Eastern Arctic in Jurassic: Paleogeography and Paleoclimatology

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Eastern part of Arctic region in Jurassic spread into both halves of modern Arctic Ocean: to the east from Taymyr and Lena river mouth in Asia, to the west from Mackenzie river mouth and Alaska in Northern America, and also to the Bering sea region.

This territory is interpreted as a part of Pacific geodynamic system (Mesozoic folding belt of North-eastern Asia and North America). Sedimentary basins of this geosystem have been interpreted as geosynclinals in former times and were characterized by very contrasting bathymetry and widely spread volcanism. From the point of view of plate tectonics, this geosystem has been formed as a result of the collision of Eurasian and North American plates with numerous microplates (terranes), which were accreting during the Jurassic to the margin of the Siberian platform.

According to the geodynamic interpretation, significant area between continental plates was occupied by a deep sea (or a gulf) of northern Paleopacific, penetrating to the modern Arctic Ocean area， and called the same name as its ophiolitic suture Anyui "paleoocean" (Zonenshain and Kuz'min，1992；see Fig. 1a). During the Triassic and Jurassic this "ocean" was steadily decreasing, moving in the direction of Pacific, and finally was closed in the Early Cretaceous, probably in Barremian. A connection between Northern Paleopacific and Arctic Ocean from this moment has been lost. Both scenarios described above implicate there was the connection between Arctic and North Pacific basins in the Early Jurassic, and the reduction of water mass exchange to the end of Jurassic.

The comparative analysis of mollusk paleobiogeography data in Arctic and North Pacific basins allows us to make more precise reconstruction of paleogeography changes and climatic fluctuations of this region during the Jurassic. Structure and biodiversity of marine biota let us suppose that on the territory of modern Arctic Ocean there was a large water area (possibly an oceanic basin) in Mesozoic as well as in Jurassic. This means that most principal factors of environment – salinity and temperature – were relatively stable in time.

There were open connections between North Pacific and Arctic basins, and during the Jurassic these connections were gradually reducing. Final separation of basins took place in Early Cretaceous, as a result of Alaska-Chukotka plate moving. According to W. Hay et al. (1999) this plate occupied large area between North America and northern Asia, and the connection was completely closed as a result of central Alaska terranes movement. Paleobiogeographic analysis allowed us to reject the hypothesis of terrane movement from tropic zone of Paleopacific to the Eastern Siberia craton. Taxonomic diversity of marine fauna of the Early Jurassic decreases to the west, Middle Jurassic is characterized by low diversity, and during the Late Jurassic the diversity grows in all taxonomic groups of marine invertebrates, due to the influence of Central Russian Sea biota (Zakharov and Rogov, 2007). The passage between Arctic and North Pacific was closed, most probably, in the Barremian: there is strong evidence that deep-water troughs near Novosibirsk islands, extending from North Pacific oceanic gulf, were still existing in Early Valanginian (Kuzmichev et al., 2009, Fig.1 A).

To the east of Urals the diversity of low-boreal ammonites slightly decreases: in North Siberia sections of Upper Jurassic, at Kheta river basin, peritethyan and many low-boreal taxa are not found. 500 km to the east, on the shore sections of Laptev sea, only high-boreal (arctic) ammonite taxa can be found, represented by several genera of Cardioceratidae and Boreal Oppeliidae (Oxfordian-Kimmeridgian), Dorsoplanitidae and Craspeditidae (Volgian, Ryazanian and Valanginian). Bivalves show very similar pattern of distribution: among shallow-water taxa, widely spread in central Russian Sea during the Oxfordian, Gryphaea and Plicatula disappear in Pechora basin sections, and low-boreal Neocrassina (Astartidae), distributed in late Oxfordian Timano-Pechora sea, can not be found in Khatanga sea.

Oxfordian and Kimmeridgian deposits of Volga river basin in central Russia contain little number of Buchia, which are abundant to the north-east, in Pechora basin sections, and which are the major element of Late Jurassic fauna in northern Siberia. In the north-eastern Asia, around the northern paleo-pole, monogenetic accumulations of Buchia are common for the Upper Jurassic sections. A very similar situation in Jurassic can be seen along the Pacific coast of northern Asia. Episodes of Boreal-Tethyan immigrations, as a rule, were caused by sensible fluctuations of water mass temperature (Fig.1 B), which, in turn, were caused by eustatic events. In the sections of Upper Jurassic of Novosibirsk islands, Chukotka, Koryakia and Okhotsk sea region cold-water buchias predominate in bivalve complexes.

This confirms that geographic Northern pole in Jurassic was located around modern Bering strait (Sellwood and Valdes, 2008). This fact is also indicated by the sedimentological data: along western Pacific coast the share of carbonate rocks is gradually decreasing to zero from South Primorje to Bering sea, being replaced by terrigenous and volcanogenic rocks. There is no data on paleotemperatures of water mass for the north of eastern Siberia. Late Jurassic seas in the North Siberia average annual water paleotemperatures were about 12 to 15°C (Berlin et al., 1970).

Acknowledgements: The research is supported by Scientific Programs of Russian Academy of Sciences Nos. 16, 17 as well as RFRF Grants Nos. 09-05-00456 and 09-05-00136.

Key words: Arctic; Jurassic; Paleogeography; Paleoclimatology

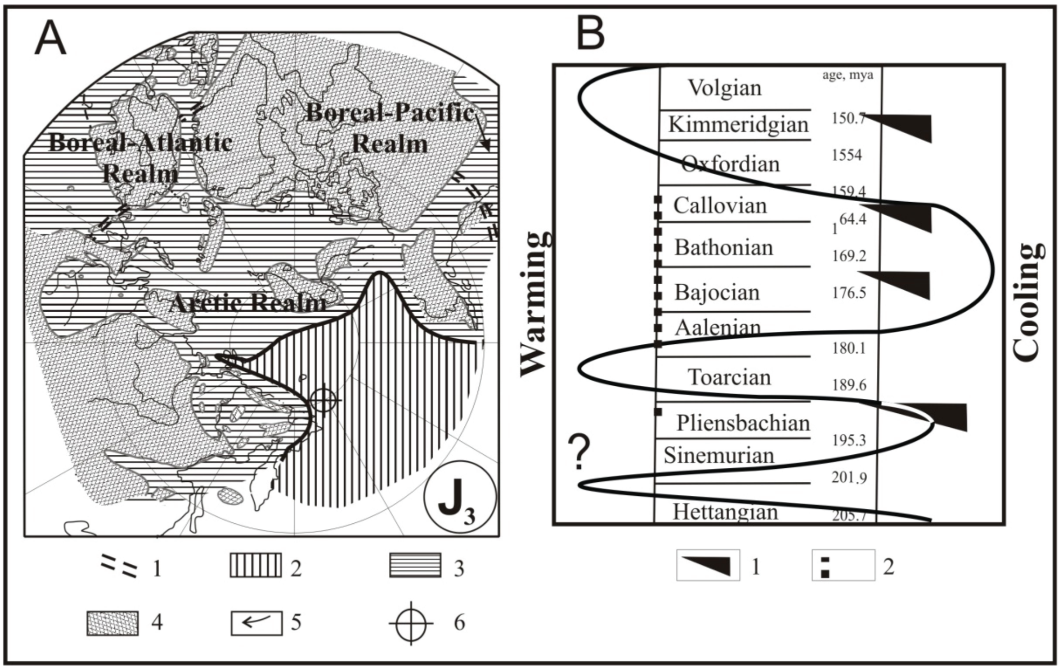

Fig.1 Volgian paleogeography of the Arctic region (A) (Zakharov et al., 2010) and Jurassic climate oscillation in Arctic (B) (based on data on fossil occurrences and mineralogical climate indicators, from Zakharov et al., 2010)
(A): 1-realms boundaries; 2 -deep basin; 3-epicontinental seas; 4-land; 5-paleocurrents;6-Northern Pole; (B): 1-biotic turnovers (length of triangles reflect their intensivity); 2-stratigraphical range of glendonite concretion

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