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Editorial

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Multilevel Approach in Biodiversity Analysis of Freshwater Algae

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The relationships between algal biodiversity and environmental conditions are determined by adaptation level of the species and the community as a whole. Bioindication is based on the principal of congruence between community composition and complexity of environmental factors. However, it is still a problem to define the role of particular environmental variables as well as to predict the community's response to environmental change.

The material for such analysis is usually represented by the empirical data an experienced algologist has in his disposal as well as literature data on regional floras. The statistical methods are selected in accordance to analytical purposes using the programs Statistica 7.1, GRAPHS, CANOCO and PRIMER-v5 package.

The preferences depend on general approaches to biodiversity analysis and the questions the research addresses. My experience through several decades of algological research suggests that biodiversity inferred from samples studies can be represented along the following lines of reasoning [1,2]. In the first place the quantitative data should be used for finding correlations of algal diversity and chemical characteristics of aquatic environment for sample separately.

This way our conclusions on beta-diversity and the quantitative justification are bound to real observation. The quantitative and qualitative relationships of species composition and chemical environment are relatively well studied and commonly evaluated with the help of numerical indices broadly used in monitoring of water quality and related environmental variables.

Yet when dealing with alpha- and gamma-diversity of freshwater algae we encounter certain difficulties, in the first place in determining the scope of communities involved as well as the scope of research tasks and the relevance of operative approaches.

To cope with these problems a multilevel approach has to be worked out with the hierarchy of levels such as:

1. Intraspecies variation level,
2. Species composition,
3. Community composition
4. Flora of a water body,
5. Flora of a catchment basin
6. Flora of ecological region
7. Flora of an inclusive geographic region

At this, the flora of the water body is not the same as what in occasional sample represent. For a lake the limit of the water body are defined by the shoreline. But river is characterized by continual changes involving the main canal and tributaries. By experience, a representative analysis has to comprise the canal as well as tributaries.

The next generalization level is the catchment basin comprising the aquatic communities of the main water body as well as the other aquatic objects within the catchment area.

The flora of ecological region embraces the species richness of a landscape-climatic domain defined on the basis of physical geography as well as terrestrial flora.

The flora of geographical region is pragmatically defined by state borders, but is more mining for large river systems or lake regions like the flora of Danube River or Ladoga Lake.

The levels of biodiversity analysis differ also in respect to research goals persuade of each of them. Thus, the intraspecies level conveys the geographical and ecological factors of below species level differentiation for the water body to regional floras. The numerical characteristic to be revealed is the ratio of intraspecies to species taxa. It is relevant to the problem of geographical constrains of intraspecies differentiation. Empirically the intraspecies polymorphism is widely different over the ranges of environmental situations but the causes and correlations are purely understood so far. For example the index of intraspecies variation varies from 1.48 for Arctic to 1.09 for Israeli algal floras [3]. The regularities of this index variation open new perspectives of the algal gamma-diversity analysis.

The species level analysis is crucial for bioindication, revealing the amplitudes of ecological tolerances for algal species and their assemblages. The most advanced bioindication systems are developed for salinity [4], acidification [5], life habits, temperature, Streaming and oxygenation, organic pollution (trophic base) (by Sládeček [6] and Watanabe [7]), the type of nutrition [8] and the trophic level [8].

The community level analysis reveals synergistic effects of environmental impacts and sensibility that is considerably higher in the algal communities of the silicate provinces of the Eastern Pacific coast in comparison with the carbonate provinces of the Mediterranean region in respect to the heavy metal pollution [9]. Canonical Correspondence Analysis (CCA) is instrumental in detecting the sensor species for technogenic borate and floride pollution.

The analysis of water body floras is pertinent to climatic differentiation such as the divergence of lacustrine algal floras in the arid regions of Eurasia, the three groups of which correspond to the salinity classes defined with Statistica 7.1 and GRAPHS programs for comparative floristic analysis. These programs added with Multivariate regression Stepwise analysis detect the cardinal factors of floristic development in particular water bodies [10].

The water body level analysis is also relevant to the problem of ecological vs. geographic differentiation. Yet the latitudinal gradient

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of their contribution to algal diversity over Eurasia [11] attest to the role of ecological factors. Thus the arcto-alpine species a geographic component in high latitude water bodies pose an ecological problem when found in the low latitude floristic assemblages.

The catchment basin level analysis gives general estimates of structural complexity, assessed with Statistica 7.1, PRIMER-v5 programs. One of the complexity criteria is the average species richness of the algal genera or the genera to species ratio. Many species per genus is evidence of stable development, whereas a high ratio of monotypic genera can be related to geological, climatic or anthropogenic impacts [12].

The ecoregion level analysis addresses the problem of climatic differentiation and distribution of algal diversity over a system of landscape/climatic regions [3].

A related problem of altitudinal biodiversity gradients such as the increase of general diversity with altitude but a reduction of relative diatom contribution in the interval 1000-2500 a.s.l. studied with GRAPHS, Statistica 7.1 [13].

The inclusive geographic region level analysis is performed in order to reveal and assess the global tendencies of biodiversity patterning such as decrease of species richness with latitude (opposite to the intraspecies variation trend) [3,11].

Conclusion

The multilevel analysis of freshwater algal biodiversity provides a system of quantitative estimates for the ecological tolerance ranges of critical species and communities as well as detecting the cardinal factors and trends at the local water body to global levels of biodiversity evolution. The programs CANOCO and Statistica 7.1 are useful in detecting correlation between biodiversity estimates and environmental variables; when complimented with PRIMER-v5 and GRAPHS they show the historic significance of contemporaneous trends and tendencies of biodiversity distribution.

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