1B-P14

The European Water Directive: Does phytoplankton reflect lake types?

Katrin TEUBNER, K. DONABAUM[1], H. GOLLMANN, M. MAIRITSCH[2], L. SCHULZ[2], H. THIES[3], M. TOLOTTI[3], S. WANZENBÖCK, Martin DOKULIL

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Among the biological parameters mentioned in the EC-Water Framework Directive to evaluate and typify lakes is phytoplankton structure, abundance and biomass listed. In order to classify lakes in Austria, phytoplankton long-term data are collected. The data set is subjected to statistical analysis to verify lake typology and to substantiate ecological reference conditions as demanded by the Water Directive.

Austria shares 4 ecoregions relevant for lakes from the 25 mentioned in the Water Directive. Lakes are grouped into these ecoregions and by altitude and area. Phytoplankton structure reflects morphometry and physico-chemical characteristics of lakes in these 4 ecoregions. Differences in phytoplankton communities are more expressed by single species than by the share of green-, blue-green algae, diatoms or other taxa of higher ranks. Therefore type-specific reference conditions for surface water bodies are better substantiated by algal species or closely related species groups than by algae of higher taxonomic level.

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Lake classification, Water Directive, Europe

Introduction

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Sites

The 14 Austrian lakes studied refer to 4 ecoregions as defined by ILIES (1978): Hungarian lowlands (**Neus**-Neusiedlersee, **AD**-Alte Donau), Dinaric Western Balkans (Carinthia: **Weis**-Weissensee, **Woer**-Woerthersee, **Klop**-Klopeiner See, **Hafn**-Hafnersee, **Laen**-Laengsee, **Faak**-Faaker See, **Flat**-Flatschacher See), Alps (Salzkammergut, Northern Limestone Alps: **Mond**-Mondsee, **Atte**-Attersee, **Trau**-Traunsee, **Hall**-Hallstaetter See; Tirol, Central Granit Alps: **Pibu**-Piburger See).

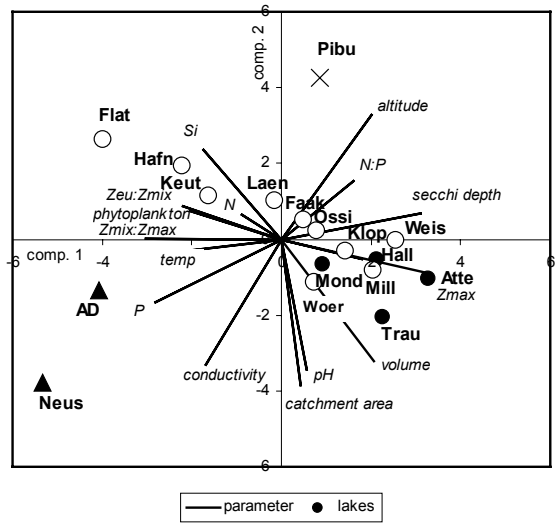


Fig. 1. Plot of the second versus the first principal component of morphometric and physico-chemical characteristics for 14 Austrian lakes (abbr. for lakes see sites studied, variance for component 1=41%, component 2=22%).

Data analysis:

Phytoplankton community structures were analysed by 160 annual averaged phytoplankton biovolume for lakes in Carinthia (Faaker See, Flatschacher See and Klopeiner See 1987-97, other 1987-98), Neusiedler See (1968-90), Piburger See (1998), Mondsee (1982-96), Attersee and Traunsee (1998), Hallstaetter See (1997-1999). Lake averages in fig.1 and 3 are based on long-term averages over all investigated years.

Data were standardised by logarithmic transformation for principal component analysis (PCA). Stepwise extraction of algal species were repeated in PCA until the first three components represented more than 60% of total variance (fig. 2 and 3).

Results

The general typology of the 14 lakes is shown in fig. 1. The 10 lakes from the Dinaric Western Balkans and the 4 lakes of the ecoregion Alps (Salzkammergut)

are scattered mainly along the axis of the first component representing high variation in maximum depth (z_{max}), secchi-depth, the mixing behaviour (mixing depth to maximum depth, z_{mix}:z_{max}), and optical properties (euphotic depth :mixing depth, z_{eu}:z_{mix}). The alpine lakes are deep (z_{max}), of great volume (volume), high transparency (secchi depth), low phytoplankton biomass and low silica concentrations. The lakes in the Dinaric Western Balkans scatter over a wider range. They represent lakes of varying depths. The shallow lakes in the region have a high z_{mix}:z_{max} and z_{eu}:z_{mix}, high phytoplankton biomass and low transparency. The large lakes of this ecoregion are more closely related to the alpine lakes.

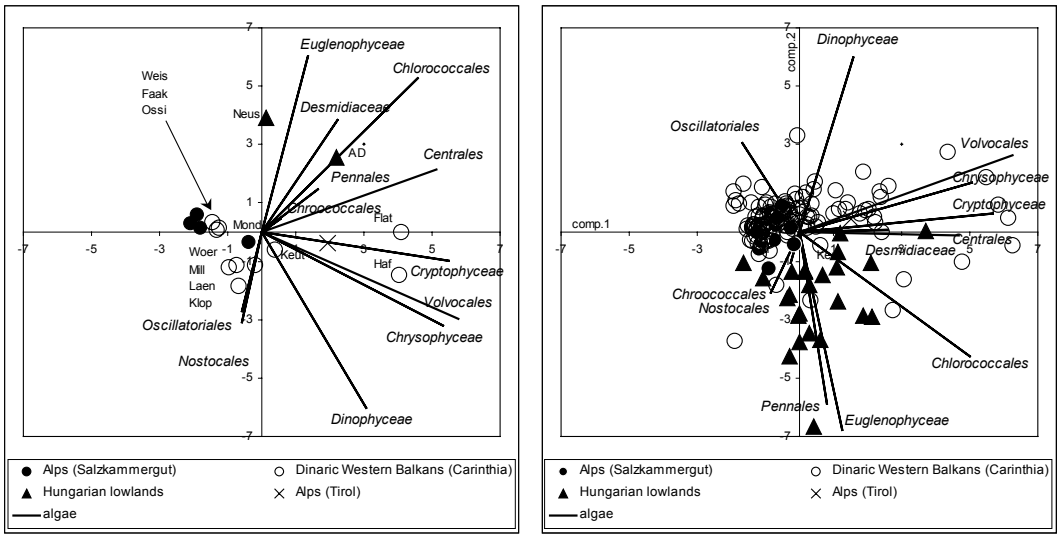
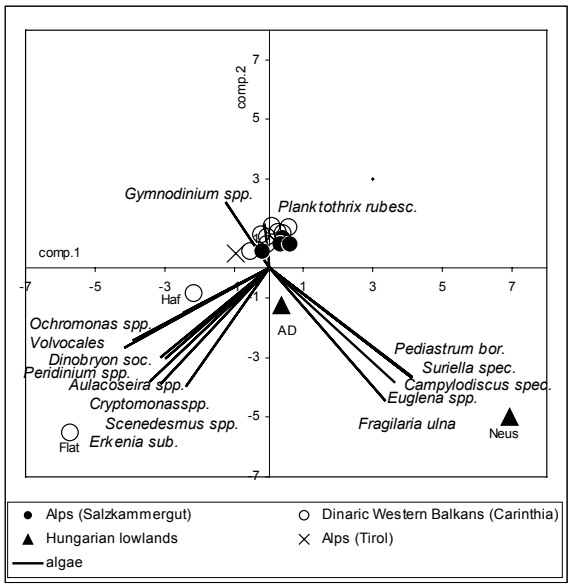


Fig. 2. PCA for phytoplankton structure of lakes (left, variance: 32%+17%=49%) and their annual averages (right, variance: 21%+15%=36%) according to higher taxonomic groups: Cyanobacteria (Chroococcales, Oscillatoriales, Nostocales), Chlorophyceae (Volvocales, Chlorococcales), Desmidiaceae, Euglenophyceae, Bacillariophyceae (diatoms: Centrales, Pennales), Dinophyceae, Cryptophyceae, Chrysophyceae.

Completely different from this pattern are lakes of either low conductivity and high altitude (Piburger See, Central Granite Alps) or high phosphorus concentration, high conductivity and low altitude (Neusiedlersee, Alte Donau, Hungarian lowlands). Phosphorus, catchment area and conductivity decrease as altitude increases. Deeper lakes have lower phytoplankton biomass and higher transparency when compared to more shallow lakes (fig. 1). Nitrogen and temperature are parameters of less importance in separating the sites.

Fig. 2 shows phytoplankton structure analysed for algal groups (higher ranks of algal taxa). The left panel illustrates the plankton of the investigated sites; the right

panel the 160 lake-years. In our data set the biomass of the green algae (Chloro- and Euglenophyceae, Desmidiales), of diatoms (Bacillariophyceae), dinoflagellates, crypto- and chrysomonadales are more characteristic for single lake types than the cyanobacteria. In both cases distinct patterns of phytoplankton for the lakes of the four ecoregions are recognisable, although some lakes overlap. The 4 lakes of the Northern Limestone Alps and the deep lakes from the Dinaric Western Balkans are mainly characterised by low biomass of green algae, centric diatoms and crypto- and chrysomonadales, while shallow Dinaric Western Balkan lakes are the opposite. Lakes of the Hungarian lowlands are separated by the lack of dinoflagellates (Neusiedlersee) or the dominance of coccal green algae (Alte Donau).



According to fig. 3, distinct patterns of phytoplankton structure separate lakes also by species or species groups (low rank taxa). The percentage of explained variance for the first two components , however, increased from 49 to 60 (fig. 3) and 36 to 43 percentage.

Fig. 3. Same as fig. 2 but algal species or species groups (variance: 35%+25%=60%).

Conclusion

Phytoplankton structure reflects morphometry and physico-chemical characteristics of lakes in the 4 ecoregions. Differences in phytoplankton communities are more expressed by single species than by the share of green-, blue-green algae, diatoms or other taxa of higher ranks. Therefore type-specific reference conditions for surface water bodies are better substantiated by algal species or closely related species groups than by algae of higher taxonomic level.

References

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9th International Conference on the Conservation and Management of Lakes

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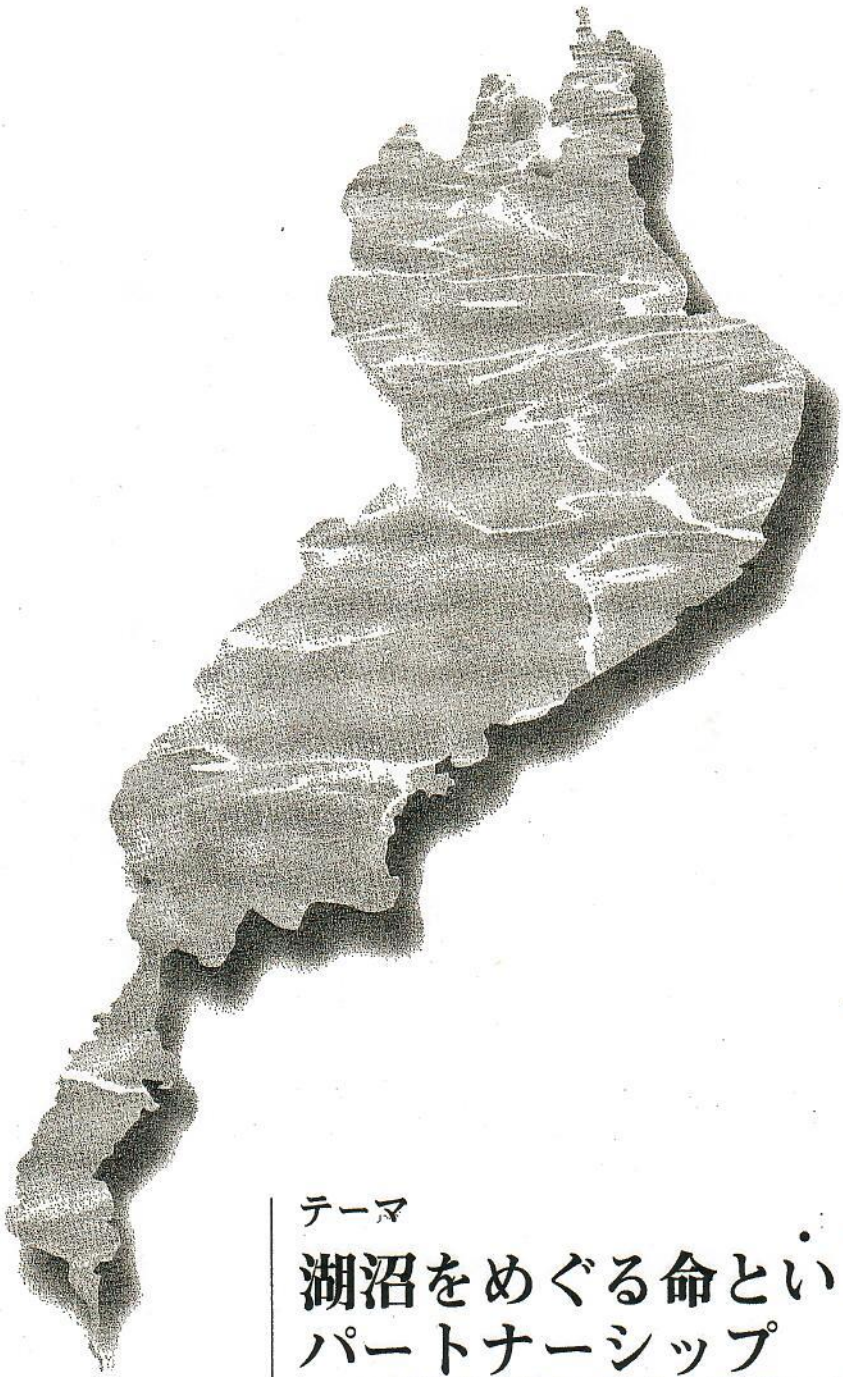

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第1分科会

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～地球淡水資源の保全と回復の実現に向けて～

Partnerships for Sustainable Life in Lake Environments :
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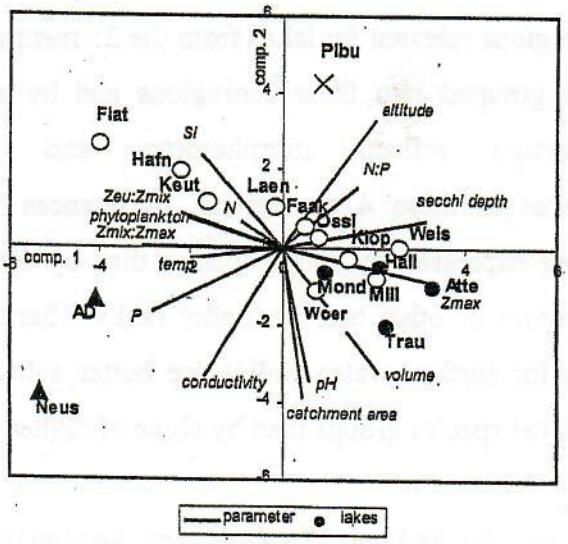

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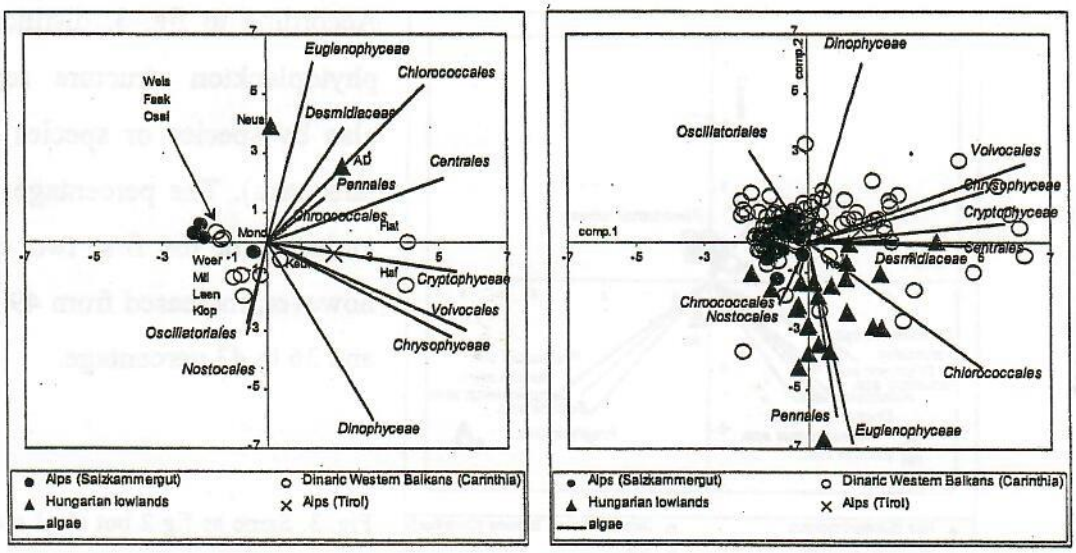

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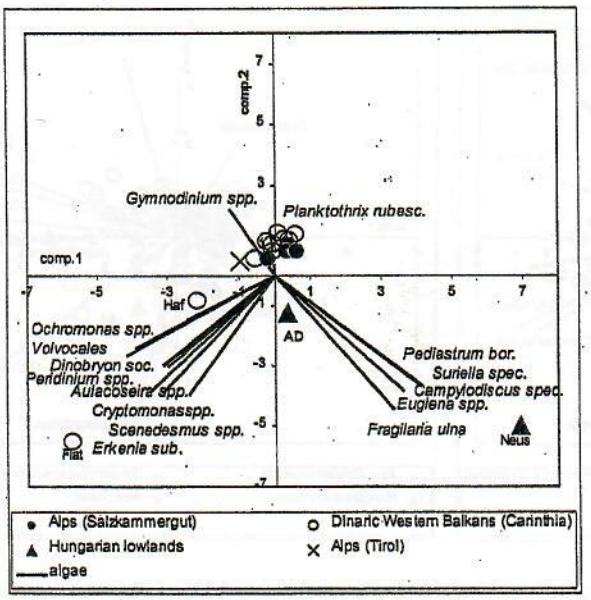

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