

Chironomids in Quaternary permafrost deposits in the Siberian Arctic

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Fossil chironomids from lacustrine sediments are frequently used as bioindicators for the reconstruction of Late Quaternary environments (Smol et al. 2005; Self et al. 2011), but there are very few records concerning chironomids from periglacial permafrost deposits (Ilyashuk et al. 2006).

Permafrost records, accessible at outcrops along the coast of Oyogos Yar at the NE-Siberian Dmitry Laptev Strait provided unique insights into the environmental history of Beringia during the last interglacial (Kienast et al. 2011). A paleontological study was carried out on the last interglacial (Kazantsevo, Eemian, Sangamoian, MIS 5) terrestrial and freshwater organism assemblages preserved in frozen deposits of a shallow paleo-lake outcropped at a permafrost cliff at Oyogos Yar (72.68°N; 143.53°E), the mainland coast of the NE-Siberian Dmitry Laptev Strait, Republic Yakutia, in the Russian Federation (Fig. 1). The Dmitry Laptev

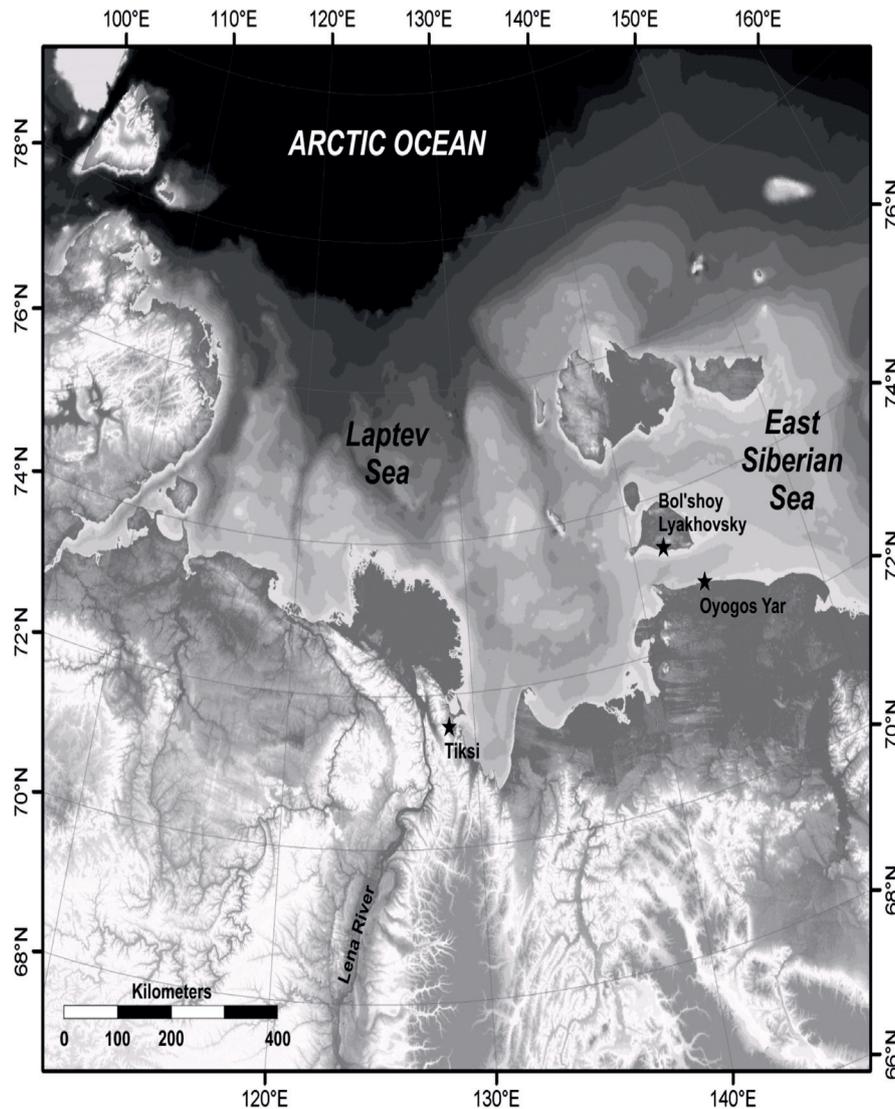


Figure 1. Location of the Bol'shoj Ljakhobskiy Island and coastal sector of Oyogos Yar in north-eastern Siberia.

Strait connects the Laptev and East Siberian seas, which are the widest and shallowest shelves worldwide. The mean temperature of the warmest month at the coast is about 4°C, the mean temperature of the coldest month is about -30°C (Station Cape Svyatoy Nos, 72° 53' N, 140°, 45' E in Rivas-Martínez, 1996-2009).

From a total of 50 chironomid head capsules, recovered from Eemian deposits, 16 taxa were identified (Table 1). Eight of these taxa belong to the subfamily Orthocladiinae and eight to the subfamily Chironominae (five Chironomini, three Tanytarsini). The dominant taxa were *Limnophyes*, *Smittia foliacea*-type and the *Psectrocladius sordidellus*-type. The majority of the taxa are indicators of temperate shallow lakes or littoral conditions that are associated with macrophytes. *Limnophyes* and the subdominant taxa, *Metriocnemus eurynotus*-type and *Parametriocnemus/Paraphaenocladus* are also frequently associated with macrophytes (Cranston et al., 1983; Brodin, 1986). Furthermore, these taxa are typically indicative of lake level fluctuations (Massaferro & Brooks, 2002). *Smittia foliacea*-type could be indicative of erosional processes or unstable lake level conditions (Cranston et al., 1983). The subdominant taxa *Chironomus anthracinus*-type and *Cricotopus laricomalis*-type are among the most frequently occurring taxa in present-day Yakutian lakes and can be found in a broad range of ecological conditions (Nazarova et al., 2005, 2008, 2011). *Tanytarsus pallidicornis*-type 1 is characteristic of relatively warm and productive lakes (Brodin, 1986). In contrast, *Tanytarsus lugens*-type and *Parakiefferiella triquetra*-type are cold stenotherms, occurring in oligotrophic cold subarctic lakes (Walker & Mathewes, 1989; Brodin, 1986). *Brillia* and *Endochironomus albipennis*-type often are associated with submerged wood and dead leaves (Cranston et al., 1983). Some species of the group *E. albipennis*-type are leaf or stem miners (Pinder & Reiss, 1983).

The chironomid record indicates the presence of submerged coarse plant debris in the paleo-lake, most probably the remains of trees and shrubs. Most of the identified chironomids indicate shallow water conditions and a pronounced macrophyte zone (Cranston et al., 1983; Brodin, 1986).

The Eemian was an interglacial period which began about 130,000 years ago and ended about 114,000 years ago. It was the second-to-latest interglacial period of the current Ice Age, the most recent being the Holocene which extends to the present day. The prevailing Eemian climate is believed to have been similar to that of the Holocene. Comparison of the Eemian fauna and modern chironomid assemblages from the 35 small permafrost lakes of Bolshoj Ljakhobskiy Island and Oyogos Yar mainland coastal area has shown certain faunistic differences (Table 1) with a higher proportion of cold tolerant taxa in modern chironomid assemblages. Remains of terrestrial and freshwater organisms, including chironomids, preserved in frozen deposits of a shallow Eemian paleo-lake indicate a boreal climate at today's Arctic during that time. The use of transfer functions on the base of chironomid assemblages (Nazarova et al. 2011) brought a mean July air temperature reconstruction of 12.9±0.9°C and a water depth of 1.00±0.34 m for the time of deposition.

Table 1. Eemian chironomid fauna from Oyogos Yar permafrost deposits and most frequent chironomid taxa from Bolshoj Ljakhobskiy Island and Oyogos Yar mainland coastal area (Northern Yakutia, Russia. Taxa that are found in modern and in Eemian sediments are given in bold.

Modern lake deposits		Eemian Permafrost deposits (130,000 to 114,000 years ago)	
16 most frequent taxa	%	Taxa	%
<i>Paratanytarsus penicillatus</i> -type	22.4	<i>Limnophyes</i>*	22.0
<i>Chironomus anthracinus</i>-type	17.0	<i>Smittia foliacea</i> -type	18.0
<i>Psectrocladius sordidellus</i>-type	13.9	<i>Psectrocladius sordidellus</i>-type	14.0
<i>Orthocladus</i> type I	10.1	<i>Chironomus anthracinus</i>-type	6.8
<i>Derotanypus</i>	5.4	<i>Cricotopus (I.) laricomalis</i>	6.0
Chironomini larvula	2.9	<i>Metriocnemus eurynotus</i>	6.0
<i>Limnophyes</i>	2.7	<i>Parametriocnemus</i>	6.0
<i>Corynoneura arctica</i> -type	2.7	<i>Brillia</i>	4.0
<i>Paratanytarsus austriacus</i> -type	2.2	<i>Microtendipes pedellus</i> -type	4.0
<i>Cladotanytarsus mancus</i> type 1	1.9	<i>Endochironomus albipennis</i> -type	2.0
<i>Orthocladus oliveri</i> -type	1.3	<i>Parachironomus varus</i> -type	2.0
<i>Metriocnemus eurynotus</i>-type	1.2	<i>Parakiefferiella triquetra</i> -type	2.0
<i>Orthocladus</i> type S	1.2	<i>Polypedilum nubeculosum</i> -type	2.0
<i>Trissocladus</i>	1.2	<i>Zavrelia</i>	2.0
<i>Acricotopus</i>	1.2	<i>Tanytarsus lugens</i>-type	2.0
<i>Tanytarsus lugens</i>-type	1.1	<i>Tanytarsus pallidicornis</i>-type 1	2.0

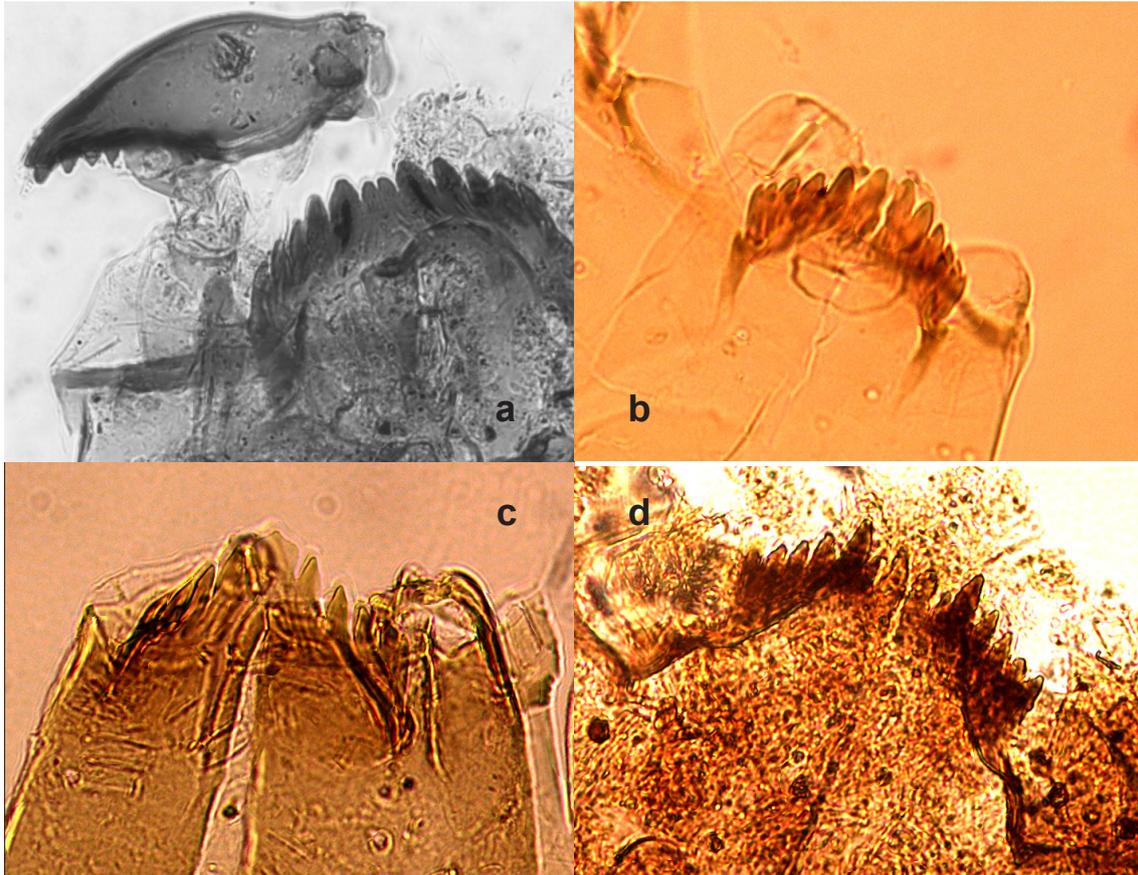


Figure 2. Photos of chironomids from Eemian permafrost deposits: (a) *Metriocnemus eurynotus*-type; (b) *Limnophyes*; (c) *Smittia foliacea*-type; (d) *Microtendipes pedellus*-type.

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