Project title

Temporal patterns of phytoplankton diversity on a European scale

Promoter: Károly Pálffy and Lajos Vörös (BLRI-HAS, Hungary)

1. Aim (for EnvEurope and LTER)

a. To assess temporal changes of phytoplankton community composition and to reveal cause-and-effect relationships between the observed trends, patterns and environmental variables.
b. To make a cross-site comparison/analysis of the putative relationships.

2. Research questions and Hypothesis (500 words)

EnvEurope includes 15 freshwater sites of various geographical location, elevation, size, depth and physico-chemical characteristics. Comparing these lakes in terms of biodiversity and linking the observed patterns to environmental variables can provide an opportunity to demonstrate the applicability of the EnvEurope network in ecological monitoring. As for the conceptual background for biodiversity, there is increasing evidence that using diversity measures based on the role of species in ecosystem functioning can yield a better understanding of community patterns than traditional taxonomic analyses (e.g. WEITHOFF, 2001; LONGHI and BEISNER, 2010). The concept of functional diversity has been found to be a useful indicator of community-level processes in a number of organism groups, such as terrestrial plants, fish assemblages or zooplankton.
In aquatic habitats, where phytoplankton is the main source of primary production, investigating algal assemblages from a functional point of view is likely to provide valuable information about ecosystem processes and responses to changes in the environment. In contrast to the advantages of functional diversity, phytoplankton species diversity can considerably restrain the amount of information regarding these processes mainly because of the large number of species occurring during the annual cycle of phytoplankton succession and the simultaneous differences in morphology and physiology among species of the same taxonomic group.
With this end in view, we would like to propose a test study on the phytoplankton of the freshwater EnvEurope sites using a functional measure of diversity. As the role of a species within a community primarily depends on its morphological and physiological traits, such as cell size, surface/volume ratio, motility or the presence/absence of phagotrophy, functional diversity is generally determined with the help of ecologically relevant traits (WEITHOFF, 2003), however, case studies on the functional diversity of freshwater phytoplankton are scarce.
Our algological research team at the Balaton Limnological Research Institute has recently finished working on determining spatiotemporal diversity patterns of phytoplankton functional groups in Lake Balaton by processing phytoplankton species composition and biomass data of several years. One of our main conclusions was that functional diversity is closely related to water temperature and trophic state, and this relationship was considerably stronger as compared to species diversity. This hypothesis could be tested on a European scale using the experiences gained during our study and phytoplankton data obtained from the aforementioned sites. Consequently, the primary aim of the proposed research project would be to define a functional classification scheme suitable for monitoring and comparing phytoplankton diversity patterns among the sites and revealing any

relationship with a number of variables (geographical location, elevation, trophic state, water temperature, etc.).

3. Spatial and temporal coverage

The project should involve as many EnvEurope/LTER freshwater sites as possible and cover the last 5-10 years depending on data availability.

4. Parameters used/needed* (if not only aquatic habitat are to be selected then the parameter group could be enlarged)

Parameter group (theme)	Selected parameter	Details about the parameter	Should be taken from existing data (yes/no)	Feasibility/constraints regarding existing data	Should be recorded in field (A5 work) (yes/no)	feasibility/ constraints regarding field sampling
1) Climate and physical variability	water temperature		yes	stratification should be a subject of discussion	optional	
	conductivity		yes	stratification should be a subject of discussion	optional	
	extinction coefficient	PAR, or optionally PAR+UV	yes	stratification should be a subject of discussion	optional	
2) Biogeochemistry data	pH		yes	stratification should be a subject of discussion	optional	a harmonized sampling method is a prerequisite
	total phosphorous concentration		yes		optional	
	total nitrogen /NH_4-N /NO_3-N concentration		yes		optional	
3) Structure and function of the ecosystems, communities and populations	phytoplankton composition	species list	yes	stratification should be a subject of discussion	optional	a harmonized sampling method is a prerequisite
	phytoplankton abundance (biomass)	abundance on the species level is necessary	yes		optional	
	chlorophyll-a concentration		yes		optional	
4) Human population and economy						

Remark: the range of variables can be extended or narrowed down depending on the data sets available for each site.

5. METHODS USED

The simultaneous use of different diversity indices is strongly recommended, since more approaches supposedly yield more information, moreover, it could provide opportunity to test the hypothesis that functional diversity is a more efficient tool for ecological monitoring as compared to taxonomical indices.
A widespread measure of species diversity is the Shannon index (KREBS, 1998), which is based on the biomass contribution of each species present in a community.
Depending on the nature of the approach chosen, different methods can be used to determine functional diversity. After selecting the relevant species traits, functional groups can be identified using cluster analysis (GOWER, 1971, modified by PODANI, 1999). If the relative biomass of each group is included in the Shannon formula, the resulting index would be suitable for elucidating changes in phytoplankton community structure and/or function on a temporal scale. However, in order to make a cross-site analysis, functional diversity should be defined as the sum of all branch lengths of the dendrogram obtained by the cluster analysis mentioned above (Petchey and Gaston, 2006), which proved to be an appropriate method for comparing different types of lakes (LONGHI and BEISNER, 2010).
The relationship between phytoplankton diversity (both functional and taxonomical) and the selected environmental variables can be evaluated with the help of different statistical methods (e.g. multiple linear regression analysis).

6. EXPECTED RESULTS

- one or more scientific publications, the co-authors of which would include all the data providers
- an international group of researchers with the potential of further joint research projects
- a clear manifestation of the benefits gained from the EnvEurope network

7. REFERENCES

GOWER, J. C. (1971) A general coefficient of similarity and some of its properties. *Biometrics*, **27**, 857–874.
LITCHMAN, E. and KLAUSMEIER, C.A. (2008) Trait-based community ecology of phytoplankton. *Annu. Rev. Ecol. Evol. Syst.*, **39**, 615–639.
LONGHI, M. L. and BEISNER, B.E. (2010) Patterns in taxonomic and functional diversity of lake phytoplankton. *Freshwater Biol.*, **55**, 1349–1366.
PETCHEY, O. L. and GASTON, K. J. (2006) Functional diversity: back to basics and looking forward. *Ecol. Lett.* **9**, 741–758.
PODANI, J. (1999) Extending Gower's general coefficient of similarity to ordinal characters. *Taxon*, **48**, 331–340.
WEITHOFF, G., WALZ, N. and GAEDKE, U. (2001) The intermediate disturbance hypothesis – species diversity or functional diversity? *J. Plankton Res.*, **23**, 1147–1155.
WEITHOFF, G. (2003) The concepts of 'plant functional types' and 'functional diversity' in lake phytoplankton – a new understanding of phytoplankton ecology? *Freshwater Biol.*, **48**, 1669–1675.