

ASSESSMENT OF THE COMMUNITY STRUCTURE AND STATUS OF WATERBIRDS IN BELARUS DURING THE SUB-BOREAL STAGE OF THE HOLOCENE

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Abstract. Comparative analysis of the structure and ratio of waterbird species in northern Belarus is made based on contemporary data and material collected during archaeological excavations. 37 species were established to be dwelling in Belarus during the second half of the Sub-Boreal stage of the Holocene, 2500–4000 years ago. During the mentioned period the waterbird community in Belarus was more diverse and structurally even than it is today. Since taiga-zone species were relatively more numerous, the community structure in general was more northern-like. In the community, stenothermal southern species, possible relics of the warmer and drier former climatic period of the Holocene, made a considerable share, too.

Key words: the Sub-Boreal stage, fossils, waterbirds, community structure, Belarus

INTRODUCTION

Many investigators relate contemporary changing ranges of many European bird species to global climatic changes, especially pronounced at the end of the 20th century (Burton, 1995; Moss, 1996; Žalakevičius, 1998; Žalakevičius, 1999). This in turn promotes search for possible faunal-genetic analogies during ancient periods of climatic changes and, firstly, during different periods of the Holocene. In this respect it is interesting not only to establish the structure of the ancient fauna during certain climatic periods, but also to compare status of the species that lived during those ancient periods and that live now.

In scientific literature, concrete data on fossils of the birds that lived in Belarus during different fauna formation periods after the glaciation are poor and fragmentary. Few attempts to analyse probable stages of the avifauna formation (Dolbik, 1958; Fedyushin, Dolbik, 1967) are likely to be based on suppositions arising from climatic and landscape changes rather than on concrete data and fossils. Therefore factual data on the structure and distribution of animal species as well as any attempts of an objective analysis of their ranges, state, and population dynamics in the context of historical epochs are particularly urgent. This is especially so for the Holocene, since this was during the post-glaciation period that faunal-genetic processes were a limiting character in the formation of contemporary biodiversity in Belarus.

MATERIAL AND METHODS

This study is based on the results of identification of bird fossils collected during archaeological excavations in the ancient settlement of humans in the Vitebsk Region in 1960–1987 (archaeological monument Osoviets-2, Archaeology of Belarus, 1997). Osteological material was brought to the Laboratory of Archaeology, the Institute of History under the Belarusian National Academy of Sciences. The material was identified at the Laboratory of Natural Investigation Methods, the Institute of Archaeology Russian Academy of Sciences (by Candidate of Biological Sciences E.E. Antipina).

A total of 660 bird fossils were analysed of which two thirds were identified to a species or to a genus. As a result, bird fossils were established to belong to 45 bird species.

For analysis, data on the group of waterbirds and on other closely related to water bodies bird species (37 in all) from the orders of Gaviiformes, Podicipediformes, Pelecaniformes, Ciconiformes, Anseriformes and some from the order Falconiformes, fossils of which account for 80% of total material, were studied. The fossils belonging to the order of Circus (2 individuals) and to that of *Cygnus* (2 individuals), however, were not identified to a species.

To make analysis of the data obtained more informative, comparison of species occurrence in sampled sub-fossils with contemporary minimal estimate values of species abundance in Belarus was made (Nikiforov et

al., 1997). Since this kind of comparison involves values that in many respects are different, comparison of relative values of contemporary abundance assessment with the occurrence in fossils was made.

To test difference between two percent age indices, G-test was used (Sokal, Rohlf, 1995). To compare structural similarity of contemporary and fossil waterfowl communities, Morisita's index was calculated (Morisita, 1959; Krebs, 1998). Simpson's index was used to assess species diversity. To estimate evenness of species community, Camargo's index was computed (Krebs, 1998).

RESULTS

The osteological material refers to the period within the interval of $4320 \pm 40 - 3350 \pm 60$ years ago (Dolukhanov et al., 1978). This period of the Holocene is the second half of the Sub-Boreal stage, which based on the contemporary stratigraphic scheme (Yelovicheva et al., 1988) took place some 4000–2500 years ago, i.e. at the end of the Neolithic period to the beginning of the Bronze Age.

Since the ancient settlement was located on the coast of a shallow lake, waterbirds evidently were hunted, which is testified by a very high representativeness of the sub-fossil faunal material regarding this bird group. The factual list of the species identified by fossils covers 70% of all waterfowl and waterbird species (except for the order Charadriiformes) including accidental visitors recorded in northern Belarus over the past 150 years and also a number of the species not observed in the region until recently (Table 1).

Quite possibly, ancient hunters could select one or another bird species to be hunted, but this, however, could not be affirmed for sure at present. Hunting motives could be diverse: food, plumage, destruction of competition for food, etc. These motives, however, hardly can be explained by any modern criteria, such as meat taste quality of certain bird species, plumage quality, and so on. Besides, since there could be used also traps, which could hardly be meant for a certain species, individuals of one or another species belonging to the same ecological group could be trapped just accidentally. Therefore we take it for granted that species were hunted randomly and that the sub-fossil material collected provides an approximate reflection of the ratio of species abundance in nature, at least in northern Belarus.

Accordingly, it is obvious that the whole of individuals that we attempt to restore based on the fossils hardly could be a real bird community of any water body or of the territory inhabited by an ancient tribe. We consider it a hypothetical community of the species, including

breeders, migrants and accidental visitors, that lived during a rather long period of time (for some 300 years) in the Sub-Boreal stage (SC) (=sub-boreal community) during existence of an ancient settlement of humans.

For comparison, we used a contemporary but in fact none the less hypothetical community (CC) (=contemporary community), the structure of which reflects the structure and ratio of variety of the waterbird species of the same taxonomic groups in Belarus of also comparatively long period of time, at least the past decade. Comparison of the two hypothetical communities, the contemporary one and the one restored by the fossils (Table 1), reveals a great species variety and comparatively low dominance of both of them, the variety of SC being, however, a little higher. Simpson's index for CC is 0.76, whereas for SC it is 0.82. The ancient community could be of a markedly more even structure; according to Camargo, structure evenness is 0.31 for SC vs. 0.14 for CC.

Irrespective of several ages separating the two communities, indicator of their structure similarity is very high (Morisita's index 0.88). Approximately one third of the species, however, demonstrates a reliably different status in these two communities with regard to abundance. Based on relative indicators, comparison was made of the ancient and contemporary status of each of the species, separately. The comparison shows that Mallard, absolutely predominant over other waterbird species at present, actually was none the less abundant during the Sub-Boreal stage of the Holocene.

Garganey, which being the second most abundant waterbird species plays a sub-dominant role today, was reliably ($G = 0.3$; $p < 0.01$) less numerous or rather rare in the ancient times. This could be logically explained taking into account that at that time at least the current Belarusian territory was very woody, just with small open grassy lake- or river-side floodplains, typical habitats of the species.

The species group with a high relative indicator of abundance (relative abundance 1.0–9.0%) at present and therefore attached to the category of common species includes 8 species. Of them, since the Sub-Boreal stage abundance indicator has reliably increased for Moorhen ($G = 9.2$; $p < 0.01$), Coot ($G = 6.2$; $p = 0.03$), and White Stork ($G = 6.3$; $p = 0.03$). High reliability of a positive change in relative abundance is shown also by Great Crested Grebe ($G = 1.8$; $p = 0.08$). On the contrary, for Tufted Duck with, however, lower reliability relative abundance has decreased compared to the one during the Sub-Boreal stage.

The species of another group, attached to the category of species that are rare at present, show a relative abundance of 0.1–0.9%, which is slightly different com-

Table 1. Community structure of waterbird species based on the fossil material of archaeological excavations of the ancient settlement Osoviets-2.

Species	Contemporary abundance assessment		Occurrence based on fossils	
	Individuals	%	Individuals	%
Mallard <i>Anas platyrhynchos</i>	160000	43.47	121	39.41
Garganey <i>Anas querquedula</i>	70000	19.02	3	0.98
Moorhen <i>Gallinula chloropus</i>	30000	8.15	1	0.33
Coot <i>Fulica atra</i>	28000	7.60	3	0.98
White Stork <i>Ciconia ciconia</i>	21000	5.70	1	0.33
Great Crested Grebe <i>Podiceps cristatus</i>	16000	4.35	4	1.30
Teal <i>Anas crecca</i>	12000	3.26	17	5.53
Tufted Duck <i>Aythya fuligula</i>	8000	2.17	19	6.19
Grey Heron <i>Ardea cinerea</i>	8000	2.17	6	1.95
Little Grebe <i>Tachybaptus ruficollis</i>	4000	1.08	2	0.65
Gadwall <i>Anas strepera</i>	2000	0.54	1	0.33
Shoveler <i>Anas clypeata</i>	2000	0.54	4	1.30
Bittern <i>Botaurus stellaris</i>	1900	0.52	1	0.33
Black Stork <i>Ciconia nigra</i>	1900	0.52	1	0.33
Goldeneye <i>Bucephala clangula</i>	1700	0.46	22	7.16
Little Bittern <i>Ixobrychus minutus</i>	600	0.16	1	0.33
Osprey <i>Pandion haliaetus</i>	240	0.07	1	0.33
Pintail <i>Anas acuta</i>	140	0.04	11	3.58
Red-necked Grebe <i>Podiceps grisegena</i>	100	0.03	11	3.58
Feruginous Duck <i>Aythya nyroca</i>	100	0.03	9	2.93
Greylag Goose <i>Anser anser</i>	100	0.03	5	1.63
White-tailed Eagle <i>Haliaeetus albicilla</i>	100	0.03	4	1.30
Goosander <i>Mergus merganser</i>	80	0.02	2	0.65
Black-throated Diver <i>Gavia arctica</i>	30	0.01	9	2.93
Smew <i>Mergus albellus</i>	30	0.01	17	5.53
Red-breasted Merganser <i>Mergus serrator</i>	20	0.01	2	0.65
Night Heron <i>Nycticorax nycticorax</i>	20	0.01	1	0.33
Wigeon <i>Anas penelope</i>	20	0.01	13	4.23
Ruddy shelduck <i>Tadorna ferruginea</i>	0	0.00	1	0.33
White Pelican <i>Pelecanus onocrotalus</i>	0	0.00	1	0.33
Little Egret <i>Egretta garzetta</i>	0	0.00	2	0.65
Red-crested Pochard <i>Netta rufina</i>	0	0.00	1	0.33
Bean Goose <i>Anser fabalis</i>	0	0.00	2	0.65
Scoup <i>Aythya marila</i>	0	0.00	3	0.98
Eider <i>Somateria mollissima</i>	0	0.00	1	0.33
Velvet Scoter <i>Melanitta fusca</i>	0	0.00	4	1.30
Total	368060	100.00	307	100.00

pared to the one during the Sub-Boreal stage or the change is unreliable according to the material studied. An exception is made by Goldeneye, which was considerable more numerous ($G = 7.0$; $p < 0.01$) in the ancient times, outnumbered only by Mallard.

The majority of the birds of the current category of very rare species, present relative abundance of which is 0.01–0.09%, were more numerous during the Sub-Boreal stage

than now; though this is completely reliable only for Pintail ($G = 4.6$; $p = 0.04$), Red-necked Grebe ($G = 4.7$; $p = 0.04$), Black-throated Diver ($G = 3.9$; $p = 0.04$), Smew ($G = 6.7$; $p < 0.01$), and Wigeon ($G = 5.7$; $p = 0.02$) and highly reliable for Ferruginous Duck ($G = 3.7$; $p = 0.06$). A number of the species enlisted in the table are of a zero status currently, which means that they do not breed in Belarus. These species, however, their ranges expanding

further to the north of Belarus, are observed here during migration period, and this is so for Bean Goose, Scoup, Velvet Scoter, or, in the case of Eider, occur as accidental visitors. Since these species could be migratory in the past as well, an assumption could be made that ancient hunters hunted them also during migration period.

As for other species, modern ranges of which spread to the south of Belarus and which nowadays are very rare visitors, namely White Pelican, Ruddy Shelduck, Red-crested Pochard, Little Egret, could be visitors during the Sub-Boreal stage as well, though with markedly more frequent occurrence.

DISCUSSION

Generalisation of comparison results regarding status of separate bird species during the Sub-Boreal stage and nowadays testifies that of the 6 species relative abundance of which during the Sub-Boreal stage was reliably higher 5 are typical taiga-zone residents and belong to the Siberian type (Goldeneye, Pintail, Black-throated Diver, Smew, Wigeon) or to the Holocene type (Red-necked Grebe) of the fauna (Shtegman, 1938). On the contrary, individuals that inhabited more southerly latitude (Moorhen, Coot, White Stork, Garganey) had considerably increased in numbers within the waterbird community compared to the Sub-Boreal stage. To sum up the above statement as well as other data presented in the table, it should be emphasised that in general the structure of the waterbird community of the Sub-Boreal stage is more northern-like compared to the contemporary structure.

This conclusion well agrees with the results of modern palynological investigation testifying to the fact that since the second half of the Sub-Boreal stage the forest flora in northern Belarus has been changed by spruce taiga-type forests, whereas in the central part of Belarus – by mixed pine and birch forests (Yakushko et al., 1988, Yelovicheva, 1993). In addition, it should be taken into account that whatever temperature and humidity indicators were at that time they could not be lower than they are today.

Today's migrants and accidental visitors make a relatively high share in the bird fossils, especially Velvet Scoter and Scoup. This adds to the waterbird community of the Sub-Boreal stage being more northern-like in structure.

In addition, this may mean that the above species were massive enough during migration period. Again, however, this shows that species structure of northern migrants and their ratio have undergone remarkable changes since the Sub-Boreal stage. This is so because

today only Bean Goose could be considered a massive migrant, whereas the remaining three species are either very rare if not accidental visitors. On the contrary, White-fronted Goose, most massive migrant among migratory geese, is, however, absent among the subfossils studied.

Another explanation of the large share of the above northern migrants within the waterbird community could be based on the fact that during the Sub-Boreal stage their breeding ranges covered the current Belarusian territory, i.e. they were far larger and southerly than today's ranges.

Certain contradiction of the above conclusion that the waterbird community was more northern-like during the Sub-Boreal stage is fossils of 5 bird species: Night Heron, Little Egret, White Pelican, Ruddy Shelduck, and Red-crested Pochard. All of them are of a step-zone origin (the Mediterranean- and Mongol-type fauna), and major areas of their current breeding ranges lie considerably more southwards off the Belarusian border. It is only Night Heron that has currently reached the Belarusian territory; for the first time its breeding colony was recorded in 1999 (Samusenko, Pinchuk, 1999).

Considering ecological and biological specificity of the above species, it is hardly possible that they could breed in taiga-zone water bodies of northern Belarus during the Sub-Boreal stage. Though, a very possible breeding site of all or some of these species could be Palessia, from where they would move to favourable in the sense of feeding water bodies during post-breeding dispersal and therefore could be quite abundant in northern Belarus. According to some data, this was just in southern and southeastern Belarus that steppe-landscape elements were formed during the xenothermal phase of the Sub-Boreal stage (Kirikov, 1960). Based on very old data, which could not be precisely dated, pelicans could be often observed on the territory of Palessia yet in the previous century.

To sum up, the community of major waterbird groups of Belarus was more diverse and even in structure during the second half of the Sub-Boreal stage of the Holocene than it is at present. Taiga-zone species were relatively more predominant, therefore the community structure was more northern-like. In addition, southerly species, possible relics of the warmer and drier former climatic period of the Holocene, made a greater share in the general structure.

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**HOLOCENO SUBBOREALIO PERIODO
VANDENS PAUKŠČIŲ BENDRIJŲ
STRUKTŪROS IR STATUSO
BALTARUSIJOJE ĮVERTINIMAS**

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SANTRAUKA

Remiantis šiuolaikiniais duomenimis ir archeologinių kasinėjimų medžiaga, atlikta šiaurės Baltarusijos šlapumų paukščių lyginamoji analizė. Nustatyta, kad antrojoje

holoceno subborealio pusėje (prieš 2500–4000 metų) Baltarusijoje gyveno 37 paukščių rūšys. Tuo metu šlapumų paukščių bendrija Baltarusijoje buvo daug įvairesnė ir struktūriškai vienodesnė negu šiais laikais. Kadangi taigos zonos rūšių buvo daugiau, bendrijos struktūra buvo labiau šiaurietiška. Tačiau bendrojoje jos struktūroje šiltamėgių pietinių rūšių dalis buvo didesnė. Beje, šios rūšys – galimi anksčiau holocene vyravusio šiltesnio ir sausesnio klimato reliktai.

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