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Subrecent pollen assemblages of bottom sediments on the south of the European part of Russia

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Abstract. This paper presents the new data of the study of subrecent pollen assemblages of bottom sediments on the south of the European part of Russia. Pollen analysis of the forest-steppe and the north steppe zones assemblages have shown that trees pollen reached about 50% of the pollen spectra. Arboreal pollen was represented by *Pinus*, *Betula, Alnus* and *Salix* and broad-leaved trees such as *Quercus, Ulmus, Tilia.* Pollen analysis of southern steppe zone – seabed deposits of the Sea of Azov and the Tsimlyansk reservoir have shown that herbaceous pollen (up to 80-90% in some sites) was dominated mainly by Chenopodiaceae in pollen assemblages. According to the results obtained from forest-steppe and steppe zones, compositions of pollen assemblages of seabed the Sea of Azov and the Don River deposits represents the modern steppe vegetation.

Keywords: pollen analysis, the Don River, the Sea of Azov, forest-steppe and steppe zones

1. Introduction

Pollen analysis is applied widely in palaeoecological studies of marine palaeoenvironments. Being reliable bioindicators of the Holocene and Pleistocene climate, pollen assemblage is a high quality tool for reconstructing of the past conditions and for improvement of Quaternary stratigraphy in the region of the Sea of Azov (Matishov 1986, 2006; Matishov et al. 2013).

One of the tools for improving of pollen analysis method is the study of surface or sub-recent pollen assemblages, which are reflected in modern "pollen rain" accumulated in the surface layer of the soil, in the upper layer of alluvium of rivers or marine bottom sediments. The aim of the study was identifying and predicting the impact of modern pollen rain on pollen assemblages of the bottom sediments of the Sea of Azov and the Don River. Much attention was paid to reflection of modern vegetation in the pollen assemblages.

2. Study area

The Don River flows through the European part of Russia. Its length is 1870 km. The area of the basin is 422 thousand square kilometers. The river rises in the East European Upland at an altitude of 180 meters above sea level. The Don enters the Taganrog Gulf of the Sea of Azov. The great extent in breadth of the Don basin has caused the difference in climatic conditions between the north and south. The average annual air temperature varies uniformly from 4°C in the north to 10°C in the south. The average temperature in January decreases from south to north from -4°C to -12° C, in July – from 25°C in the south to 20°C in the north. The mean annual precipitation of the Don basin ranges from 350 to 500 mm.

The Sea of Azov has one of the largest estuaries located in the south of the East European Plain. The isolation of the Sea of Azov has started from the Early Holocene (about 11,700 cal years ago). Climate of the Azov region is temperate-continental. The mean January temperature is -5°C

in the northern part of the seashore and about 0°C in the south. The mean July temperature is 22–24° C. The mean annual precipitation changes from 400 to 600 mm.

The study area is located into the forest-steppe and steppe vegetation zones. The vegetation cover of the forest-steppe is represented by meadows and meadow steppes, which alternate with small parts of the forest, formed by *Quercus, Acer, Ulmus, Tilia*, and other trees. Vegetation of the southern part of the Don basin and the northern and eastern shores of the Sea of Azov is south steppe with stipa (*Stipa ucrainica, Stipa lessingiana, Stipa capillata*) and sheep fescue (*Festuca valesiaca*) as dominant species. However, the natural plant cover was greatly changed by human impact over the past 300 years. The present-day landscape is almost entirely anthropogenically modified, and native herbaceous communities have been replaced by agricultural land that is either in use or has been abandoned.

3. Material and methods

The material for the studies was the pollen assemblages of sub-recent bottom sediments come from alluvial deposits The Don River and marine deposits the Sea of Azov. The work was carried out at equal distances from the source of the river to the estuary. An upper mud layer of alluvial deposits, that formed over the past several years, was used for analysis. Samples were selected in the coastal part, mainly in the waterways, where the speed of water flow was negligible. The samples of the surface layer of bottom sediments were analyzed in various parts of the Sea of Azov. The materials obtained during the cruise of the research vessel of the Southern Scientific Center of the Russian Academy of Sciences.

Samples for pollen analysis were processed using the pollen extraction procedure developed by Grichuk (1940), which is the standard method of pollen analysis in Russia. The treatment included separation by heavy liquid (cadmium iodide) with a density of 2.2 g/cm^3. In each sample, ~500 terrestrial pollen grains were counted. Relative frequency of pollen was calculated based upon the total terrestrial pollen sum, i.e. arboreal pollen (AP) and non-arboreal pollen (NAP).

4. Results and Discussion

Pollen analyses of sub-recent sediments are characterized by some specific features in the sub-arid regions on the south of the European part of Russia.

4.1. Forest-steppe

Pollen analysis of the forest-steppe zone assemblages have shown that trees pollen reached about 50% of the total sum (Fig. 1). In the group of AP pollen of *Pinus sylvestris* L.and *Betula* predominated, and participation of *Alnus, Quercus* and *Salix* in the formation of pollen assemblages was significant. *Picea abies* L. pollen was found in all of the forest-steppe zone assemblages, but it was represented singly. Herbaceous pollen typical of meadow communities was characterized by wide variety of taxa. Pollen of Asteraceae, Chenopodiaceae, Poaceae and Brassicaceae predominated to a small extent (up to 15%). Spores were diverse, but their content in the assemblages didn't exceed 3–5%. According to the pollen records revealed from forest-steppe zones, a high content of trees and permanent presence of herbaceous taxa were characteristic for distribution of meadows and meadow steppe, which alternate with forest patches.

4.2. Steppe (northern part)

In the pollen assemblages of samples collected in the middle reaches of the Don, the amount of pollen of the tree species gradually decreased (Fig. 1). The number of *Betula* pollen was reduced there; the content of *Quercus* pollen remained approximately at the same level in comparison tothe forest-steppe zone. The composition of the grassy components of the pollen assemblages was similar to the forest-steppe zone. Taxonomic diversity was reduced in comparison to the reforestation zone. And it was represented mainly by ferns of the family of Polypodiaceae s. l.

4.3. Steppe (southern part)

Samples selected in the Tsimlyansk reservoir (Fig. 1) differed sharply in the ratio of components, which is expressed in the minimum amount of pollen of tree species in the pollen assemblages. The drop in the flow rate in the reservoir caused an increase in the deposition of pollen from the local components of the vegetation cover, which occupied most of the pollen assemblages. The samples were dominated by pollen of grassy plants (up to 90%), of which 75% belonged to the representatives of the family Chenopodiaceae, which reflected the spread of local complex steppe vegetation. In the sediments located downstream, there was an increase in pollen of tree species such as *Quercus, Pinus sylvestris* L. and *Betula*. It indicates the presence of small areas of the combination of birch communities and floodplain vegetation, distributed along the valley of the Don and Seversky Donets rivers.

Pollen analysis of seabed deposits of the Sea of Azov has shown that herbaceous pollen (up to 80% in some sites) was dominated mainly by Chenopodiaceae, Asteraceae, *Artemisia* (Fig. 2). The participation of Poaceae pollen was relatively high; Apiaceae, Fabaceae, Rosaceae, Lamiaceae, Cichoriaceae occurred constantly. Pollen of typical steppe plants (*Ephedra*, *Echinops*, Plumbaginaceae, Dipsacaceae)

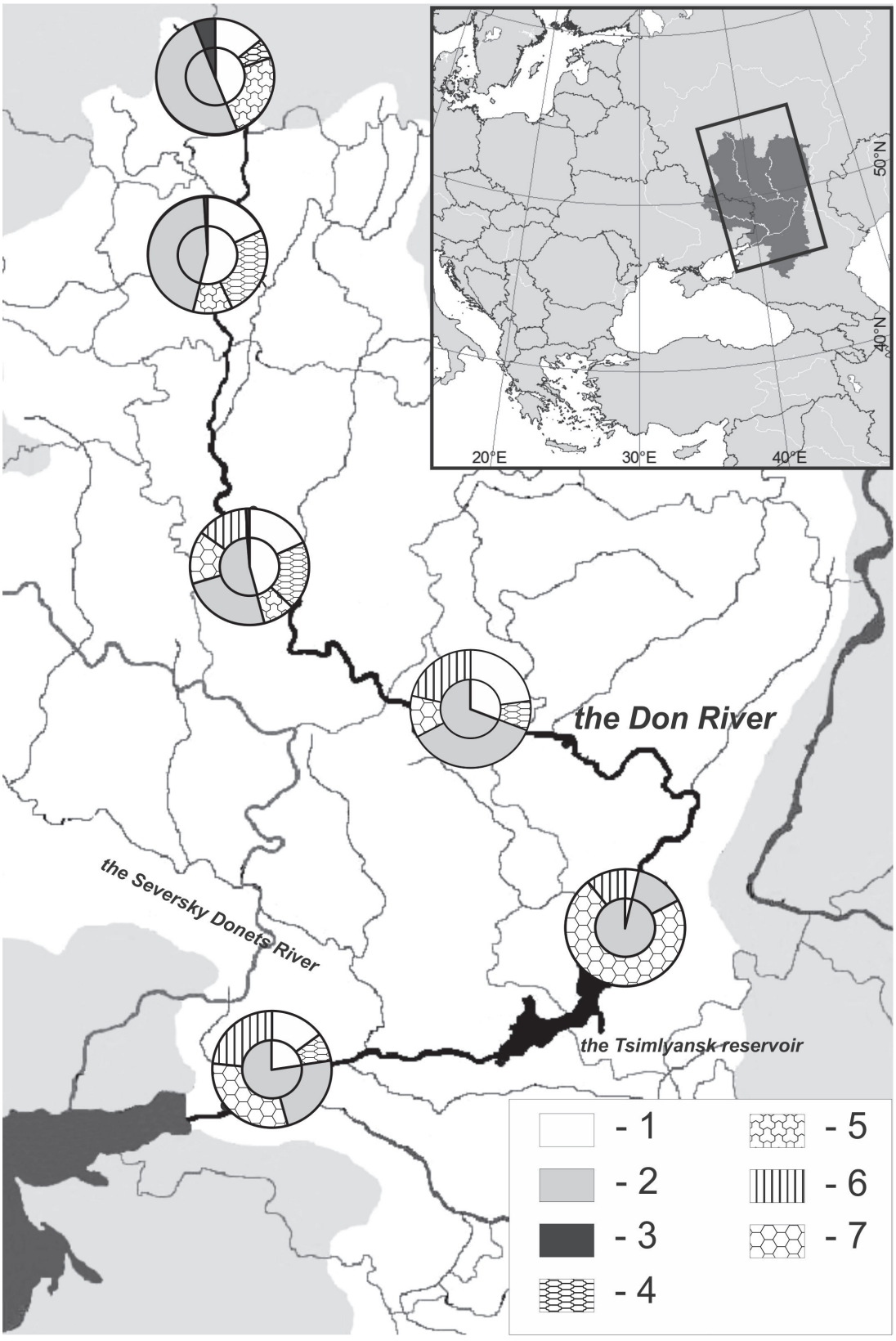

Figure 1. Pollen assemblages of surface sediments of the Don River

(1 – Trees&Shrubs; 2 – Herbs; 3 – Spores; 4 – *Pinus*; 5 – *Betula*; 6 – Asteraceae; 7 – Chenopodiaceae)

was also a permanent component of the assemblages. Arboreal pollen was represented by *Pinus sylvestris* L., *Betula, Alnus* and broad-leaved trees such as *Quercus, Ulmus, Tilia, Carpinus, Fagus* and *Juglans*. Pollen assemblages from marine sediments and samples from inundated coast, marine bars and splits were characterised by notably higher proportion of arboreal pollen, apparently, due to the long distance transport by rivers inflowing into the Sea of Azov. It is important to note, that spores (Polypodiaceae s. l and *Sphagnum*) and pollen of aquatic plants (*Sparganium*, *Typha latifolia, Potamogeton*) were identified only in marine sediments.

The obtained results allow us to conclude that compositions of pollen assemblages of seabed the Sea of Azov and the Don River deposits represent the modern steppe vegetation adequately. Changes in the composition and ratio of components from forest-steppe to steppe occurred quite naturally as the plant zones change. The transport of pollen and spores by water from the northern regions to the Sea of Azov was insignificant. Thus, marine sediments can be used for studies of vegetation development in the past.

Acknowledgements

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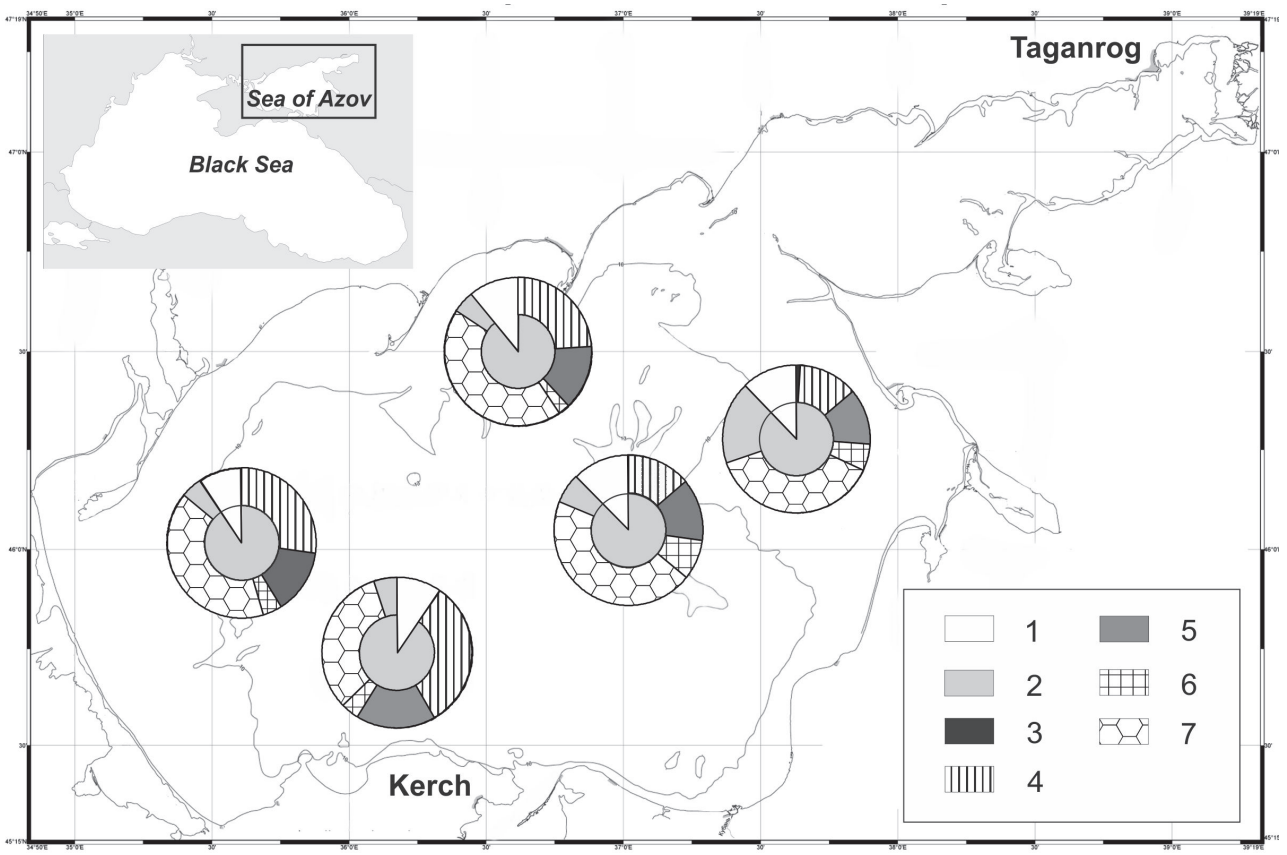

Figure 2. Pollen assemblages of surface sediments of the Sea of Azov

(1 – Trees and shrubs; 2 – Herbs; 3 – Spores; 4 – Asteraceae; 5 – *Artemisia*; 6 – Poaceae; 7 – Chenopodiaceae)