CHIRONOMID-BASED INFERENCES OF LOCAL AND REGIONAL ENVIRONMENTAL CHANGE DURING THE EARLY MIDDLE WEICHSELIAN IN NORTHEAST FINLAND

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With 2 Figures

ABSTRACT: A fossil-rich lacustrine deposit dated to ca. 50 thousand years ago with little post-depositional disturbance was recovered from the high-latitude Sokli-site (NE Finland). Analysis of fossil chironomid remains showed that a shallow lake was present at the study site, and that climate conditions were dynamic during the lake's existence.

RESUMO: Um depósito lacustre rico em fósseis, aproximadamente com 50 mil anos de idade, foi recuperado numa área a grande latitude no Norte da Finlândia (Sokli). O presente depósito apresentava pouca perturbação pós-deposicão. As análises de restos dos fósseis quironomídeos revelou que o depósito se encontrava num lago de pouco profundidade, tendo estado sujeito a condições climáticas dinâmicas.

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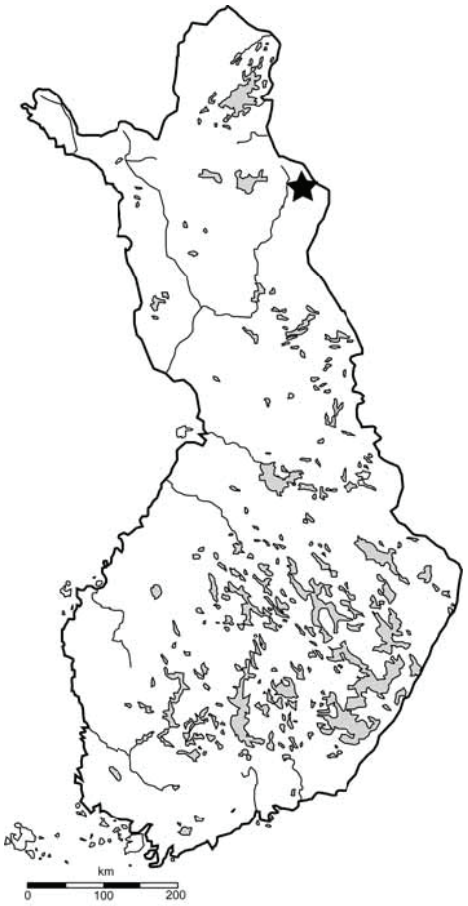
INTRODUCTION

Fossil chironomids have been widely used to reconstruct lacustrine environments and regional climate conditions during the Late-Glacial and Holocene periods. However, chironomid-based palaeoenvironmental reconstructions covering periods prior to ca. 15,000 years before present (BP) are still sparse (BROOKS, 2006). An exceptional lacustrine record dating back to the earlier part of the Middle Weichselian, ca 50 thousand years BP, was obtained from the Sokli site in Northeast Finland (HELMENS *et al*., 2000; 2007; Fig 1). Different sedimentological and botanical proxy-indicators were analyzed in order to reconstruct local and regional environmental changes. Furthermore, fossil chironomid remains were studied in the sequence to examine palaeoenvironmental changes and to reconstruct the influence of external factors such as climate change on the aquatic ecosystem.



The Sokli site

A 26m long and nearly continuous sedimentary sequence spanning the last 130,000 years has been encountered in a small sedimentary basin (67º48'N, 29º18'E, 220m a.s.l.) in Northeast Finland (see Fig. 1). Several glacial-deglacial cycles can be recognized in the sedimentary record, and 4 successive lacustrine bodies have been identified (HELMENS *et al*., 2000; 2007). Using radiocarbon and luminescence dating, the lower 3 lacustrine deposits were dated to the last interglacial (equivalent to MIS-5E, ca 120 ka BP), the Brørup interstadial (equivalent to MIS-5C, ca 100 ka BP) and the Odderade interstadial (equivalent to MIS-5A, ca 80 ka BP). The first results of a high-resolution fossil analysis on the uppermost limnic deposit are presented here. These sediments have been dated to the earlier part of the middle Weichselian, ca. 50 ka BP.

Fig. 1. Map of Finland, showing the location of the Sokli study site.

METHODS

The interval between 5.20 and 7.20 m core depth (in borehole Sokli B-series) was subsampled in 5-centimeter thick intervals and 39 wet sediment samples (weight range: 3.65 – 38.54 g) were used for chironomid analysis. First, the samples were immersed in 10% KOH for at least 4 hours and subsequently rinsed on a 100 µm sieve to remove fine particles from the samples. Using a dissecting microscope, chironomid remains were hand picked at 35x magnification, and mounted on permanent slides. The fossil head capsules were identified following the literature listed in BOHNCKE *et al*. (2008).

Chironomid record and environmental inferences

A total of 65 chironomid taxa were identified in the sediments of the Sokli-record. In the lowermost part of the record chironomid remains were sparse, but above 6.75 m core depth, a minimum count sum of 50 head capsules (hc) was reached for all samples. The average count sum in the samples above 6.75m core depth was 89 hc/sample (range: 54 – 199 hc). The high number of taxa with a preference for littoral to sub-littoral habitats suggests that throughout the record a shallow lake was present at the Sokli site.

The lowermost samples (up to 6.75m core depth; chironomid-zone I) represent the pioneer stage of the record. Different species are present, but as counts are low in this part of the record, the abundances of the encountered taxa are highly variable (Figure 2). Among the taxa that first appeared at the Sokli-site were *Tanytarsus lugens*-type*, Microtendipes* and *Polypedilum nubeculosum*-type.

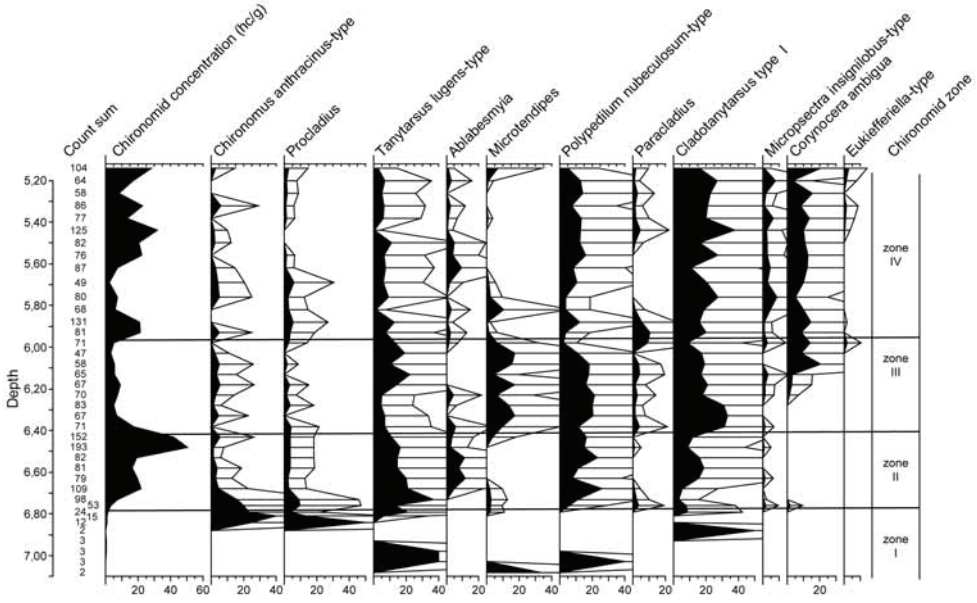


Fig 2: Chironomid diagram for the Sokli study site showing selected taxa and zone boundaries. Taxa are expressed as a percentage of the total head capsule number, the chironomid productivity as the number of head capsules per gram of wet sediment.

The onset of chironomid-zone II shows a sharp increase in the concentration of chironomid remains, reaching values of 50 hc/g wet sediment. The assemblages are initially dominated by *Chironomus anthracinus*-type and *Procladius*. Both these taxa have a large temperature tolerance, but i.e. HEIRI (2001) states that *C. anthracinus*-type reaches its highest modern abundances in lakes at intermediate elevation in the Swiss Alps, rather than in lowland lakes. Towards the upper part of this zone, the abundance of *T. lugens*-type increases. This taxon also has a large temperature-tolerance, but has been considered to be indicative for cool and oligotrophic conditions. Toward the top of chironomid-zone II, abundances of *C. anthracinus*-type, *Procladius* and *T. lugens*-type decline, and these taxa are replaced by taxa that are indicative of higher July air temperatures such as *Polypedilum nubeculosum*-type and *Cladotanytarsus* type I. This gradual transition could be the result of a steadily increasing summer temperature at the Sokli-site. The peak of *Endochironomus albipennis*-type near the end of chironomid zone II might indicate rising temperatures too, but also could be related to increased nutrient availability in the lake.

Cladotanytarsus type I is the dominant taxon at the onset of chironomid-zone III, showing a decreasing abundance over the entire zone. Another important taxon in this zone is *Microtendipes*, which reaches a maximum abundance of 20%. BEDFORD *et al*. (2004) state that this genus is "generally considered to be a warm stenothermic taxon … but at Whitrig Bog this taxon responded best to intermediate temperatures". The increase in *Microtendipes* could therefore be indicative of temperatures that are best classified as "intermediate to warm", and the gradual warming trend that was observed in chironomid zone II is probably interrupted. The absence of taxa indicative of high nutrient availability, together with the relatively low concentration of chironomid remains, suggests a return to mesotrophic conditions.

During the final stage of the lake (chironomid-zone IV), *Microtendipes* disappears from the spectrum and is replaced by *Corynocera ambigua*. This species was formerly considered to be a true cold-water stenotherm, but those ideas have recently been questioned by BRODERSEN & LINDEGAARD (1999). Although the adult midges of *C. ambigua* are hardly able to fly, they have been shown to be fast migrating, and the temperature-preference of this species is probably "intermediate" to "low-arctic". *Paracladius*, a taxon that is generally considered to be a true cold-stenotherm, shows two phases with high abundances: around 5.90m core depth and in the uppermost part of the core, between 5.20-5.50m. Thirdly, *Stictochironomus* shows high values in the upper part of the record. All these changes together can be interpreted as indicating a return to colder conditions. However, *Polypedilum nubeculosum*-type and *Cladotanytarsus* type-I are still the dominant taxa in the assemblages, and they imply intermediate- to warm summer temperatures.

An interesting feature of chironomid zone IV is the occurrence of stream-indicating taxa such as *Eukiefferiella* and *Prodiamesa*. Together with the coarser-grained

sediment in this interval, this suggests increasing influence of the nearby ice-sheet on the lake-catchment through proglacial streams. The close and advancing ice sheet is further demonstrated by the uppermost part of the lacustrine deposit, which gradually changes into a glacial till deposit, without a hiatus in the sedimentary sequence (HELMENS *et al*., 2007).

CONCLUSIONS

A fossil-rich lacustrine deposit dated back to the ca. 50ka ago with little post-depositional disturbance was recovered from the high-latitude Sokli-site (NE Finland). Chironomid analysis of this sequence showed changing concentrations of chironomid remains and a dynamic composition of the chironomid- assemblages throughout the record:

- The high number of taxa with a preference for littoral to sublittoral habitats suggests that a shallow lake must have existed at the Sokli site.
- The chironomid assemblages and the changes between the different zones suggest that climate was a major forcing factor with respect to the presence of the different chironomid taxa.

The Sokli-site therefore offers the possibility to derive quantitative palaeotemperature estimates based on fossil chironomid remains, for a time period where the number of such records is still very limited.

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