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Late Holocene climate and environmental changes in Kamchatka inferred from the subfossil chironomid record

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ABSTRACT

This study presents a reconstruction of the Late Holocene climate in Kamchatka based on chironomid remains from a 332 cm long composite sediment core recovered from Dvuyurtochnoe Lake (Two-Yurts Lake, TYL) in central Kamchatka. The oldest recovered sediments date to about 4500 cal years BP. Chironomid head capsules from TYL reflect a rich and diverse fauna. An unknown morphotype of Tanytarsini, *Tanytarsus* type klein, was found in the lake sediments. Our analysis reveals four chironomid assemblage zones reflecting four different climatic periods in the Late Holocene. Between 4500 and 4000 cal years BP, the chironomid composition indicates a high lake level, well-oxygenated lake water conditions and close to modern temperatures (~13 °C). From 4000 to 1000 cal years BP, two consecutive warm intervals were recorded, with the highest reconstructed temperature reaching 16.8 °C between 3700 and 2800 cal years BP. Cooling trend, started around 1100 cal years BP led to low temperatures during the last stage of the Holocene. Comparison with other regional studies has shown that termination of cooling at the beginning of late Holocene is relatively synchronous in central Kamchatka, South Kurile, Bering and Japanese Islands and take place around 3700 cal years BP. From ca 3700 cal years BP to the last millennium, a newly strengthened climate continentality accompanied by general warming trend with minor cool excursions led to apparent spatial heterogeneity of climatic patterns in the region. Some timing differences in climatic changes reconstructed from chironomid record of TYL sediments and late Holocene events reconstructed from other sites and other proxies might be linked to differences in local forcing mechanisms or caused by the different degree of dating precision, the different temporal resolution, and the different sensitive responses of climate proxies to the climate variations. Further high-resolution stratigraphic studies in this region are needed to understand the spatially complex pattern of climate change in Holocene in Kamchatka and the surrounding region.

1. Introduction

The Kamchatka Peninsula shapes the eastern edge of Siberia and separates the Sea of Okhotsk from the Pacific Ocean. It is one of the least studied regions in Eurasia. The climate history of the last 400 years in Kamchatka is well documented in tree-ring and ice-core records and suggests short-term climate oscillations at centennial to decadal time scales (Solomina et al., 2007; Sano et al., 2009, 2010). Less is known about the Holocene environmental dynamics in the region (Pisaric et al., 2001; Razjigaeva et al., 2004; Fradkina et al., 2005; Kokorowski et al., 2008).

Studies of the Holocene climate in Kamchatka are limited and mainly focus on reconstruction of vegetation dynamics from pollen records in peat sections (Dirksen and Uspenskaya, 2005; Dirksen and Dirksen, 2008) or reconstructions of glacial dynamics in southern and central Kamchatka (Zech et al., 1997; Savoskul, 1999). The present study is focussed on qualitative and quantitative reconstructions of environmental changes using chironomids, which have proven to be useful indicators of environmental variations (Battarbee, 2000; Smol et al., 2005; Stief et al., 2005; Kienast et al., 2011; Self et al., 2011). Past climate can be quantified from fossil

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chironomid assemblages by using inference models (Larocque et al., 2001; Solovieva et al., 2005; Barley et al., 2006; Nazarova, 2012; Nazarova et al., in press), which link the present distribution and abundance of chironomids to contemporary climate. The main objective of our study is to perform a palaeoecological reconstruction of the late Quaternary climate and environment in Kamchatka from sediments of Dvuyurtochnoe Lake (Two-Yurts Lake, TYL), situated in Central Kamchatka. The specific aim is to provide reconstructions of mean July air temperature (T_{July}), using the newly developed for north-eastern Russia chironomid-inferred mean July temperature model (Nazarova et al., 2011).

2. Study area

The Kamchatka is a peninsula in the Russian Far East that lies between the Pacific Ocean to the east and the Sea of Okhotsk to the west (Fig. 1). The longitudinal extent of the peninsula is approximately 1600 km and the maximum width is 500 km (Nazarova,

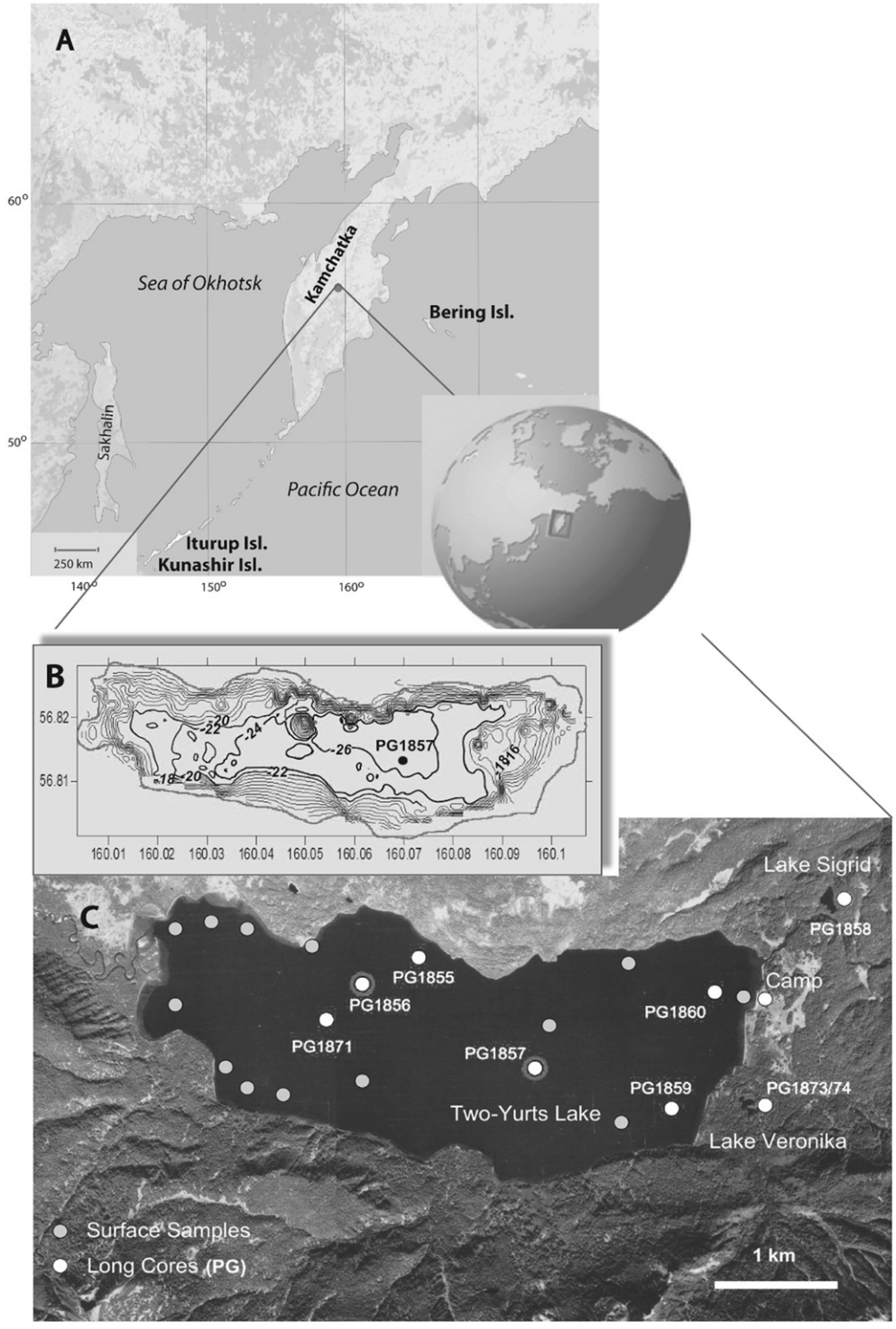

Fig. 1. A. Map of the region and location of the TYL in Kamchatka; B. Bathymetric map of TYL; C. Position of the sampling sites.