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DISTRIBUTION TRENDS OF BREEDING BIRD SPECIES IN BELARUS UNDER CONDITIONS OF GLOBAL CLIMATE CHANGE

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Abstract. Over the past 100 years, obvious changes in population numbers have been recorded for 112 breeding bird species in Belarus, i.e. almost half of the country's 225 breeding species. Forty nine bird species demonstrated negative trends. Three of them Great Bustard (*Otis tarda*), Pallid Harrier (*Circus macrourus*), and Peregrine (*Falco peregrinus*) are becoming extinct. Positive population trends were recorded for 63 bird species. Numbers of 23 species grew, and 33 species were extending both their quantity and ranges. Seven species were scarce and irregular breeders. Twenty seven new breeding bird species were recorded in Belarus during the past 100 years and 25 of them – over the past 50 years. 69.2% of bird species have spread over the territory of Belarus from the south. New breeding species were recorded most frequently in 1971–1980, however at the end of the 1990s the trend declined. As to habitation, 84% of the above species are closely connected to water bodies or wetlands. Global climate change has brought about an increase in bird numbers and an extension of their ranges. As a result of the significantly warming climate, a rapid extension of the quantities and habitats of typical representatives of steppe avifauna occurred in 1970–1990.
Key words: avifauna, Belarus, climate, amelioration, dynamics, population trends

Introduction

This study is the first attempt to analyse the dynamics of the status and range of a multitude of bird species in Belarus during the 20th century in the context of global climate change.

The time span between 1850 and 1950 is considered the last period of the significant climate warming during Holocene in the Northern hemisphere as well as world-wide (Burton 1995). Many climatologists believe that climate has begun to warm up steadily at the end of the 1890s, reaching its peak in the 1930s. Some authors distinguish the interval between 1910 and 1939 as the period of 'Arctic warming' (Khromov 1956; Loginov 1996).

Shifts in breeding ranges and numbers of over 40 bird species – inhabitants of the northern Eurasian tundra – were described with regard to the climate warming (Uspenski 1963).

It has already become widely accepted that during the recent 20–30 years another, even more pronounced, climate warming has been occurring. Such an enormous environmental change affects the functioning of ecosystems as a whole as well as their components, including population dynamics and structure of bird communities. Among other aspects of climatic consequences, faunogenesis is of a particular importance, considering its increased intensity both globally and regionally. This enables tracing pronounced dynamic processes even on a comparatively small territory, such as Belarus.

Many scientists associate current alterations in breeding ranges of several European bird species with global climate change, which became especially noticeable at the end of the 20th century (Burton 1995; Moss 1996; Žalakevičius 1998, 1999; Thomas & Lennon 1999).

The present paper aims at reviewing changes in the composition, distribution and numbers of bird species recorded in Belarus in the light of the impact of global climate change during the second half of the 20th century.

Material and methods

Data on the status and population dynamics of different bird species over the last 100 years are a result of a thorough comparative analysis of the whole scientific information available to us, archival documents regarding Belarus, and relevant data published in neighbouring countries (Shnitnikov 1913; Zedlitz 1920, 1921; Fedyushin & Dolbik 1967; Tomialojc 1990). The population estimates used in the paper had been made earlier (Tucker & Heath 1994; Snow & Perrins 1998) to be defined more precisely with a detailed description of methods used for the estimation later (Nikiforov *et al*.

1997). Accordingly, different researchers made related evaluations based on long-term studies in permanent study sites. With regard to bird species extending their distribution ranges, monitoring of the process was carried out based on reports sent to Ornitho-Faunistic Database of the Institute of Zoology (National Academy of Sciences of Belarus) by many birdwatchers from around Belarus.

The most recent changes that occurred during past two decades (the 1980s–1990s) are shown in Table 1. These changes were not taken into consideration during estimation of prevailing trends for the 20th century. The exception was made for the species re-occurring in the country for the first time since 1980. For such species, the trends in the 1980s–1990s were considered as trends for the 20th century.

Table 1. Bird species that demonstrated a pronounced population dynamics during the 20th century (adapted from Nikiforov *et al*. 1997). Trends in the 1980s and the 1990s: +2 – significant increase, +1 – insignificant increase, 0 – stable, -1 – insignificant decrease, -2 – significant decrease, x – becoming extinct, f – fluctuating.

Species and trends									
1. Decrease in number and range		2. Decrease in number		3. Increase in number and range		4. Increase in number		5. Scarce and irregular breeder	
Gavia arctica	0	*Ixobrychus minutus*	-1	*Phalacrocorax carbo*	+2	*Ardea cinerea*	+1	*Tadorna tadorna*	?
Aythya nyroca	-1	*Anas platyrhynchos*	f	*Nycticorax nycticorax*	+1	*Ciconia nigra*	+1	*Phasianus colchicus*	?
Circus macrourus	x	*Anas querquedula*	f	*Egretta alba*	+1	*Aythya ferina*	+1	*Glareola nordmanni*	?
Falco peregrinus	x	*Milvus milvus*	-1	*Tachibaptus ruficollis*	0	*Aythya fuligula*	+1	*Himantopus himantopus*	?
Falco vespertinus	-1	*Milvus migrans*	-2	*Podiceps nigricollis*	f	*Bucephala clangula*	0	*Calidris alpina*	?
Lagopus lagopus	-1	*Circus cyaneus*	f	*Anser anser*	+2	*Mergus albellus*	0	*Lymnocryptes minimus*	?
Tetrao urogallus	-1	*Aquila chrysaetos*	-1	*Cygnus olor*	+2	*Pandion haliaetus*	+1	*Larus melanocephalus*	?
Otis tarda	x	*Aquila clanga*	0	*Mergus merganser*	+1	*Haliaeetus albicilla*	+1		
Burhinus oedicnemus	-1	*Falco columbarius*	-1	*Haematopus ostralegus*	+1	*Circaetus gallicus*	+1		
Tyto alba	-1	*Falco tinnunculus*	-1	*Charadrius hiaticula*	+1	*Circus aeruginosus*	+1		
Otus scops	-1	*Bonasia bonasia*	-1	*Pluvialis apricaria*	+1	*Buteo buteo*	+1		
Galerida cristata	-1	*Tetrao tetrix*	-1	*Tringa stagnatilis*	+1	*Fulica atra*	0		
Lanius minor	-1	*Perdix perdix*	f	*Tringa nebularia*	+1	*Vanellus vanellus*	+1		
Acrocephalus paludicola	-1	*Coturnix coturnix*	+1	*Xenus cinereus*	+1	*Larus canus*	+1		
		Crex crex	-1	*Numenius phaeopus*	0	*Sterna hirundo*	+1		
		Porzana parva	+1	*Larus ridibundus*	f	*Columba palumbus*	+1		
		Grus grus	0	*Larus argentatus*	+1	*Asio otus*	0		
		Philomachus pugnax	-1	*Larus cachinnans*	+1	*Strix nebulosa*	+1		
		Gallinago media	-2	*Chlidonias leucopterus*	+1	*Parus cyanus*	+1		
		Gallinago gallinago	-1	*Chlidonias hybrida*	+1	*Pica pica*	+1		
		Limosa limosa	-1	*Streptopelia decaocto*	+1	*Corvus frugilegus*	+1		
		Numenius arquata	-1	*Strix uralensis*	+1	*Corvus corone cornix*	+1		
		Tringa totanus	-1	*Merops apiaster*	+1	*Corvus corax*	+1		
		Tringa glareola	-1	*Dendrocopos syriacus*	+1				
		Columba oenas	-1	*Motacilla citreola*	+2				
		Bubo bubo	-1	*Locustella luscinioides*	+1				
		Athene noctua	-1	*Phylloscopus trochiloides*	+1				
		Asio flammeus	-1	*Phoenicurus ochruros*	+1				
		Coracias garrulus	-2	*Turdus iliacus*	+1				
		Upupa epops	-1	*Panurus biarmicus*	+1				
		Picus viridis	-1	*Remiz pendulinus*	+1				
		Lullula arborea	-1	*Serinus serinus*	0				
		Lanius collurio	-1	*Carpodacus erythrinus*	+1				
		Corvus monedula	-1						
		Passer domesticus	-1						

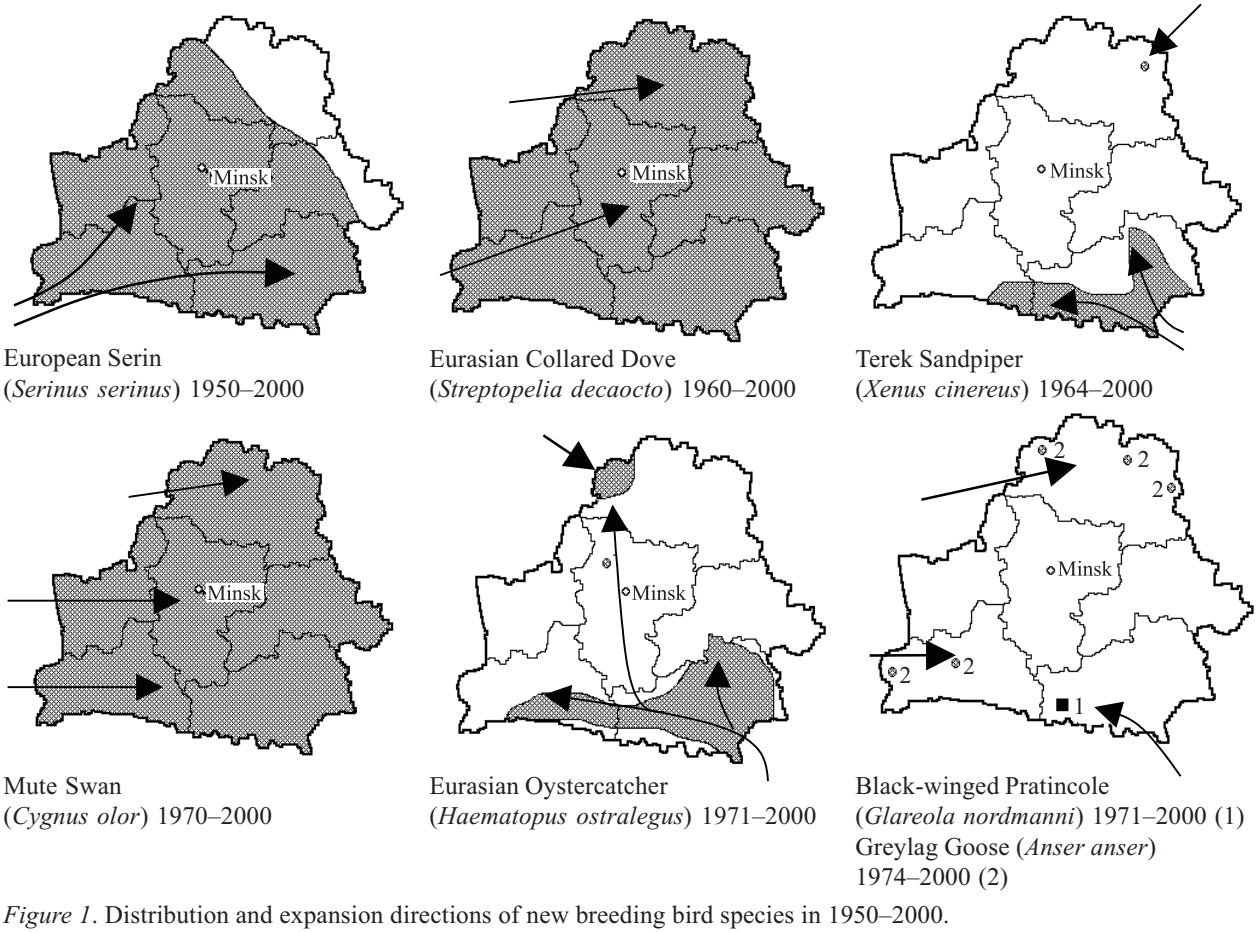
Results

Obvious changes in population numbers were recorded in Belarus during the 20th century for 112 out of 225 breeding bird species, i.e. for half of all the species breeding in the country (Nikiforov *et al*. 1997). The other bird species underwent changes too, however they were too unremarkable to be revealed without special studies. A comparison of bird population trends during the 20th century with those over the last 20 years demonstrated an overall stability for most species. Changes in population trends were recorded for less than 25% of bird species (Table 1).

Negative population trends predominated over the 20th century for 49 bird species (columns 1 and 2 in Table 1), or 43.8% of all the species demonstrating pronounced dynamics. In addition, 14 of them contracted their breeding ranges (column 1) and three (Great Bustard (*Otis tarda*), Pallid Harrier (*Circus macrourus*), and Peregrine (*Falco peregrinus*)) were going extinct (were not recorded as breeding birds in Belarus). Towards the end of the 20th century (the 1980s–1990s) the status of seven species became stable or nearly stable. Two species (Quail (*Coturnix coturnix*) and Little Crake (*Porzana parva*)) even increased in number.

For 36 species, positive population trends predominated. Besides, 25 new breeding bird species were recorded in Belarus during the past 50 years, and 27 species – during 100 years, so in total positive population trends were demonstrated by 63 bird species or 56.3% of all the species with pronounced dynamics (columns 3, 4 and 5). Forty seven of them showed positive trends in the 1980s–1990s as well. Numbers of nine species were unchanging or fluctuated. The remaining seven species were scarce and irregular breeders showing no population changes.

Species with marked territorial expansion are, undoubtedly, the most interesting ones from the point of view of regional faunogenesis. Such were 33 species (column 3), or more than half of all the species with positive population dynamics. In addition, we classified (with some reservations) seven rare breeders (column 5) as expansive species. Probably, at the study moment they were at an initial stage of penetration in Belarus and were not going to become regular breeding species. One of the most important factors was that 25 species (62.5% of all the species demonstrating territorial expansion) had started to breed in the past 50 years (Fig. 1). Other two species Marsh Sandpiper (*Tringa stagnatilis*) and Goosander (*Mergus merganser*), earlier recorded just occasionally, were recognised as regular breeders as a result of the expansion of their habitats and population growth.



European Serin (*Serinus serinus*) 1950–2000

Eurasian Collared Dove (*Streptopelia decaocto*) 1960–2000

Terek Sandpiper (*Xenus cinereus*) 1964–2000

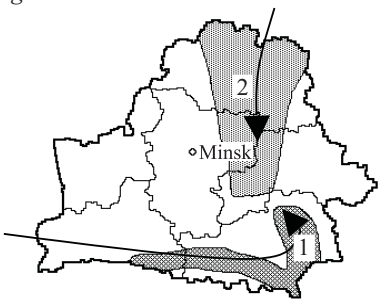
Mute Swan (*Cygnus olor*) 1970–2000

Eurasian Oystercatcher (*Haematopus ostralegus*) 1971–2000

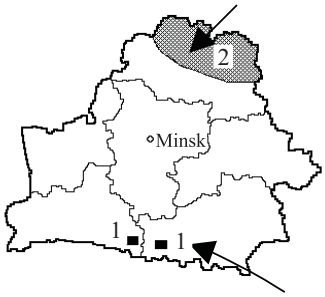
Black-winged Pratincole (*Glareola nordmanni*) 1971–2000 (1)
Greylag Goose (*Anser anser*) 1974–2000 (2)

Figure 1. Distribution and expansion directions of new breeding bird species in 1950–2000.

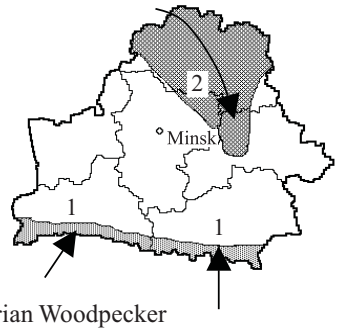
Figure 1 continued



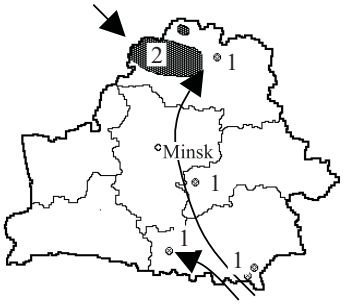
Common Ringed Plover (*Charadrius hiaticula*) 1973–2000 (1)
Greenshank (*Tringa nebularia*) 1975–2000 (2)



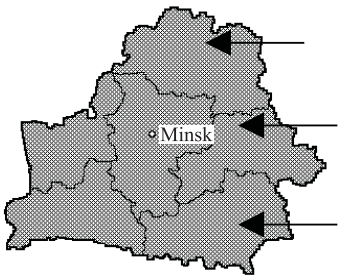
Black-crowned Night Heron (*Nycticorax nycticorax*) 1976–2000 (1)
Whimbrel (*Numenius phaeopus*) 1976–2000 (2)



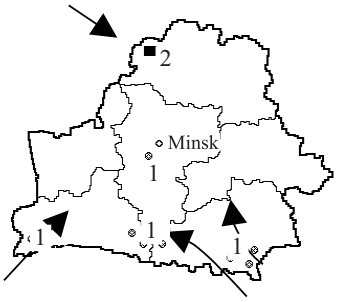
Syrian Woodpecker (*Dendrocopos syriacus*) 1980–2000 (1)
European Golden Plover (*Pluvialis apricaria*) 1976–2000 (2)



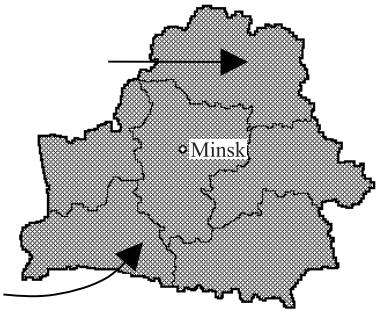
European Bee-eater (*Merops apiaster*) 1980–2000 (1)
Herring Gull (*Larus argentatus*) 1982–2000 (2)



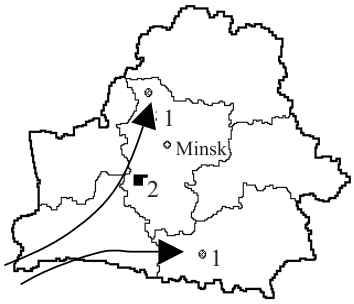
Citrine Wagtail (*Motacilla citreola*) 1982–2000



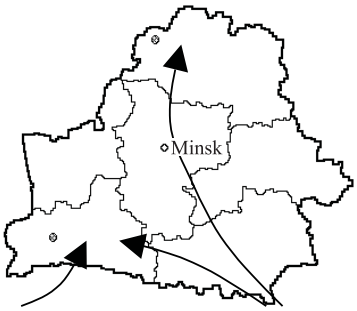
Whiskered Tern (*Chlidonias hybridus*) 1988–2000 (1)
Dunlin (*Calidris alpina*) 1984–2000 (2)



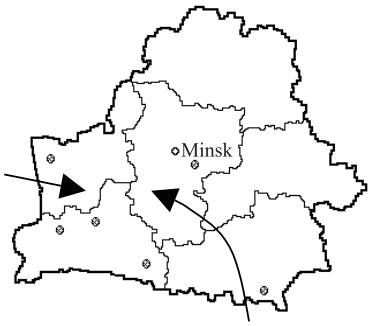
Great Cormorant (*Phalacrocorax carbo*) 1988–2000



Mediterranean Gull (*Larus melanocephalus*) 1988–2000 (1)
Common Shelduck (*Tadorna tadorna*) 1989–2000 (2)



Yellow-legged Gull (*Larus cachinnans*) 1990–2000



Bearded Tit (*Panurus biarmicus*) 1993–2000

Great Egret (*Egretta alba*) 1994–2000

Black-winged Stilt (*Himantopus himantopus*) 1996–2000

The highest rates of appearance of new breeding species were recorded during 1971–1980, but the trend markedly declined towards the end of the 1990s (Fig. 2). Irrespective of that species expansion increased during 1970–1980 for the bird species distribution ranges of which were in the vicinity of Belarus.

Direction of the changes in distribution areas is the most important indicator while explaining (understanding) the factors determining them. Distribution of such directions recorded for new breeding species in Belarus, as well as species showing range expansion (columns 3 and 5 in Table 1), is shown in Figure 3.

Since the direction of temperature gradient going perpendicular to isotherms in Belarus, as well as in the Baltic states (Žalakevičius 1998), is SW–NE, the direction of the colonisation from W, SW, S, and SE should be regarded as northern and from E, NE, N, and NW – as southern. As it could be seen, species colonisation occurred as follows: 69.2% of bird species expanded their ranges northwards and 30.8% – southwards.

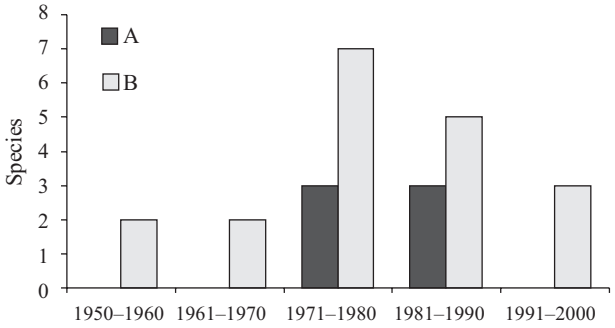


Figure 2. Dynamics of new breeding 'northern' (A) and 'southern' (B) bird species in 1950–2000.

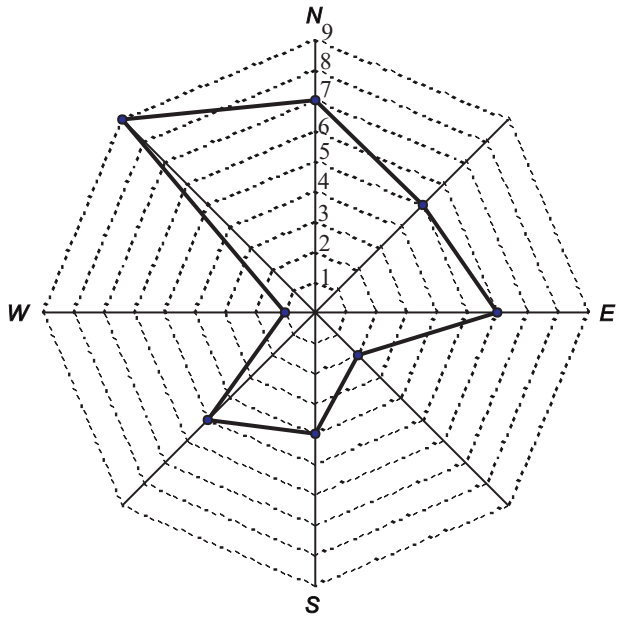


Figure 3. Numbers of bird species showing different directions of range expansion in 1950–2000.

Taking into account that southern species are mostly representatives of steppe and forest-steppe zones, the connection of their expansion with the climatic warming seems quite probable. As it was convincingly shown in Lithuania, which neighbours Belarus (Žalakevičius 1998, 1999), the shift of bird species distribution areas north-eastwards should be connected with the contemporary climate warming. Therefore, recent population trends of 20, out of 25, newly recorded in Belarus breeding bird species with distribution areas moving northwards can also be a result of the global warming.

Finally, analysis of ecological characteristics of the species that have repopulated Belarus reveals that their overwhelming majority (84%) is closely connected in their habitation with water bodies or wetlands. The same is true of 'southern' species, 71.4% of them inhabiting water-coastal and wetland ecosystems. It is well known that climate change is closely connected with alterations in sediment quantity (Drozdov & Grigoryeva 1963; Budiko 1980). The characteristics of the ongoing warming and aridity of the climate in Belarus are presented in Figure 4.

Climate warming increases the aridity of southern parts of distribution areas, forcing bird populations to move into more humid and moderate northern latitudes (Krivenko 1991). Therefore, not only rising temperatures, but also the aridity of habitats in southern latitudes might have significantly contributed to the increased northward expansion of southern species in 1970–1990. Different scientists more than once discussed cases of similar climatic impact that had been observed previously in the postglacial faunogenesis in Europe (Krivenko 1991; Burton 1995).

Discussion

The most important conclusion to be drawn from the above-presented data is that during the last thirty years of the 20th century the ever-developing Belarusian avifauna underwent especially marked changes. In fact, over 10% of bird species have become breeders just during the past 50 years. It should be pointed out that the Belarusian avifauna has been developing for over 10,000 years, since the end of the last Pleistocene glaciation. Of course, some of the new breeding species have re-occurred in Belarus after some time of absence. For example, Greylag Goose (*Anser anser*), Great Cormorant (*Phalacrocorax carbo*), and Mute Swan (*Cygnus olor*) were mentioned as breeding species in chronicles and the first ornithological papers (Tyzenhaus 1846). Such species as Black-crowned Night Heron (*Nyctico-*

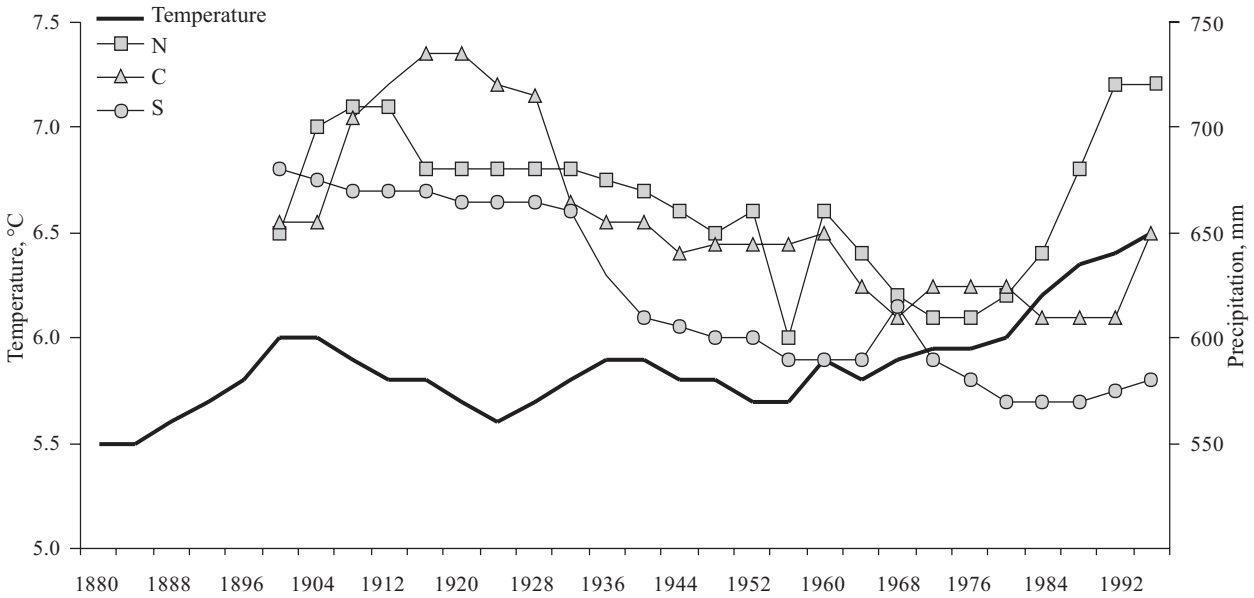


Figure 4. Dynamics of annual temperature (T °C) and precipitation (mm) in Belarus (according to Loginov 1996). Precipitation: N – northern part, C – central part, S – southern part.

rax nycticorax) and Great Egret (*Egretta alba*) were discovered in fossilised remains from earlier Holocene periods (Nikiforov 2001). However, their reappearance, as well as proliferation of new – previously unknown in the region – bird species is an evidence of significant changes in habitat conditions that took place during the second half of the 20th century.

Anthropogenic impact and global climate change are considered two major causes of possible changes in species distribution ranges.

Could anthropogenic activities have led to the range expansion of new bird species in Belarus? Cessation of human persecution could be regarded as one of possible reasons (but not the only one) of the appearance of several bird species. This first of all is true of Mute Swan, Greylag Goose, Great Cormorant, and Great Egret, however, cannot explain the appearance of the other 20 species. In addition, though some bird species, for example, Mute Swan and Great Egret, have not been on the European hunt list for a long time, active expansion of their breeding ranges took place only during the recent decades. Accordingly, human disturbance cannot be considered a key factor of the rapid expansion of bird species at the end of the 20th century. Anthropogenic transformation of natural habitats and the formation of new anthropogenic biotopes, such as agricultural lands and monodominant forests, neither could be regarded a factor leading to species expansion. Table 2 shows that the majority of re-occurring species breed on wetland and near-aquatic habitats, having no relation to anthropogenic landscape. Furthermore, though wetlands were more common in Belarus in the past, they were not inhabited by the above species. Some of the species, such as Collared Dove (*Streptopelia decaocto*), European Serin (*Serinus serinus*), and Syrian Woodpecker (*Dendrocopus syriacus*), predominate in small towns and rural settlements, which have not changed much over the last decades.

The relation between species expansion and the current climate warming is even more obvious in the light of the fact that the overwhelming majority of species (69.2%), represented by typical inhabitants of forest-steppe and steppe zones, have expanded their ranges northwards. The northward spread of bird ranges as a result of global climate change is often cited by different authors, including those from neighbouring countries (Krivenko 1991; Moss 1996; Thomas & Lennon 1999; Žalakevičius 1998, 1999).

It is noteworthy that the first breeding records of bird species in Belarus do not coincide with the peaks of the climate warming. Some species were recorded in the country for the first time during the cool and humid period of 1950–1960. Different periods of expansion to a certain extent can be explained by different expansion rates and distances from initial distribution areas to the territory of Belarus.

The climate change-driven bird expansion theory can be somewhat refuted by the fact that a limited number of 'northern' species exhibit the opposite trend – they actually spread southwards. Whimbrel (*Numenius phaeopus*), European Golden Plover (*Pluvialis apricaria*), Greenshank (*Tringa nebularia*) and, possibly, Dunlin (*Calidris*

Table 2. Habitat preference of new breeding bird species having occupied Belarus in the 20th century.

Species	Habitat type
Phalacrocorax carbo	Coastal area (shore)
Nycticorax nycticorax	Coastal area (shore)
Egretta alba	Coastal area(shore)
Anser anser	Coastal area (shore)
Cygnus olor	Coastal area (shore)
Tadorna tadorna	Coastal area (shore)
Haematopus ostralegus	Coastal area (shore)
Himantopus himantopus	Coastal area (shore)
Charadrius hiaticula	Coastal area (shore)
Pluvialis apricaria	Wetland (raised bog)
Calidris alpina	Coastal area (shore)
Tringa nebularia	Wetland
Xenus cinereus	Coastal area (shore)
Numenius phaeopus	Wetland
Glareola nordmanni	Coastal area (shore)
Larus melanocephalus	Coastal area (shore)
Larus argentatus	Coastal area (shore)
Larus cachinnans	Coastal area (shore)
Chlidonias hybridus	Coastal area (shore)
Streptopelia decaocto	Urban habitats
Merops apiaster	Dry open areas
Dendrocopos syriacus	Urban habitats
Motacilla citreola	Wetland
Panurus biarmicus	Coastal area (shore)
Serinus serinus	Urban habitats

alpina) are among such species. So, in addition to the direct impact of global climate change, the shifts of ranges can be determined by some other factors or mechanisms. To sum up it could be said that the expansion of bird species in the region is a natural on-going process that has been lasting with ups and downs throughout the post-glaciation period. During periods of time of significant climatic changes (we are experiencing one at the moment), the intensity of the process can vary to a large extent, and the relation between shifts of bird distribution ranges and climate change becomes obvious.

Conclusions

1. Belarusian (and, probably, European) avifauna is still undergoing substantial formation through immigration and emigration of species (dynamic change in distribution ranges).
2. The above processes are accompanied by such recurrent climatic changes as warming, which has been observed since the last decades of the 20th century.
3. In general, in the dynamics of faunogenesis positive population trends predominated during the 20th century and its second half in particular.

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Perinčių paukščių rūšių pasiskirstymo tendencijos globalios klimato kaitos sąlygomis Baltarusijoje

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Santrauka

Per pastaruosius 100 metų 112 perinčių paukščių rūšių populiacijų gausumas Baltarusijoje ženkliai pasikeitė. 49 rūšims buvo nustatyti neigiami pokyčiai. 3 iš šių (Great Bustard (*Otis tarda*), Pallid Harrier (*Circus macrourus*) ir Peregrine (*Falco peregrinus*)) baigia išnykti. Teigiami pokyčiai nustatyti 63 rūšims. 23 rūšių populiacijų pagausėjo, 33 rūšių pagausėjo ir jų arealai išsiplėtė. 7 rūšys sutinkamos retai ir peri nepastoviai. Per pastaruosius 100 metų Baltarusijoje užregistruotos 27 naujos perinčių paukščių rūšys, iš kurių 25 užregistruotos per pastaruosius 50 metų. 69.2% rūšių arealai išsiplėtė į Baltarusiją iš pietų. Daugiausia naujųjų perinčių rūšių atrasta 1971–1980 metais, o baigiantis aštuntajam dešimtmečiui jų buvo atrandama vis mažiau ir mažiau. 84% šių rūšių buveinės glaudžiai siejosi su vandens telkiniais arba pelkėmis. Dėl visuotinės klimato kaitos paukščių skaitlingumas išaugo, o jų arealai išsiplėtė. Žymus klimato atšilimas 1970–1990 metais sąlygojo greitai augantį tipinių stepinės avifaunos atstovų ir jų buveinių skaičių.

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