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Stratigraphy and ecostratigraphic distribution of foraminiferal morphogroups from the Upper Jurassic of the Makar'yev section (*Unzha River, Volga River basin*)

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Abstract

Investigation of the Upper Callovian to Lower Kimmeridgian microfossils from the Makar'yev reference section (Unzha River, East European Platform) has been carried out. The section is characterized by ammonite debris and abundant associations of benthic and planktic foraminifers. It is a perfect object for stratigraphic and paleoecological researches. The biostratigraphic distribution of foraminifers from the Makar'yev section allows one to identify standard foraminifera zones of the East European Platform, as well as to upgrade some of them. The analysis of vertical and lateral ammonites and foraminiferal distribution, completed with lithostratigraphy, has precised the stratigraphic volume and position of boundaries of several lithological units.

An improved stratigraphic scheme for the Kostroma area of the Moscow Depression is proposed. Analysis of the composition, structure, and dynamic changes of the foraminiferal assemblages has been performed. The morphofunctional analysis of foraminiferal genera has for the first time identified how foraminiferal morphogroups differing in their life style and feeding strategy varied with short-term paleoenvironmental changes. These morphogroup changes allow establishing four ecostratigraphic levels. These paleoecological data have been calibrated along with geochemical factors. They have shown a crisis of foraminiferal association during the Late Oxfordian and Early Kimmeridgian. A similar crisis has also been discovered in the north of Siberia, which may be an argument for its global distribution. The analysis of the taxonomic composition and the density of foraminiferal associations, in parallel with the structure of the association, has revealed a succession of transgressive and regressive events during the Late Callovian–Early Kimmeridgian. It allows the typification of each assemblage in relation with each event and underlines the occurrence of second-order sea-level fluctuations (middle part of the Middle Oxfordian and the earliest Kimmeridgian).

Keywords: Oxfordian; Kimmeridgian; stratigraphy; foraminifera; associations; paleoecology; morphogroups analysis; biofacies; Russian Sea; East European Platform

Introduction

Upper Jurassic sections from the central part of the East European Platform represent a reference object for paleoecological investigations. In recent years, these sections were thoroughly restudied with among others, lithostratigraphic, biostratigraphic (mainly ammonites), and geochemical purposes. Then, a new lithostratigraphic subdivision was proposed, ammonite zonation was improved, paleotemperatures of the basin reconstructed, and relative quantitative eustatic curve and geochemical data were proposed (Glowniak et al., 2010; Hantzpergue et al., 1998; Mesezhnikov et al., 1989; Mitta et al., 2012; Price and Rogov, 2009; Riboulleau et al., 1998; Rogov, 2005; Sahagian et al., 1996; Wierzbowski and Rogov, 2011; Yakovleva, 1993; Zakharov and Rogov, 2003; and others).

The Makar'yev section is one of these reference sections. It is exposed along the bank of the Unzha River (Volga River basin) near the town of Makar'yev (Fig. 1). The Makar'yev section is defined by Upper Callovian to Lower Kimmeridgian clayed beds that naturally crops out along the river. Despite the low thickness of the stratigraphic units, the section is characterized by numerous ammonites and abundant foraminiferal assemblages; hence the constant attention brings to this

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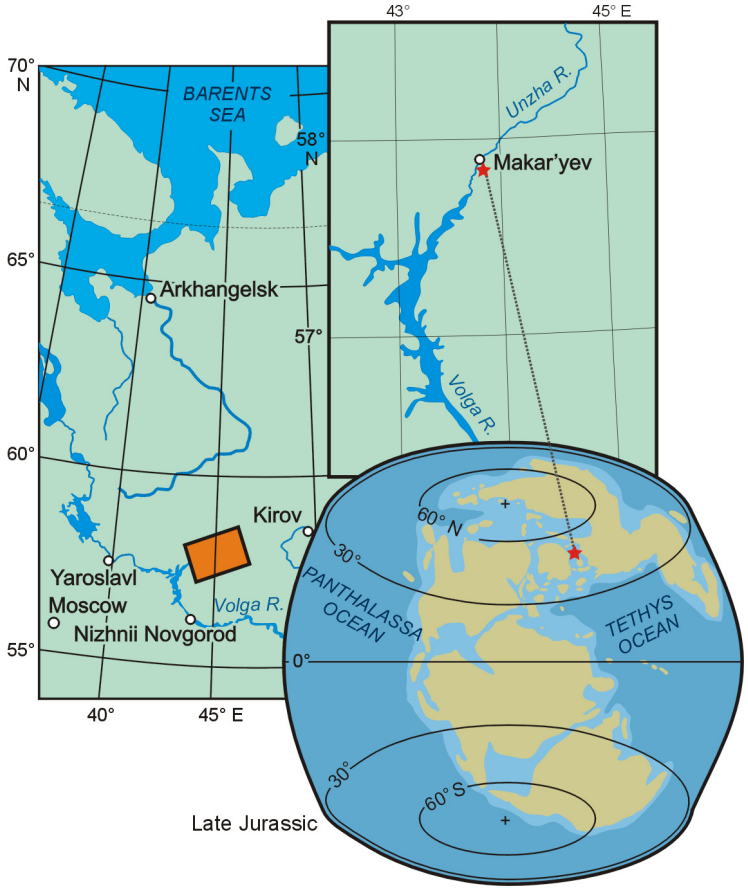

Fig. 1. Geographical location of the studied area (orange rectangle) and the Makar'yev reference section (red star) (Upper Callovian–Lower Kimmeridgian) and Late Jurassic global paleogeographical map (Nikitenko et al., 2015).

section. Following these researches, the ammonite and foraminiferal biostratigraphy of the Oxfordian and Kimmeridgian from the Makar'yev section has been developed and improved, as well as some regional lithostratigraphic correlations have been performed. The Makar'yev section has been identified as the stratotype section of several foraminifer's zones and lithostratigraphic units (Mesezhnikov et al., 1989; Olfer'ev, 1986, 2012; Yakovleva, 1993; and others).

Later this section has been restudied by French and Russian experts under the International Program "Peri-Tethys". A bed-by-bed sampling with associated detailed ammonite zonation, variations of geochemical parameters, and reconstruction of paleotemperatures were performed. Micropaleontological samples were also collected during the fieldwork, and represent the core of the present research (Hantzpergue et al., 1998; Riboulleau et al., 1998). The mentioned lithological, biostratigraphic, and geochemical data of the Makar'yev section have been correlated with the obtained micropaleontological results.

The main aim of this study is to detail the Upper Jurassic stratigraphy of the studied region and to develop biofacies and ecostratigraphic reconstructions based on foraminifers. Indeed, previous publications of the Upper Jurassic microfauna from the European part of Russia have been usually limited to monographic, biostratigraphic, and paleobiogeographic aspects (Azbel and Grigelis, 1991; Grigelis, 1982, 1985a,b; Kuznetsova, 1979; Mesezhnikov et al., 1989; and others). In other hand, micropaleontological data are commonly used in Jurassic paleoecology and biofacies investigations worldwide. The present study displays a morphofunctional analysis of some foraminifer's genera. The resulting morphogroups differing by their life-style and feeding strategy varied during the Late Callovian to the Early Kimmeridgian along with short-term paleoenvironmental changes. The paleoecological results based on foraminifers have been correlated with previously published geochemical data (Hantzpergue et al., 1998; Riboulleau et al., 1998). The combined analysis of both planktic and benthic foraminiferal distribution during the Oxfordian and the Kimmeridgian may elucidate paths of the plankton spreading and reasons of its gradual migration northward to the Arctic basins (Pechora River basin).

The absence of tectonic activity during the Late Jurassic of the East European Platform makes possible the reconstruction of the quantitative curve of eustatic sea level changes using calculation methods (Sahagian et al., 1996). Apparently, the recorded large-scale transgressive and regressive events have been interrupted by faster and smaller sea level changes (fluctuations of the second order). Those cannot be detected with usual or calculation methods. Furthermore; the great sensibility of the microfauna to environmental changes, and the analysis of their subsequent variations after transgressive