathers, and after their fledging, he found eight Blue Tit eggs sunk in the nesting material. In this case, too, the likely solution is that the eight, and for some reason infertile, Blue Tit eggs were abandoned and the Great Tit laid her clutch on them. János Dénes found a Great Tit nestling alongside a clutch of six Blue Tit eggs in the Börzsöny Hills on 11 May 2009. All nestlings fledged successfully.

At Hidegkút, Tóth-Almási (2007) observed Marsh Tits attending a nestbox, but the birds disappeared after egg-laying. Then the box was occupied by Blue Tits, the female laid her eggs, incubated, and the pair raised the nestlings successfully, among which there were five Marsh Tit nestlings along with their own six offspring *(Photo 30)*. This case was unambiguously nest(hole) parasitism.

Great Tit *(Parus major)* – **Eurasian Nuthatch** *(Sitta europaea)*
On 24 April 2017, I checked a Nuthatch nest in the Börzsöny Hills, which contained 4 Great Tit and 5 Nuthatch eggs. Green moss was visible in the nest base, which is typical of Great Tits. Presumably, the Nuthatches took the hole from the Great Tits, or perhaps the Tits deserted it. The Nuthatches constructed their typical nest of bark pieces and began to lay their own eggs. Again, this was not a case of brood parasitism, but of nest(hole) parasitism *(Photo 31)*.

Eurasian Tree Sparrow *(Passer montanus)* – **Great Tit** *(Parus major)*
In 2018, Eurasian Tree Sparrows bred in a log nestbox in Nagyhódos. One addled egg remained in the nest after the nestlings fledged. The box was occupied by Great Tits for the second breeding. They constructed their own nest and laid their eggs, while the addled Tree Sparrow egg still remained there and was continuously incubated by the Great Tits. Once again, this case of a remnant egg from the previous breeding of a different species is not brood parasitism, even though it may seem so at first sight on the basis of the clutch shown in the photograph *(Photo 32)*.

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Photo 1. Four Mute Swan eggs with two Greylag (*) eggs
1. fotó Bütyköshattyú-tojások mellé rakott két nyárilúd-tojás

Photo 2. Five Mute Swan eggs with two Greylag (*) eggs
2. fotó Bütyköshattyú-tojások mellé rakott két nyárilúd-tojás

Photo 3. Six Whooper Swan eggs with one Greylag (*) egg
3. fotó Énekeshattyú-tojások mellé rakott nyárilúd-tojás

Photo 4. 11 Gadwall eggs with tree Tufted Duck (*) eggs
4. fotó Kendermagosréce-fészekbe rakott három kontyosréce-tojás

Photo 5. Nine Gadwall eggs with five Tufted Duck (*) eggs
5. fotó Kendermagosréce-fészekbe rakott öt kontyosréce-tojás

Photo 6. Seven Common Pochard eggs with one Ferruginous Duck (*) egg
6. fotó Barátréce-fészekbe rakott cigányréce-tojás

Photo 7. Four Mallard eggs with two Ferruginous Duck (*) eggs
7. fotó Tőkésréce-fészekbe rakott két cigányréce-tojás

Photo 8. Two Black-headed Gull eggs with one Ferruginous Duck (*) egg
8. fotó Dankasirály-fészekbe rakott cigányréce-tojás

Photo 9. Tree Black-headed Gull eggs with one Ferruginous Duck (*) egg
9. fotó Dankasirály-fészekbe rakott cigányréce-tojás

Photo 10. Two Black-headed Gull eggs with two Ferruginous Duck (*) eggs
10. fotó Dankasirály-fészekbe rakott két cigányréce-tojás

Photo 11. Seven Red-crested Pochard eggs with two Mallard (*) eggs
11. fotó Üstökösréce-fészekbe rakott két tőkésréce-tojás

Photo 12. Nine Gadwall eggs with one Mallard (*) egg
12. fotó Kendermagosréce-fészekbe rakott tőkésréce-tojás

Photo 13. Eight Tufted Duck eggs with tree Gadwall (3) eggs
13. fotó Kontyosréce-fészekbe rakott három kendermagosréce-tojás

Photo 14. 12 Tufted Duck eggs with six Gadwall (*) eggs
14. fotó Kontyosréce-fészekbe rakott hat kendermagosréce-tojás

Photo 15. Two Whiskered Tern eggs with two Great Crested Grebe (*) eggs (Photo: János Perényi)
15. fotó Fattyúszerkő-fészekbe rakott két búbosvöcsök-tojás (Fotó: Perényi János)

Photo 16. Tree Whiskered Tern eggs with one Black-necked Grebe (*) egg
16. fotó Fattyúszerkő-fészekbe rakott feketenyakúvöcsök-tojás

Photo 17. Tree Whiskered Tern eggs with one Black-necked Grebe (*) egg
17. fotó Fattyúszerkő-fészekbe rakott feketenyakúvöcsök-tojás

Photo 18. Two Black-headed Gull eggs with one Eurasian Coot (*) egg
18. fotó Dankasirály-fészekbe rakott szárcsatojás

Photo 19. Two Common Tern eggs with tree Black-winged Stilt (*) eggs
19. fotó Küszvágócsér-fészekbe rakott három gólyatöcs-tojás

Photo 20. Two Black-headed Gull eggs with one Black-winged Stilt (*) egg
20. fotó Dankasirály-fészekbe rakott gólyatöcs-tojás

Photo 21. One Little Tern egg with two Little Ringed Plover (*) eggs
21. fotó Kiscsér-tojás mellé rakott két kislile-tojás

Photo 22. Two Common Tern eggs with one Little Ringed Plover (*) egg
22. fotó Küszvágócsér-fészekbe rakott kislile-tojás

Photo 23. Four Black-necked Grebe eggs with one Black-headed Gull (*) egg
23. fotó Feketenyakúvöcsök-fészekbe rakott dankasirály-tojás

Photo 24. Tree Black-winged Stilt eggs with two Common Tern (*) eggs
24. fotó Gólyatöcs-fészekbe rakott két küszvágócsér-tojás

Photo 25. Four Blackbirds eggs with tree Song Thrush (*) eggs (Photo: László Novák)
25. fotó Feketerigó fészekbe rakott három énekesrigó-tojás (Fotó: Novák László)

Photo 26. Five Western Jackdaw eggs with one Common Kestrel (*) egg
26. fotó Vörös vércsétől elfoglalt odúba rakott csóka fészekalj

Photo 27. Tree Red-footed Falcon eggs with one Long-eared Owl (*) egg
27. fotó Kék vércse által foglalt fészekbe rakott erdeifülesbagoly-tojás

Photo 28. Six Common Kestrel eggs with tree Long-eared Owl (*) eggs (Photo: Sándor Zsíros)
28. fotó Vörös vércse által foglal költőládába rakott három erdeifülesbagoly-tojás (Fotó: Zsíros Sándor)

Photo 29. Tree European Roller chicks with one Eurasian Scops Owl (*) chick (Photo: Tamás Kiss)
29. fotó Szalakóták elfoglalták a füleskuvik által lakott odút és az abban lévő tojást is kikeltették a sajátjaikkal együtt (Fotó: Kiss Tamás)

Photo 30. Six Blue Tits nestlings with five Marsh Tit chick in one nest box (Photo: Péter Tóth-Almási)
30. fotó Kékcinege-odúba rakott barátcinege tojásokat is kikeltették a kékcinege-szülők és felnevelték valamennyi fiókát (Fotó: Tóth-Almási Péter)

Photo 31. Five Nuthatch eggs with four Great Tit (*) eggs
31. fotó Csuszka-fészekbe rakott négy széncinege-tojás

Photo 32. Six Great Tit eggs with one Eurasian Tree Sparrows (*) egg
32. fotó Mezeiveréb-költésből visszamaradt záp tojást a széncinegék nem távolították el, hanem mellé rakták saját tojásaikat

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Evolution of Galliformes and their presence in the Carpathian Basin

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Abstract Due to the number of specimen, their size and weaker flight capabilities they are one of the favorite preys of furred and feathered carnivores. Due to this factor quite a number of skeletal fragments remained and fossilized over millions of years, especially in caves. Their presence in Europe can be traced back to the Eocene, but the majority of finds come from the Neogene and the Quaternary. In the Carpathian Basin they are known since the beginning of the Neogene. The text is complemented with the bibliography concerning the fossilized material, one figure and six table.

Keywords: Europe, Carpathian Basin, evolution, Galliformes, grouses

Összefoglalás Egyedszámuk, méretük, életmódjuk, és gyengébb repülési képességük következtében kedvenc prédaállataik a tollas és szőrmés ragadozóknak. Az előbbieknek köszönhetően így elég sok vázrészük fennmaradt és fosszilizálódhatott az évmilliók folyamán, főleg a barlangi lelőhelyeken. Európai jelenlétüket már az eocéntól követni lehet, de a leletek többsége a neogénből és a kvarterből származik. A Kárpát-medencéből a neogén elejétől ismertek. A szöveget kiegészíti a fosszilis anyagot felölelő irodalomjegyzék, egy ábra és hat táblázat.

Kulcsszavak: Európa, Kárpát-medence, evolúció, tyúkfélék, fajdok

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Introduction

Their dimensions vary (sexual dimorphism is a usual characteristic), they are herbivores or omnivores. Apart from quails they are relatively poor fliers, thus they are non-migratory birds. They usually form harem, species living in pairs are uncommon. They nest on the ground, their nestlings are precocial. Two families live in Europe: Phasianidae and Tetraonidae.

Pheasants, chickens, partridges, and quails live in Eurasia and Africa, mostly in grassy, bushy areas, and nest on the ground. Fossil remains also mostly come from sites in Europe. Their earliest representatives are *Paraortyx lorteti, P. brancoi, Pirortyx major*, from the Eocene and Oligocene of France, *Palaeortyx* species from the Miocene of France, Czech Republik and Hungary (Mátraszőlős, Rudabánya, Sümeg, Tardosbánya), *Plioperdix hungaricus* from the Miocene of Hungary (Rátka), *Miogallus* species *(M. altus, M. medius)* from the Miocene of France, Germany, Hungary and Spain, *Alectoris* species *(A. bavarica, A. prisca, A. edwardsi, A. donnezani)* from the Miocene of Germany and France, as well as *Francolinus capeki* and *Gallus beremendensis* from the early Pleistocene of Romania and Hungary. Peacocks today live in Southern Asia (one species lives in Africa), but their extinct species come from Europe. From the Miocene of Greece, Hungary, Moldavia and Ukraine

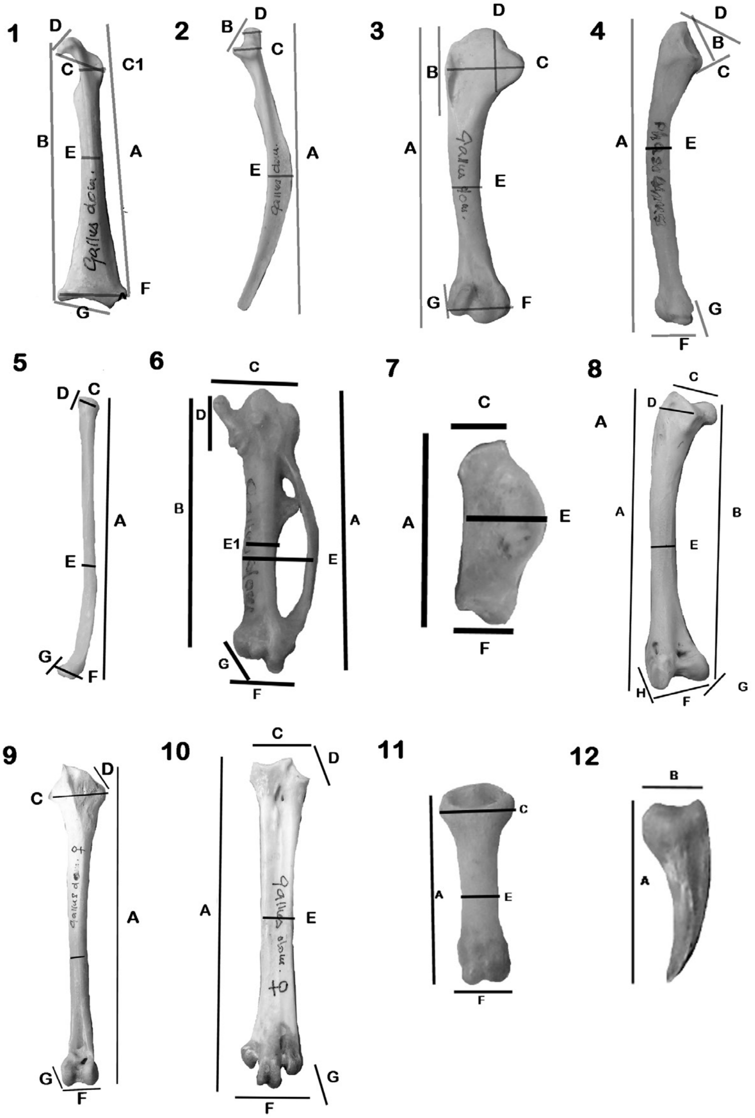

Figure 1. *Gallus gallus domesticus* L. 1758: 1. *coracoideum,* 2. *scapula*, 3. *humerus,* 4. *ulna*, 5. *radius,* 6. carpometacarpus, 7. *phalanga alae* 1 *digiti* II., 8. *femur,* 9. *tibiotarsus,* 10. *tarsometatarsus,* 11. *phal. pedis,* 12. *phal. unguis,* A – total lenghts, B – partial lengths, C – width of *proximal epiphysis,* C1 – partial width of *proximal epiphysis,* D – thickness of *proximal epiphysis,* E – width of *diaphysis,* E1 – partial width of *diaphysis,* F – width of *distal epiphysis,* G – thickness of *distal epiphysis,* H – hight of *distal epiphysis*

1. ábra *Gallus gallus domesticus* L. 1758: 1. hollócsőrcsont, 2. lapocka, 3. felkarcsont, 4. singcsont, 5. orsócsont, 6. kézközépcsont, 7. kézujjperc, 8. combcsont, 9. lábszárcsont, 10. csüd, 11. lábujjperc, 12. karomcsont, A – teljes hossz, B – részleges hossz, C – proximális epifizis szélesség, C1 – részleges proximális epifizis szélesség, D – proximális epifizis vastagság, E – diafizis szélesség, E1 – részleges diafizis szélesség, F – disztális epifizis széleség, G – disztális epifizis vastagság, H – disztális epifizis magasság

Pavo archiaci, from the Pliocene of Ukraine, Hungary, France and Bulgaria *P. bravardi* are known. Turkeys in the meantime inhabit Central America, with a medium-large stature. The earliest finds are from the Miocene of the USA *(Rhegminornis calobates, R. kimballensis*). Recent species are known since the Quaternary.

Tetraonidae inhabit Eurasia, they eat sprouts and seeds, and possess a weak flight capability. They nest on the ground. Their fossil remains are only known since the end of the Neogene. Such are *Tetrao rhodopensis* from the Pliocene of Bulgaria, *Tetrao partium, T. praeurogallus* from the Pliocene and early Pleistocene of Hungary, Bulgaria and Romania, as well as *Tetrastes praebonasia* from the early Pleistocene of Hungary. Extinct species of grouses lived in the Carpathian Basin and the Balkan at the end of the Neogene and from the beginning of the Quaternary. Fossilized finds of ptarmigans *(Lagopus)* come from recent species. Recent species are known since the Quaternary.

A particularly special find from the Eocene of the outer perimeter of the Carpathian Basin is the almost complete imprint of a Leipoa (Megapodiidae Swinson, 1837), which unfortunately had not been described and publicated. Similar European finds are only known from the Paleogene of France (Quercy, Rosiéres, Saint-Gérand-Puy; (*Quercymegapodius depereti* and *Q. brodkorbi* Mourer-Chauviré, 1992; *Ameripodius alexis* Mourer-Chauviré, 2000).

Their classification is made easier due to the fact that the shape of their coracoid bone cannot be mistaken as that of any other birds order.

Abbreviations: Q1-Q2 – Lower Pleistocene; **Q3 (Q3/I-Q3/II)** – Middle Pleistocene; **Q4/I** – Upper Pleistocene; **Q4/II** – Holocene; † – extinct/fossil species – subspecies.

A – total lengths; B – partial lengths; C – width of proximal epiphysis; C1 – partial width of proximal epiphysis; D – thickness of proximal epiphysis; E – width of diaphysis; E1 – partial width of diaphysis; F – width of distal epiphysis; G – thickness of distal epiphysis; H – hight of distal epiphysis. R-2: Rudabánya locality 2. See *Figure 1* with measurement method.

Taxonomy

Ord. Galliformes (Temminck), 1820

Fam. Phasianidae Vigors, 1825

Galliformes possess typical characteristics of the order. They appear quite frequently in layers of sites – and often in large numbers – already from the Eocene. Consequently numerous fossilized taxa were described in Europe in the last one and a half century. Most of their skeletal fragments can be quite easily identified and distinguished from remains of members of other orders, but due to significant homologization it is much more difficult to tell the difference between genera and species, especially with specimen of smaller and Middle posture; due to this their taxonomical classification is often highly debated.

Quail *(Coturnix coturnix)* is one of the typical recent smaller types. Forms on this scale and more or less shared morphological characteristics are known under a number of genera and species from the Neozoic of Europe: † *Palaeortyx* Milne-Edwards 1869, † *Taoperdix* Milne-Edwards, 1869, † *Plioperdix* Kretzoi, 1955, † *Palaeocryptonix* Depéret, 1792 and

Coturnix Bonnaterre, 1791 modern genera. Mlikovskỳ (2002) classifies all of the extinct genera to the recent one naming morphological similarity as the reason, unifying most of the species as well, only leaving two extinct taxa on the species level: *Coturnix gallica*, and *C. longipes*. Ursula Göhlich and Cecile Mourer-Chauviré (2005) showed, that the above species listed under a common name can clearly be distinguished based on morphological characteristics, and they stand by the original names. Since we share their opinion, we will present the identified material of the Carpathian Basin in accordance with it.

A similar case applies in Middle-sized (partridge-rock partridge-francolin size) examples. Here Mlikovskỳ classifies almost all described fossil genera under *Alectoris*: *Palaeoperdix* Milne-Edwards, 1869), *Lambrechtia* Jánossy, 1974, as well as larger examples of previously listed genera *(Plioperdix, Palaeocryptonix)* and fossil species of the recent *Francolinus*. He divides them into three other fossil species: outside of the species already belonging to this genus (*Alectoris bavarica* Ballmann, 1969 from the early Miocene of Germany, MN 3; *A. prisca* (Milne-Edwards, 1869), *A. edwardsi* (Depéret, 1887) and *A. donnezani* (Depéret, 1892). He classifies every Middle-sized fossil galliform into the latter genus. As for fossil partridge species (*Perdix palaeoperdix* Mourer-Chauviré 1975, *Perdix jurcsáki* Kretzoi 1962, *Perdix perdix jurcsáki* Jánossy, 1976), he places them under the recent *Perdix perdix*

Perusing a significant amount of this material we cannot share the viewpoint of Mlikovskỳ, since partridge, francolin and rock partridge species can easily be distinguished based on their morphological characteristics in their fossil and recent forms as well. Characteristics of the humerus of rock partridges and francolins for example differ greatly from that of partridges and small-middle sized Galliformes (*Gallus* species). Since this is a group quite clinging to their habitat rather than migrating, populations with different characteristics and due to them the formation of different forms, the emergence of endemic forms, is a natural process.

In case of larger Galliformes (chickens, pheasants) Mlikovskỳ keeps the genus *Miogallus* created by Lambrecht (1933), and classifies all others into it *(Gallus, Phasianus, Miophasianus)*, as well as larger species belonging to Middle-sized genera (*Palaeortyx maxima* (Lydekker, 1893), *Palaeoperdix medius* (Cheneval, 2000)). Of this category in the Carpathian Basin only material from Rudabánya and Devínska Nová Ves, Slovakia is known, as *Miophasianus* cf. *medius* (Jánossy, 1993), and *Miophasianus altus* (Švec, 1986). There was no great change in the classification of peacocks in terms of originally described fossil species, here he only classifies *Gallus (Pavo) aesculapi* into species *Pavo archiaci*, and he puts *P. bravardi* (Gervais, 1849) in place of *Gallus bravardi.*

Lately Nichita Zelenkov (2016) has revideated numerous pieces of the material, among them are those from the Carpathian Basin.

– † ***Palaeortyx brevipes* Milne-Edwards, 1869** / syn. † *Palaeoperdix* (Milne-Edwards, 1871) / † *Palaeortyx grivensis* Lydekker, 1893 / *Coturnix* † *gallica* (Mlikovskỳ, 2002).

Site and era: Rudabánya, Upper Miocene (MN 9) (Kessler 2009b); Sümeg, Upper Miocene (MN 11-12); Tardosbánya, Upper Miocene (MN 12) (Jánossy 1976b); Polgárdi, Upper Miocene (MN 13) (Kessler 2009b); Osztramos 1, Lower Pliocene (MN 15) (Jánossy 1972, Kessler 2009b); Csarnóta 2, Lower Pliocene (MN 15) (Kessler 2009b) (all in Hungary). From sites in Europe outside the Carpathian Basin: MP 16-28: France; MN 2-12: Czech

Republik, France, Germany, Spain **Q1-2:** Poland; **Q3:** Czech Republik, Germany, Poland (Tyrberg 1998, Mlíkovský 2002).

Material: cranial fragments of *coracoideum*, *humerus* distal epiphysis, *scapula* fragment (Rudabánya); *metacarpus* fragment (Sümeg), *tibiotarsus* (n = 2), (Csarnóta).

Dimensions: *coracoideum* E = 2.5 mm; *scapula* C = 3.02 mm, E = 2.05 mm, *humerus*: A = app. 37.0 mm, E = 2.71–3.62 mm, F = 5.68–7.61 mm, *tibiotarsus*: F = 5.56–6.16 mm, G = 4.86–5.79 mm, *tarsometatarsus*: C = 4.36–4.96 mm, E = 2.36–2.69 mm, F = 5.66 mm.

Somewhat larger material in size than the recent quail, but identical to it in characteristics, which can be easily distinguished from *Palaeocryptonix* species.

Typical site of the species ranges from Grive-Saint-Alban (Upper Miocene, MN 8) to Măluşten, Eastern Romania (MN 15) through the Carpathian Basin.

– † *Palaeortyx gallica* Milne-Edwards, 1869 / syn. *P. intermedia* Ballmann, 1969 / *Coturnix † gallica* (Mlikovskỳ 2002).

Site and era: Grund, Lower Miocene (MN 5) (Austria), (Göhlich 2003); Litke 2, Lower Miocene (MN 5) (Kessler & Hír 2012); Mátraszőlős 1, Middle Miocene (MN 6-8) (Kessler 2009b); Rudabánya, Upper Miocene (MN 9) (Kessler 2009b); Polgárdi, Upper Miocene (MN 13) (Kessler 2009b) (all in Hungary); Kőalja 2 Middle Miocene (MN 6) (Kessler & Venczel 2009), (Romania). From sites in Europe outside the Carpathian Basin: MP 16-28: France; MN 2-12: Czech Republik, France, Germany, Spain **Q1-2:** Poland; **Q3:** Czech Republik, Germany, Poland (Tyrberg 1998, Mlíkovský 2002).

Material: *humerus*, distal fragment (Litke 2); *coracoideum*, cranial fragment (Kőalja 2); *tibiotarsus* distal fragment and distant *phalanx* (Mátraszőlős 1); *coracoideum* fragments (n=3), (Rudabánya), *ulna*, *tibiotarsus*, *femur, tarsometatarsus* fragments (n=3), (Polgárdi).

Dimensions: *coracoideum* C = 3.35–3.64 mm, D = 5.65 mm; E = 2.57–2.75 mm; *humerus*: F = 8.13 mm; G = 3.96 mm; *ulna*: B = 5.27 mm, C = 4.47 mm, E = 2.66 mm; *femur*: E = 3.21 mm, F = 7.06 mm, G = 5.67 mm; *tibiotarsus* E = 2.92 mm, F = 5.31 mm, G=4.82 mm.

Somewhat larger in size than the recent species (based on data of Göhlich & Mourer-Chauviré 2005). Its geographic spread is similar to the previous species.

– †*Palaeortyx phasianoides* Milne-Edwards, 1869 /syn. † *Palaeoperdix longipes* (Milne-Edwards, 1869) / *Coturnix † longipes* (Mlikovskỳ, 2002).

Site and era: Litke 2, Lower Miocene (MN 5) (Kessler & Hír 2012); Rudabánya, Upper Miocene (MN 9) (Kessler 2009b) (all in Hungary). From sites in Europe outside the Carpathian Basin: MP 28: France; MN 2-12: Czech Republik, France, Germany, Spain (Mlíkovský 2002).

Material: *coracoideum*,, cranial fragment (Litke 2); *coracoideum*, cranial fragments, partial *metacarpus*, distal fragment of the *tibiotarsus* (Rudabánya).

Dimensions: *coracoideum* C = 3.98 mm, E = 3 mm, *carpometacarpus* A = app. 30 mm, E = 3.4 mm, *tibiotarus* F = app. 5.8 mm, *tarsometatarsus*: C = 6.15–6.29 mm, E = 2.9–3.04 mm.

In case of the *metacarpus* the *processus intermetacarpalis* is highly developed, while remaining characteristics of the other bones indicate common morphological characteristics of the genus. Based on dimensions it can be classified to the largest *Palaeortyx* species (Göhlich & Mourer-Chauviré 2005).

They have been reported from numerous sites, from the Late Oligocene of France (MP 28) from Desse to Germany and Czech Republik to the Upper Miocene of Hungary. It is also known from the Late Miocene of Spain.

† *Míoryaba* Zelenkov, 2016

† *Mioryaba magyaricus* Zelenkov, 2016

Site and era: Polgárdi, Upper Miocene (MN13), (Hungary), (Zelenkov 2016).

Originally described as *Palaeortyx brevipes* (Kessler 2009b).

Material: *coracoideum*, *scapula*, *humerus* (n = 6), *tarsometatarsus* (n = 4), (Polgárdi 4,5);

Dimensions: *coracoideum*,: minimum shaft width, 1.8; shaft height (thickness) at the level of its minimum width 1.9; length from the cranial edge to caudal edge of the *caput scapularis* 7.6 mm. *Tarsometatarsus*: total length, 28.8, proximal width, 5.4, minimum shaft width, 2.5, height of *trochlea metatarsi* III, 3.0–3.1 (n = 3); width of *trochlea metatarsi* III, 2.5; distal end width, 5.8, 6.2 mm.

– † ***Plioperdix* (Kretzoi, 1955)**

– † *Plioperdix hungaricus* (Jánossy, 1991) (syn. † *Palaeocryptonyx hungaricus* Jánossy, 1991).

Site and era: Rátka, Upper Miocene (MN 12-13) (Kessler 2009b); Polgárdi 4, 5, Upper Miocene (MN 13) (Jánossy 1991, 1995, Kessler 2009b, Zelenkov 2016); Beremend 26, Lower Pliocene (MN 15) (Kessler 2009b), Beremend 17, 18 Lower Pleistocene (Q1) (Jánossy 1992, 1996) (all in Hungary). From sites in Europe outside the Carpathian Basin: MN 14-15: France, Germany, Ukraine; **Q1-2:** Czech Republik, Poland; **Q3:** Czech Republik, Germany, France, Italy, Poland, Spain, Ukraine (Tyrberg 1998, Mlíkovský 2002).

Material: *coracoideum*, *humerus*; distal fragment of *humerus*; left *femur*; distal fragment of the *tibiotarsus*; *carpometacarpus*; *tarsometatarsus* (Polgárdi 4 and 5 localities, Hungary), Upper Miocene (MN 13);

In case of smaller representatives of the genus the humerus is characteristically stout, while the *tarsometatarsus* is typically slim. Characteristics of the species described by *Jánossy* verify better flight capabilities compared to other, more grounded species supposedly more capable of running. The shape of the *caput humeri*, the depth of the *fossa pneumotricipitalis*, the shape of the distal epiphysis and the whole *humerus* differ from those of recent small and medium-sized species. They fit the diagnosis of the genus, so the classification to the genus *Alectoras* is incorrect. The only whole, almost complete skeleton of the Carpathian Basin was found of this species from Rátka, classified incorrectly as a Charadriidae at the showcase at the privately owned museum in Tállya, however the typical shape of the coracoid bones clearly indicate its true place.

It has not been reported from any other site than those mentioned above. J. Mlikovskỳ classified it along with other members of the genus as belonging to the taxon *Alectoris* † *donnezani* (Deperet, 1892).

Dimensions: *Table 1.*

† *Eurobambusicola* Zelenkov, 2016

† *Eurobambusicola turolicus* Zelenkov, 2016

Site and era: Polgárdi, Upper Miocene (MN 13), Hungary (Zelenkov 2016)

Material: *coracoideum*; *humerus* (n = 3), distal fragment of the *tibiotarsus*; *carpometacarpus* (Polgárdi 5 locality).

Originally classified as † *Paleocryptonix hungaricus* Jánossy, 1991 (Jánossy 1991, 1995, Kessler 2009b).

Dimensions: *coracoideum*: total length along the medial edge, 26.6–26.8 (n = 3), length from the cranial to caudal edge of the *cotyla scapularis*, 7.6–8.2 (n = 5); minimum shaft width, 2.1–2.3 (n = 6); thickness at this level, 2.0–2.3 (n = 5). *Scapula*: shaft width just caudal to the *facies articularis humeralis*, 2.6–2.7 (n = 2). *Humerus*: total length, 37.4, 37.7; maximum width of the proximal end, 9.5, 9.3; minimum dorsoventral width of the shaft, 3.3–3.6 (n = 5), greatest width of the distal end, 7.3–7.7 (n = 4). *Carpometacarpus*: total length, 18.7, 19.6 dorsoventral height of *the trochlea carpalis*, 2.9, 3.1. *Tibiotarsus*: width of the distal end, 5.3–5.7 (n = 3). *Tarsometatarsus*: reconstructed total length, ~33; width of the proximal end, 6.0–6.4 (n = 3); width of the distal end, 6.3–6.6 (n = 3).

– *Francolinus* (Stephens, 1819)

– *Francolinus* † *capeki* Lambrecht, 1933 / syn. *Francolinus* † *subfrancolinus* Jánossy, 1976 / *Francolinus* † *minor* Jánossy, 1974 / † *Lambrechtia capeki* Jánossy, 1974 / *Alectoris* † *donezzani* (Depéret, 1892), (after Mlikovskỳ 2002).

Site and era: MN 15: Beremend 26 (Kessler 2009b); Csarnóta 2 (Jánossy 1976, 1979) (all in Hungary); MN 16: Beremend 1-3, 5, 15, 18 (Jánossy 1974, 1976b, 1992, 1996); Osztramos 7 (Jánossy 1973, 1976b, 1979a); Villány 3 (Jánossy 1976b, 1979) (all in Hungary); Betfia 13 (Kessler 1975, Gál 2002); **Q1:** Németóvár 4B (Deutsch-Altenburg, Austria) (Jánossy 1981); Beremend 16 (Jánossy 1976b, 1979); Osztramos 2, 8 (Jánossy 1976b, 1979, Jánossy & Kordos 1976) (all in Hungary); Betfia 2, 5, 9 (Kormos 1913, Čapek 1917, Lambrecht 1933, Jánossy 1976b, Kessler 1975, Gál 2002) (Romania); **Q2:** Somssich-hegy 2 (Hungary) (Jánossy 1983, 1986); Betfia 5, 7, 7/2-3 „Aven” (Romania) (Kretzoi 1962, Kessler 1975, Jánossy 1976b, Gál 2002). From sites in Europe outside the Carpathian Basin: **Q1-2:** Germany; **Q3:** Croatia, Czech Republik, Germany (Tyrberg 1998).

Quite a number of fossil material is available, similar in scale and characteristics to the francolins. They can be easily distinguished from partridges and rock partridges based on their morphological characteristics.

The typical species (*Francolinus capeki* (Lambrecht, 1933)) was described from the Lower Pleistocene site of Betfia 2. Outside the Carpathian Basin it is known from the Late Pliocene of Poland (Weze, MN 15; Rebielice Królewskie, MN 16), Etulia (Moldavia) (MN 16), Odessa, Kotlovina (Ukraine) (MN 16), Tourkoubonia (Greece) (MN 16-17), Untermassfeld and Sackdilling (Germany) (**Q1-Q2**), as well as Chlum, Koneprusy, Stránská Skála (Czech Republik) (Q2).

All of the areas mentioned above are outer neighboring the Carpathian Basin! We can thus easily conclude, that we have a small-sized Galliformes typical to Central Europe in the early Pliocene, while the species *Alectoris donnezani* (Deperet, 1892) is spread from France to Russia and Israel, the area bypassing the Carpathian Basin from the north towards east. He also classifies species *Palaeocryptonyx donnezani* (Depéret, 1892), *Ammoperdix ponticus* Tugarinov, 1940, *Pliogallus coturnoides* Tugarinov, 1940, *Chauvereria balcanica* Boev, 1997 and *Alectoris baryosefi* Tchernov, 1980, not considering the morphological differences between rock partridges and francolins.

Dimensions: *Table 2*.

– *Coturnix* Bonaterre, 1791

– *Coturnix coturnix* (Linnaeus, 1758)

Q1: Beremend 16, 17 (Hungary) (Jánossy 1992, 1996); **Q2:** Hundsheim (Austria) (Jánossy 1974, 1976b); Somssich-hegy 2 (Hungary) (Jánossy 1983, 1986); Méhész 4E (Vcelare, Slovakia) (Horáček 1985, Mlíkovskỳ 2002); **Q3/I:** Budapest – Várhegy (Hungary) (Jánossy 1976b, 1979, 1986); Gombaszög (Gombasek, Slovakia) (Kessler 2009b); **Q3/II:** Süttő 1-4 (Jánossy 1976b, 1979); Uppony I. (Jánossy 1976b, 1979) (all in Hungary); Brassó – Fortyogóhegy – Gensperger Cave (Brașov, Romania) (Gál 2002); **Q4/I:** Bajót – Jankovich Cave (Lambrecht 1933, Jánossy 1976b, 1979); Budapest – Remete Cave (Jánossy 1976b, 1979); Budapest – Remetehegyi Shelter Cave (Kormos 1914a, Lambrecht 1933, Jánossy 1976b, 1979); Gencsapáti (Jánossy 1976b, 1979); Hámor – Puskaporos Shelter Cave (Lambrecht 1912a, b, 1916, 1933, Jánossy 1976b, 1979); Pilisszántó I. Shelter Cave (Lambrecht 1915, 1933, Jánossy 1976b, 1979); Tatabánya – Kálváriahegy, cave n. 4. (Gál 2008a); Tatabánya – Szelim Cave (Jánossy 1976b, 1979); Varbó – Lambrecht Kálmán Cave (Jánossy 1976b, 1979) (all in Hungary); Kőrösmart (Râpa, Romania) (Jánossy in Hamar & Csák 1969, Kessler 1974a, Gál 2002); Lándzsásötfalu (Hôrka – Ondrej, Slovakia) (Mlíkovskỳ 2000); Óruzsin-Antal Cave (Oruzer, Slovakia) (Nehring 1880, Róth 1881, Lambrecht 1912b, 1933); **Q4/II:** Teufelslucken (Austria) (Soergel 1966); Bodajk – Rigólyuk (Kordos 1984); Csapástető (Jánossy 1976); Hosszú-hegyi Cave (Jánossy 1976, Kordos 1981); Legény Cave (Lambrecht 1914); Ordacsehi – Kistöltés (Gál 2005, 2007a); Répáshuta – Rejtek Shelter Cave (Jánossy 1962c, 1976b); Gálospetri (Galoșpetreu) (Kessler 1980–81, Gál 2002); Körösbánlaki Cave (Bălnaca) (Kessler 1982); Peterd – Turda Gorge – Magyar Cave (Petrești) (Kessler & Gál 1998, Gál 2005); Székelykeresztúr (Cristuru Secuiesc) (Gál 2008b), (all in Romania). From sites in Europe outside the Carpathian Basin: **Q1-2:** Spain, Ukraine; **Q3:** Czech Republik, France, Germany, Malta, Russia, Ukraine; **Q4:** Belgium, Bosnia-Herzegovina, Bulgaria, Czech Republik, France, Georgia, Germany, Greece, Ireland, Italy, Luxemburg, Malta, Moldova, Poland, Russia, Spain, Ukraine, United Kingdom (Tyrberg 1998).

– *Alectoris* Kaup, 1829

– *Alectoris* † *donnezani* (Depéret, 1892)

Site and era: MN 15: Ajnácskő (Hajnacka) (Kessler 2009b); Ivánháza (Ivanovce) (Mlikovskỳ 2002); MN 17-18: Kolon 2 (Horáček 1985, Mlikovskỳ 2002) (all in Slovakia); **Q1:** Németóvár (Deutsch-Altenburg, Austria) (Döppes & Rabeder 1997, Mlikovskỳ 1998); **Q2:** Méhész 4E (Vcelare, Slovakia) (Horáček 1985, Mlikovskỳ 2002). From sites in Europe outside the Carpathian Basin: MN 14-15: France, Germany, Ukraine; **Q1-2:** Poland; **Q3:** Czech Republik, Germany, Poland, Ukraine (Tyrberg 1998, Mlíkovský 2002).

A fossil species having typical rock partridge characteristics, it can be easily distinguished from partridges and francolins. The typical species is only additionally known from the Perpignan (Lower Pliocene, MN 15) site in France.

– *Alectoris graeca* (Meisner, 1804)

Q3/II: Vindija (Croatia) (M. Malez 1961, V. Malez 1973, 1988, M. Malez & Rukavina 1975, Musil 1980); **Q4/I:** Hámor-Puskaporos Shelter Cave (Hungary) (Lambrecht 1912a, b, 1916, 1933, Jánossy 1976b, 1979); **Q4/II:** Kazánszoros – Climente I. Cave (Cazanele Mari) (Kessler 1980–81, Gál 2002); Kazánszoros – Töröklik Cave (Cazanele Mari) (Kessler 1974b, Fischer & Stephan 1977) (all in Romania). From sites in Europe outside the Carpathian Basin: **Q1-2:** Greece, Italy; **Q3:** Azerbaijan, France, Greece, Italy, Malta; **Q4:** Bosnia-Herzegovina, Bulgaria, France, Georgia, Italy, Luxemburg, Montenegro, Russia, Spain, Ukraine (Tyrberg 1998).

– ***Alectoris rufa* (Linnaeus, 1758)**

From sites in Europe outside the Carpathian Basin: **Q3:** Spain; **Q4:** France, Portugal, Spain (Tyrberg 1998).

– *Perdix perdix † jurcsaki* Jánossy, 1976 / syn. *Perdix † jurcsaki (*Kretzoi, 1962).

Site and era: **MN 15:** Beremend 26 (Kessler 2009b); MN 16: Beremend 18 (Kessler 2009b); **Q1:** Németóvár (Deutsch-Altenburg, Austria) (Jánossy 1981); Beremend 16, 17 (Kessler 2009b); Győrújfalu (Kessler 2009b); Osztramos 5 (Jánossy 1972) (all in Hungary); Betfia 2, 5, 9 (Romania) (Kormos 1913, Čapek 1917, Lambrecht 1933, Kessler 1975, Jánossy 1976b, Gál 2002); **Q2:** Betfia 5, 7, "Aven" (Kretzoi 1962, Kessler 1975, Jánossy 1976b, Gál 2002); **Q3/I:** Betfia 7 (Kessler 1975, Jánossy 1976b, Gál 2002) (all in Romania); Tarkő, Várbarlang (Hungary) (Jánossy 1976b, 1979). From sites in Europe outside the Carpathian Basin: **Q3:** Greece (Tyrberg 1998).

The rich collection of material shows typical mosaicity in scale. While the *ulna*, *meatcarpus*, *tibiotarsus* and *tarsometatarsus* are long and slim, the *coracoideum* and *humerus* are robust. The partridge described from the Betfia 5 site distinguishes itself with larger dimensions than its recent counterparts. Based on examining seventy-five *tarsometatarsus* Jánossy (1976b) proposed classifying it as a new subspecies, while Mlikovskỳ (2002) classified it along with the recent partridge. After examining *coracoideum*,, *scapula*, *humeri*, *metacarpae*, wing *phalanges*, *tibiotarsae* and *tarsometatarsae*, we propose to keep the subspecies classified by Jánossy. The subspecies is only known from the Carpathian Basin, but shares many characteristics with the species *P. palaeoperdix* Mourer-Chauviré, 1975 described from the Middle Pleistocene of France (Q2), also classified by Mlikovskỳ (2002) as the fossil predecessor of the recent partridge.

Dimensions: *Table 3*.

– ***Perdix † palaeoperdix* Mourer-Chauviré, 1975**

From sites in Europe outside the Carpathian Basin: **Q2:** France (Tyrberg 1998).

– ***Perdix perdix*** **(Linnaeus) 1758**

Q3/I: Hundsheim (Austria) (Jánossy 1974, 1976b); Tarkő 1-16 (Jánossy 1962b, 1976b, 1979); Budapest – Várhegy (Jánossy 1976b, 1986); Vértesszölős 2 (Jánossy 1976b, 1979); **Q3/II:** Cave in the Cserépfalu – Hór Valley (Jánossy 1976b, 1979); Sütő 6-9. (Jánossy 1976b, 1979) (all in Hungary); **Q4/I:** Krapina (Lambrecht 1915, V. Malez 1973, 1984, V. Malez-Bačić 1979); Velika Pecina (V. Malez 1984, 1988); Veternica (V. Malez 1973, 1988, V. Malez-Bačić 1979, Musil 1980) (all in Croatia); Bajót – Öregkő (Lambrecht 1915); Bajót – Baits Cave (Jánossy 1976b, 1979); Balla Cave, Bajót – Hóman Cave (Jánossy 1976b, 1979); Istállóskő, Bajót – Jankovich Cave (Lambrecht 1933, Jánossy 1976b, 1979); Budapest – Remetehegy Shelter Cave (Kormos 1914, Lambrecht 1933, Jánossy 1976b, 1979); Cserépfalu – Subalyuk Cave (Jánossy 1976b, 1979); Pilisszántó I. – Shelter Cave (Lambrecht 1915, 1933, Jánossy 1976, 1979); Répáshuta – Balla Cave (Lambrecht 1912a, b, 1933, Mottl 1938, 1941); Szilvásvárad – Istállóskő Cave (Lambrecht 1912a,b, 1933, Jánossy 1952, 1954, 1955, 1976b, 1979); Tatabánya – Calvary mountain cave n. 4. (Gál 2008a); Tatabánya – Szelim Cave (Jánossy 1976b, 1979); Varbó – Lambrecht Kálmán Cave (Jánossy 1976b, 1979) (all in Hungary); Nándor – Nándori Cave (Nandru), (Jánossy 1965, Fischer & Stephan 1977, Kessler 1985, Jurcsák & Kessler 1988, Gál 2002, 2003); Ohábaponor – Bordu Mare Cave (Ohaba Ponor) (Kessler 1985, Jurcsák & Kessler 1988, Gál 2002, 2003); Szegyestel – Tibocoaia Cave (Sighiștel) (Kessler 1982, 1985, Gál 2002) (all in Romania); Dévényújfalu (Devínska Nová Ves) (Kessler 2010); Óruzsin – Antal Cave (Oruzer) (Nehring 1880, Róth 1881, Lambrecht 1912b, 1933) (all in Slovakia); **Q4/II:** Teufelslucken (Austria) (Soergel 1966); Balatonkeresztúr – Réti-dülő **(**Gál 2007a); Bodajk – Rigólyuk (Kordos 1984); Csákvár – Esterházy Cave (Kretzoi 1951–52); Csév Cave (Jánossy 1976b); Ecsegfalva 23 (Pike-Tay *et al.* 2004, Gál 2007b); Endrőd 119 (Jánossy 1985, Gál 2005, 2007b); Felsőnyék – Várhegy (Gál 2007a); Hosszú-hegyi Cave (Jánossy 1976b, Kordos 1981); Legény Cave (Lambrecht 1915); Ludas – Budzsák (Bökönyi 1974, Gál 2005); Répáshuta – Rejteki Shelter Cave (Jánossy 1962c, 1976b); Szendrő (Gál 2005, Tassi 2006); Tatabánya-alsó – Törekvés Cave (Kessler 2009b); Tác – Gorsium (Bökönyi 1984, Jánossy 1985); Visegrád – Vár (Bökönyi & Jánossy 1965, Jánossy 1976b) (all in Hungary); Gyulafehérvár (Alba Iulia) (Gál 2005); Körösbánlaki Cave (Bălnaca) (Kessler 1982); Révi caves (Vadu Crișului) (Kessler 1982); Remetelórév – Bólyi-kő Cave (Lorău – Piatra Boiului) (Kessler 1982); Szegyestel – Drăcoaia Cave (Sighiștel) (Kessler 1982); Székelykeresztúr (Cristuru Secuiesc) (Gál 2008b); Vargyasi-szoros – Homoródalmás caves (Vârghiș) (Jurcsák & Kessler 1988); Vársonkolyos caves (Şuncuiuș) (Kessler 1982) (all in Romania). From sites in Europe outside the Carpathian Basin: **Q1-2:** Ukraine; **Q3:** Azerbaijan, Croatia, Czech Republik, France, Georgia, Italy; **Q4:** Austria, Belgium, Bosnia-Herzegovina, Bulgaria, France, Georgia, Germany, Irlanda, Italy, Luxemburg, Moldova, Montenegro, Poland, Russia, Serbia, Spain, Ukraine, United Kingdom (Tyrberg 1998).

– ***Perdix*** **sp.**

Q1: Beremend 16, 17 (Hungary) (Jánossy 1992, 1996);

From sites in Europe outside the Carpathian Basin: **Q3:** France; **Q4:** Czech Republik, France, Portugal (Tyrberg 1998).

– *Ammoperdix* Gould, 1851

– *Ammoperdix* sp.

Q3/I: Gombaszög (Gombasek, Slovakia) (Kessler 2009b). From sites in Europe outside the Carpathian Basin: **Q4:** Greece (Tyrberg 1998).

– † ***Miogallus* Lambrecht, 1933**

– † *Miogallus altus* (Milne-Edwards, 1869) / syn. *Phasianus* † *altus* Milne-Edwards, 1869; † *Miophasianus medius* Milne-Edwards, 1869.

Site and era: Dévényújfalu (Devinská Nová Ves, Slovakia) Middle Miocene (MN 6-7) (Švec 1986, Kordos 1987, Mlikovskỳ 2002); Felsőtárkány – Felnémet 2/7, Mátraszőlős 2, Middle Miocene (MN 7/8) (Kessler & Hír 2012a); Rudabánya, Upper Miocene (MN 9) (Jánossy 1994) (all in Hungary). From sites in Europe outside the Carpathian Basin: MN3-9: France, Germany, Spain, Turkey (Mlíkovský 2002).

Material: distal part of the *coracoideum* bone (R-2), *scapula* (Felsőtárkány – Felnémet 2/3), distal fragment of the *tibiotarsus* (R-2, 1990), *tarsometatarsus* fragment with spur (R-2 Rudabánya), *phalanges pedis* (n = 5), (Mátraszőlős 2).

Dimensions: *scapula* B = 13.73 mm; C = 7.75 mm; E = 6.57 mm; *humerus* E = 11 mm, F = 21.45 mm, *femur* C = 18.5 mm, D = 14.15 mm; *phalanges pedis* = 11.75; 10.29; 9.44; 9.11; 7.75.

From the incredibly fragmented Rudabánya material only the relation to galliformes can be determined, even indicated by the presence of spurs. Other finds fit into characteristics of the extinct species.

From fossil material bearing similar characteristics numerous species had been described across Europe, from Spain to France and Germany through Turkey, from the Lower Miocene (MN 2-5) all the way to the Upper Miocene (MN 9).

– *Gallus* Brissson, 1760

– *Gallus* † *beremendensis* Jánossy, 1976

Site and era: MN 15: Beremend 26 (Kessler 2009b); Csarnóta 2 (Kessler 2009b); **MN 16:** Beremend 5, Villány 3 (Jánossy 1976b, 1996, Kessler 2009b); **Q1:** Beremend 17 (Jánossy 1992, Kessler 2009b) (all in Hungary). It is not known from sites in Europe outside the Carpathian Basin.

It bears similar morphological characteristics to the genus *Gallus*, but is smaller than the recent species. The objections of Mlikovskỳ (2002) (he classifies it as belonging to "*genus incertae sedis"*) regarding the head of the *humerus (caput)* the shape of *crista biccipitalis* are exaggerated, since they fit well inside the limits of differing characteristics of a fossil type. The rich material from Beremend 17 and 26, Csarnóta 2 and Villány 3 we identified, however, verifies Jánossy's diagnosis Finds greatly distinct from partridge and francolin species belonging typically to Galliformes prove the earliest appearance of the genus *Gallus* in Europe.

Dimensions: *Table 4*.

A fossil species of a similar age (*Gallus moldavicus* Burčak-Abramovič *et al.* 1993) was described from Moldavia, which may also explain the emergence of the genus in the

Carpathian Basin. Presence of the genus Gallus in the Late Pleistocene of Europe is debated, since according to the conventional view chickens were imported from southeastern Asia at the beginning of historical times. Fossil finds coming from obviously undomesticated species seem to rival this theory. It can be rightfully assumed that in warmer periods of the Quaternary the genus *Gallus* was present (with one or even more species) in the southern part of Europe, and thus in the Carpathian Basin. Their absolute age could only be reliably determined by a series of isotopic examinations.

– *Gallus* sp.

Q3/II: Vindija (Croatia) (M. Malez 1961, V. Malez 1973, 1988, V. Malez & Rukavina 1975, Musil 1980); **Q4/I:** Esküllő – Igric Cave (Aştileu) (Kessler 1985); Nándor – Nándori Cave (Nandru) (Téglás 1880, Lambrecht 1912b); Ohábaponor – Bordu Mare Cave (Ohaba Ponor) (Kessler 1985, Jurcsák & Kessler 1988, Gál 2002, 2003) (all in Romania); **Q4/II:** Grosse Offenbergerhöhle (Austria) (Bocheński & Tomek 1994); Budapest – Francia Cave (Kessler 2009b); Csákvár – Esterházy Cave (Kretzoi 1954); Csobánka – Csontos Cave (Kessler 2009b); Legény Cave (Lambrecht 1915); Rezi (Kessler 2009b); Tatabánya – Denevér Cave; Tatabánya-alsó – Törekvés Cave (Kessler 2009b) (all in Hungary); Körösbánlaki Cave (Bălnaca) (Kessler 1982); Révi caves (Vadu Crişului) (Kessler 1982); Révtízfalusi Cave (Zece Hotare) (Kessler 1985); Szkerisóra – Sasok Cave (Scărişoara, Peştera Vulturilor) (Kessler 1982, Jurcsák & Kessler 1988); Vársonkolyos caves (Şuncuiuş) (Kessler 1982); Vaskóh (Vaşcău) (Kessler 1982); Jászó – Takács Menyhért Cave (Jasov, Slovakia) (Kormos 1914). From sites in Europe outside the Carpathian Basin: **Q3:** France, Ukraine, United Kingdom; **Q4:** Azerbaijan, Czech Republik, France, Georgia, Germany, Ireland, Italy, Moldova, Poland, Serbia, Spain, Ukraine, United Kingdom (Tyrberg 1998).

– *Phasianus* Linnaeus, 1758
– *Phasianus* sp.

Q3/II: Vindija (Croatia) (M. Malez 1961, V. Malez 1973, 1988, V. Malez & Rukavina 1975, Musil 1980); **Q4/II:** Csákvár – Esterházy Cave (Kretzoi 1954); Visegrád – Vár (Bökönyi & Jánossy 1965, Jánossy 1976b) (all in Hungary); Körösbánlaki Cave (Bălnaca, Romania) (Kessler 1982); Jászó – Takács Menyhért Cave (Jasov, Slovakia) (Kormos 1914). From sites in Europe outside the Carpathian Basin: **Q3:** Georgia, Russia; **Q4:** Bosnia-Herzegovina, Croatia, France, Georgia, Germany, Ireland, Italy, Luxemburg, Spain, Ukraine, United Kingdom (Tyrberg 1998).

– *Pavo* Linnaeus, 1758
– *Pavo* † *bravardi* (Gervais, 1849)

From the early Pliocene of Osztramos 1 described from a *phalanges* 2. digiti III. pedis (Hungary) (Jánossy 1976b, 1979). From sites in Europe outside the Carpathian Basin: **MN 14-17:** Bulgaria, France, Greece, Moldova, Ukraine (Mlíkovský 2002).

Dimensions: A = 17.5 mm, E = 3.02 mm.

Matched with the above species based on its shape and dimensions, this is the largest fossil Galliformes found in the Carpathian Basin.

It first appears in the eastern parts of Europe (Ukraine, MN 14), then in the Carpathian Basin in the Late Pliocene. It spreads up to France (Perpignan, Upper Pliocene, MN 15) and is known up to the early Pleistocene (MN 17). The genus subsequently only appears in the Holocene in Europe, possibly due to colonization. This can be assumed because the genus is not present from the Middle and Upper Pleistocene and the Holocene all the way to historical times.

– ***Syrmaticus* Wagler, 1832**

– *Syrmaticus* † *phasianoides* Zelenkov, 2016 /syn. *P.* † *aesculapi phasanoides* Jánossy, 1991.

The extinct peacock species was identified from the Upper Miocene of Polgárdi 4 (Hungary) based on a *premaxilla*, coracoideum, 2 radius fragments, 4 *carpometacarpus* (1 whole and 2 fragmented), 3 *phalanges pedis* (Jánossy 1991, 1995, Kessler 2009b). It is also known from the Late Miocene of Moldavia (Kolkotova Balka, MN 9-10), Ukraine (Nova-elisatovkova, Belka, Zovten, MN 11-13), and Greece (Pikermi, MN 12) (Mlikovskỳ 2002).

Material: *coracoideum* holotype, *carpometacarpus*, maxilla, all come from the Polgárdi 4 locality.

Dimensions: *coracoideum* A = 56.5 mm, *carpometacarpus* A = 38.75 and 42.47 mm, B = 34.64 and 37.11 mm, C = 10.75 and 12.98 mm, D = 6.54 and 7.24 mm E = 8.21 mm, F = 7.35–8.48 mm, G = 4.52–5.09 mm, *radius* E = 3.16 and 3.34 mm, F = 6.91 and 7.48 mm, G=3.68 and 4.55 mm; *phalanges pedis* A = 7.94 mm, 12.45 mm, 18.36 mm.

The robustness of the coracoideum, *facies articularis humeralis, cotyla scapularis* and the *facies articularis sternalis*, differing from typical chickens and pheasants, resemble that of a peacock. Characteristics of the *metacarpus*, however, are more similar to chickens and pheasants.

– *Numida* Linnaeus, 1766

– *Numida meleagris* Linnaeus, 1758

Q4/II: Jászó – Takács Menyhért Cave (Jasov, Slovakia) (Kormos 1914);
It is not known from any other Europian site.

– **Perdicidae gen. et sp. foss. indet.**

MN 6: Kőalja 2 (Subpiatra, Romania) (Kessler & Venczel 2009).

– **Perdicidae gen. et sp. indet.**

Q4/I: Kőrösmart (Râpa, Romania) (Jánossy in Hamar & Csák 1969, Kessler 1974, Gál 2002); **Q4/II:** Tűzköves Cave (Hungary) (Kessler 2009b).

Fam. Tetraonidae Vigors, 1825

The case of grouses is similar to Galliformes'. Mlikovskỳ (2002) classifies the fossil species to the recent species in this case as well. However, during the diagnosis of the respective species non-negligible morphological and dimensional differences are listed, on the other hand it is also quite improbable, that types of today would have remained unchanged from the Upper Pleistocene to modern times. We also have to consider, that the ancestors of today's Tetraonidae lived in different environments than those of today, and the climate change they had gone through during the Upper Pleistocene unavoidably influenced both their morphological characteristics and lifestyles. The Upper Pliocene, Lower, and Middle Pleistocene materials are discussed separately as fossil species, while we only classify Upper Pleistocene finds as recent grouses.

– *Tetrao* Linnaeus, 1758

Grouses were typical ground dwelling birds – mostly living in woodlands – of the Quaternary of the Carpathian Basin, but their numbers declined in the Holocene due to climate and environmental changes, as well as falling prey to humans.

The first reported presence of capercaillies comes from the early Pliocene of Bulgaria (Dorkovo, MN 14), then finds from Csarnóta and Beremend came from the early Pleistocene, and Weze (MN 15), Poland with a similar age, and Upper Pliocene material found in Hungary (Rebielice Królowskie and Osztramos 7, MN 16). In Germany and Czech Republik it is only known from the early Pleistocene (Sackdilling, Erphingen, and Holstein, Stránská Skála, **Q1-2**). It does not appear to the west of this region all up to the Late Pleistocene! *T.* † *rhodopensis* Boev, 1998 (Dorkovo, MN 14), which can also be considered *T. praeurogallus*, marks its southernmost appearance (Mlikovskỳ 2002).

Contrary to capercaillies, black grouses and their ancestors spread to France already by the Late Pliocene (Seneze, MN 17), and is common during the early and Middle Pleistocene of Germany and Czech Republik (Sackdilling, Erphingen, Voigstedt and Chlum 6, Stránská skala, **Q1-3**). The southernmost point is again Bulgaria (Vǎršec MN 17), where Boev (1995) classified a fossil grouse as *Lagopus* † *balcanicus*, which Mlikovskỳ (2002) again lists as belonging to the recent species. It is also known from the Middle Pleistocene of Ukraine (Certkov, **Q3**).

Currently grouses (apart from the hazel grouse, *Bonasa*) typically prefer cold, they live in regions higher above sea level, and colder latitudes. This can be seen in their spread and presence in the Carpathian Basin as well. The arctic and rock ptarmigans disappeared from the area in the last centuries, but even then they lived in higher areas, as do capercaillies and black grouses, even if humans played a significant factor regarding the fact. Their presence in plains and hill areas obviously indicate colder climates. As for their habitats, apart from the ptarmigans *(Lagopus)* they are specifically woodland species, and lived in tundralike birch forests, pine and juniper forests on plains. Temperature requirements of hazel grouses is indicated by their appearance in interglacial and interstadial areas, and they currently live in woodland areas as well. Capercaillies *(Tetrao urogallus)* receded into pine forests of higher mountains, while Black Grouses *(Tetrao tetrix)* into subalpine and alpine juniper forests. Rock Ptarmigans *(Lagopus mutus)* lived in open, rocky mountain areas, while Willow Ptarmigans *(L. lagopus)* in more wet tundra-like environments.

– *Tetrao* † *praeurogallus* Jánossy, 1969 / syn. *T.* † *conjugens* Jánossy, 1974/ *T.* † *macropus* Jánossy, 1976.

Site and era: MN 15: Csarnóta 2 (Jánossy 1976a, 1979, Kessler 2009a); Beremend 26 (Kessler 2009a); **Q1:** Osztramos 7 (Jánossy 1972, 1976a, 1979); **Q2:** Nagyharsányhegy 1-4

(Lambrecht 1916, 1933, Jánossy 1976a, 1979) (all in Hungary); Betfia 5 (Romania) (Kessler 1975, Gál 2002); Méhész 1. (Vcelare, Slovakia) (Jánossy 1976a, 1979); **Q3/I**: Hundsheim (Austria) (Jánossy 1974, 1976a); Tarkő 10 (Hungary) (Jánossy 1962b, 1976a, 1979). From sites in Europe outside the Carpathian Basin: **Q1-2:** Poland; **Q3:** Czech Republik, Germany, Poland (Tyrberg 1998).

With a few exceptions (the *foramen pneumaticum* on the proximal part of the *humerus* is significantly wider, the *impressio musculis coracobrachialis* is shorter and narrower than those of the recent type) the morphological characteristics of all of the skeletal fragments match the recent capercaillie, apart from the *phalanges pedis* (which are larger, hence the name *T. macropus*). Isolation of the other two fossil species – *Tetrao † conjugens* Jánossy, 1974 and *Tetrao † macropus* Jánossy, 1976 – is based primarily on robustness, as well as the dimensions being between capercaillies and black grouses. We have to consider, however, the quite substantial sexual dimorphism regarding size, meaning the fossil species suggesting a transition between capercaillies and Black Grouses *(T. conjugens)* may as well come from a smaller female. We suggest keeping the taxon *T. praeurogallus*, on one hand since its description precedes others on the timescale, and on the other it presents the view that it was the direct ancestor of capercaillies of today. This means we do not share the opinion of Mlikovskỳ (2002) regarding classification to the recent species.

Dimensions: *Table 5*.

– *Tetrao urogallus* Linnaeus, 1758

Q3/II: Vindija (Croatia) (M. Malez 1961, V. Malez 1973, 1988, V. Malez & Rukavina 1975, Musil 1980); Vindija (M. Malez 1961, V. Malez 1973, 1988, V. Malez & Rukavina 1975, Musil 1980); Uppony (Hungary) (Jánossy 1976a); **Q4/I:** Repolusthöhle (Austria) (Mottl 1951, Jánossy 1976a); Velika Pecina (V. Malez 1984, 1988); Veternica (V. Malez 1973, 1988, V. Malez-Bačić 1979, Musil 1980) (all in Croatia); Budapest – Remete Cave (Jánossy 1976b, 1979); Budapest – Remete-hegy Shelter Cave (Kormos 1914, Lambrecht 1933, Jánossy 1976a, 1979); Csákvár-Eszterházy Cave (Lambrecht 1933, Mottl 1938, Kretzoi 1954, Jánossy 1976a, 1979); Felsőtárkány – Peskő Cave (Lambrecht 1912, 1933, Jánossy 1976a, 1979); Hámor – Puskaporos Shelter Cave (Lambrecht 1912, 1916a, 1933, Jánossy 1976a, 1979); Pilisszántói I. Shelter Cave (Lambrecht 1915, 1933, Jánossy 1976a, 1979); Répáshuta – Balla Cave (Lambrecht 1912, 1933, Mottl 1938, 1941); Répáshuta – Ballavölgyi Cave (Mottl 1941); Sály (Jánossy 1976a); Szárazgerence (Jánossy 1976a, 1986); Szilvásvárad – Istállóskő Cave (Lambrecht 1912, 1933, Jánossy 1952, 1955, 1976a, 1979); Tatabánya – Szelim Cave (Jánossy 1976a, 1979); Varbó – Lambrecht Kálmán Cave (Jánossy 1976a, 1979) (all in Hungary); Esküllő – Igric Cave (Peștera Igrița – Aștileu) (Kessler 1985); Kőrösmart (Râpa) (Jánossy in Hamar & Csák 1969, Kessler 1974a, Gál 2002); Hidegszamos – Csont Cave (Someșul Rece – Peștera cu Oase) (Lambrecht 1915); Nándor – Nándori Cave (Nandru), (Jánossy 1965, Fischer & Stephan 1977, Kessler 1985, Jurcsák & Kessler 1988, Gál 2002, 2003) (all in Romania); Lándzsásötfalu (Hôrka – Ondrej) (Mlíkovskỳ 2000); Óruzsin – Antal Cave (Oruzer) (Nehring 1880, Róth 1881, Lambrecht 1912, 1933); Óruzsin – Nagy Cave (Oruzer) (Nehring 1880, Róth 1881, Lambrecht 1912, 1933) (all in Slovakia); **Q4/II:** Marchegg (Rabeder 1992, Döppes & Rabeder 1997);

Teufelslucken (Soergel 1966) (all in Austria); Jósvafő – Musztáng Cave (Kessler 2009a); Répáshuta – Rejtek Shelter Cave (Jánossy 1962c, 1976a) (all in Hungary); Kazánszoros – Töröklik Cave (Cazanele Mari-Cuina Turcului) (Kessler 1974b, Fischer & Stephan 1977); Peterd – Turda Gorge – Magyar Cave (Petrești – Cheile Turzii, Peștera Ungureasca) (Kessler & Gál 1998, Gál 2005) (all in Romania). From sites in Europe outside the Carpathian Basin: **Q1-2:** Czech Republik, Poland; **Q3:** Czech Republik, France, United Kingdom; **Q4:** Austria, Belgium, Croatia, Czech Republik, France, Italy, Luxemburg, Poland, Russia, Spain, Switzerland, United Kingdom (Tyrberg 1998).

– *Tetrao* † *partium* (Kretzoi, 1962) /syn. *Lyrurus* † *partium* Kretzoi, 1962.

Site and era: **MN 13:** Polgárdi 4 (Kessler 2009a); **MN 15:** Beremend 26 (Kessler 2009a); Csarnóta 4 (Kessler 2009a); **MN 16:** Beremend 18, Villány 3 (Jánossy 1992, 1996, Kessler 2009a); **Q1:** Beremend 16, 17 (Jánossy 1992, 1996, Kessler 2009a); Osztramos 2, 8 (Jánossy 1976a, 1979) (all in Hungary); Betfia 2, 9 (Romania) (Kormos 1913, in Čapek 1917 and Lambrecht 1933, as *Lyrurus tetrix*; Jánossy 1976a, Kessler 1975, Gál 2002); Betfia 5, 7, 7/2-3 (Romania) (Kretzoi 1962, Kessler 1975, Jánossy 1976a, Gál 2002); Méhész (Vcelare, Slovakia) (Jánossy 1976a), **Q2:** Nagyharsányhegy 1-4 (Lambrecht 1916, 1933, Jánossy 1976); Somssich-hegy 2 (Jánossy 1983) (all in Hungary); **Q3/I:** Hundsheim (Austria), (Jánossy 1974, 1976a); Tarkő 2, 3, 4, 7, 12 (Hungary) (Jánossy 1962, 1976a); Betfia 7/4 (Romania) (Kessler 1975, Jánossy 1976a, Gál 2002); Gombaszög (Gombasek, Slovakia) (Jánossy 1976a, Kessler 2009a). From sites in Europe outside the Carpathian Basin: **Q1-2:** France; **Q3:** Czech Republik, Germany (Tyrberg 1998).

Dimensions: *Table 6*.

With examinations on the rich fossil material available it can be shown, that the wingbones of the fossilized type are usually longer and more robust than those of the recent ones, while it is the opposite is true regarding legs. This shows better flight capabilities of the fossil type, and less developed ground mobility. Its rather early (Late Miocene) appearance is also interesting. This fact alone makes the suggestion of Mlikovskỳ (2002) to classify it as recent species unacceptable.

– *Tetrao tetrix* † *longipes* Mourer-Chauviré, 1975

From sites in Europe outside the Carpathian Basin: **Q3:** France (Tyrberg 1998).

– *Tetrao tetrix* Linnaeus 1758

Q1: Németóvár (Deutsch-Altenburg, Austria) (Döppes & Rabeder 1997, Mlíkovskỳ1998); **Q2:** Hundsheim (2002); Méhész 4E (Vcelare, Slovakia) **(**Horáček 1985, Mlíkovskỳ 2002); **Q3/I:** Budapest – Várhegy (Jánossy 1976a, 1979, 1986); Vértesszőlős (Jánossy 1976a, 1979) (all in Hungary); **Q3/II:** Vindija (Croatia) (M. Malez, 1961, V. Malez 1973, 1988, V. Malez & Rukavina 1975, Musil 1980); Cserépfalu – Hórvölgy Cave (Jánossy 1976a, 1979); Solymár (Jánossy 1976a); Sütő 6-9. (Jánossy 1976a, 1979); Uppony (Jánossy 1976a, 1979) (all in Hungary); **Q4/I:** Grosse Badl-höhle (Fladerer 1993), Luegloch (Mottl 1953) (all in Austria); Velika Pecina (Croatia) (V. Malez 1984, 1988); Bajót – Öregkő (Lambrecht 1913); Bajót – Baits Cave (Jánossy 1976a, 1979); Budapest – Remete Cave (Jánossy

1976a, 1979); Budapest – Remetehegy Shelter Cave (Kormos 1914, Lambrecht 1933, Jánossy 1976b, 1979); Cserépfalu – Subalyuk Cave (Jánossy 1976b, 1979); Csobánka – Kiskevély Cave (Lambrecht 1912, 1915, 1933, Jánossy 1976a, 1979); Felsőtárkány – Peskő Cave (Lambrecht 1912, 1933, Jánossy 1976a, 1979); Gencsapáti (Jánossy 1976b, 1979); Hámor – Puskaporos Shelter Cave (Lambrecht 1912, 1916, 1933, Jánossy 1976a); Hámor – Herman Ottó Cave (Lambrecht 1915, 1933); Jósvafő – Porlyuk Cave (Jánossy 1976a, 1979); Kecskésgalya (Mottl 1941); Kesztölc – Bivak Cave (Jánossy 1976a); Nagyvisnyó – Háromkút Cave (Jánossy 1976a); Pilisszántó I. Shelter Cave (Lambrecht 1915, 1933, Jánossy 1976a, 1979); Répáshuta – Balla Cave (Lambrecht 1912, 1933, Mottl 1938, 1941); Répáshuta – Ballavölgy Cave (Mottl 1941); Répáshuta – Poroslyuk (Jánossy 1976a); Szárazgerence (Jánossy 1976a, 1986); Szilvásvárad – Istállóskő Cave (Lambrecht 1912, 1933, Jánossy 1952, 1955, 1976a); Tata (Lambrecht 1915, 1933, Jánossy 1986); Tatabánya-Szelim Cave (Jánossy 1976a, 1979); Tokod – Nagyberek (Jánossy 1976a, 1979); Varbó – Lambrecht Kálmán Cave (Jánossy 1976a, 1979) (all in Hungary); Barcarozsnyó – Gura Cheii Cave (Râșnov) (Gál 1998, 2002); Kőrösmart (Râpa), (Jánossy in Hamar & Csák 1969, Kessler 1974a, Gál 2002); Nándor – Nándori Cave (Nandru), (Jánossy 1965, Fischer & Stephan 1977, Kessler 1985, Jurcsák & Kessler 1988, Gál 2002, 2003); Peterd – Turda Gorge – Binder Cave (Petrești – Cheile Turzii) (Kessler 1985, Gál 2002); Rév – Kecske Cave; Rév – Pince Cave (Vadu Crișului) (Mottl 1941, Gál 2002); Szegyestel – Tibocoaia Cave (Sighiștel) (Kessler 1982, 1985, Gál 2002) (all in Romania); Lándzsásötfalu (Hôrka Ondrej, Slovakia) (Mlíkovskỳ 2000); **Q4/II:** Teufelslucken (Austria) (Soergel 1966); Balatonkeresztúr – Réti-Dülő (Gál 2007a); Balatonszemes – Bagódomb (Gál 2007a); Berettyóújfalú – Herpály (Gál 2005); Békés – Városerdő (Jánossy 1976a, 1985); Ecsegfalva 23 (Pike-Tay *et al.* 2004, Gál 2007b); Endrőd 39,119 (Jánossy 1985, Gál 2005, 2007b); Felsőnyék – Várhegy (Gál 2007a); Hosszú-hegyi zsomboly (Jánossy 1976a, Kordos 1981); Ludas – Budzsák (Bökönyi 1974, Gál 2005); Mezőfény (Gál 2004); Pilismarót – Malompatak (Jánossy 1985); Répáshuta – Rejtek Shelter Cave (Jánossy 1962, 1976a); Visegrád – Vár (Bökönyi & Jánossy 1965, Jánossy 1976a) (all in Hungary); Gálospetri (Galoșpetreu) (Kessler 1980–81, Gál 2002); Kazánszoros – Climente I. Cave (Cazanele Mari) (Kessler 1980–81, Gál 2002); Kazánszoros – Töröklik Cave (Cazanele Mari – Cuina Turcului) (Kessler 1974b, Fischer & Stephan 1977); Mezősámsond (Şincai) (Bindea 2008); Peterd – Szentkirály (Sâncrai) (Gál 2005); Turda Gorge – Magyar Cave (Cheile Turzii – Peștera Ungureasca) (Kessler & Gál 1998, Gál 2005); Szind – Túr Gorge (Tureni – Cheile Turului) (Gál 2005); Vargyasi szoros – Homoródalmás caves (Cheile Vârghisului) (Jurcsák & Kessler 1986, 1988); Vársonkolyos – Izbîndiş Cave (Şuncuiuș) (Kessler 1977b, Gál 2002) (all in Romania). From sites in Europe outside the Carpathian Basin: **Q1-2:** Czech Republik, Poland; **Q3:** Czech Republik, France, Germany, Italy, Russia, Ukraine; **Q4:** Austria, Belgium, Bosnia-Herzegovina, Croatia, Czech Republik, France, Germany, Greece, Ireland, Italy, Luxemburg, Moldova, Poland, Russia, Spain, Switzerland, Ukraine, United Kingdom (Tyrberg 1998).

– *Tetrao mlokosiewieczi* Taczanovski, 1875

From sites in Europe outside the Carpathian Basin: **Q3:** Georgia; **Q4:** Armenia, Georgia, Russia (Tyrberg 1998).

– *Tetrao* sp.

Q3/I: Várhegy (Hungary) (Jánossy 1976); **Q4/I:** Nándor – Nándori Cave (Nandru, Romania) (Téglás 1880, Lambrecht 1912). From sites in Europe outside the Carpathian Basin: **Q3:** Belgium; **Q4:** Belgium, Ukraina, United Kingdom (Tyrberg 1998).

– *Tetraogallus caucasicus* Pallas, 1811

From sites in Europe outside the Carpathian Basin: **Q3:** Georgia; **Q4:** Georgia, Russia (Tyrberg 1998).

– *Bonasa* Stephen, 1810

– *Bonasa † praebonasia* Jánossy, 1974 / syn. *Tetrastes † praebonasia* Jánossy, 1974.

Site and era: **Q1:** Beremend 17 (Hungary) (Jánossy 1992); **Q3/I:** Hundsheim (Austria) (Jánossy 1974); Tarkő 1-16 (Hungary) (Jánossy 1962, 1976a,c). From sites in Europe outside the Carpathian Basin: **Q3:** France, Poland (Tyrberg 1998).

Material: coracoideum cranial part, proximal and distal fragment of the *tarsometatarsus* (Tarkő 11 and 12), entire *humerus*, *ulna* fragment (Hundsheim).

Dimensions: *tarsometatarsus* A = approx. 39–40 mm, E = 2.9 mm, *humerus* A = 49.8 mm.

Regarding skeletal characteristics it matches the recent species, the only difference is the higher placement of the *foramen vasculare distale* on the distal part of the *tarsometatarsus* (2.3 mm, while on the 8 recent and 5 subfossil specimens this varies between 0.8 and 1.6 mm). The *humerus* found at the site Beremend 17 (Jánossy 1992) is considered by Mlikovskỳ to be *Alectoris donnezani* (Deperet, 1892). In our opinion it is not a rock partridge, but a hazel grouse.

It is also known from the Lower Pleistocene of Kozi Grzbiet, Poland (Q2) and Stránská Skalá, Czech Republik (Q2), as well as from the Middle Pleistocene of Montoussé 3, France (Q3) (Mlikovskỳ 2002).

– *Bonasa bonasia* (Linnaeus, 1758)

Q4/I: Krapina (Croatia) (Lambrecht 1915, V. Malez 1973, 1984, V. Malez-Bačić 1979); Szárazgerence (Jánossy 1976a, 1986); Varbó – Lambrecht Kálmán Cave (Jánossy 1976a, 1979) (all in Hungary); Barcarozsnyó – Gura Cheii Cave (Râșnov) (Gál 1998, 2002); Homoródalmási – Orbán Balázs Cave – Vargyasi szoros (Cheile Vârghișului) (Kessler 1977a, Gál 2002) (all in Romania); Óruzsin – Antal Cave (Oruzer) (Slovakia) (Nehring 1880; Róth 1881, Lambrecht 1912, 1933); **Q4/II:** Grosse Offenbergerhöhle (Austria) (Bochenski & Tomek 1994); Hosszú-hegyi Cave (Jánossy 1976a, 1979, Kordos 1981); Mélyvölgy (Jánossy 1976a); Répáshuta – Rejtek Shelter Cave (Jánossy 1962c, 1976a, 1979), (all in Hungary); Révtízfalusi Cave (Zece Hotare) (Kessler 1985); Szegyestel – Drăcoaia Cave; caves in the Szegyestel Valley (Sighiștel) (Kessler 1982); Székelykeresztúr (Cristuru Secuiesc) (Gál 2008b); Szkerisóra – Coiba Mare Cace (Scărișoara) (Kessler 1982, Jurcsák & Kessler 1988); Vársonkolyos – Kismagyar Cave (Şuncuiuș – Peștera Napișteleu) (Kessler 1977b, Gál 2002) (all in Romania). From sites in Europe outside the Carpathian Basin: **Q3:** Czech Republik, United Kingdom; **Q4:** Austria, Croatia, Czech Republik, France, Germany, Serbia, Spain, United Kingdom (Tyrberg 1998).

– *Lagopus* (Brisson, 1760)

– *Lagopus lagopus † noaillensis* (Mourer-Chauviré, 1975)

From sites in Europe outside the Carpathian Basin: **Q3:** France (Tyrberg 1998).

– *Lagopus lagopus* (Linnaeus, 1758)

Q3/I: Vértesszőlős 2 (Hungary) (Jánossy 1976a, 1979); Aranyosszohodol – Lúcsia Cave (Sohodol, Romania) (Gál 2002); **Q3/II:** Vindija (Croatia) (M. Malez 1961, V. Malez 1973, 1988, V. Malez & Rukavina 1975, Musil 1980); Cserépfalu – Hórvölgyi Cave (Jánossy 1976a, 1979); Uppony (Jánossy 1976a) (all in Hungary); **Q4/I:** Grosse Badlhöhle (Fladerer 1993); Hundsteig bei Krems (Lambrecht 1933); Hundsteig bei Krems (Lambrecht 1933); Luegloch (Mottl 1953); Merkenstein (Wettstein & Mühlhofer 1938); Schwarzgrabenhöhle (Spahni 1954); Velika Pecina (V. Malez 1984, 1988); Velika pecna Lipi (V. Malez 1984, V. Malez-Bačić 1979) (all in Croatia); Bajót – Öregkő (Lambrecht 1915); Bajót – Baits Cave (Jánossy 1976a, 1979); Bajót – Hóman Cave (Jánossy 1976a, 1979); Budapest – Remete Cave (Jánossy 1976a, 1979); Budapest – Remetehegyi Shelter Cave (Kormos 1914, Lambrecht 1933, Jánossy 1976a, 1979); Csákvár – Eszterházy Cave (Lambrecht 1933, Mottl, 1938, Kretzoi 1954, Jánossy 1976a, 1979); Felsőtárkány – Peskő Cave (Lambrecht 1912, 1933, Jánossy 1976a, 1979); Hámor – Puskaporos Shelter Cave (Lambrecht 1912, 1916, 1933, Jánossy 1976a, 1979); Hámor – Herman Ottó Cave (Lambrecht 1915, 1933); Kesztölc – Bivak Cave (Jánossy 1976a, 1979); Nagyvisnyó – Háromkút Cave (Jánossy 1976a); Pilisszántó I. Shelter Cave (Lambrecht 1915, 1933, Jánossy 1976a, 1979); Répáshuta – Balla Cave (Lambrecht 1912, 1933, Mottl 1938, 1941); Répáshuta – Ballavölgyi Cave (Mottl 1941); Sály (Jánossy 1976a); Szilvásvárad – Istállóskői Cave (Lambrecht 1912, 1933, Jánossy 1952, 1955, 1976a, 1979); Tatabánya – Szelim Cave (Jánossy 1976a, 1979); Varbó – Lambrecht Kálmán Cave (Jánossy 1976a, 1979); Vaskapu Cave (Mottl 1941) (all in Hungary); Barcarozsnyó – Gura Cheii Cave (Râșnov) (Gál 1998, 2002); Kőrösmart (Râpa) (Jánossy in Hamar & Csák 1969, Kessler 1974a, Gál 2002); Rév – Vizes Cave (Vadu Crisului – Peştera cu Apă) (Mottl 1941); Rév – Kecske Cave; Rév – Pince Cave (Vadu Crișului – Peștera Caprei, Peștera Pivnicei) (Mottl 1941, Gál 2002); Vargyas – Medve Cave (Vârghis – Peștera Ursului) (Mottl 1942) (all in Romania); Detrekőszentmiklós – Pálffy Cave (Dzeráva Skála – Plávecky Mikulas) (Lambrecht 1913, 1933, Mottl 1938, 1941, Musil 1980); Novi I. III. (Lambrecht 1912, 1933, Nehring 1880, Róth 1881); Óruzsin – Antal Cave (Oruzer) (Nehring 1880, Róth 1881, Lambrecht 1912, 1933) (all in Slovakia); **Q4/II:** Grosse Offenbergerhöhle; Hohlensteinhöhle; Knochenhöhle (Bocheński & Tomek 1994); Teufelslucken (Soergel 1966) (all in Austria); Répáshuta – Rejtek Sheler Cave (Hungary) (Jánossy 1962c, 1976a); Gálospetri (Galoșpetreu) (Kessler 1980–81, Gál 2002); Vargyasi szoros – Homoródalmás caves (Cheile Vârghișului) (Jurcsák & Kessler 1988); Vársonkolyos – Izbîndiş Cave (Şuncuiuș) (Kessler 1977b, Gál 2002) (all in Romania). From sites in Europe outside the Carpathian Basin: **Q1-2:** France; **Q3:** Czech Republik, France, Germany, Poland, Russia, Ukraine, United Kingdom; **Q4:** Austria, Belgium, Bosnia Herzegovina, Croatia, Czech Republik, Denmark, France, Germany, Ireland, Italy, Luxemburg, Moldova, Montenegro, Poland, Russia, Spain, Switzerland, Ukraine, United Kingdom (Tyrberg 1998).

– *Lagopus mutus* † *correzenzis* (Mourer-Chauviré, 1975)

From sites in Europe outside the Carpathian Basin: **Q3:** France (Tyrberg 1998).

– *Lagopus mutus* (Montin, 1781)

Q3/I: Aranyosszohodol – Lúcsia Cave (Sohodol, Romania) (Gál 2002); **Q3/II:** Vindija (Croatia) (M. Malez 1961, V. Malez 1973, 1988, 1991, V. Malez & Rukavina 1979, Musil 1980); Cserépfalu – Hórvölgy Cave, Sütő 6-9. (Jánossy 1976a, 1979) (all in Hungary); **Q4/I:** Grosse Badlhöhle (Fladerer 1993); Luegloch (Mottl 1953); Merkenstein (Wettstein & Mühlhoffer 1938); Repolusthöhle (Mottl 1951, Jánossy 1976a) (all in Austria); Velika Pecina (V. Malez 1984, 1988); Velika pec na Lipi (V. Malez 1984, V. Malez-Bačić 1979) (all in Croatia); Bajót – Öregkő (Lambrecht 1915); Bajót – Baits Cave (Jánossy 1976a, 1979); Bajót – Hóman Cave (Jánossy 1976a, 1979); Budapest – Remete Cave (Jánossy 1976a, 1979); Budapest – Remetehegyi Shelter Cave (Kormos 1914, Lambrecht 1933, Jánossy 1976a, 1979); Csákvár – Eszterházy Cave (Lambrecht 1933, Mottl 1938, Kretzoi 1954, Jánossy 1976a, 1979); Csobánka – Kiskevélyi Cave (Lambrecht 1912, 1915, 1933, Jánossy 1976a, 1979); Felsőtárkány – Peskő Cave (Lambrecht 1912, 1933. Jánossy 1976a, 1979); Hámor – Puskaporos Shelter Cave (Lambrecht 1912, 1916, 1933, Jánossy 1976a, 1979); Hámor – Herman Ottó Cave (Lambrecht 1915, 1933); Kesztölc – Bivak Cave (Jánossy 1976a, 1979); Nagyvisnyó – Háromkút Cave (Jánossy 1976a); Pilisszántó I. Shelter Cave (Lambrecht 1915, 1933, Jánossy 1976a, 1979); Répáshuta – Balla Cave (Lambrecht 1912, 1933, Mottl 1938, 1941); Répáshuta **–** Ballavölgyi Cave (Mottl 1941); Sály (Jánossy 1976a, 1979); Szilvásvárad – Istállóskő Cave (Lambrecht 1912, 1933, Jánossy 1952, 1955, 1976a, 1979); Tatabánya-Szelim Cave (Jánossy 1976a, 1979); Vaskapu Cave (Mottl 1941) (all in Hungary); Barcarozsnyó – Gura Cheii Cave (Râșnov) (Gál 1998, 2002); Esküllő – Igric Cave (Așștileu-Pestera Igrița) (Kessler 1985); Hidegszamos – Csont Cave (Someșul Rece – Peștera cu Oase) (Lambrecht 1915); Ohábaponor – Bordu Mare Cave (Ohaba Ponor) (Kessler 1985, Jurcsák & Kessler 1988, Gál 2002, 2003); Rév – Vizes Cave (Vadu Crișului – Peștera cu Apă) (Mottl 1941); Szamosfalva (Someșeni) (Kormos 1913, Lambrecht 1933) (all in Romania); Detrekőszentmiklós – Pálffy Cave (Dzeráva Skála – Plávecky Mikulas) (Lambrecht 1913, 1933, Mottl 1938, 1941, Musil 1980); Novi I. III. (Lambrecht 1912, 1933, Nehring 1880, Róth 1881); Óruzsin – Antal Cave, Óruzsin – Nagy Cave (Oruzer) (Nehring 1880, Róth 1881, Lambrecht 1912, 1933) (all in Slovakia); **Q4/II:** Grosse Offenbergerhöhle; Hohlensteinhöhle; Knochenhöhle (Bocheński & Tomek 1994) (all in Austria); Répáshuta – Rejtek Shelter Cave (Hungary) (Jánossy 1962, 1976a); Vargyasi Pass – Homoródalmási caves (Cheile Vârghișului, Romania) (Jurcsák & Kessler 1986, 1988). From sites in Europe outside the Carpathian Basin: **Q3:** Czech Republik, France, United Kingdom; **Q4:** Austria, Belgium, Bosnia Herzegovina, Bulgaria, Croatia, Czech Republik, France, Germany, Ireland, Italy, Luxemburg, Montenegro, Norway, Poland, Russia, Serbia, Spain, Switzerland, Ukraine, United Kingdom (Tyrberg 1998).

– *Lagopus* sp.

Q3/II: Vindija (Croatia) (M. Malez 1961, V. Malez 1973, 1988, V. Malez & Rukavina 1975, Musil 1980); **Q4/I:** Veternica (Croatia) (V. Malez 1973, 1988, V. Malez-Bačić 1979, Musil 1980); Szárazgerence (Jánossy 1976a, 1986); Tata (Lambrecht 1915, 1933, Jánossy 1986) (all in Hungary); Szegyestel – Tibocoaia Cave (Sighiștel, Romania) (Kessler 1982, 1985, Gál 2002); Porács (Porac, Slovakia) (Jánossy 1976a); **Q4/II:** Kazánszoros – Climente I. Cave (Kessler 1980–81, Gál 2002); Tropfsteinhöhle Tunnelhöhle (Fladerer 1993). From sites in Europe outside the Carpathian Basin: **Q3:** France, Germany, Spain; **Q4:** Austria, Bosnia Herzegovina, Croatia, Czech Republik, France, Germany, Ireland, Poland, Russia, Spain, Switzerland, United Kingdom (Tyrberg 1998).

– **Galliformes indet. foss.**
MN 13: Polgárdi 4, 5 (Hungary), (Kessler 2009a);

Conclusions

Galliformes have always been birds represented by many species in large numbers from the Neogene in the Carpathian Basin. They are remarkable not only due to the 22 taxa and the enormous number of fossil material present at the sites (several hundred or several thousand bones), but also the continuous presence of smaller Galliformes (partridge- and quail-reLated birds) and larger grouses, as well as observing the gradual transitions into new species.

Apart from *Palaeoperdix* and *Palaeocryptonix* types the early representatives of peacocks and actual chickens are also present. Later direct ancestors of the recent species emerge. Climate changes of the Quaternary had greatly reduced this abundance of species, and not only did Pliocene and Lower Pleistocene Galliformes vanish, but the spread of recent quills and partridges also decreased, and hazel grouses were replaced by ptarmigans In the Holocene the opposite of the phenomenon happens.

Grouses are only known from the end of the Miocene (MN 13) both from the Carpathian Basin and Europe. They spread during the Quaternary, and were one of the period’s most significant ground dwelling birds. During the Holocene, however, their significance fell both in numbers and area, as they receded to higher habitats above sea level and their population greatly decreased In the Quaternary the Carpathian Basin was one of their most significant habitats in Europe, which is clearly indicated both by the number of species and the number of finds.

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Table 1. Size table of *Palaeocryptonix hungaricus* Jánossy, 1991

Abbreviations: A – total length of bone in mm; B – partial lengths; C – width of proximal epiphysis; D – thickness of proximal epiphysis; E – width of diaphysis; E1 – partial width of diaphysis; F – width of distal epiphysis; G – thickness of distal epiphysis; H – hight of distal epiphysis (femur)

1. táblázat *Palaeocryptonix hungaricus* Jánossy, 1991

Rövidítések: A – teljes hossz mm-ben; B – részleges hossz; C – proximális epifizis szélessége; D – proximális epifizis vastagsága; E – diafizis szélessége; E1 – diafizis részleges szélessége; F – disztális epifizis szélesége; G – disztális epifizis vastagsága; H – disztális epifizis magassága (combcsont)

Bone	A	B	C	D	E	F	G	H	Sites	References
coracoideum	38.00		9.70		3.50	7.40			Polgárdi 5	Jánossy 1991
″	27.40		4.80		2.20	5.20			″	″
″	28.00		4.50		2.40	5.50			″	″
″	29.00		5.50		2.50	6.20			″	″
″	29.60		5.00		2.60	5.80			″	″
ulna	23.40								″	″
″	25.00								″	″
femur	26.50								″	″
″	26.60								″	″
tibiotarsus	24.40								″	″
″	26.70					4.60			″	″
″			6.50						″	″
″						4.50			″	″
tarsometatarsus			7.50						″	″
″						5.00			″	″
coracoideum						5.20			″	Kessler 2009
ulna						5.60			″	″
humerus						5.60			″	″
″					2.62	5.35	4.34		Beremend 26	″
carpometacarpus	19.28	16.35	6.12		3.61	4.52	2.46		″	″
″	21.62	20.46	6.01	3.98	4.43		2.43		″	″
″	22.33	21.22	6.37	4.32		4.49	2.64		″	″
″	22.61	20.66	6.47	5.05		4.50	2.51		″	″
″						5.19	4.35		″	″
femur	20.24					4.26	2.74		″	″
″	21.58					4.48	2.61		″	″
″			4.68	2.89					″	″
″			5.84	2.18					″	″
″					2.14	4.73	3.80		″	″
″						4.35	2.54	2.23	″	″
carpometacarpus		26.01	5.76	4.75	3.00				Beremend 18	″
″					2.54	4.74	3.68		″	″

Table 2. Size table of *Francolinus capeki* (Lambrecht, 1933)
Abbreviations: A – total length of bone in mm; B – partial lengths; C – width of proximal epiphysis; C1 – partial width of proximal epiphysis *(coracoideum)*; D – thickness of proximal epiphysis; E – width of diaphysis; F – width of distal epiphysis; G – thickness of distal epiphysis

2. táblázat *Francolinus capeki* (Lambrecht, 1933)
Rövidítések: A – teljes hossz mm-ben; B – részleges hossz; C – proximális epifizis szélessége; C1 – proximális epifizis részleges szélessége (hollócsőrcsont); D – proximális epifizis vastagsága; E – diafizis szélessége; F – disztális epifizis szélesége; G – disztális epifizis vastagsága

Bone	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**C1**	**Sites**	**References**
humerus						6.90			Villány 3	Jánossy 1976b
"						8.00			"	"
"						10.60	5.60		"	"
carpometacarpus	27.70				3.50				"	"
ulna	40.00								"	"
tibiotarsus						5.50			Nagyharsányhegy 2	"
humerus						7.70			Csarnóta 2	"
tibiotarsus						5.80			"	"
phal.pedis 1. D.IV	9.50				1.50				"	"
"	9.60				1.50				"	"
femur						5.90			Osztramos 7	"
phal.ped. 2. D.II	10.90				1.20				"	"
phal.ped. 1. D.III			3.60						"	"
humerus						8.20			Osztramos 8	"
tarsomaetatarsus	28.00				2.60				Beremend 15	Jánossy 1992
humerus	40.00		10.80		3.80	7.00			Beremend 16	"
carpometacarpus	18.60								"	"
coracoideum								3.47	Betfia 13	Gál 2002
" 13 piece.			5.53-6.50	3.53-3.93	2.94-3.85		7.01-8.10	3.47-3.71	Betfia 9	"
scapula4 piece		7.77-8.55	3.55-4.15	3.44	3.00-3.26				"	"
humerus 3 piece	41.46	12.40	11.49		4.11-4.60	8.21-8.40	4.52-4.74		"	"
ulnae 7 piece			5.10-5.51		2.42-2.75	5.40-5.87	4.20-4.70		"	"

Bone	A	B	C	D	E	F	G	C1	Sites	References
radius 8 piece	36.10-36.78		2.84-2.93	3.38-3.62	1.62-2.07	3.87-4.23	2.23-2.56		"	"
carpometacarpus 19 p.	23.25-24.98	20.73-22.87	6.46-7.15	3.76-5.15	4.83-5.12	4.33-5.18	2.93-3.10		"	"
phal..alae 1.D.II. 3 piece	9.90		3.28	3.49	4.56-4.59	4.23-4.53	2.33-2.42		"	"
femur			8.40	6.16	3.33	7.26	5.34		"	"
tibiotarsus 5 piece					3.00-3.36	5.83-6.12	5.70-5.96		"	"
tarsometatarsus 11 piece	36-25-38.93		6.23-6.53	6.50-6.60	2.86-3.16	7.00-7.48	4.96-5.65		"	"
humerus 4 piece	41.55-42.75	12.26-14.00	9.41-12.25		3.85-4.60	7.44-8.54	4.56-4.78		Betfia 2	"
ulna					2.89	5.77			"	"
carpometacarpus 3 piece	23.46	20.87	6.97	4.06	5.21	4.79-4.85	2.57-2.74		"	"
tibiotarsus 5 piece			9.60	5.60	3.11-3.16	5.93-6.16	5,57-5.82		"	"
tarsometatarsus 10 piece	37.70		5.58-6.80	5.45-6.30	3.10-3.30	6.90-7.50	5.20-5.64		"	"
tibiotarsus						6.17	5.96		Betfia 5	"
ulnae					2.50				Betfia "Aven"	"
coracoideum 7 oiece	31.82-34.08	28.36-32.63	3.87-6.13	3.96-6.52	2.54-3.16	8-29-10.22	6.58-7.13		Beremend 26	Kessler 2009
humerus					3.84	7.95	4.72		"	"
ulna 2 piece		5.40	4.70	6.76	2.89-3.40	4.56	3.07		"	"
"	19.28-22.33	16.35-21.22	6.01-6.47	3.98-5.05	3.61-4.43	4.26-5.84	2.46-3.18		"	"
phalanga.alae 1.D.II.	9.44		3.29	2.73	4.30				"	"
femur					3.30	3.19	1.66		"	"
tibiotarsus			8.24	5.91					"	"
tarsometatarsus 4 piece	38.69		6.04	5.34	2.61-2.75	6.46-7.03	4.40-5.57		"	"
humerus 3 piece	40.75	13.21	10.32	9.98	3.17-3.35	6.93-7.06	4.14-4.33		Beremend 18	"

Table 3. Size table of *Perdix perdix jurcsaki* Jánossy, 1976
Abbreviations: A – total length of bone in mm; B – partial lengths; C – width of proximal epiphysis; C1 – partial width of proximal epiphysis (coracoideum); D – thickness of proximal epiphysis; E – width of diaphysis; F – width of distal epiphysis; G – thickness of distal epiphysis

3. táblázat *Perdix perdix jurcsaki* Jánossy, 1976
Rövidítések: A – teljes hossz mm-ben; B – részleges hossz; C – proximális epifizis szélessége; C1 – proximális epifizis részleges szélessége (hollócsőrcsont); D – proximális epifizis vastagsága; E – diafizis szélessége; F – disztális epifizis szélesége; G – disztális epifizis vastagsága

Bone	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**C1**	**Sites**	**References**
humerus			13.67		4.62	9.03	5.32		Betfia 2	Kretzoi 1962
phalanga.alae 1.D.II.			3.40	3.50					“	“
tarsometatarsus					3.46				“	“
coracoideum 4 piece			5.44		2.90-2.93	8.80		5.00	Betfia 9	Gál 2002
ulna 3 piece			5.55	7.26	2.58-2.78	6.19-6.43	5.04-5.05		“	“
coracoideum	35.20	33.01	6.95	4.14	3.56		8.01	3.57	Betfia 2	“
carpometacarpus 4 p.	26.25-26.54	23.72-23.96	7.00-7.65	4.40-5.02		4.86-5,20	2.62-3.11		“	“
coracoideum 3 piece					2.62-2.90				Betfia 5	“
scapula			4.55		3.32				“	“
humerus2 piece					4.55-4.57	9.36-9.56	5.08-5.46		“	“
	45.93	5.95-6.68	5.44-6.04	7.90-8.66	2.50-2.90	6.36-6.46	5.11-5.34		“	“
carpometacarpus 2 p.	25.31	22.90	7.24	5.20	5.34-5.40	3.07-3.23	3.81		“	“
tibiotarsus						7.12	6.80		“	“
tarsometatarsus 2 piece			6.83	5.86	3.67				“	“
tibiotarsus					4.60	6.90	6.50		Betfia “Aven”	“
tarsometatarsus	44.50				3.50	8.10			“	“
carpometacarpus	25.39	22.90	6.41	3.76	5.60	4.81	3.00		Betfia 7	“
coracoideum	41.52	39.62	7.93	5.95	4.07	12.16	9.74		Beremend 26	Kessler 2009
scapula		10.04	5.30	4.59					“	“
humerus 21 piece	39.33-40.32	10.63-14.01	7.36-11.08	8.39-11.01	3.56-4.32	7.09-8.21	3.96-4.63		“	“

Bone	A	B	C	D	E	F	G	C1	Sites	References
tibiotarsus			7.72	5.81					“	“
tarsometatarsus 2 piece	44.19		8.36-8.82		3.93-4.06				Beremend 18	“
humerus	46.36	14.87	12.86	13.13	4.86	8.86	5.36		Beremend 17	“
carpometacarpus 3 p.	25.54-27.70	24.36-26.00	6.83-8.00	4.47-4.65	4.13-5.72	2.62-2.91			“	“
ulna					8.88	5.14			Győrújfalu	“
tarsometatars	43.98		7.90		4.09				“	“

Table 4. Size table of *Gallus beremendensis* Jánossy, 1976
Abbreviations: A – total length of bone in mm; B – partial lengths; C – width of proximal epiphysis; D – thickness of proximal epiphysis; E – width of diaphysis; F – width of distal epiphysis; G – thickness of distal epiphysis

4. táblázat *Gallus beremendensis* Jánossy, 1976
Rövidítések: A – teljes hossz mm-ben; B – részleges hossz; C – proximális epifizis szélessége; D – proximális epifizis vastagsága; E – diafizis szélessége; F – disztális epifizis szélesége; G – disztális epifizis vastagsága

Bone	A	B	C	D	E	F	G	Sites	References
humerus	53.00		14.00		5.70	10.00		Beremend 5	Jánossy 1976b
coracoideum	41.52	39.62	7.93	5.95	4.07	12.16	9.74	Beremend 26	Kessler 2009
scapula		10.04	5.30		4.59			“	“
humerus 7 piece	39.33-40.32	11.33-14.01	10.14-11.08	9.81-11.01	3.72-4.32	7.33-7.64	4.11-4.37	“	“
phalanga alae 1. D.II.	9.44		3.29	2.73	4.30			“	“
femur					3.09	6.74	6.01	“	“
tibiotarsus 3 piece			7.72-8.24	5.81-5.91	3.39	6.79	6.03	“	“
tarsometatarsus 5 piece	38.69		6.04	5.34	2.61-2.75	5.19-7.03	4.34-5.57	“	“
humerus 2 piece	46.36	14.87-17.65	12.86-13.55	13.13-14.46	4.46-5.22	8.86	5.36	Beremend 17	“
ulna 2 piece		6.20	6.38	7.87	3.53-4.07	6.86	5.47	“	“
carpometacarpus 3 p.	25.54-28.59	24.36-26.43	6.84-8.36	4.47-5.31		4.13-6.11	2.62-4.10	“	“

Table 5. Size table of *Tetrao praeurogallus* Jánossy, 1969

Abbreviations: A – total length of bone in mm; B – partial lengths; C – width of proximal epiphysis; D – thickness of proximal epiphysis; E – width of diaphysis; E1 – partial width of diaphysis *(carpometacarpus)*; F – width of distal epiphysis; G – thickness of distal epiphysis

5. táblázat *Tetrao praeurogallus* Jánossy, 1969

Rövidítések: A – teljes hossz mm-ben; B – részleges hossz; C – proximális epifizis szélessége; D – proximális epifizis vastagsága; E – diafizis szélessége; E1 – diafizis részleges szélessége (kézközépcsont); F – disztális epifizis szélesége; G – disztális epifizis vastagsága

Bone	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**E1**	**Sites**	**References**
humerus	96.00		24.50		10.50	20.50	11.10		Csarnóta 2	Jánossy 1976a
radius	79.00					9.00			“	“
tibiotarsus						17.00			“	“
phal.pedis 2. D.II.	22.00				4.00				“	“
phal.pedis 1. D.III.	27.00				5.00				“	“
phal.pedis 2. D.III	20.50				4.40				“	“
phal.pedis 3. D.III.	18.60				4.10				“	“
humerus	130.00		32.80		11.40	22.40	12.60		Méhész (Vcelare)	“
ulna						11.00			“	“
carpometacarpus	60.00		17.00			12.00	6.00	6.00	“	“
“						11.48	5.84	5.45	Nagyharsányhegy	“
coracoideum	63.91.	60.71	13.78	8.37	5.59	18.68	14.75		Beremend 26	Kessler 2009
humerus		28.01	23.39	25.81	9.97	18.26	10.25		“	“
tibiotarsus		13.28	12.77		7.27	13.49	13.25		“	“
carpometacarpus						10.30	6.10	5.60	Betfia 5	Gál 2002

Table 6. Size table of *Tetrao partium* (Kretzoi, 1962)

Abbreviations: A – total length of bone in mm; B – partial lengths; C – width of proximal epiphysis; D – thickness of proximal epiphysis; E – width of diaphysis; E1 – partial width of diaphysis (carpometacarpus); F – width of distal epiphysis; G – thickness of distal epiphysis

6. táblázat *Tetrao partium* (Kretzoi, 1962)

Rövidítések: A – teljes hossz mm-ben; B – részleges hossz; C – proximális epifizis szélessége; D – proximális epifizis vastagsága; E – diafizis szélessége; E1 – diafizis részleges szélessége (kézközépcsont); F – disztális epifizis szélesége; G – disztális epifizis vastagsága

Bone	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**E1**	**Sites**	**References**
coracoideum					4.11				Betfia 5	Kretzoi 1962
tarsometatarsus			8.70		4.40	9.50	8.00		“	“
humerus					8.20	16.50			Osztramos 2	Jánossy 1976a
carpometacarpus		43.50	12.80					5.30	“	“
phalanga pedis ?	18.60				9.00				“	“
carpometacarpus		41.70	11.80		8.30			4.30	Osztramos 8	“
phalanga pedis ?	17.00				7.10				Méhész (Vcelare)	“
tibiotarsus 2 piece					8.90-10.00				“	“
phalanga pedis ?	10.10		3.90		2.20	3.00			Villány 3	“
tibiotarsus					7.80				“	“
phalanga pedis ?	17.89		5.00		2.80	4.00			Betfia 2	“
scapula	9.72				4.50				Betfia 9	Gál 2002
phalanga alae 1. D.II.	12.43		4.03	4.53	5.37		2.85		“	“
femur				10.20	6.00				“	“
tibiotarsus						6.24	6.57		“	“
tarsometatarsus					5.80				“	“
carpometacarpus								5.00	Betfia 2	“
tarsometatarsus					4.18	10.49	7.00		“	“
phalanga pedis ? 2 p.	12-26-16.24		3.05-4.79	3.31-5.20	2.68-2.90	2.07-3.60			“	“
ulna					4.90	10.38	8.00		Betfia 5	“
radius					3.88	7.17	4.22		“	“
carpometacarpus	45.71		15.81			8.75	4.84	4.00	“	“
ulna					4.32				Betfia 7	“
tibiotarsus						9.55	8.50		“	“
ulna					4.68				Polgárdi 4	Kessler 2009
carpometacarpus	34.63	31.88	11.46	6.06	9.61	7.29	4.54		Csarnóta 4	“
phalanga pedis 4 piece	7.57-13.90								“	“
phalanga unguis 2 p.	11.45-12.30								“	“
radius					3.68	8.01	4.39		Beremend 26	“
tarsometatarsus						5.30			“	“
coracoideum			9.52	7.24					Beremend 18	“
tibiotarsus					6.01	9.55			Beremend 17	“

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New species in the Hungarian avifauna in 2017

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Abstract Two new species appeared in the Hungarian avifauna in 2017: the Siberian Accentor and the Bonaparte's Gull. A Siberian Accentor was observed and photographed at Surány near Pócsmegyer between 18th–29th January. A Bonaparte's Gull was seen and photographed over Hortobágy Fishponds at Hortobágy on 14th April. With the observations of these species, the number of bird species known to occur in Hungary rose to 416.

Keywords: bird checklist, Hungarian Checklist and Rarities Committee, Siberian Accentor, *Prunella montanella*, Bonaparte's Gull, *Larus philadelphia*

Összefoglalás 2017-ben két, Magyarország faunájára nézve új madárfaj bukkant fel: a szibériai szürkebegy és a Bonaparte-sirály. A szibériai szürkebegyet 2017. január 18–29. között figyelték meg és fényképezték a Pócsmegyer közigazgatási területén lévő Surány mellett, a Bonaparte-sirályt pedig 2017. április 14-én látták és fényképezték a Hortobágyon, a Hortobágyi-halastó felett. E két faj előkerülésével a Magyarország mai területén valaha bizonyítottan előfordult madárfajok száma 416-ra emelkedett.

Kulcsszavak: Magyarország madarainak névjegyzéke, MME Nomenclator Bizottság, szibériai szürkebegy, *Prunella montanella*, Bonaparte-sirály, *Larus philadelphia*

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In 2017, two bird species were accepted by the Hungarian Checklist and Rarities Committee as new to the Hungarian fauna. These are the Siberian Accentor and the Bonaparte's Gull. By these, the number of bird species found in Hungary (with present-day political borders) to date has risen to 416.

Prunella montanella (Pallas, 1776) – Siberian Accentor
18th–29th January, 2017, Pócsmegyer, Surány, 1 individual (L. Molnár and others)

The Siberian Accentor breeds from Northern Ural Mountains through Siberia, to the eastern and the western shores of Okhotsk Sea and Barents Sea, and from the upper flow of rivers Ob and Yenisey through the Altai to the Amur region. Two subspecies are recognized: the populations breeding in Northeast Siberia, east of River Lena, are described as ssp. *badia*. The populations in the western part of the breeding area (west of River Lena) belong to the ssp. *montanella* (del Hoyo *et al.* 2005). The breeding range of the nominate subspecies reach the extreme northeastern part of Europe on the western slopes of Ural Mountains, it also breeds on the Bol'shezemel'skaya tundra, the More-Yu River basin and the Chornaya basin (Estafiev *et al.* 1997). The species breeds in boreal and subarctic zones of Siberia, mainly along the northern edge of coniferous and deciduous forests, in river valleys, in dense vegetation of bushes and trees often close to rivers, also in forests of the taiga zone, and on mountains up to the tree line in sparse woodlands (del Hoyo *et al.* 2005). It migrates to the central and eastern parts of China, and to the Korean Peninsula for the winter (del Hoyo *et al.* 2005).

European occurrences, outside Russia, had been scarce and sporadic until 2016 (Lewington *et al.* 1991, Lorgé 2006). Its first known European occurrence dates back to the turn of the 19th century, in Austria (von Pelzeln 1871), there are three records from Northern Italy, where two specimens were shot in 1884 and 1901 (Picchi 1904) and one more in the fall of 1907 (Lewington *et al.* 1991). After decades of absence it was observed in Czechia: a young specimen was caught near Postupice in December 1943 (Černý 1944a, b). It is notable that there had been no records from Sweden until 1976 (Lindell *et al.* 1978), neither from the UK until 2016 (Stoddard 2018). Between 1975 and 2015, a significant number of occurrences was recorded only in the southern part of Fennoscandinavia. Out of the 32 European records from these years, 11 came from Finland (Koivula *et al.* 2017), nine from Sweden (Sikora *et al.* 2018), two from Norway (Koivula *et al.* 2017). Between 1975 and 2015, there are four more European records from the Ukraine (Fesenko *et al.* 2017), and one record from each of the following countries: Lithuania, Belarus (Zuenok 1999), Poland (Fijewski 1996, Stawarczyk *et al.* 2017), Denmark, Luxembourg (Lorgé 2006) and Slovakia (Fulín & Šmelko 1996).

An unexpected irruption of Siberian Accentor was to be witnessed in the fall of 2016 (Ławicki *et al.* 2016, Riezing 2016). A total of 231 birds were observed or trapped in Europe (Sikora *et al.* 2018): 75 individuals in Finland, 72 in Sweden, 14 in Great Britain, 13 in Denmark, 11 in Norway, ten in Poland, nine in Latvia, eight in Germany, eight in Estonia, four in Lithuania, four in the Ukraine, and single individuals were reported from the Netherlands, the Czech Republic and Hungary. Most birds (195 individuals) were recorded on the Baltic coast and in the Danish Straits, most records (177 birds) originated from areas within 5 km of the sea shore and from sea islands. The irruption in Europe started in the first week of October, and peaked between 14th and 20th October, when 41% of all recorded individuals were noted (12–16 birds/day). 95% of records were made in October and November of 2016, and the remaining 11 records between December 2016 and March 2017 (Sikora *et al.* 2018). An analysis of records suggests that the most likely route to Europe was southwest along the southern coast of the White Sea, continuing across South-Central Fennoscandinavia and the Baltic region to Western Europe. The first individuals probably arrived to the Baltics in late September, and northern parts of Europe – including Great Britain – were reached rapidly in early October. Overall, these data suggest an active migration toward west and southwest in October (Koivula *et al.* 2017).

The most plausible reasons for this unprecedented influx may be the lack of experience in orienteering by young individuals coupled with weather conditions (favourable easterly tail winds in Northern Russia in September and a cold burst from northeast-east in early October), common wildfires and early winter in Siberia (Koivula *et al.* 2017, Sikora *et al.* 2018, Stoddard 2018). In contrast to large numbers of birds observed in fall, their numbers in winter and spring dropped heavily indicating high mortality and/or their return to the east (Sikora *et al.* 2018).

Regarding the countries adjacent to Hungary, the Siberian Accentor occurred one time in Austria, one time in Slovakia, and eight times in the Ukraine. In northern Austria (Obermeisling) an individual was collected in the fall in the end of the 18th or the beginning of the 19th century (probably between 1798 and 1806) (von Pelzeln 1871, Glutz von Blotzheim 1985). It is likely identical with the specimen described erroneously from Hungary by Temminck (1820–1840). In Slovakia one specimen was trapped on 4th November, 1994 near Rožňava (Fulín & Šmelko 1996). This Slovakian record is also the first of the species from the Carpathian Basin. In the Ukraine, the first record of the Siberian Accentor comes from 1985: a female bird was trapped near Kyiv. Until 2000, another bird was also recorded near Donetsk and two others were simultaneously caught in Kharkiv. Four new Ukrainian records occurred in 2016: one individual was trapped on 3rd November near Kosachivka, another bird was caught with mist nets on 24th November at the same place, one bird was caught on 28th November in Rozumovka, and another on 22nd December at a marsh near Pohreby (Fesenko *et al.* 2017).

In Hungary, one Siberian Accentor was seen by Lídia Molnár on the 18th of January, 2017 near Surány (Pócsmegyer) on the Szentendrei Island of River Danube, north of Budapest. The bird was repeatedly observed and photographed by several birdwatchers until the 29th of January. This was the first record of the Siberian Accentor in Hungary, and the second in the Carpathian Basin.

Larus philadelphia (Ord, 1815) – Bonaparte's Gull
14th April, 2017, Hortobágy, Hortobágy Fishponds, 1 ad. individual (M. Molnár)

Bonaparte's Gull breeds in the northern part of North America, ranging from South Alaska to areas south of Hudson Bay, throughout the boreal forests of Canada (del Hoyo *et al.* 1996, Malling Olsen & Larsson 2007, Malling Olsen 2018). Unlike other gull species, it prefers to nest on trees, mainly conifers. The northern edge of its range is confined by the tree line (Malling Olsen 2018). They breed either as solitary pairs or in small, loose colonies, near muskeg lakes or bog ponds, typical wet habitats of the taiga (del Hoyo *et al.* 1996). Birds breeding on the western part of their range migrate to the Pacific coast of North America for the winter. Part of the breeding population east of Saskatchewan province in Canada migrates south or southwest along the Mississippi valley, another part at the Great Lakes, and another across the St. Lawrence River. These populations winter at the south and the southwest coasts of North America. In the past few decades, the number of birds wintering near inland waters has been growing (Malling Olsen & Larsson 2007, Malling Olsen 2018).

Bonaparte's Gull is a rare but regular vagrant in Europe. Most of its European occurrences are recorded in fall, but, in smaller numbers, it is also observed in winter and spring (Mitchell 2017). Most European records originate from the Atlantic coast, where birds drifting from North America with the North Atlantic cyclones reach the European continent. In spring they seem to occur somewhat further north than in fall, as overwintering birds arriving to Europe in fall follow their traditional American migration route to the north (Hoogendoorn & Steinhaus 1990). Most occurrences have been recorded in Western Europe: more than 210 in the UK, more than 70 in Ireland, more than 30 in Iceland, more than 30 in Spain, more than 25 in France, and more than ten in Norway. It has also been sighted occasionally in Belgium, the Netherlands, Denmark, Germany, Sweden and Portugal (Lewington *et al.* 1991, Mitchell 2017). It is a rare vagrant in inland regions of Europe, without any records in the neighboring countries, thus no records in the Carpathian Basin, until recently. The closest occurrence to Hungary was in Czechia, where one adult individual was seen at Hradecký Fishpond at Tovačov, on 24th April, 1988 (Doupal 1989).

Only an unverified observation have been featured in the ornithological literature from present-day Hungary: a single individual was claimed to be observed at River Danube in Budapest, on the 22nd of February, 1984 (Bankovics 1989). However, due to the lack of photograph and detailed description, and also due to the fact that the observer was unaccompanied at the observation, this record was not validated by the Hungarian Checklist and Rarities Committee, and was denied inclusion into the Hungarian checklist.

An adult Bonaparte's Gull in breeding plumage was seen and photographed by Márton Molnár on 14th April, 2017 at the Hortobágy Fishponds in the Hortobágy. This was the first well- documented and confirmed record of Bonaparte's Gull for Hungary, and the first record for the Carpathian Basin as a whole.

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