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Distribution and morphological variability of *Cyclotella*-taxa in the late glacial of Längsee (Austria)

Kerstin Huber[1], Rolf Klee[2] & Roland Schmidt[1]

[1]Institute of Limnology, Austrian Academy of Sciences, Mondseestr. 9, 5310 Mondsee, Austria; kerstin.huber@oeaw.ac.at; roland.schmidt@oeaw.ac.at
[2]Bavarian Environmental Agency, Demollstr. 31, 82407 Wielenbach, Germany; rolf.klee@lfu.bayern.de

INTRODUCTION

Längsee is a small meromictic lake (Löffler 1973) situated in the Carinthian lowland in Austria at an altitude of 548 m a.s.l. We have selected Längsee and the time interval of the Late-Pleniglacial and the older Late-Glacial (summarized here as “late glacial”), which approximately covers the time from 20 000 to 13 000 years before present, for several reasons: Since the lake is situated south of the Alps close to the end-moraines of the last ice age, fossil-bearing sediments date back to the time of deglaciation. Schmidt et al. (1998) described a warm period from Längsee, with an upper boundary of about 15 000 ^{14}C years, which was called “Längsee oscillation” (Schmidt et al. 2001). Data about this interstadial are, however, scarce in the Alps. Since future scenarios predict the disappearance of glaciers in the Alps during present global warming, studies of the development of pro-glacial lakes are of interest. In the present study we focus on the stratigraphic distribution and morphological variability of selected *Cyclotella*-taxa (*C. comensis* Grunow, *C. ocellata* Pant., and *C. distinguenda* Hust.) in comparison with related taxa.

MATERIAL & METHODS

The sediment core was taken in January 2006 with the UWITEC-Mondsee piston sampler (Schultze & Niederreiter 1990). Coring was performed from the ice at the lake’s maximum depth of 21.4 m. For sub-sampling, the plastic tubes containing the sediment were cut into halves and sub-samples were taken at 0.5 cm intervals. For diatom analyses samples were prepared with 30 % H_2O_2 and 10 % HCl according to Battarbee (1986). Aliquot-evaporated suspensions were embedded in Naphrax. At least 500 valves were counted wherever possible using a light microscope (Leitz Laborlux S) with phase contrast oil immersion objectives (N.A. 1.32) at a magnification of 1250x. For dating we used AMS radiocarbon (^{14}C) dating from terrestrial plant macrofossils (Hajdas et al. 1993), mainly seeds from *Betula*. Diatom stratigraphies were zoned with constrained optimal sum of squares partitioning using the program ZONE (Juggins 1991).

RESULTS & DISCUSSION

Four zones were differentiated (Fig. 1). Below 430 cm (zone 1) no diatoms were found at all. Because of the age of ca. 20 000 years, it might represent the phase of deglaciation. It was followed by a period characterised by an assemblage of *Staurosira/Fragilaria*- and *Cyclotella*-taxa (mainly *C. comensis* MT1 according to Wunsam et al. 1995 and *C. ocellata).* It was interpreted as a time of warming, which, according to dating, most probably corresponds with the Längsee oscillation. During zone 2 benthic *Staurosira/Fragilaria*-taxa predominated at the expense of planctonic *Cyclotella*. According to Schmidt et al. (2004), many of these taxa are more frequent in coldwater lakes. Hence, it was interpreted as a period of climate deterioration. The zones 3 and 4 are characterised by an expansion of *Cyclotella*-taxa, which were also present in zone 1, but at lower abundances. *C. comensis*

MT 1 and *C. ocellata* are again the dominant taxa. In zone 4 *C. distinguenda* occurred more frequently. The zones 3 and 4 correspond to the older Late-Glacial. The boundary between the zones 2 and 3 was dated at ca. 14.5 kyrs before present (BP).

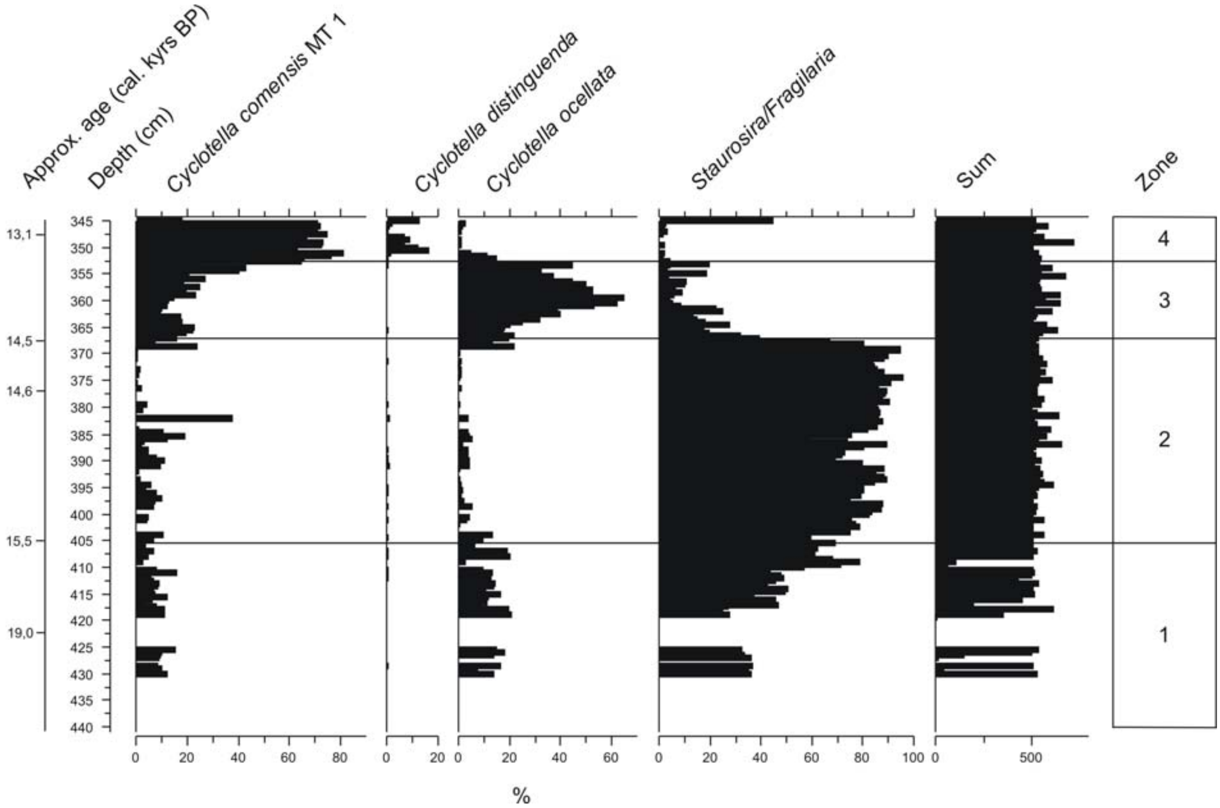

Fig. 1. Percentage diagram of selected diatoms in the Längsee core.

Wunsam et al. (1995) divided *C. comensis* from Alpine lakes into 4 morphotypes. Morphotype 1 (MT 1) was the dominant *C. comensis* type in our core section. It was described by Wunsam et al. (1995) as valves with a star-shaped central area with five or more radial depressions and elevations and the opening of one central fultoportula. The radial depressions of the central area commonly show smaller punctae, which, however, do not penetrate the siliceous wall. The marginal costae are of equal length and bear marginal fultoportulae on each second to sixth costa, visible with the openings at the outside valve (see also Håkansson 2002: fig. 349–351). Similar valves were described from a Swedish lake by Håkansson (2002: fig. 346–348) as *Cyclotella rossii* Håk., which is commonly distributed in subarctic lakes.

C. distinguenda and *C. plitvicensis* Hust. are very closely-related taxa. According to Håkansson (2002), the major difference is that the central area of *C. plitvicensis* is flat and that of *C. distinguenda* is undulated (cf. Hustedt 1945). In the light microscope the undulation was not always clearly visible in the Längsee material, whereas in the SEM a slight undulation was detectable, especially when tilting the samples. According to Håkansson (2002), the central area of *C. distinguenda* is structureless, although sometimes a number of lines can be found in the depression of the undulation, appearing to be external wrinkles. These wrinkles could be found in valves of the Längsee core, but additionally the central areas could have punctae, which do not penetrate the siliceous cell wall. Such punctae have been described for *C. plitvicensis,* not for *C. distinguenda*. One rimoportula is located marginally, more or less radial, on one costa, which corresponds to *C. plitvicensis*.

C. plitvicensis is restricted to the highly oligotrophic Lakes Plitvice in Croatia, whereas *C. distinguenda* is a cosmopolitan (Krammer & Lange-Bertalot 1991) and wide spread in oligo- to mesotrophic lakes (Wunsam & Schmidt 1995). Since the major differential feature is the undulation of the central area in *C. distinguenda* (according to Håkansson 2002), all valves of the Längsee core were attributed to this species, although the punctae of the central area are confusing.

Cyclotella ocellata in Håkansson (2002) can have 3 to 5 (or even more) papillae and corresponding depressions in the central area. The depressions do not penetrate the siliceous wall. In the Längsee core valves with up to 7 depressions were found, but most had 3 to 5. All morphotypes occured in the same samples (Fig. 2). Hence it appears that the different morphotypes are not related to changes in the environment during the entire time window.

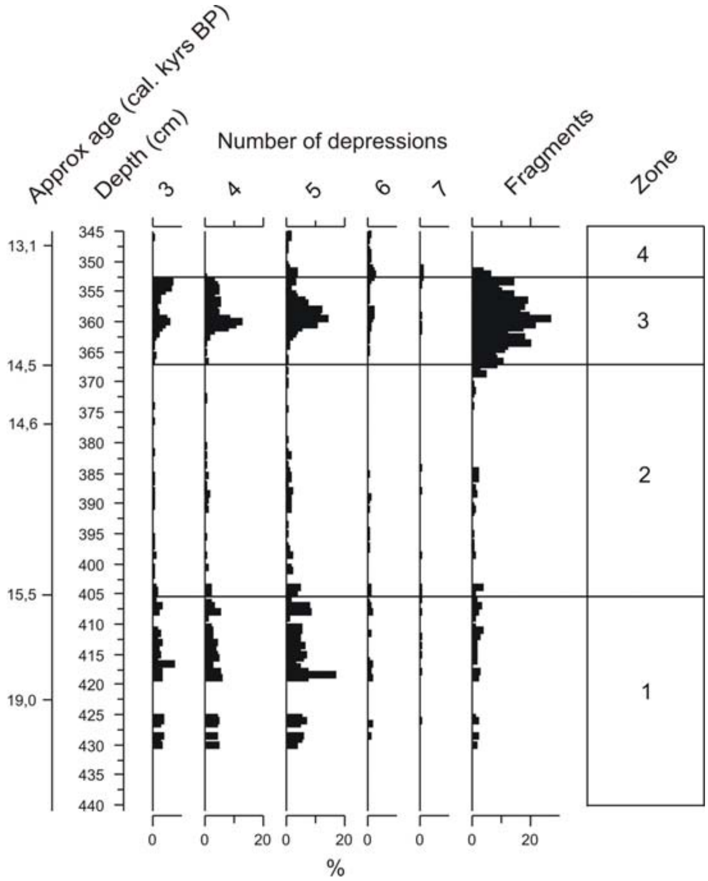

Fig. 2. Percentage diagram of different morphotypes of *Cyclotella ocellata* in the Längsee core.

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