

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

Jacques VAN IMPE

Received: April 08, 2019 – Revised: August 10, 2019 – Accepted: October 31, 2019



Van Impe, J. 2019. The mystery of *Anser neglectus* Sushkin, 1897. Victim of the Tunguska disaster? A Hungarian story. – *Ornis Hungarica* 27(2): 20–58. DOI: 10.2478/orhu-2019-0014

**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 20<sup>th</sup> 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*shoz való hasonlósága 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* 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 telet. 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

Former addresses: Institute of Hygiene and Epidemiology, Juliette Wytman street, Brussels, Belgium, Royal Belgian Institute of Natural Sciences, Vautier street, Brussels, Belgium

Current address: Dr. Van de Perrelei, 51B, B-2140-Borgerhout, Belgium

e-mail: jacques.vanimpe@telenet.be

## 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 19<sup>th</sup> 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 Bean 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 Ufinski 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 19<sup>th</sup> – beginning of the 20<sup>th</sup> 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 19<sup>th</sup> and the first half of the 20<sup>th</sup> 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 20<sup>th</sup> century Europe. Or in the words of Bauer and Glutz von Blotzheim (1968) in their Handbuch: “the marked instability in the occurrence of *A. neglectus* 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: Sushkingans, 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

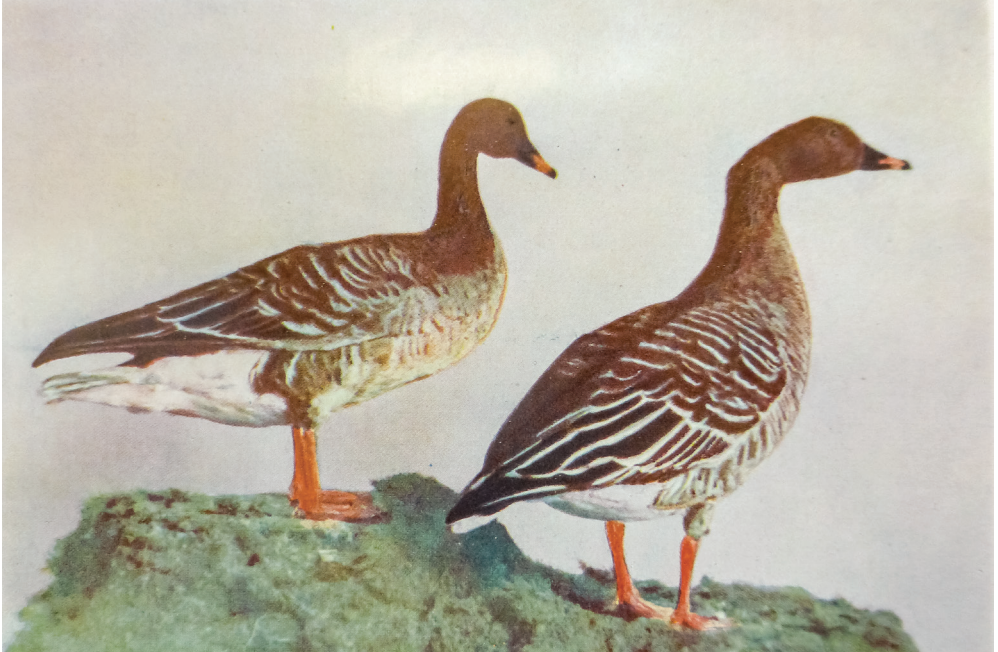


Figure 1. *Anser neglectus*. Adult (right) and juvenile bird (left). Shot resp. on 4 March 1923 and 23 December 1928, puszta Hortobágy (Photo: L. Szomjas in J. Schenk, 1929)  
 1. ábra *Anser neglectus*. Öreg (jobbra) és fiatal madár (balra)

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'yeu & 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 ("rostrum 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

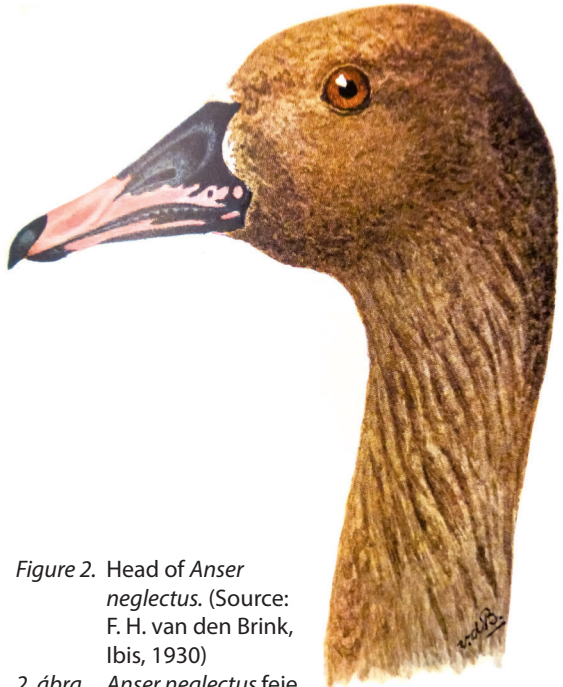


Figure 2. Head of *Anser neglectus*. (Source: F. H. van den Brink, Ibis, 1930)  
 2. ábra *Anser neglectus* feje

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".

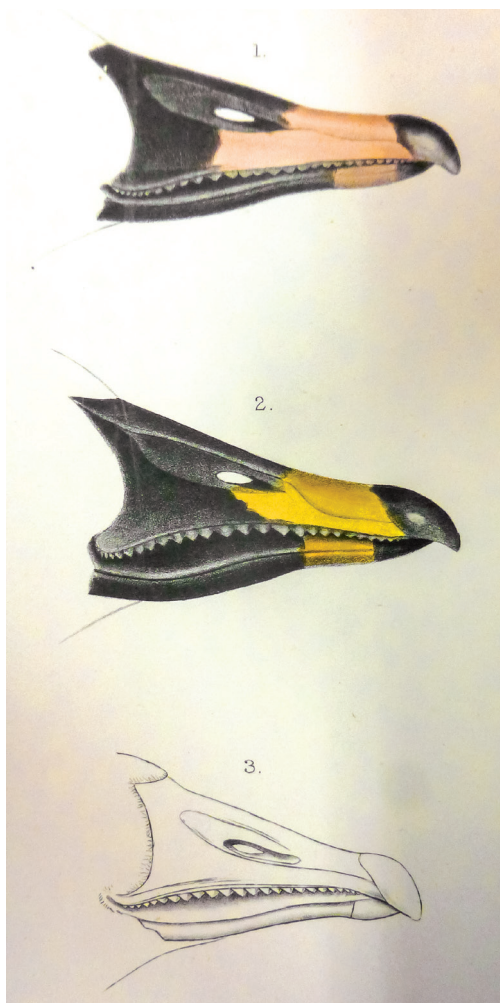


Figure 3. Bill of *Anser neglectus* (above), *A. f. rossicus* (middle) and *A. brachyrhynchus* (below). (After original drawings of P. P. Sushkin, Ibis 1897).

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)

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

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)



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, Csörgy 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, Csörgy 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: “ye-ye”, 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, Csörgy 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 ( $\sigma$ ) of each measurement. The values of n and  $\sigma$  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 $\pm$ $\sigma$
<i>A. neglectus</i>	A.	452-485	75-79	55-63	11/57.7 $\pm$ 2.5
	B.	411-482		54-69	
<i>A. f. fabalis</i>	A.	410-490	66-73	56-71.5	37/64.1 $\pm$ 4.4
	B.	409-498		54-72	
<i>A. f. middendorffii</i>	A.	450-505	74-84	74-83	13/77.0 $\pm$ 4.9
	B.	449-503		64-83	
<i>A. f. rossicus</i>	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	<i>A. neglectus</i>	<i>A. f. fabalis</i>	<i>A. f. middendorffii</i>	<i>A. f. rossicus</i>
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

<p>Species: Sushkin 1897a, Sushkin 1897b, Madarasz 1899, 1900, 1909, Oates 1899, Menzbir 1900, 1902, 1934, Buturlin 1901, Zhitkov &amp; 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 &amp; Dement'yev 1935, Stegmann 1935.</p> <p>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.</p> <p>Species or subspecies: Csörgey 1927–28.</p> <p>No strong opinion: Hartert 1932, K. H. Voous <i>in litt.</i> 12.03.1974, Roselaar 1977, Johansen 1962, Alex &amp; Shergalin 2013.</p>	
<p>Authors with other opinions:</p> <p>Dementieff 1936.</p> <p>Buturlin &amp; Dement'yev 1935, Uspenski 1965</p> <p>Arrigoni degli Oddi 1929, Tugarinov 1941, Dement'yev &amp; Gladkov 1952, Mayr &amp; Cottrell 1979.</p> <p>Matvejev &amp; Vasič 1973.</p> <p>Hachler 1944, Johansen <i>in litt.</i> <i>in</i> Delacour 1951, Delacour 1951, 1954, Johansen 1959, Vaurie 1965, Ali &amp; Ripley 1968</p> <p>Voous <i>et al.</i> 1973, Bauer &amp; Glutz von Blotzheim 1968, Cramp &amp; Simmons 1977.</p> <p>Sangster &amp; Oreel 1996, Ruokonen &amp; Aarvak 2011.</p>	<p>Opinions:</p> <p>Individual variation of <i>A. f. fabalis</i></p> <p>Most probably individual variation of North European and West Siberian forms of <i>Anser fabalis</i></p> <p>Synonym of <i>A. f. fabalis</i></p> <p>Synonym of Bean Goose</p> <p>Colour phase</p> <p>Mutation</p> <p>"Typological thinking" of former authors has been the source of a wrong classification (see below)</p>

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, Ryabitshev 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*". Zarudnyi 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 (South-east 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<sup>o</sup> 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 30<sup>th</sup> June (17<sup>th</sup> 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 1<sup>st</sup> 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<sup>2</sup>), 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’khovtov 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 20<sup>th</sup> century many researchers (including Alphéraky 1905, Schallow 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. March 1932 a young male SBG was shot near Sibiu (now Romania) from a group of six geese. The description of this bird is convincing (Kammer 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<sup>2</sup> 23.5 km<sup>2</sup>; Shungak-Kul’, 54°24’36” N, 55°14’00” E, surface area 0.7 mi<sup>2</sup>, 2.4 km<sup>2</sup>). 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 sensu 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 20<sup>th</sup> 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 steppe 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 steppe 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 Fox-tail *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*. Pantelev 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.*).

## Acknowledgements

The mystery of *A. neglectus* required more than 40 years of work and many of those involved in the research have passed away. I would like to express my gratitude to Georges Huyskans†, Paul Maes† and Matheus van Deursen† for the many discussions about this subject and their permission to take measurements of a collection of heads of *A. f. fabalis* and *A. f. rossicus* (collection M. van Deursen†).

My colleagues Guido Bulteel, Jef De Ridder, Willy Suetens† and Herman Voet carried out extensive research into the former appearance of Taiga Bean Geese in the southeastern of the Netherlands and helped me collect literature. I am much indebted to T. Csörgő and S. Faragó who kindly improved the manuscript.

I am grateful to the correspondents who have tried to clarify the views on the *A. neglectus* mystery: P. Beretzk†, S. Eck†, V. I. Emelyanov, V. V. Grichik, L. Falgari, G. Jacobs, A. Keve†, J. Konečká, K. E. Litvin, L. Megyery, F. Perco, E. E. Shergalin, I. Sterbetz†, D. Symens†, L. van den Bergh, C. Van Den Berghe, Prof. Dr. K. H. Voous†. I am much

indebted to Mrs. E. Koloyartseva and Mr. L. Mennes for kindly teaching me the Russian language. I would like to thank G. Lenaerts for correcting the English text. I praise the Be-splatnaya Elektronnaya Biologicheskaya Biblioteka of Russia. Thanks to their great efforts, it brought back to life innumerable forgotten ornithological works from the past which were extremely helpful to the researcher. I would also like to praise the Biodiversity Heritage Library of the American Museum of Natural History and the Smithsonian Libraries. Many thanks are due to Dr. A. V. Bardin, the editor of the *Russkiy Ornitologicheskii Zhurnal*, for the ornithological information which he always provided promptly to readers abroad. Finally, my deep admiration goes out to several highly acclaimed former scientist-ornithologists, among whom the following researchers certainly need mentioning: S. Alpheraky, S. A. Buturlin, T. Csörgey, G. P. Dement'yev, H. Grote, Gy. Madarász, E. Nagy, J. Schenk, P. P. Sushkin, B. Stegman, A. Ya. Tugarinov, N. A. Zarudniy, and B. M. Zhitkov, as well as the Hungarian hunter ornithologists G. and L. Szomjas and T. Tarján. They all contributed significantly to my endeavours to clarify the mystery of *Anser neglectus* Sushkin, 1897.

## References

- Alex, U. & Shergalin, J. 2013. Biografien osteuropäischer Ornithologen (10): Arkadij Jakovlevič Tugarinov (1880–1948): Avifaunist Zentralsibiriens, Begründer der russischen Paläornithologie und Spezialist für die Anseriformes [Biographies of East European Ornithologists (10): Arkadij Jakovlevič Tugarinov (1880–1948): Avifaunist of Central Asia, founder of Russian Palaeo-ornithology and specialist for the Anseriformes]. – *Ornithologische Mitteilungen* 65(11–12): 323–328. (in German)
- Alex, U. & Shergalin, J. 2015a Biografien osteuropäischer Ornithologen (19) Peter Petrovič Suškin (1868–1928): Begründer der Leningrader Schule der Systematik, Zoogeografie und Paläontologie in der Ornithologie [Biographies of East European Ornithologists (19) Peter Petrovič Sushkin (1868–1928): Founder of the Leningrad School of systematics, Zoogeography and Palaeo-ornithology]. – *Ornithologische Mitteilungen* 67(9–10): 275–280. (in German)
- Alex, U. & Shergalin, J. 2015b Biografien osteuropäischer Ornithologen (17): Nikolaj Aleksejevič Zarudnij (1859–1919) – Avifaunist und Taxonom Transkaspens, Mittelasiens und Persiens [Biographies of East European Ornithologists (17) Nikolaj Aleksejevič Zarudniy (1859–1919): Avifaunist and taxonomist of Transcaspia, Central Asia and the Persian Empire]. – *Ornithologische Mitteilungen* 67(5–6): 155–160. (in German)
- Ali, S. & Ripley, S. D. 1968. Handbook of the Birds of India and Pakistan, Vol. 1. – Oxford University Press, Oxford
- Alphéraky, S. 1905. The geese of Europe and Asia. – Rowland Ward Ltd., London.
- Alphéraky, S. 1907. A few words in reply to Mr. E. W. Oates' paper on the species of Bean-Geese. – *Journal Bombay Natural History Society* 17: 598–602.
- Andreev, G. V. 1991. International Program for studies of ecological consequences of earth collisions with small bodies in the solar system. – *Proceedings IMC Potsdam*, pp. 82–84.
- Andreev, G. V. & Vasilyev, N. V. 1995. An international program for studies of ecological consequences of the earth collisions with the solar system small bodies (from the point of view of the Tunguska catastrophe of 1908) – *Astronomical and Astrophysical Transactions* 8: 311–315. DOI: 10.1080/10556799508226948
- Anonymus, 1973. A Hortobágy Nemzeti Park. Map és a hozzá csatlakozó természetvédelmi területek vázrajza [The Hortobágy National Nemzeti Park. Map and drawing of relevant nature conservation areas]. (in Hungarian)
- Arrigoni degli Oddi, E. 1929. *Ornitologia Italiana* [Italian Ornithology]. – Hoepli, Milano (in Italian)
- Artobolevskiy, V. M. 1924. Materialy k poznaniyu ptits yugo-vostoka Penzenskoy gubernii [Data to the knowledge of the birds of the southeastern Government of Penza]. – *Bulletin of the Moscow Society of Naturalists: Biology Section* 32(1–2): 162–193. (in Russian)
- As'keev, I. V. & As'keev, O. V. 1999. Ornitofauna Respubliki Tatarstan (konspekt sovremennogo sostoyaniya) [Ornithofauna of the Republic of Tatarstan (Abstract of the actual status)]. – *Akademiya Nauk of the Republic of Tatarstan, Kazan* (in Russian with English Summary)

- Ayé, R., Schweizer, M. & Roth, T. 2012. Birds of Central Asia. – Christopher Helm, London
- Barthel, P. H. & Frede, M. 1989. Die Bestimmung der Gänse der Gattung *Anser* [The identification of Geese belonging to the genus *Anser*]. – *Limicola* 3: 1–31. (in German)
- Bauer, K. M. & Glutz von Blotzheim, U. N. 1968. Handbuch der Vögel Mitteleuropas. Band 2, Anseriformes (1. Teil) [Handbook of the Birds of Central Europe]. – Akademische Verlagsgesellschaft, Frankfurt am Main (in German)
- Berezovikov, N. N. 2018. Innokentiy Nikolaevich Zhukov (1894–1956) – ornitolog, okhotoved, pisatel'- naturalist i zamechatelnyy kraeved Sibiri [Innocent Nikolay Zhukov – ornithologist, hunter, author-naturalist and remarkable student of Siberia]. – *Russkiy Ornitologicheskij Zhurnal* 27 (1621): 2687–2703. (in Russian)
- Berry, J. 1934. The occurrence of an unusual goose of the type *Anser neglectus* in Scotland. – *Ibis* 76: 80–85. DOI: 10.1111/j.1474-919X.1934.tb01544.x
- Bianki, V. L. 1918–22. Rasprostranenie ptits v Severo-Zapadnoy chasti Evropeyskoy Rossii [Distribution of birds in the northwestern part of European Russia]. – *Ezhedodnik Zoologicheskogo Muzeya Rossiyskoy Akademii Nauk* 23: 97–128. (in Russian)
- Boere, G. C., Galbraith, C. A. & Stroud, D. A. 2006. (eds.) Waterbirds around the World. – The Stationery Office, TSO Scotland LTD, Edinburgh, UK.
- Bogdanov, M. N. 1871. Ptitsy i zveri chernozemnoy polosy Povolsh'ya i doliny Sredney i Nishney Volgi (biogeograficheskie material) [Birds and animals of the Black Earth stripe along the Volga and in the valley of the Mid- and the Lower Volga (Bio-geographical contribution)]. – *Trudy Obshchestva Estestvoispytateley pri Imperatorskom Kazanskom Universitet, Vol. 1., N 1: 4–158.* (in Russian)
- Brazil, M. A. 2009. A Field Guide to the Birds of East Asia. – Christopher Helm, London
- Brent, R. L., Gordon, W. E., Bennett, W. R. & Beckman, D. A. 1993. Reproductive and tetralogic effects of electromagnetic fields. – *Reproductive Toxicology* 7(6): 535–580. DOI: 10.1016/0890-6238(93)90033-4
- Burskiy, O. V., Pagenkopf, K. & Forstmayer, V. 2003. Ptitsy Srednego Eniseya: annotirovanny spisok vidov [Birds of the Middle Yenisei River: an annotated list of species]. – *Materialy k Rasprostraneniyu Ptits na Urale, v Priyral'e i Zapadnoy Sibiri* 9: 48–71. (in Russian)
- Buturlin, S. A. 1901. Dikie Gusi Rossiyskoy Imperii. Kratkiy ocherk s opisaniem novykh form [Wild geese of the Russian Imperium. A short description of new forms]. – *Psovaya i Rusheynaya Okhota* 4: 1–16., 5: 17–32., 6: 33–47., Tula (in Russian)
- Buturlin, S. A. 1907. On Bean-Geese. – *Journal Bombay Natural History Society* 17: 603–607.
- Buturlin, S. A. 1908. Bean-Geese of Asia. – *Journal Bombay Natural History Society* 18: 555–561.
- Buturlin, S. A. 1934. A vetési ludfajták szemléje – Übersicht der Saatgansrassen [A review of the races of the Bean Goose]. – *Aquila* 38–41: 219–226. (in Hungarian and German)
- Buturlin, S. A. 1935. Polnyy Opredelitel' Ptits SSSR. T. 2, pp. 77–91. – In: Buturlin, S. A. & Dement'yev, G. P. (eds.) Gagarovye, Veslonogie, Tsapli, Plastinchatoklyuyve, Kurinye, Pastushkovye, Triperstki [A complete determination list of the birds of the USSR, Vol. 2. – In: Buturlin, S. A. & Dement'yev, G. P. (eds.) Pygopodes, Steganopodes, Herodiones, Lamellirostres, Gallinae, Paludicolae, Hemipodii]. – KOIZ, Moscow & Leningrad (in Russian)
- Buturlin, S. A. & Dement'yev, G. P. 1935. Polnyy Opredelitel' Ptits SSSR. T 5. Cpisok Ptits SSSR, obshchiy ocherk stroeniya i shizin ptits. Bibliografiya [Complete Determination List of Birds of the USSR, General Outline of their Structure and their Life. Bibliography]. Vol. 5. – KOIZ, Moscow & Leningrad (in Russian)
- Cao, L., Barter, M. & Lei, G. 2008. New Anatidae population estimates for eastern China: implications for current flyway estimates. – *Biological Conservation* 141: 2301–2309. DOI: 10.1016/j.biocon.2008.06.022
- Cao, L., Zhang, Y., Barter, M. & Lei, G. 2010. Anatidae in eastern China during the non-breeding season: Geographical distribution and protection status. – *Biological Conservation* 143: 650–659. DOI: 10.1016/j.biocon.2009.12.001
- Chernel, I. 1902. Az állatok világa. Brehm Alfréd 'Tierleben' című nagy művének magyarba áttüzetett kiadása. Madarak. Első kötet. Varjúszzerű madarak [Life of Animals. Hungarian edition of the great work 'Tierleben' of Alfred Brehm, Birds]. – Légrády Testvérek, Budapest. (in Hungarian)
- Chernel, I. 1907. Adatok Magyarország madárfaunájához. Daten zur Vogelfauna Ungarns [Data concerning the bird fauna of Hungary]. – *Aquila* 14: 179–187. (in Hungarian and German)
- Chernel, I. 1917. Adatok Magyarország madárfaunájához. Daten zur Vogelfauna Ungarns [Data concerning the bird fauna of Hungary]. – *Aquila* 24: 7–24. (in Hungarian and German)
- Chernel, I. (ed.) 1918. Nomenclator avium Regni Hungariae. A Magyar Birodalom madarainak névjegyzéke [Checklist of the birds of the Hungarian Empire]. – Magyar Királyi Ornithologiai Központ, Budapest. (in Hungarian)

- Cramp, S. & Simmons, K. E. L. (eds.) 1977. The Birds of the Western Palearctic, Vol. 1. Oxford University Press, Oxford.
- Csörgey, T. 1928. A nagy lilik (*Anser albifrons* Scop.) csőrjegyé. Das Schnabel-Erkennungszeichen der Blässgans (*Anser albifrons* Scop.) [The bill recognition sign of the White-fronted Goose (*Anser albifrons* Scop.)]. – Aquila 34–35: 313–315. (in Hungarian and German)
- Danilov, A. 1930. Materialy po nekotorym vidam palearkticheskikh gusey, proletayushchikh v rayone Chitinskogo okruga (po sboram za vesnu 1929 goda) [Data concerning some species of Palearctic geese migrating through the district of Chita (according to the collections of the spring of 1929)]. – Zapiski Zabaykal'skogo Otdela DV Obschestva Kraevedeniya. (ZOK) i Chitinskogo Muzeya Imeni Kuznetsova A. K., 1: 57–83, Chita. (in Russian)
- Danilov, N. N., Ryzhanovskiy, V. N. & Ryabitsev, V. K. 1984. Ptitsy Yamala [The Birds of Yamal Peninsula]. – 'Nauka', Moscow (in Russian)
- Delacour, J. 1951. Taxonomic notes on the Bean Geese, *Anser fabalis* Lath. – Ardea 39: 135–142.
- Delacour, J. 1954. The Waterfowl of the World, Vol. 1. pp. 114–123. – Country Life, London
- del Hoyo, J., Elliott, A. & Sargatel, J. (eds.) 1992. Handbook of the Birds of the World, Vol. 1. Ostrich to Ducks. – Lynx Edicions, Barcelona
- del Hoyo, J. & Collar, N. J. 2014. HBW and BirdLife International. Illustrated Checklist of the Birds of the World, Vol. 1. Non-passeres. – Lynx Editions, Barcelona
- Dement'yev, G. P. 1941. Dopolneniya k tomam pyerovomu, vtoromu, tryet'yemu i chetyvertomu "Polnogo opredeliteya ptits SSSR" [Additions to volumes one, two, three and four "A complete review of the birds of the USSR"]. – In: Buturlin, S. A. & Dement'yev, G. P. (red.) Polnyy opredelitel' ptits SSSR. Tom 5. Spisok ptits SSSR. Obshiy ocherk stroyeniya i zhizni ptits. Bibliografiya [A complete review of the birds of the USSR. Check list of birds of the USSR. Bibliography]. – KOIZ, Moskva & Leningrad: pp. 13–94. (in Russian)
- Dement'yev, G. P. & Gladkov, N. A. (red.) 1952. Ptitsy Sovyetskogo Soyuza. Tom 4. [The Birds of the Soviet Union. Vol. 4.] – Gosudarstvennoye Isdatyel'stvo 'Sov'yetskaya 'Nauka', Moskva. (in Russian)
- Dement'yev, G. P. & Starostinits, I. V. 1952. Ptitsy Turkmenistana [The Birds of Turkmenistan]. – Isd.-vo Akad. Nauk Turkmeniskoy SSR, Ashkhabad (in Russian)
- Dement'ev, G., Gladkov, N. A., Isakov, Yu. A., Kartashev, N. N., Kirikov, S. V., Mikheev, A. V. & Ptushenko, E. S. 1967. Birds of the Soviet Union. Vol. 4. Translated from Russian. – Israel Program for Scientific Translations, Jerusalem.
- Dementieff, G. 1936. Essai de révision des formes de l'Oie des moissons *Anser fabalis* Latham [Attempted review of the races of the Bean Goose *Anser fabalis* Latham]. – Alauda 8: 169–193. (in French)
- den Hollander, A. N. J. 1947. Nederzettingen en -problemen in de Grote Hongaarsche Laagvlakte [Settlements and problems about settlements in the Great Hungarian Plain]. – J. M. Meulenhoff, Amsterdam (in Dutch)
- Dobzhansky, T. 1941. Genetics and the Origin of Species. 2<sup>nd</sup> ed. – Columbia University Press, New York
- Dolgushin, I. A. 1960. Ptitsy Kazakhstana [The Birds of Kazakhstan]. Vol. I. – Isd.-vo Akad. Nauk Kazakskoy SSR, Alma-Ata. (in Russian)
- Eck, S. 1996. Die Palaearktischen Vögel – Geospezies und Biospezies. [The Palaearctic Birds Geospecies and Biospecies. – Zoologische Abhandlungen Staatliches Museum für Tierkunde Dresden 49, Supplement, pp. 103
- Emel'yanov, V. I. 2000. Morfometricheskij analiz gumennika kak osnova okhrany i ratsional'nogo ispol'zovaniya gusey Prieniseyskoy Sibiri [Morfometric analysis of the Bean Goose as a basis for protection and rational use of resources of geese in Pre-Yenisei Siberia]. – Byulleten Krasnoyarskogo Regional'nogo Molodeshnogo Ekol. Obschestvennogo Dvisheniya 'Za sokhranenie prirodnogo naslediya 1: 1–124. (in Russian)
- Emel'yanov, V. I. 2004. Ekologicheskie osnovy okhrany i ratsional'nogo ispol'zovaniya resursov gusey (Anserinae) i lebedey (Cyginae) na yuge Prieniseyskoy Sibiri. Avtoferat [Ecological basis for the protection and the rational use of resources of Anserinae and Cyginae in the south of Pre-Yenisei Siberia] Dissertatsiya kandidatskaya Biologicheskii Nauk Krasnodarskogo Gosudarstvennogo Un-ta, Krasnoyarsk (in Russian)
- Emel'yanov, V. I. 2012. Middendorff's Taiga Bean Goose *Anser fabalis middendorffii* Severtsov, 1873. – In: Savchenko, A. P., Baranov, A. A., Zadelonov, A. A. et al. (eds.) Red Data Book of the province Krasnoyarsk, Vol. 1., 3<sup>rd</sup> ed. – Krasnoyarsk (in Russian)
- Emel'yanov, V. I. 2013. Sovremennoe sostoyanie i chislennost' serogo gusya *Anser anser* i gumennika *Anser fabalis* v ochagakh gnezhdovaniya Minusinskoy kotloviny [Actual status and numbers of *Anser anser* and *A. fabalis* on the breeding grounds of the Minusinsk Hollow]. – Russkiy Ornitologicheskij Zhurnal 22(917): 2456–2457. (in Russian)

- Emel'yanov, V. I. 2014. Sibirskiy tayoshnyy gumennik *Anser fabalis middendorffii* Severtsov, 1873 i zapadnyy tayoshnyy gumennik *Anser fabalis fabalis* Latham, 1787. [Middendorff's Taiga Bean Goose *A. f. middendorffii* Severtsov, 1873 and Taiga Bean Goose *A. f. fabalis* Latham, 1787] – In: Savchenko, A. P., Baranov, A. A., Emel'yanov, V. I. *et al.* (eds.) Red Data Book of the Republic of Khakasiya (Animals), 2<sup>nd</sup> ed. – Krasnoyarsk & Abakan, pp. 111–112., 115–116. (in Russian)
- Emel'yanov, V. I. & Savchenko, A. P. 2015. Current status of geese in the south of Central Siberia. – International Conference 'Waterfowl in northern Eurasia: Research, conservation, and sustainable use', 30 November – 6 December 2015. – Salekhard, Russia, pp. 123–125.
- Emel'yanov, V. I. & Savchenko, A. P. 2016. Sovremennoe sostoyanie i problemy sokhraneniya gusey na yuge Tsentral'noy Sibiri [Actual status and problems of the protection of wild geese in South-Central Siberia]. – Casarca 19: 129–152. (in Russian with English Summary)
- Emel'yanov, V. I., Savchenko, A. P., Temerova, V. L., Savchenko, P. A., Karpova, N. V. & Koshkina, L. A. 2018. Tayoshnyy gumennik Evenkii: Ekologiya i sovremennoe sostoyanie [The Taiga Bean Goose in Evenkia: ecology and actual status]. – Vestnik Krasnoyarskogo Agrarnogo Universiteta 2: 215–224. (in Russian)
- Faragó, S. 1994. Habitat use, daily activity and feeding of the geese of Lake Fertő. – Aquila 101: 65–88.
- Faragó, S. 2016. A vadlúd monitoring eredményei a 2014/2015-ös idényben Magyarországon [Results of geese monitoring in Hungary in the season 2014/2015]. – Magyar Vízivad Közlemények 27: 3–53.
- Faragó, S. & Gosztonyi, L. 2009. Population trend, phenology and dispersion of common waterfowl species in Hungary based on a ten year long time series of the Hungarian Waterfowl Monitoring. – Acta Silvatica & Lignaria Hungarica: 5: 83–107.
- Filatova, E. A. & Lanovenko, E. N. 2012. Izmenenie kharaktera prebyvaniya i chislenosti nekotorykh vidov gidrofil'nykh ptits na zimovkakh v Uzbekistane [Changes in the residence pattern and numbers of some waterbirds in their wintering grounds of Uzbekistan]. – Ornitologicheskii Vestnik Kazakhstana i Sredney Azii. 1: 100–106. (in Russian with English Summary)
- Fridman, V. S. 2012. Trudnosti biologicheskoy kontseptsii vida i puti ikh preodoleniya (na primere ptits) [The difficulty of the biological species concept and ways to overcome them (for example birds)]. – Berkut 21(1-2): 127–182. (in Russian with English Summary)
- Gasparini, L., Alvisi, F., Biasini, G., Bonatti, E., Di Martino, M., Morigi, C., Longo, G., Pipan, M., Ravaioli, M., Sacchetti, F., Sacchi, M. & Vigliotti, L. 2001. Geophysical/sedimentological study of a lake close to the epicenter of the great 1908 Siberian (Tunguska) explosion. – NGF Abstracts and Proceedings 1: 29–30.
- Gavrilenko, N. I. 1929. Ptitsy Poltavshchiny [The Birds of the Regio Poltava]. – Izdanie Poltavskogo Soyuzza Okhotnikov, Poltava (in Russian)
- Gill, F. & Donsker, D. (eds.) 2019. IOC World Bird List (v 9.2) DOI: 10.14344/IOC.ML.9.2
- Grant, P. R. 1975. The classical case of character displacement. – Journal of Evolutionary Biology 8: 237–337.
- Grichik, V. V. 1995. K faune i biologii gnezdovaniya ptits Yugorskogo poluostrova (krajnyy Severo-Vostok Evropeyskoy Rossii) [On the fauna and the biology of nesting birds in the Yugor peninsula (most north-eastern part of European Russia)]. – Fauna i Sistematika: Trudy. Zoologicheskogo Muzeya Belaruskogo Universiteta 1: 271–288. (in Russian with English Summary)
- Grote, H. 1920. Ornithologische Beobachtungen aus dem südlichen Uralgebiet (Orenburg) [Ornithological records from the Southern Ural region (Orenburg)]. – Journal für Ornithologie 68: 124–156.
- Grote, H. 1930a Zum Zuge der Suschkingans [On the migration of Sushkin's Bean Goose]. – Ornithologische Monatsberichte 38: 174–176. (in German)
- Grote, H. 1930b Die Suschkingans (*Anser neglectus* Suschk.) in Russland [The Sushkin's Goose (*Anser neglectus*) in Russia]. – Ornithologische Monatsberichte 38: 7–9. (in German)
- Grote, H. 1934. A vetési lúdfajták ismertető jegyei – Die Kennzeichen der Saatgansrassen [On the field marks of the races of the Bean Goose]. – Aquila 38–41: 211–218. (in Hungarian and German)
- Grote, H. 1932. Zum Zuge von *Anser neglectus* Suschk [On the migration of *Anser neglectus* Suschk]. – Ornithologische Monatsberichte 40: 149. (in German)
- Habeck, O. & DeSmedt, B. 2002. The Tunguska Event: Eyewitness accounts – The Vurdalak Conjecture. Not published Report
- Hachler, E. 1944. Über die Farbenvarietäten einiger Saatgansformen [On the color varieties in the races of the Bean Goose]. – Verhandlungen des naturforschenden Vereines in Brünn 75: 157–171. (in German)
- Haffer, J. 2003. Avian zoogeography, speciation and the museum tradition. – Bulletin of the British Ornithologists' Club 123A: 7–25.

- Hardell, L. & Sage, C. 2008. Biological effects from electromagnetic field exposure and public exposure standards. – *Biomedicine Pharmacotherapy* 62: 104–109. DOI: 10.1016/j.biopha.2007.12.004
- Hartert, E. 1921. Die Vögel der Paläarktischen Fauna. Systematische Übersicht der in Europa, Nord-Asien und der Mittelmeerregion vorkommenden Vögel [The Birds of the Palearctic Fauna. A Systematic Review of the Birds of Europe, North Asia and the Mediterranean Region]. Vol. II: 1283–1285. – R. Friedländer u. Sohn, Berlin (in German)
- Hartert, E. 1932. Die Vögel der Paläarktischen Fauna Heft 1: 432–434. [The Birds of the Palearctic Fauna Vol. 1. 432–434. – R. Friedländer u. Sohn, Berlin (in German)]
- Hartmann, W. K. 2000. Siberia Explosion. Reconstructing an Asteroid Impact from Eyewitness Accounts. – Report from Planetary Science Institute. Tucson, Arizona
- Heinroth, O. 1929. Fachsitzung im Januar 1929. [Professional Meeting in January 1929]. – *Journal für Ornithologie* 77: 526–527. (in German)
- Horváth, L. & Szabó, L. V. 1981. The ornithology of the Hortobágy. – In: Mahunka, S. (ed.) The fauna of the Hortobágy National Park. Vol. I. – Akadémiai Kiadó, Budapest: pp. 391–407.
- Huxley, J. S. 1942. Evolution, the Modern Synthesis. – G. Allen, Unwin, London.
- Huyskens, P. R. G. 1986. Het Europees Rietganzenprobleem *Anser fabalis* [The Bean Geese problem in Europe]. – *Oriolus* 52: 105–256. (in Dutch with English Summary)
- Ilichyov, V. D. & Fomin, V. E. 1988. Ornithofauna i izmenenie Sredy (na primere Yushno- Ural'skogo Regiona [Avifauna and environmental change (for example the Regio of South-Ural)]. – *Nauka, Moscow* (in Russian with English Summary)
- Irwin, D. E. 2009. Incipient ring speciation revealed by a migratory divide. – *Molecular Ecology* 18: 2923–2925. DOI: 10.1111/j.1365-294X.2009.04211.x
- Ivanov, A. I., Kozlova, E. V., Portenko, L. A. & Tugarinov, A. Ya. 1951. Ptitsy CCCP [The Birds of the USSR]. Vol. 1. – *Isd.-vo Akad. Nauk USSR, Moscow & Leningrad* (in Russian)
- Jia, Q., Koyama, K., Choi, C.-Y. & Kim, H.-J. 2016. Population estimates and geographical distributions of swans and geese in East Asia based on counts during the non-breeding season. – *Bird Conservation International* 26: 397–417. DOI: 10.1017/S0959270915000386
- Johansen, H. 1945. Om racer af Sædgaas [On the races of the Bean Goose]. – *Dansk Ornitologisk Forening Tidsskrift* 39: 106–127. (in Danish)
- Johansen, H. 1959. Die Vogelfauna Westsibiriens. 3. Teil (Non-Passeres) [The bird Fauna of West Siberia Vol. 3. (Non-Passeres)]. – *Journal für Ornithologie* 100: 60–78. (in German)
- Johansen, H. 1961. A Magyarországon telelő vetési ludak. Saatgänse aus Winterquartieren in Ungarn [Bean Geese in the wintering areas in Hungary]. – *Aquila* 67–68: 33–38. (in Hungarian and German)
- Johnsgard, P. A. 2010. Ducks, Geese and Swans of the World. – University of Nebraska Press. Lincoln
- Kalyakin, V. N. 2001. Novye dannye po faune ptits Novoy Zemli i Zemli Frantsa – Iosifa [New data on bird fauna of Novaya Zemlya archipelago and Franz-Josef land]. – *Ornitologiya* 29: 8–28. (in Russian with English Summary)
- Kammer, A. 1932. Die siebenbürgischen Gänse [The Geese of Transylvania]. – *Verhandlungen und Mitteilungen der Siebenbürgischen Vereins für Naturwissenschaften zu Hermannstadt. Fortgesetzt: Mitteilungen der Arbeitsgemeinschaft für Naturwissenschaften Sibiu-Hermannstadt* 81–82: 35–42. (in German)
- Karamzin, A. N. 1901. Ptitsy Buguruslanskogo i sopedel'nykh s nim chastey Bugul'minskogo, Buzulukskogo uezdov, Samarskoy gubernii i Belebeyskogo uezda, Ufimskoy gubernii [Birds of Buguruslan and its adjacent parts of the counties Bugul'min, Buzuluk, of the government of Samara and of the Belebey county of the Yfa oblast]. – *Materialy k Poznaniyu Fauny I Flory Rossiyskoy Imperii. Otd. Zool.*, 5: 203–394. (in Russian)
- Kazakov, V. P., Lapushkin, V. A. & Fisher, S. V. 2016. K ornitofaune Permskogo kraya [On the avifauna of the Perm province]. – *Fauna Urala i Sibiri* 2: 86–90. (in Russian with English Summary)
- Keve, A. & Sterbetz, I. 1964. Tentative counts of geese and ducks in Hungary. – *Proc. 1<sup>st</sup> European Meeting on Wildfowl Conservation (St. Andrews, Scotland), 16–18 October 1963.* pp. 39–43.
- Keve-Kleiner, A. 1943. Néhány rendszertani megjegyzés a bécsi Naturhistorisches Museum magyar madártani anyagáról. Einige systematische Bemerkungen über das ungarische ornithologische Material in der Sammlung des Wiener Naturhistorischen Museums [Some systematic remarks concerning the Hungarian ornithological material in the collection of the Museum of Natural History in Vienna]. – *Aquila* 50: 301–310. (in Hungarian and German)
- Kim, H.-J. & Park, H.-C. 2011. Populations change of the Bean Goose (*Anser fabalis*) wintering at the Upo Wetland, Korea. – *Journal of Ecology & Environment* 34: 69–74. DOI: 10.5141/JEFB.2011.009



- Kimchi, T. & Terkel, J. 2001. Magnetic compass orientation in the Blind Mole Rat *Spalax ehrenbergi*. – Journal of Experimental Biology 204: 751–758. DOI: 10.1006/anbe.2000.1565x.doc.org/
- Klafs, G. & Stübs, J. 1987. Die Vogelwelt Mecklenburgs – Bezirke Rostock, Schwerin, Neubrandenburg. Dritte Auflage [The Bird Fauna of Mecklenburg – Cispomermania]. – Verlag Gustav Fischer, Jena
- Klein, E. 1927. Zur ornithologie Bulgariens [On the Birds of Bulgaria]. – Ornithologische Monatsberichte 35: 181. (in German)
- Koblik, E. A. & Arkhipov, V. Yu. 2014. Fauna Ptits Stran Severnoy Evrazii v Granitsakh Byvshego SSSR: Spiski Vidov [Avifauna of the States of Northern Eurasia (former USSR): Checklists]. – Zool. Issledovaniya 14, Tovarishestvo Nauchnykh Isdaniy KMK. (in Russian with English Summary)
- Koblik, E. A., Red'kin, Ya. A. & Arkhipov, V. Yu. 2006. Spisok Ptits Rossiyskoy Federatsii [Checklist of the Birds of Russian Federation]. – KMK Scientific Press Ltd., Moscow, (in Russian with English Summary)
- Kondo, B., Baker, J. M. & Omland, K. E. 2004. Recent speciation between the Baltimore Oriole and the Black-backed Oriole. – Condor 106: 674–680. DOI: 10.1650/7496
- Kondo, B., Peters, J. L., Rosensteel, B. B. & Omland, K. E. 2008. Coalescent analyses of multiple loci support a new route to speciation in birds. – Evolution 62: 1182–1191. DOI: 10.1111/1558-5646.2008.0034.x
- Königstedt, D. 1990. Über Saatgänse (*Anser fabalis*) mit abweichend gefärbten Schnäbeln und Füßen [On Bean Geese (*Anser fabalis*) with aberrant colors of bill and feet]. – Zoologische Abhandlungen Staatliches Museum. für Tierkunde Dresden 45: 141–144. (in German)
- Korovin, V. A. 1997. Ptitsy Yushnoy okonechnosti Chelyabinskoy oblasti [The birds of the southern tip of the Chelyabinsk region]. – Materialy k Rasprostraneniyu Ptits na Urale, v Priural'e i Zapadnoy Sibiri 3: 74–97. (in Russian)
- Kreuzberg-Mukhina, E. A. 2006. The effect of habitat change on the distribution of waterbirds in Uzbekistan and the possible implications of climate change. – In: Boere, G. C., Galbraith, C. A. & Stroud, D. A. (eds.) Waterbirds around the world. – The Stationery Office, Edinburgh, pp. 277–282.
- Lack, D. 1968. Ecological adaptations for breeding in birds. – Methuen, London.
- Lack, D. 1971. Ecological isolation in birds. – Harvard University Press, Cambridge, Massachusetts.
- Lapushkin, V. A. & Kazakov, V. P. 2000. Ptitsy okrestnostey Kisherti [Birds of the surroundings of Kishertsy District]. – Materialy k Rasprostraneniyu Ptits na Urale, v Priural'e i Zapadnoy Sibiri 6: 125–130. (in Russian)
- Lebret, T. & Philippona, J. 1968. Ganzen in de Hongaarse poesta [Geese in the Hungarian puszta]. – De Levende Natuur 71: 91–95. (in Dutch with English Summary)
- Lombry, Th. 2015. L'évènement de la Tunguska [The Tunguska event] <http://www.astrosurf.com/luxorion/impacts-tunguska.htm>.
- Longo, G., Bonatti, E., Di Martino, M., Foschini, L. & Gasperini, L. 2001. Exploring the site of the Tunguska impact. – NGF Abstracts and Proceedings of the Norwegian Geological Society 1: 48–50.
- Madarász, Gy. 1899. Magyarország madarai. Die Vögel Ungarns [The Birds of Hungary] – Budapest.
- Madarász, Gy. 1900. *Anser neglectus* Sushk. a magyar orniszbán [*Anser neglectus* in the Hungarian Ornis]. – Természettudományi Füzetek 23: 75–79. (in Hungarian and German)
- Madarász, Gy. 1909. Adatok a vadludak természetrajzához. [On the Natural History of wild geese]. – Annales Musei Historico-naturalis Hungarici 7: 302–306. (in Hungarian with German Summary)
- Marino, A. A. & Becker, R. O. 1977. Biological effects of extremely low frequency electric and magnetic fields: a review. – Physiological Chemistry and Physics 9: 131–147.
- Martens, J. 2012. Arten und Unterarten im Spannungsfeld aktueller ornithologischer Systematik [Species and Subspecies in the field of tension of current ornithological systematics]. – Anzeiger des Vereins Thüringer Ornithologen 7: 153–170. (in German)
- Matvejev, S. D. & Vasić, V. F. 1973. Catalogus Faunae Jugoslaviae. IV/3 Aves. – Academia Scientiarum et Artium Slovenica, Ljubljana. Published report.
- Mayr, E. 1942. Systematics and the Origin of Species. – Columbia University Press, New York
- Mayr, E. 1963. Animal species and evolution. – Harvard University Press, Cambridge, Massachusetts.
- Mayr, E. 1976. Evolution and the diversity of life. – Harvard University Press, Cambridge, Massachusetts.
- Mayr, E. 2006. Typological versus population thinking. – In: Sober, E. (ed.) Conceptual Issues in Evolutionary Biology. 3<sup>rd</sup> ed. – Bradford Books, The MIT Press London.
- Mayr, E. & Cottrell, G. W. (eds). 1979. Check-List of Birds of the World, Vol. 1. 2<sup>nd</sup> ed. – Harvard University Press, Cambridge
- Meklenburtsev, R. N., Sagitov, A. K., Kashkarov, D. Yu., Mitropol'skiy, O. V., Fotteler, E. R. et al. 1987. Ptitsy Uzbekistana. [The Birds of Uzbekistan]. Vol. 1. – Isdatel'stvo 'FAN' Uzbekskoy SSR, Tashkent (in Russian)

- Menzbir, M. A. 1900. Okhotnich'i i Promyslovyaya Ptitsy Evropeyskoy Rossii i Kavkaza [Hunting and Game birds of the European Part of Russia and the Caucasus]. Vol. 1. – Tipolit. T-va I.N. Kushnerev i K°, Moscow (in Russian)
- Menzbir, M. A. 1902. Okhotnich'i i Promyslovyaya Ptitsy Evropeyskoy Rossii i Kavkaza [Hunting and Game Birds of the European Part of Russia and the Caucasus]. Vol. 2. – Tipolit. T-va I. N. Kushnerev i K°, Moscow (in Russian)
- Menzbir, M. A. 1934. Ocherk Istorii Fauny Evropeyskoy Chasti SSSR [Historical Essay concerning the Fauna of the European Part of the USSR]. – Isd.-vo Biomedgiz, Moscow & Leningrad (in Russian)
- Mitropol'skiy, O. V. (ed.) 2012. Nikolay Aleekseevich Zarudnyy kak issledovatel' Turkestanskogo Kraya. Nazemnye pozvonochnye shivotnye aridnykh ekosistem: 24-27 oktyabrya 2012 g., Tashkent [Terrestrial Vertebrates of Arid Ecosystems: Data of the International Conference dedicated to the Memory of N. A. Zarudny (24-27 October 2012, Tashkent)]. – Isd.-vo Chinor ENK, Tashkent (in Russian)
- Morozov, V. V. 2016. Ptitsy verkhnego techeniya reki Adz'vy (Bol'chезemel'skaya tundra) [Birds of the upper Adzva River basin (Bolshezemelskaya tundra)]. – Ornitologia 40: 62–69. (Russian with English Summary)
- Nagy, E. 1907. Vadlúdjárás a Hortobágyon. Zug der Wildgänse im Hortobágy [The migration of wild geese in the Hortobágy]. – Aquila 14: 332–334. (in Hungarian and German)
- Nagy, E. 1924. A Hortobágy madárvilága. A Hortobágy jelentősége a madárvonulásban. Az itt átvonuló madarak. Die Vogelwelt der Pusta-Hortobágy in Ungarn. Die Bedeutung der Pusta-Hortobágy für den Vogelzug. Die hier durchziehenden Wildgänse [The bird world of the puszta Hortobágy in Hungary. The importance of the puszta Hortobágy for bird migration. On the geese migrating here]. – Aquila 30–31: 272–288. (in Hungarian and German)
- Nagy, E. 1934. A vetési ludak újabb rendszertani beosztásáról. Über die neuere systematische Einteilung der Saatgänse [On a new systematic classification of the Bean Geese]. – Aquila 38–41: 229–247. (in Hungarian with German Summary)
- Nagy, L. 1961. A volt Bihari Sárret jelenlegi madárvilága [The present bird-life of the drained marsh – land of Sárret in East Hungary]. – Aquila 67–68: 151–157. (in Hungarian)
- Naumkin, D. V. 2005. Vodoplavayushchie i okolovodnye ptitsy Kungurskoy lesostepi (Permskaya oblast') [Waterfowl and waterbirds of the Kungur forest steppe (Perm government)]. – Materialy k Rasprostraneniyu ptits na Urale v Priural'e i Zapadnoy Sibiri 11: 212–219. (in Russian)
- Naumov, R. L. 1985. Jenissej-Gebiet, West- und Ostsajan, Tuwinische ASSR [Yenisei river region, Western and Eastern Sayan mountains, Tuvan Autonomous Republic]. – In: Il'ichev, V. D. & Flint, V. E. Handbuch der Vögel der Sowjetunion. Band 1. [Handbook of the Birds of the Soviet Union Vol. 1.]. – A. Ziemsens Verlag, Wittenberg Lutherstadt: pp. 125–130.
- Nesvetajlo, V. D. 1998. Consequences of the Tunguska catastrophe: dendrochronoincidence interferences. – Planetary and Space Science 46: 155–161. DOI: 10.1016/S0032-0633(97)00144-x
- Niethammer, G. 1938. Handbuch der deutschen Vogelkunde. Band II. [Handbook of the birds of Germany. Vol. 2.]. – Akademische Verlagsgesellschaft, Leipzig (in German)
- Oates, E. W. 1899. A manual of the game birds of India, Part 2. Water Birds. – A. J. Combridge & C°, Bombay.
- Ol'khovator, A. Yu. 2018. The Tectonic Interpretation of the 1908 Tunguska Event. – <http://olkhov.narod.ru/tunguska.htm>.
- Omland, K. E., Lanyon, S. M. & Fritz, S. J. 1999. A molecular phylogeny of the New World orioles (*Icterus*); the importance of dense taxon sampling. – Molecular Phylogenetics and Evolution 12: 224–239. DOI: 10.1006/mpev.1999.0611
- Päckert, M., Martens, J., Wink, M., Feigl, A. & Tietze, D. T. 2012. Molecular phylogeny of Old World swifts (Aves, Apodiformes, Apodidae: *Apus* and *Tachymarptis*) based on mitochondrial and nuclear markers. – Molecular Phylogenetics and Evolution 63: 606–616. DOI: 10.1016/j.ympev.2012.02.002
- Panteleev, A. V. & Potapova, O. R. 2000. Pozdnegolotsenovyie ptitsy iz arkeologicheskoy stoyanki okrestnostey g. Salekharda (Sever Zapadnoy Sibiri) [Late Holocene birds from an archeological site near Salekhard (North Western Siberia)]. – Russkiy Ornitologicheskii Zhurnal 9, Ekspress-issue 106: 3–31. (in Russian)
- Parslow-Otsu, M. 2010. Letter to Joseph Morlan concerning the field determination of *A. f. serrirostris* and *A. f. middendorffii*. – Not published letter
- Perco, F. 2012. *Anser fabalis rossicus* cfr *neglectus*. – Not published report – <http://www.sbic.it/index.php?mact-News>
- Peters, J. L. 1931. Check-list of Birds of the World. Vol. 1. – Harvard University Press, Cambridge, Massachusetts.

- Pfander, P. V. 2018. Tragediya okolovidovoy sistematiki [The tragedy of the species-level systematics]. – *Russkiy Ornitologicheskii Zhurnal* 25, Ekspress-Issue 1558: 301–335. (in Russian)
- Pleske, Th. 1928. Birds of the Eurasian Tundra. – *Memoirs of the Boston Society of Natural History* 6(3): 314.
- Podmaryov, A. I. 2010. Gumennik *Anser fabalis* v Krasnokamskom rayone Bashkirii za 2010 g. [Bean Goose *Anser fabalis* in the Krasnokam district of Bachkortostan during the year 2010]. – In: Valuev, V. A. (ed.) *Materialy Vedeniya Krasnoy Knigi Respubliki Bashkortostan za 2010 god. Issue II/ ПИЦ башГУ, Ufa.* (in Russian)
- Polyakov, G. I. 1910. K ornitologicheskoy faune Moskovskoy gubernii. Ptitsy otradov Pygopodes, Longipennes, Lamellirostres i Steganopodes [On the bird fauna of Moscow Government. Birds of the orders Pygopodes, Longipennes, Lamellirostres i Steganopodes]. – *Materialy k Poznaniyu Fauny i Flory Rossiyskoy Imperii, Otdel Zoologicheskii* 10: 1–211. (in Russian)
- Popov, E. A. 2015. Nekotorye vstrechi redkikh ptits v Chelyabinskoy oblasti v 2015 gody. [Some records of rare birds in the government of Chelyabinsk during the year 2015]. – *Fauna Urala i Sibiri* 2: 145–152. (in Russian with English Summary)
- Prato, F. S., Desjardins-Holmes, D., Keenlside, L. D., DeMoor, J. M., Robertson, J. A. & Thomas, A. N. 2013. Magnetoreception in laboratory mice: Sensitivity to extremely low-frequency fields exceeds 33 nT at 30 Hz. – *Journal of the Royal Society Interface* 10(81): 2012.1046. DOI: 10.1098/rsif.2012.1046
- Randler, C., Förschler, M. I., Gonzales, J., Aliabadian, M., Bairlein, F. & Wink, M. 2012. Phylogeography, pre-zygotic isolation and taxonomic status in the endemic Cyprus Wheatear *Oenanthe cypriaca*. – *Journal für Ornithologie* 153: 303–312. DOI: 10.1007/s10336-011-0744-8
- Redkin, Ya. A., Arkhipov, V. Yu., Volkov, S. V., Mosalov, A. A. & Koblik, E. A. 2016. Vid ili ne vid? Spornye taksonomicheskie traktovki ptits Severnoy Evrazii [Species or no species? Controversial taxonomic interpretations on birds of northern Eurasia]. – *Russkiy Ornitologicheskii Zhurnal* 25: 141–171. (in Russian)
- Repacholi, M. H. 1998. Low-level exposure to radiofrequency electromagnetic fields: health effects and research needs. – *Bioelectromagnetics* 19: 1–19. DOI: 10.1002/(SICI)1521-186x(1998)19:1<1
- Ringleben, H. 1953. Zum Vorkommen nordischer Wildgänse als Durchzügler und Wintergäste in Schleswig-Holstein [On the occurrence of northern wild geese as birds of passage and winterers in Schleswig-Holstein]. – *Naturwissenschaftlichen Vereins für Schleswig-Holstein* 26: 138–145. (in German)
- Robson, C. 2015. *Birds of South-East Asia. Concise ed.* – Bloomsbury Publ. PLC, London
- Rogachëva, E. V. 1988. Ptitsy Credney Sibiri. Rasprostranenie, chislennost', zoogeografiya [Birds of Central Siberia. Distribution, numbers, zoogeography]. – 'Nauka', Moscow (in Russian)
- Rogachëva, E. V. 1992. *The birds of Central Siberia.* – Husum Druck – Verlagsgesellschaft, Husum.
- Rogacheva, E. V. & Syroechkovskiy, E. E. 2015. Central Eurasia – The last terra incognita of goose ranges. – *International Conference 'Waterfowl in Northern Eurasia': Research, Conservation and Sustainable Use, 30 November – 6 December 2015.* – Salekhard (Russia): pp. 170–171.
- Roselaar, C. S. 1977. De geografische variatie van de Rietgans [The geographical variation in the Bean Goose]. – *Watervogels* 2: 61–68. (in Dutch with English Summary)
- Rozenfeld, S. B., Zamyatin, D. O., Vangeluwe, D., Kirtaev, G. V. *et al.* 2018. Lesnoy gumennik v Yamalo-Nenetskom Avtonomnom Okruge [The Taiga Bean Goose in the Yamalo-Nenets Autonomous Area]. – *Casarca* 20: 28–52. (in Russian with English Summary)
- Rubtsov, A. S. 2015. Reproductive isolation and the notion of species in birds. – *Biology Bulletin* 42(9): 793–807.
- Rubtsov, V. 2009. *The Tunguska mystery.* – Springer, Dordrecht.
- Ruokonen, M. & Aarvak, T. 2011. Typology revisited: historical taxa of the Bean Goose – Pink-footed Goose complex. – *Ardea* 99: 103–112. DOI: 10.5253/078.099.0112
- Rustamov, A. K. & Kovshar, A. F. 2007. Ptitsy Sredney Azii [Birds of Central Asia]. – *Soyuz Okhrany Ptits Kazakhstana, Almaty.* (in Russian)
- Ryabitshev, V. K. 2008. Ptitsy Urala, Priural'ya i Zapadnoy Sibiri [The Birds of the Ural, Pre-Ural and West Siberia]. 3<sup>rd</sup> ed. – *Isdatelstvo Uralskogo Universiteta, Yekaterinburg* (in Russian)
- Ryabitshev, V. K. 2014. Ptitsy Sibiri [The Birds of Siberia]. Vol. 2. – *Kabinetnyy Uchenyy, Moscow & Yekaterinburg.* (in Russian)
- Ryabitshev, V. K. & Ryabitshev, A. V. 2015. Ptitsy Verkhne-Tazovskogo zapovednika i ego okrestnostey (Yamalo-Nenetskiy avtonomnyy okrug) [Birds of the Upper Taz Nature Reserve and its vicinity (the Yamal-Nenets Autonomous Area)]. – *Fauna Urala i Sibiri* 2: 174–205. (in Russian with English Summary)
- Rychkov, Y. G. 2000. A possible genetic trace of the Tunguska catastrophe of 1908? – *RIAP Bulletin* 6(1): 3–5.
- Salvadori, T. 1905. Notes on Alphéraky's 'Geese of Europe and Asia'. – *Ibis* 5(8): 528–535.

- Sangster, G. & Oreel, G. J. 1996. Progress in taxonomy of Taiga and Tundra Bean Geese. – *Dutch Birding* 18: 310–316.
- Schalow, H. 1917. Einige Bemerkungen zur Vogelfauna von Nowaja Zemlja [Some remarks concerning the Bird fauna of Novaya Zemlya]. – *Journal für Ornithologie* 65: 215–222.
- Schenk, J. 1929. Die Suschkingans (*Anser neglectus*) in Ungarn [The Sushkin's Bean Goose in Hungary]. – *Journal für Ornithologie* 77: 282–291.
- Schenk, J. 1930a. Die Durchzugsgebiete der ungarischen Suschkingänse [The migration area of the Sushkin's Bean Goose]. – *Ornithologische Monatsberichte* 38: 172–174.
- Schenk, J. 1930b. A gegeľud (*Anser neglectus* Sushk.) Magyarországon. Die Suschkingans (*Anser neglectus* Sushk.) in Ungarn [The Sushkin's Bean Goose (*Anser neglectus* Sushk. in Hungary)]. – *Aquila* 36–37: 54–67. (in Hungarian and German)
- Schenk, J. 1934. További adatok az *Anser neglectus* Sushk. és *Anser carneirostris* But.-ról. Weitere daten über *Anser neglectus* Sushk. und *Anser carneirostris* But [Further data about *Anser neglectus* Suschk. and *Anser carneirostris* But.]. – *Aquila* 38–41: 193–210. (in Hungarian and German)
- Schiöler, E. L. 1921. Sushkins gaas, *Anser neglectus* Sushk. truffen i Danmark [Occurences of Sushkin's Goose *Anser neglectus* in Denmark]. – *Dansk Ornitologisk Forenings Tidsskrift*. 15: 37–46. (in Danish)
- Scott, P. 1956. Some photographic studies of the Pink-footed Goose. – *British Birds* 49: 172–173.
- Serra, R., Cecchini, S., Galli, M. & Longo, G. 1994. Experimental hints on the fragmentation of the Tunguska cosmic body. – *Planetary and Space Science* 42: 777–783.
- Silagadze, Z. K. 2005. Tunguska genetic anomaly and electrophonic meteors. – *Acta Physica Polonica B* 36: 935–964.
- Sober, E. (ed.) 2006. *Conceptual Issues in Evolutionary Biology*. 3<sup>rd</sup> ed. – Bradford Books, Cambridge, Massachusetts and London.
- Spisok Ptits Uzbekistana 2017. [Birdlist of Uzbekistan]. – [https://ru.wikipedia.org/wiki/Список\\_птиц\\_Узбекистана](https://ru.wikipedia.org/wiki/Список_птиц_Узбекистана). (in Russian with English Summary)
- Stegmann, B. 1935. Wo brütet *Anser neglectus* Suschkin? [Where *Anser neglectus* is breeding?]. – *Ornithologische Monatsberichte* 43: 27–28.
- Stepanyan, L. S. 1990. Konspekt Ornitologicheskoy Fauny SSSR. [Conspectus of the Ornithological Fauna of the USSR]. – 'Nauka', Moskva (in Russian)
- Stepanyan, L. S. 2003. Konspekt ornitologicheskoy fauny Rossii i sopredel'nykh territoriy v Granitsakh SSSR kak istoricheskoy oblasti [Conspectus of the ornithological fauna of Russia and adjacent territories (within the frontiers of the USSR, as an historical area)]. – 'Akademkniga', Moskva (in Russian)
- Sterbetz, I. 1967. A Magyarországon telelő lilikek ökológiai problémái. Ecological problems of White-fronted Geese passing the winter in Hungary. – *Aquila* 73–74: 33–49. (in Hungarian and English)
- Sterbetz, I. 1975. A vadlúdvonulás alakulása a magyarországi gyülekezőhelyeken [Development of wild-geese migration on the Hungarian gathering-places]. – *Aquila* 82: 181–194. (in Hungarian with English Summary)
- Sterbetz, I. 1977. Einfluss der Veränderungen der Agrarumwelt auf die Tierwelt des Naturschutzgebietes Kardoskút [Influence of changes in the agricultural world on wildlife in the nature reservation Kardoskút]. – *Aquila* 84: 65–81. (in German)
- Sterbetz, I. 1978. A nagy lilik (*Anser albifrons*), a kis lilik (*Anser erythropus*) és a vetési lúd (*Anser fabalis*) táplálkozási viszonyai Magyarországon [Feeding of the Bean Goose (*Anser fabalis*), White-fronted Goose (*Anser albifrons*) and Lesser white-fronted Goose (*Anser erythropus*) in Hungary]. – *Aquila* 85: 93–106. (in Hungarian)
- Sterbetz, I. 1980. Megfigyelések a Suschkin lúd (*Anser neglectus* Suschk.) etológiájáról és ökológiájáról [Observations concerning the ethology and ecology of the Sushkin Goose (*Anser neglectus* Suschk.)]. – *A Hajdúsági Múzeum Évkönyve* 4: 43–44. (in Hungarian with English Summary)
- Stresemann, E. 1922. Eine für Deutschland neue Gans: *Anser neglectus* Suschkin [A new goose for Germany]. – *Ornithologische Monatsberichte* 30: 107–109. (in German)
- Stresemann, E. 1929. Abermals eine Suschkingans (*Anser neglectus*) bei Berlin erlegt [Once again a Sushkin's Goose killed near Berlin]. – *Ornithologische Monatsberichte* 37: 35–39. (in German)
- Stresemann, E. 1930. Wiederum eine Suschkingans in Deutschland erlegt [Once again a Sushkin's goose killed in Germany]. – *Ornithologische Monatsberichte* 38: 9–10. (in German)
- Stresemann, E. 1934. Zum vierten Mal eine Suschkingans (*Anser neglectus*) in Deutschland erlegt [A Sushkin's Goose for the fourth time killed in Germany]. – *Ornithologische Monatsberichte* 42: 22. (in German)
- Strom, H., Øien, I. J., Opheim, J., Kuznetzov, E. A. & Khakhin, G. V. 1994. Seabird censuses in Novaya Zemlya 1994. Working report. – *Norwegian Ornithological Society Report* 2. pp. 38.

- Stuart Baker, E. Ch. 1929. The Fauna of British India, including Ceylon and Burma, Vol. 6. (2<sup>nd</sup> ed.). – Taylor and Francis, London.
- Sushkin, P. P. 1897a Ptitsy Ufimskoy Gubernii [Birds of the Government Ufa]. – Materialy k Poznaniyu Fauny i Flory Ross. Imp. Otd. Zool. Issue 4. Tovarishchestvo I. N. Kushneryov i K<sup>o</sup>, Moscow (in Russian)
- Sushkin, P. 1897b On the new Palaearctic Goose *Anser neglectus*. – Ibis 39: 5–8.
- Sushkin, P. 1905. *Anser neglectus*. – In: Alphéraki, S. (ed.) The geese of Europe and Asia. – Rowland Ward Ltd., London: pp. 78–86.
- Sushkin, P. P. 1938. Ptitsy Sovetskogo Altaya i Prileshashchikh Chastey Severo-Zapadnoy Mongolii [Birds of the Soviet part of the Altai and the neighbour parts of North-West Mongolia]. Vol. 1. – Isd.-vo Akademii. Nauk SSSR, Moscow & Leningrad (in Russian)
- Syroechkovsky, E. E. Sr. 1959. Novye materialy po ornitofaune Sredney Sibiri (basseyn Podkamennoy Tunguski) [New data concerning the bird fauna of Central Siberia (lowland of the Podkamennaya Tunguska)]. – Uchen. Zap. Krasnoyarskogo Gosudarstvennogo Pedagogicheskogo Un-ta. Kaf. Botaniki i Zoologii, Krasnoyarsk 15: 225–239. (in Russian)
- Syroechkovsky, E. E. Jr. 2006. Long-term declines in Arctic Goose populations in eastern Asia. – In: Boere, G. C., Galbraith, C. A. & Stroud, D. A. (eds.) Waterbirds around the world. – The Stationery Office, Edinburgh, U. K.: pp. 649–662.
- Syroechkovsky, E. V. & Kaliyakin, V. N. 1996. Sistematischeskiy status gumennika *Anser fabalis* (Latham, 1787) Yugorskogo poluostrova, ostrova Vaygach i Novoy Zemli [The systematic status of the Bean Goose (*Anser fabalis* (Latham, 1787)) on the Yugor peninsula, Vaigach Island and Novaya Zemlya]. – Casarca 2: 168–183. (in Russian with English Summary)
- Szalay, E. L. 1902. Az *Anser fabalis* (Lath. 1823) és *neglectus* (Sushk. 1897), – a *Larus ridibundus* (L. 1758) és *canus* (L. 1758) mellsontvázainak comparativ osteológiája. Comparatieve Osteologie der Brust-Schulter-apparate von *Anser fabalis* (Lath. 1823) und *neglectus* (Sushk. 1897) – *Larus ridibundus* L. 1758) und *Larus canus* (L. 1758) [Comparative osteology of the glenohumeral joint in *Anser fabalis* (Lath. 1823) and *neglectus* (Sushk. 1897) – *Larus ridibundus* and *L. canus*]. – Aquila 9: 12–29. (in Hungarian and German)
- Szomjas, G. 1916. Levelek a Hortobágyról. Briefe aus der Hortobágy [Letters from the Hortobágy]. – Aquila 23: 345–347. (in Hungarian and German)
- Szomjas, G. 1917. Madártani jegyzetek a Hortobágyról az 1916. és 1917. évekből. Ornithologische Notizen von der Hortobágyer Heide aus den Jahren 1916 und 1917. [Ornithological notes from the Hortobágy heather in the years 1916 and 1917]. – Aquila 24: 273–288. (in Hungarian and German)
- Szomjas, L. 1922. Madártani hírek a Hortobágyról. Ornithologisches aus dem Hortobágy [Ornithological notes from the Hortobágy]. – Aquila 29: 165–166. (in Hungarian)
- Szomjas, L. 1926. A vadludak viszonylagos gyakorisága a Hortobágyon. Die relative Häufigkeit der Wildgänsearten im Hortobágy [The relative frequency of the wild geese species in Hortobágy]. – Aquila 32–33: 158–160. (in Hungarian and German)
- Szomjas, L. 1934. Madártani hírek a Hortobágyról. Ornithologische Nachrichten aus der Hortobágy Puszta [Ornithological News Bulletin from the puszta Hortobágy]. – Aquila 38–41: 341–344., 402–405. (in Hungarian and German)
- Tarasov, V. V. & Grachov, S. V. 2016. Ptitsy Oktyabr'skogo rayona Chelyabinskoy oblasti [Birds of Oktyaber district of Chelyabinsk government]. – Fauna Urala i Sibiri 2: 191–213. (in Russian with English Summary)
- Tarján, T. 1921. Adatok a Hortobágy madárvilágához. Beiträge zur Vogelwelt des Hortobágy [Contribution to the bird world of the Hortobágy]. – Aquila 28: 180–182. (in Hungarian and German)
- Tarján, T. 1926. A vadludak viszonylagos gyakorisága a Hortobágyon. Die relative Häufigkeit der Wildgänsearten im Hortobágy [The relative frequency of the wild geese species in Hortobágy]. – Aquila 32–33: 154–160. (in Hungarian and German)
- Tobias, J. A., Seddon, N., Spottiswoode, C. N., Pilgrim, J. D., Fishpool, L. D. C. & Collar, N. J. 2010. Quantitative criteria for species delimitation. – Ibis 152: 724–746. DOI: 10.1111/j.1474-919x.2010.01051.x
- Torimi, A. 2018. Xeno-canto. 2015–2018. Bird Songs from the whole World. *A. f. middendorffii*. – Xeno-canto Foundation, Naturalis Biodiversity Center
- Tugarinov, A. Ya. 1910. Gusi nishnyago Eniseya [The Geese of the Lower Yenisei River]. – Ornitologicheskii Vestnik 1: 44–49. (in Russian)
- Tugarinov, A. Ya. 1912. K ornitofaune Eniseyskoy gubernii [On the birdfauna of the Yenisei government]. – Ornitologicheskii Vestnik 2: 124–128. (in Russian)

- Tugarinov, A. Ya. 1927. Ptitsy Prieniseyskoy Sibiri. Spisok i rasprostranenie [Birds of Pre-Yenisei Siberia. Species list and distribution]. – Zapiski Sredne-Sibirskogo Otdela Ryckckogo Geograficheskogo Obshcheta, (RGO), Ser. 2, 1(1): 1–43. (in Russian)
- Tugarinov, A. Ya. 1932. Ptitsy SSSR. Utki, gusi, lebedi i krokhalii [Birds of USSR. Ducks, geese, swans and Mergini]. – Opredeliteli po Faune SSSR. Izdavaemye Zoologicheskim Institutom Akad. Nauk. SSR. 5: 63–64. (in Russian)
- Tugarinov, A. Ya. 1941. Fauna SSSR. Novaya seriya. N° 30. Ptitsy. Platinchatoklyuyve [Birds of the USSR. New Series. Birds. Lamellirostres]. Vol. 1., Part 4., Isdatelstvo Akademii Nauk USSR. Moscow & Leningrad (in Russian)
- Tugarinov, A. Ya. & Buturlin, S. A. 1911. Materialy po ptitsam Eniseyskoy Gubernii [Data concerning birds of the government Yenisei]. – Zapiski Krasn. Podotdela Vostochno-Sibirskogo Otdela Russk. Geograficheskogo Obshchectva. Vol. 1., Part 2–4., Tip. M. I. Abalakova (in Russian)
- Udvardy, M. 1941. Die Vogelwelt der Puszta Hortobágy [The Bird World of the Puszta Hortobágy]. – Tisia 5: 92–169.
- Uspenski, S. M. 1965. Die Wildgänse Nord-Eurasiens [Wild Geese of Northern Eurasia]. – Wittenberg-Lutherstadt. /Die Neue Brehm Bücherei/ (in German)
- Vaganov, E. A., Hughes, M. K., Silkin, P. P. & Nesvetailo, V. D. 2004. The Tunguska event in 1908: evidence from tree-ring anatomy. – Astrobiology 4: 391–399. DOI: 10.1089/ast.2004.4.391
- Valuev, V. A. 2010. Ornitofauna ozera Asli-Kul' [The bird fauna of lake Asli-Kul']. – Materialy po Flore i Faune Respubliki Bashkortostan, Issue 1. Otv. Red. V. A. Valuev, PITS, bashGU, Ufa, pp. 35–38. (in Russian)
- van den Bergh, L. 1985. Het voorkomen van de Taiga Rietgans *Anser fabalis fabalis* in Nederland [On the occurrence of the Taiga Bean Goose *Anser fabalis fabalis* in the Netherlands]. – Limosa 58: 17–32. (in Dutch with English Summary)
- van den Bergh, L. 2004. De Sushkins Gans *Anser fabalis neglectus* en de Buturlingans *Anser (fabalis) carneirostris* [On the Sushkin's Goose *Anser fabalis neglectus* and the Buturlin's Goose *Anser (fabalis) carneirostris*]. – Vogeljaar 52: 200–209. (in Dutch with English Summary)
- van den Brink, F. H. 1930. The occurrence of Sushkin's Bean-Goose (*Anser neglectus* Sushkin) in the Netherlands. – Ibis 6(4): 555–559. DOI: 10.1111/j.1474-919X.1930.tb02965.x
- Van Impe, J. 1980. Ecologie et éthologie des Oies des moissons *Anser fabalis fabalis* et *Anser fabalis rossicus* [Ecology and ethology of the Bean Geese *Anser fabalis fabalis* and *Anser fabalis rossicus*]. – Gerfaut 70: 499–558. (in French with English Summary)
- Van Impe, J. 1988. Het voorkomen van Rietganzen met de kenmerken van Sushkins Rietgans *Anser fabalis 'neglectus'* en Buturlins Rietgans *A. f. 'carneirostris'* in de 'Groote Peel' Nederland [On the occurrence of Bean Geese with field characters of Sushkin's Bean Goose and Bururlin's Bean Goose in the 'Grote Peel', the Netherlands]. – Oriolus 54: 40–41. (in Dutch with English Summary)
- Vartapetov, L. G. 1998. Ptitsy Severnoy Taygi Zapadno-Sibirskoy Ravniny [The Birds of the Northern Taiga of the West Siberian Plain]. – 'Nauka', Sib. Predpriatie RAN, Novosibirsk, (in Russian)
- Vasil'ev, N. V. 2004. Tungusskiy Meteorit. Kosmicheskiy Fenomen Leta 1908 g. [The Tunguska Meteorite. A Cosmological Phenomenon during Summer 1908]. – 'Russkaya Panorama', Moscow (in Russian)
- Vasilyev, N. V., Andreev, G. V., Anfingonov, J. F. & Budaeva, L. I. 2002. About the possible nature of mutation violations in the region of Tunguska 1908 catastrophe. – Workshop 'Astrobiology in Russia', March 15–29, 2002. St. Petersburg, Russia
- Vasvári, M. 1929. A vörösnakú lúd téli szállása állatföldrajzi megvilágításban. Die Winterquartiere der Rothalsgans in tiergeografische Beleuchtung [The winter haunts of the Red-breasted Goose in the animal geography]. – Aquila 34–35: 214–241. (in Hungarian and German)
- Vaurie, Ch. 1965. The Birds of the Palearctic Fauna. Non-passeriformes. – H. F. & G. Witherby Ltd., London
- Vertse, A. 1967. A Magyarországon telelő lilikek ökológiai problémái. A lilik előfordulása a múlt században. Oecological problems of White-fronted Geese passing the winter in Hungary. Presence of White-fronted Geese in the last century. – Aquila 73–74: 11–32. (in Hungarian and English)
- Voous, K. H. 1963. Een Sushkins Gans uit Nederland [A Sushkin's Goose from the Netherlands]. – Limosa 36: 149–151. (in Dutch with English Summary)
- Voous, K. H., Hartsuijker, L. & Smit, J. J. 1973. Sushkins Rietganzen in Nederland. [Sushkins Bean Geese in the Netherlands]. – Limosa 46: 228–232. (in Dutch with English Summary)
- Vorontsov, N. N. & Lyapunova, E. A. 1984. Explosive chromosomal speciation in seismic active regions. – In: Bennet, M., Gropp, A. & Wolf, U. (eds.) Chromosomes Today 8. pp. 279–294. Allen, Unswin, London

- Wallace, A. R. 1889. Darwinism: of the theory of natural selection with some of its Applications. – Macmillan Publishers, London.
- Wiltschko, W. & Wiltschko, R. 2005. Magnetic orientation and magnetoreception in birds and other animals. – *Journal of Comparative Physiology A* 191: 675–693.
- Winker, K. 2010. Is it a species? – *Ibis* 152: 679–682. DOI: 10.101111/J.1474.919x.2010.0106.x
- Witherby, H. F. & Ticehurst, N. F. 1908. On the more important additions to our knowledge of British Birds since 1899. – *British Birds* 1: 24–27.
- Zabelin, M. M. 1996. Zametki o taeshnom gumennike i lebede-klikune v Turukhanskom rayone Krasnoyarskogo kraya [On the Taiga Bean Goose and the Whooper Swan in Turukhansk district of the Krasnoyarsk province]. – *Casarca* 2: 308–312. (in Russian with English Summary)
- Zakharov, V. A. 2006. Ptitsy Yushnogo Urala (vidovoy sostav, rasprostranenie, chislennost') [The Birds of the Southern Urals (list of species, distribution and numbers)]. – Miass, IGZ UrO RAN, Ekaterinburg. (in Russian)
- Zarudniy, N. A. 1888. Ornitologicheskaya Fauna Orenburgskogo Kraya [The Ornithological Fauna of the Province of Orenburg]. – *Zapiski Imperatorskoy Akademii Nauk po Fiziko-Matematicheskomy Otdela*, 57, N° 1. Eggers i Comp., Sankt Petersburg. (in Russian)
- Zarudniy, N. A. 1910a Ptitsy Pskovskoy Gubernii [The Birds of the Government Pskov]. – *Zapiski Imperatorskoy Akademii Nauk po Fiziko-Matematicheskomy Otdeleniyu. Serie 8, Vol. 25., N 2.* (in Russian)
- Zarudniy, N. A. 1910b Zametki po ornitologii Turkestana [Notes on the ornithology of Turkestan]. – *Ornitologicheskyy Vestnik* 2: 99–117. (in Russian)
- Zelenkov, N. V. 2008. Chetvertichnye guseobraznye Dyuktayskoy peshchery (Yugo-Vostochnaya Yakutiya) [Quaternary Anseriforms of the Djuktai cave (South-Eastern Sakha Republic)]. – *Casarca* 11(1): 13–21. (in Russian with English Summary)
- Zelenkov, N. V. & Kurochkin, E. N. 2014. Two new waterfowl species (Aves: Anseriformes) from the Upper Pleistocene of Yakutia: the first extinct species of quaternary birds from Russia. – *Paleontological Journal* 48: 645–654.
- Zhitkov, B. M. 1912. Ptitsy Poluostrova Yamala [The Birds of the Yamal Peninsula]. – *Eshegodnik Zoologicheskogo Muzeya Inperatorskoy Akademii Nauk* 17(3–4): 311–369. (in Russian)
- Zhitkov, B. M. & Buturlin, S. A. 1901. Po Severy Rossii [In the North of Russia]. – *Zemlevedenie Kn. 3–4:* 29–206. (in Russian)
- Zhukov, V. S. 2006. Ptitsy Lesostepi Sredney Sibiri [The Birds of the Forest Steppe of Central Siberia]. – 'Nauka', Novosibirsk (in Russian)

