Diversity of meiofauna in the lacustrine profundal zone: Bathymetric differences and influence of environmental factors

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ABSTRACT

The diversity and species richness of total meiofauna, Harpacticoida and Oligochaeta in relation to depth and other environmental variables were studied at nine stations and in two profundal depth zones in Lake Päijänne which includes both oligotrophic and eutrophicated or organically loaded areas.

Diversity was on average higher in the upper part of the profundal zone than at maximum depths. This may show that the greater temporal stability in temperature at greater depths does not surpass the effect of the lower temporal stability in oxygen content. The productivity factor may be a more important reason for the bathymetric difference in diversity than the stability factor. Diversity in the lower profundal zone shows a negative correlation with variables indicating pollution while in the upper profundal zone a positive one with those variables, thus emphasizing the importance of the production factor in determining diversity in the upper profundal. Diversity was higher within the oligochaetes than within the harpacticoids, which may imply that oligochaetes have a longer evolutionary history as part of the lacustrine benthic system.

Of the environmental variables, phytoplankton biomass had the highest influence on total diversity in the lower profundal zone, oxygen being next in importance. The sedimentation of organic matter was most important in the upper part of the profundal zone, where oxygen did not have any significant effect on diversity. Some explaining factors determining bathymetric diversity differences are discussed in relation to the theoretical expectations.

Introduction

The meiofauna has been investigated more in marine environments than in lakes, and is less well-known than the macrofauna, particularly regarding the lacustrine profundal zone.

It has been assumed that in aquatic habitats, both marine and freshwater, diversity generally decreases with increasing depth (Brown, 1988), although this bathymetric pattern may not be universal in deep-sea communities, for instance (Grassle, 1989). Little work has been done on the bathymetric distribution of benthic diversity in freshwaters. Bazzanti and Seminara (1987) examined a lake with a deoxygenated hypolimnion, Ruggiu and Saraceni (1972) found a reduction in diversity with depth, Särkkä (1972) demonstrated a maximum in the sublittoral and a minimum in the deeper profundal zone, and Särkkä (1975) observed a decrease in diversity of the meiofauna with depth. Särkkä (1982) found
a maximum at 2–3 m on the inside of the littoral zone, and Jakher (1986) showed a negative correlation between diversity and depth, but a positive one between diversity and oxygen.

It has been also assumed that stability generally increases diversity (Pielou, 1975), but so can disturbance (Connell, 1978) and stress (Kolasa, 1984). As a whole, six main factors seem to affect or are often presented which affect diversity gradients (Krebs, 1978): time, spatial heterogeneity, competition, predation, environmental stability and productivity.

Especially regarding the meiofauna, it can be questioned whether the meiofauna is a “real system” or community and whether the general regularities of diversity gradients are to be seen within it. It has also been suggested that there is no loss of information when families or higher taxonomic levels are examined rather than species (Warwick, 1988), diversities of this kind having already been used for meiofauna by Särkkä (1975). The converse is less well known, i.e. whether diversity behaves in the same way within separate taxonomic groups as for the whole zoobenthos or when higher taxonomic levels are used, as assumed by Margalef (1958).

Basic factors influencing diversity can be tested by comparing bathymetric zones, e.g. the upper and lower profundal zones studied here, which show some differences, especially in stability and productivity. Stability should be higher in the deepest parts with respect to temperature, which in the present lake fluctuates only between about 1 and 8 °C within a year in the deepest parts of the hypolimnetic space but rises to about 10–15 °C in the upper profundal zone during the summer stratification. Oxygen can fluctuate more in the lower profundal zone, however, where it can reach zero by the end of the winter, whereas it does not usually decrease below about 60–70% of saturation at 20 m.

The present material was obtained basically in order to acquire a knowledge of the taxonomic composition of the meiofauna and of anthropogenic effects in a lake which has two separate regional gradients from polluted to clean. Sampling was also planned in order to reveal differences between two depths within the profundal zone, the upper part just below the thermocline and the maximum depths in each sampling area. Earlier research and the present material together provide basic information on the species composition, reveal new records for Finland in some groups, especially the meiobenthic oligochaetes, and enable examination of the environmental impact of organic load and eutrophication on the species composition of harpacticoids (Särkkä, 1979, 1987, 1989, 1992).

Although the use of diversity indices has been criticized in general (Hurlbert, 1971) and specifically for describing anthropogenic influence (Guhl, 1987), one of them, the most widely used Shannon index, was chosen here and evaluated together with species richness viz. number of species. Because it was also of interest to see whether diversity would behave in the same way in certain dominant taxonomic groups as within the total meiofauna, it was also examined within two of the quantitatively most important groups, Oligochaeta and Harpacticoida.

Material and methods

The material was obtained from Lake Päijänne, Finland, in May-June 1986 from 10 stations, one of which was later excluded because of the semi-otic nature of narrow part of lake. A Kajak-type corer of 15.9 cm² was used and samples were taken in 5 replicates from