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Russian Geology and Geophysics 57 (2016) 574–585

RUSSIAN GEOLOGY AND GEOPHYSICS

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Holocene climate changes in southern West Siberia based on ostracod analysis

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Received 11 February 2015; accepted 28 May 2015

Abstract

The study presents a summary of the latest data on ostracod microfaunas from Middle–Upper Holocene lacustrine deposits of southern West Siberia collected from lakes Malye Chany, Bol'shaya Lozhka, Beloe, and paleolake Chicha. A total of 28 ostracod species were identified. The identified ostracod assemblages reveal local variations in the lake ecosystems as well as general trends, which can be correlated with both regional and global climate changes. A cooling episode during the second half of the Subboreal is marked by the transition from a warm-water mesohaline assemblage to cold-water candonid ostracods at ca. 3.4 cal ka BP. The widespread occurrence of mesopolythermophilic ostracod species at 1.9–0.6 cal ka BP indicates the end of cooling and lowering of lake-water level. From 0.6 cal ka BP to present, the ostracod assemblages area characterized by the high specific diversity, which is probably an indication of the increased variability of aquatic ecosystems due to fluctuations in salinity and water levels of the lakes. Climate changes identified by ostracod assemblages are consistent with the climatic trend constrained by early palynological studies.

Keywords: ostracods; Holocene; paleontology; climatostratigraphy; paleoecology; southern West Siberia

Introduction

Ostracods, a widespread group of skeletal hydrobionts found in almost in all types of Holocene freshwater habitats, have shown to be important objects of paleobiological studies and tools for paleogeographic reconstructions due to a unique combination of their population, morphophysiological, and ecological characteristics, such as a short life cycle, a high reproductive rate, excellent skeletal preservation of both adult and larval stages in fossil taphocenoses. Ostracod species can be used as indicators for interpreting the water quality of aquatic habitats due to their different ecological requirements and tolerances to the main physicochemical parameters of a water body, including temperature and salinity.

Previous reconstructions of Holocene environmental and climatic changes in southern West Siberia were based primarily on radiocarbon dating and palynological data (Arkhipov and Volkova, 1994; Blyakharchuk, 2003; Khazina, 2006; Khotinskii, 1977; Levina and Orlova, 1993; Orlova, 1990) and to a lesser extent on microfaunal data (Khazin and Khazina, 2008; Khazin et al., 2009; Krivonogov et al., 2012a). The goal of this paper is to summarize the recent available data on the ostracod faunas from lacustrine deposits of southern West Siberia and discuss microfaunal, palynological, and radiocarbon dating results to elucidate the history and past changes in climate and water bodies of the study area.

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1068-7971/$ - see front matter © 2016, V.S. Sobolev IGM, Siberian Branch of the RAS. Published by Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.rgg.2015.05.012

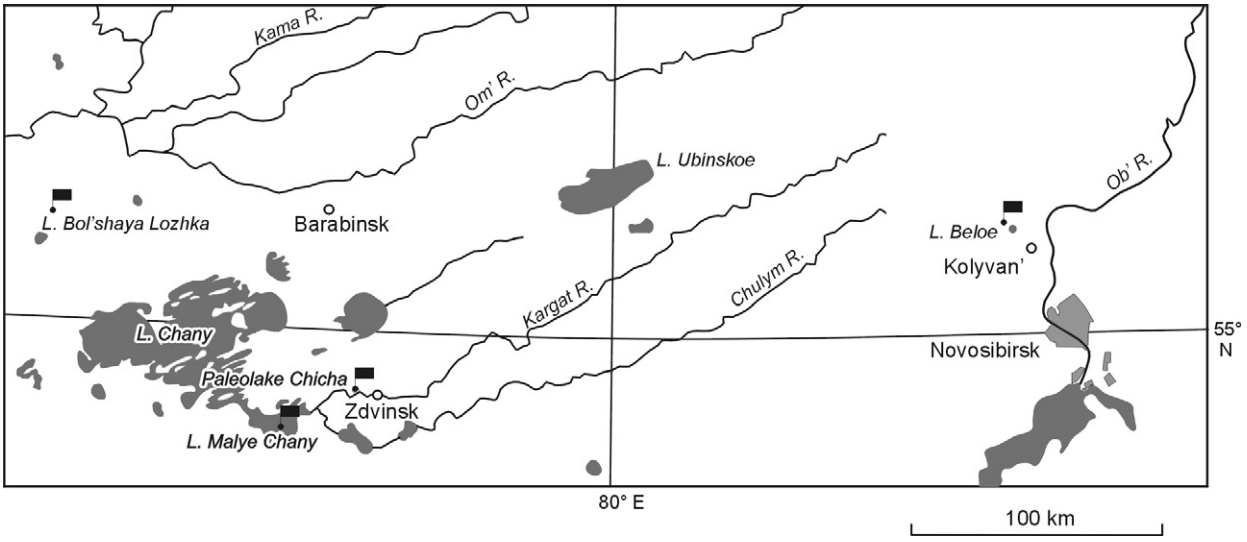

Fig. 1. The study area.

Materials and methods

Microfaunal remains were collected from four lakes in southern West Siberia (Baraba plain): lakes Malye Chany, Bol'shaya Lozhka, Beloe, and paleolake Chicha (Fig. 1). Lacustrine sediments were recovered by percussion coring technique (coordinates of the coring sites are shown in Table 1) using a modified Livingstone piston corer with a brass (for soft sediments) or stainless steel (for compacted sediments) tube 2 m long and 7.6 cm wide. The retrieved core preserves all the sediment along with its structures. The coring was conducted from a platform floating on a lake surface. The dry lakebed of paleolake Chicha was drilled using an exploratory corer representing a 1 m in length and 4 cm in diameter coring tube slotted along its length, which does not protect samples from contamination and allow sediment from other beds to be captured during entry and retrieval of the corer. To avoid contamination the surface of the working half of the corer is cleaned by removing a layer of sediment that formed around a slot. The possibility of sample contamination cannot be always reduced due to high viscosity of water-saturated loams at Chicha locality. This was probably the main cause of discrepancy in radiocarbon dating results (Table 1), however, ostracod and palynological data showed no bias that can be related to contamination.

The extraction of ostracod shells from sediments was performed using a 100 g aliquot to ensure comparability between counting results. Rock samples were disintegrated in water and washed through a 0.067 mm sieve. Ostracod valves were picked from dried residue under an MBS-10 binocular and determined under a Zeiss Stemi 2000 microscope.

Radiocarbon dating of core samples was performed by accelerator mass spectrometry (AMS) at the University of Arizona (AA), Woods Hole Oceanographic Institution (OS), Korean Institute of Geoscience and Mineral Resources (ISa, ICa), and Beta Analytic Inc. (Beta), and scintillation counting at the SOAN Laboratory of the Institute of Geology and Mineralogy, Siberian Branch, Russian Academy of Sciences. Ages were calibrated using the Calib 7.0 software (Reimer et al., 2013) at the 2-sigma confidence level. Due to stratigraphic disturbance, some dates were rejected from the age models and event reconstructions (see notes to Table 1).

The reconstruction of climatic and environmental changes was based on several key parameters that influence ostracod species, such as water temperature, salinity, and depth (Meisch, 2000; Practical Guide…, 1989). Environmental changes recorded in lakes based on ostracod ecology were then compared with regional climatic changes using the palynological data obtained from the same lakes (Khazin and Khazina, 2008; Khazin et al., 2009; Khazina, 2006; Krivonogov et al., 2012a), as well as available paleoclimatic reconstructions for southern West Siberia (Arkhipov and Volkova, 1994; Blyakharchuk, 2003; Levina and Orlova, 1993).

Results of ostracod analysis

Lake Malye Chany is a freshwater lake located in the Kupino and Zdvinsk districts, Novosibirsk region, with a surface area of 200 km², mean water depth of 1.4 m and TDS of 0.8 g/L. Lake Malye Chany lies at 106 m a.s.l. and is connected through a channel to Lake Chany, a larger saline lake. The Kargat and Chulym Rivers flow into Lake Malye Chany.

A 300 cm long sediment core was recovered from a borehole drilled to a depth of 360 cm in the center of the lake. The lake sediment core consists of basal brownish gray sand and gray sapropelic loam grading into clay gyttja at its top (Fig. 2). The age of the sediments was constrained by five radiocarbon dates, of which two mollusk shell dates were stratigraphically reversed (Table 1) and the source of this reversal is not immediately apparent. One anomalously old radiocarbon age of 4130 ± 50 yr BP obtained on small bivalves may be attributed to a reservoir effect or the incorporation of