UNIVERSITY OF AMSTERDAM

See attached. Unravelling Drivers for the Spatial Distribution of Diatom Communities in Eutrophic Wetlands
A. Goldenberg Vilar

Summary

Freshwater habitats harbor diverse communities of benthic phototrophic micro-organisms such green algae, diatoms and cyanobacteria. Especially diatoms occupy a wide range of different substrates such as sediments, rocks or water plants and represent very different life strategies featuring either permanent attachment, migratory movement, or colony formation. Diatom species have been intensively used to indicate the quality of inland waters, and especially under the current European legislation, assessments of ecological quality are essential. This study aimed to better understand the relationship between diatom species distribution and environmental parameters and to strengthen ecological monitoring in the Dutch lowlands. I used a tiered model of species selection presuming environmental filtering at local and regional scales and introduced aspects of spatial ecology from studies on macroscopic organisms. Diatom communities in eutrophic ditch systems in the lower part of North Holland were investigated: many of these ditches were located in peat lands. I pursued the following objectives: 1. to determine the dominant drivers dictating the distribution of diatom species with special emphasis on the role of water turbidity, 2. to weigh the importance of sampling design, and 3. to test and optimize ecological monitoring based on diatoms.

Suspended particles and turbidity were hypothesized to be important factors selecting species of benthic diatoms. Experiments in the laboratory and in enclosures were carried out to test this hypothesis and field observations in three peat land areas differing in water turbidity were used for verification (Chapter 2). The results revealed that suspended peat particles covered and smothered the biofilms and reduced the density and species diversity of attached algal communities. Particle driven selection of diatom species with different growth forms was indicated through comparative studies of communities at sites with different particle concentrations. In turbid waters diatom species attaching flat to surfaces were less represented than those with erect growth forms, while also planktonic and motile species became more numerous.

Analysis of distribution of diatom species within three contrasting water systems (mesotrophic, eutrophic and hypertrophic, Chapter 3) demonstrated the importance of spatial factors such as known from studies on larger organisms. The role of selective environmental factors versus (scale dependent) spatial factors was investigated following sampling of diatoms on trajectories in the three systems. The results of our analysis revealed that an important part of the variance in diatom community composition can be attributed to spatial factors (e.g. dispersal related processes), denoting a patchy distribution of diatom communities at the scales up to 6000 m. It was found that spatial factors dominated at low nutrient levels, while environmental filtering dominated at high nutrient levels, leading to a homogenous distribution of species.

Although diatom communities are used worldwide for ecological assessments and great effort has been spent on the standardization of sampling techniques, aspects such as the scale of sampling and the degree of spatial heterogeneity have rarely been considered. The issues regarding sampling design were examined in Chapter 4, where specifically sampling effort (number of valves identified), regime (nested or independent) and extent (500 m or 6000 m) have been analyzed to assess their influence on the estimation of diatom diversity patterns in two contrasting systems (mesotrophic and hypertrophic). It has been found that nested regimes that combine individual samples yielded lower estimates of diatom β and γ-diversity in comparison to independent regimes, because the difference between sample size and community size was larger in the nested sampling. In addition, the study revealed that sampling at different extents (from 500 m to 6000 m) might be necessary to obtain an acceptable description of the community in

highly diverse and patchy ecosystems. On the other hand, sampling at larger extents in the hypertrophic area does not lead to a higher β-diversity, because eutrophication homogenizes algal communities in degraded peat lands.

Chapter 5 aimed to expand the knowledge obtained in the previous chapters and to analyze the drivers of diatom community structure at the scale of the province of North Holland. Using advanced modelling techniques (Self-Organizing Maps) we were able to identify the different community types present in the province as a result of the interaction of environmental factors. The five community types identified are the result of the filtering effect of eutrophication even when all the area is rich in nutrients and common species dominated in all the five clusters. The communities belonging to the five clusters differed in the relative proportion of ecological guilds of diatoms, ranging from an abundance of low profile and high profile growth forms towards a dominance of motile and planktonic forms in the most degraded areas.

In Chapter 6 the main drivers of diatom community composition were discussed and suggestions for an improved monitoring of diatoms and diatom based ecological objectives were presented. Environmental filtering in eutrophic ditches was found to be associated with high concentrations of particles and resulted in a dominance of diatom guilds formed by motile and planktonic species. Increasing the numbers of diatom valves (from 200 to 500) and testing for regional distribution of diatoms species (enabling the assessment of β-diversity) were brought forward to improve current sampling schemes. It was argued that a substantial share of low profile species and regionally heterogenic distribution of species provide a key to the ecological rehabilitation of degraded ditches.