Analysis of paleoflora composition in water bodies of Western Siberia in the Paleogene

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Abstract. On the basis of paleobotanical data, analysis of paleoflora composition, taphocoenose, having a continuous series of paleocarpological data, there have been observed the main stages of development of the water body flora in the Eocene and Oligocene. The explored paleoflora of the Western Siberia water bodies almost entirely consisted of extinct and very far from the modern flora species. It is shown that the individual elements of the Oligocene hydrophilic flora remained almost unchanged in the distant shelters (refugia) and up to the present time. The paleocarpological data showed that the Oligocene water body paleoflora consisted of 109 species and was represented by 20 families and 30 genera. The ten leading families of that period, according to the recent data include 87 species, accounting for 89.6% of the total number of taxa. Climate deterioration (cooling, increasing of continentality) affected the thermophilic forms of water body Paleogene paleoflora, many species of this flora disappeared by the beginning of the Neogene.
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Introduction

For continental tertiary sediments of virtually all of the continental deposits, where the orthofauna findspots (mammals residues) are very rare, the leading biostratigraphic role belongs to paleobotany, in particular to paleocarpology, the main object of which is fossil diasporidia (seeds, fruits, and other plant remains of generative sphere) [1-3].

The most difficult phase of studying the flora of any region is to restore the historical stages of its development [4-6]. The identification of the major stages in the development of water body flora of the studied territory is necessary for solving the crucial issue of botanical geography, which is the definition of relictness for certain species. J. Stoller [7] considered that the appearance time establishment of a species included into composition of a certain flora can be done only on the basis of paleobotanical data that give evidence of a species existence in a given area; only such paleobotanically proven data of species can talk about their relict nature. Of great importance for understanding the history of flora and vegetation of the Western Siberia are the works of the Soviet paleocarpology school founder, Nikitin P.A., his son Nikitin V.P. and Dorofeyev P.I., and many other researchers of the Siberian region paleofloras. In the monograph written by Nikitin V.P. "Paleocarpology and Paleogene and Neogene Stratigraphy of Asiatic Russia" [8] there are analysed fossil complexes of many hundreds of locations in the Asiatic Russia (mainly from Western Siberia); there is traced the history of the flora and fauna of Western Siberia and north-eastern Russia during the late Paleogene and Neogene. There is also given a table of geochronological spread over of more than 1,600 species of fossil plants, among which more than 20% (about 360 species) belong to the aquatic and coastal aquatic plants.

Methodology.

In this paper, all paleoflora fossil dating are given in accordance with the above schemes used in the work of Adamenko O.M. "Mesozoic and Cenozoic Eras of Steppe Altai" [9]. In some provided evidences on the Western Siberia there are used dating given by Nikitin V.P. in the work "Paleocarpology and Paleogene and Neogene Stratigraphy of Asiatic Russia" [8]. The work is based on the materials of the richest in Russia collection fund of paleocarpological laboratory of "Novosibirskgeology", OJSC (Novosibirsk), which foundations were laid in the 20s years by the first domestic paleocarpologist Nikitin P.A. The analyses data of cores of dozens of bore wells, sections of numerous outcrops along the rivers Om, Tom, Vakh, Ishim, Uy, Shish, Dem'yanka and others in the Western Siberia. **Main part.** Paleoflora of the Western Siberia water bodies of Upper Eocene - Lower Oligocene according to its state of exploration currently is sparse and represented only by 8 species. Relatively small number of taxa of this era is primarily explained by a low state of exploration and quite scarce paleobotanical materials. With the forthcoming of the new data on paleocarpology, palynological studies, these data undoubtedly will only be extended.

The paleoflora of Oligocene water bodies consisted of 109 species, was represented by 20 families and 30 genera. Considering the flora of this era, it is necessary to realize that it has been presented, undoubtedly, by a great number of species, genera and families, which total number of taxa was by 3-4 orders higher. The ten leading families of this period include 87 species that constitutes 89.6% of the total number of taxa. Oligocene relics are represented by 26 species from 12 families: Azolla inflate, A. juganica, Salvinia aspera, S. cerebrate, Brasenia baltica Dorof., etc. The most numerous family in the flora of the Paleogene water bodies is represented by the Cyperaceae family. The Upper Eocene – Lower Oligocene in the paleoflora of the West Siberia water bodies for the first time appear representatives of the Dulichium – D. subtile Balueva et V.P. Nikit. genus, which existed in the flora until the late Rupel. In the Oligocene, the family Cyperaceae is represented by 15 species and 4 genera (Dulichium, Cladium, Scirpus and Carex). Rhode Dulichium – currently the North American taxon [10] – is a high herbaceous plant, inhabiting the swamps, banks of ponds and temporarily flooded sites in eastern part of the North America, from Canada to Florida and in the west from California to Colombia. In Siberia, its representatives are known from the Eocene (extremely archaic spices) to the Late Pliocene. The Potamogetonaceae family in Oligocene in western Siberia is represented by 13 species, of which four species are relics of this period (not presenting in the paleofloras of the next Cainozoic epochs), these are the Potamogeton tomskianum Dorof., P. auriculatus V.P. Nikit., P. laceratus V.P. Nikit., и P. spiniferus V.P. Nikit. The upper Eocene – Lower Oligocene the Drepanocarpella genus is represented in the Western Siberia by three species – Drepanocarpella antique V.P. Nikit., D. tymensis V.P.Nikit., and D. tavdensis (Dorof.) V.P. Nikit., wherein the first species is a relic of the Eocene (the seeds are not present in the paleocarpological complexes of the subsequent epochs). In the deposits of the Western Siberia there are found the seeds of 23 species of Nymphaeaceae representatives, belonging to 10 genera. The first founds of the Nymphaeales seeds refer to the Upper Eocene – Holocene. These are the archaic representatives of the Nymphaeaceae – Nymphaea paradoxa Balueva et V.P. Nikit., Pania prisca Balueva et V.P. Nikit., Pseudonymphaeae prisca Balueva et V.P. Nikit. family, growing in warm shallow bays of the Chegan sea and numerous lakes. Interesting are the seeds of the extinct Pania genus. According to various diagnostic features, they are similar both to the Nuphar and Nymphaea genus seeds; the genus is known only in the Paleogene of the West Siberian plate. No less interesting are the seeds similarities of the Pseudonymphaeae genus representatives, resembling the seeds of several genera – Nuphar, Nymphaea, Brasenia and Euryale (the predominant similarity with Nymphaea). In the Oligocene, the family is already represented by the 9 species, new genus and species appear – Tavdenia sibirica Dorof., Eoeuryale macrosperma Dorof., Nuphar tavdensis Dorof., N. macrosperma Dorof., etc. In the Upper Eocene –Oligocene, the Azollaceae family is represented by the species of the ancient extinct section Azolla sect. Pricsa G. Bal. et V. Nikit., A. oligocaentica G. Bal., A. asiatica G. Bal., A. Kryshtofovichiana G. Bal. In the Oligocene on the territory of the Western Siberia, the family is already represented by one genus and 8 species, the new species appear - Azolla aspera, A. monilifera P. Nikit., A. inflata G. Bal., A. juganica G. Bal. The last two species are relics of the Oligocene and are not presented in the sediments of other Cainozoic floras in the Western Siberia in. The first founds of endocarp bur-reeds (Sparganiaceae) in paleocarpological collections are marked for the Oligocene (in total 8 species are described), of which 4 species are relics of this period; these are S. elongatum Dorof., S. fusicarpum, S. pusillum Dorof. and S. tomskianum P. Dorof. The Oligocene interesting findings of the Sparganium eurycarpum Engelm. species endocarps, nowadays growing in the New England, British Columbia, in the coastal waters from Washington to the Lower California in North America [11]. Endocarps of this species are found in the paleocarpological collections from the late Rupel (Oligocene) to middle Miocene in the Asian Russia [8]. The first seeds founds of the Brasenia (Cabombaceae) genus representatives are marked in the Oligocene paleoflora of the Western Siberia from the Tavda River. This is very archaic Brasenia, still exclusively the West Siberian ones, – Brasenia chandleri V. Nikit., B. nymphaeoides Dorof., B. sibirica Dorof., B. tuberculata C. et E.M. Reid and others. In general, in the Oligocene on the territory of the Western Siberia, there were growing 7 species, including B. nymphaeoides and Brasenia baltica Dorof. In the Miocene they are already not found. The Salvinia (Salviniaceae) genus in its fossils state is known on the territory of the Western Siberia from the Upper Eocene – Early Oligocene, and is represented by species, which are far removed from the modern species – S S. kulundica G. Bal., S. oligocaenica R. Sobol. and S. nikitinii Dorof. In the Oligocene the genus is represented in the Western Siberia already by 8 species, among which, from the previous period there remained only S. nikitinii, which was growing in the water bodies of the Pleistocene. Representatives of the Typha (Typhaceae) genus are almost an indispensable component of seed complexes of the Paleogene, Neogene and Quaternary ages. Rogozov seeds are presented in more than 1,000 paleocarpological collections. In most cases, the remnants of Typha are preserved as fossils in the form of internal leathery seed coat. These residues are deprived of specific characters and are seldom referred to any species definition. The first information about the findings of the Typha genus seeds are known from the Upper Eocene, these are the seeds of T. prisca Balueva et V.P. Nikit., the species is known from a single deposition location in the Galkino village, Pavlodar region of Kazakhstan Republic. In the subsequent Cainozoic periods, the seeds of this species do not occur. Later, in the seed complexes of the Lower-Middle Oligocene of Western Siberia there have been already noted 5 species of reed maces. These are T. dusenbaica Dorof., T. maxima V.P. Nikit., T. pusilla Dorof., T. tavdensis Dorof. and T. prisca Balueva et V.P. Nikit. The first information about the founds of the Alismataceae family representatives refer to the Oligocene (fruit of Caldesia proventitia P.Nikit ex P.V. Nikit., Alismataria aemulans P. Nikit., Sagisma turgidum P. Nikit., S. tavdensis Dorof., S. parnassiforme P. Niki t.) among which, only S. tavdensis Dorof. does not pass to the subsequent periods, being a relic of the Oligocene. The Hydrocharis morsus-ranae (Hydrocharitaceae) seeds are known from the Upper Oligocene sediments. From the Lower Oligocene there are also described the seeds of the second Hydrocharitaceae species representatives – Stratioites, represented by 5 species (Stratioites imperfectus V.P.Nikit., S. inversus P. Nikit., S. sibiricus Dorof., S. tavdensis (Dorof.) V.P. Nikit., S. tuberculatus E. Reid. The first two types are relics of the Oligocene. In the Paleogene and Neogene of the Asian Russia, the fossil seeds of the Lythraceae family representatives are quite often present in sediments. The earliest founds of seeds of the Decodon JF Gmel. Genus representatives refer to D. sphenosus Balueva et V.P. Nikit., a species typical for the Late Eocene complexes in West Siberia. In the Oligocene, the genus is represented by five species, there appear the seeds of D. nikitinii Dorof., D. sibiricus Dorof., D. spinosus V.P. Nikit. and D. tavdensis Dorof. (the Oligocene relict). The Decodon genus nowadays does not grow in Siberia. Now, the monotypic genus, modern D. verticillatus (L.) Ell., is spread along the swamps and silty shores of the water bodies in the eastern part of the USA [12]. The Haloragaceae family in the seed complexes is represented by two genera (the extinct on the territory of Siberia Proserpinaca genus and modern Myriophyllum genus) and by 3 species – Myriophyllum debilis V.P. Nikit., Proserpinaca pterocarpa Dorof., P. reticulata C. et E.M. Reid. Currently, the representatives of the Proserpinaca genus (3 species) are the perennial aquatic grasses, spread in the North America, Central America and adjacent islands [13].

Conclusion

The greater or lesser geological antiquity of the flora fossil can be defined in several ways, but numerous attempts of comparing the horizons of the continental Cainozoic of the Asiatic Russia with the common scale longlines at best remain hypothetical. Indeed, even in the Mediterranean, there are still present tense debate about the scope and limits of the Paleogene longlines, and especially about the Neogene, the relationship between marine and continental horizons, and the correlation of Cainozoic sediments of the northern Asia and Europe is dramatically hampered by the still weak paleontological state of exploration of the first ones [14-16]. Analysis of successive evolutionary flora transformations in the Paleogene and Neogene of the Western Siberia is definitely related to climate change and general physiographic conditions; it made it possible to trace the development of the flora phasing in the Paleogene and Neogene. It was found that in the history of the Tertiary flora development of North Asia, there can be distinguished three major phases: Eocene Pre-Turgaic, characterized by spread of close to the subtropical broadleaved-coniferous forests with evergreen trees and shrubs; began in the early Oligocene and ended in the late Miocene Turgaic stage of the mesophilic moderately thermophilic forest flora domination. The contemporary floral stage begins with Eopleistocene, when the flora composition of each particular area there were held only a few mainly local exotics and occasional relics of the Past-Turgaic stage, and when there were practically formed the present climates and contemporary vegetation of the modern North Asia.

Summary

Considering the history of development of the water body flora in the south of Western Siberia, it can be concluded that the development of the water body flora went mostly autochthonous, i.e. it arose out of the Eocene-Oligocene local flora. The water body flora core was shaped in the Pliocene-Pleistocene on the bases of the combined variants of the Pavlodar and Kochkovsk floras, as well as due to the thermophilic elements of the ancient Mediterranean flora. Later it developed here in the Western Siberia and reached its peak in the Upper Miocene - Lower Pliocene (208 species). At all stages of its history, it notes the simultaneous participation of European-Siberian, Siberian and Japanese, Siberian and American or common moderately Holarctic elements. This indicates an overall Paleogene bases of all local floras of the temperate zone of the northern hemisphere and movements (migration) of individual plants, their groups or even entire formations which, settling in a new territory, were included into the local formation and with them gave rise to a new flora, sometimes substantially different from the first.

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