Proceedings of the 1st Central European Diatom Meeting 2007
Kusber, W.-H. & Jahn, R. (ed.)
Botanic Garden and Botanical Museum Berlin-Dahlem, Freie Universität Berlin
ISBN 978-3-921800-63-8, © BGBM, Berlin 2007.
doi:10.3372/cediatom.124 (available via http://dx.doi.org/)

Distribution of pelagic Centrales and their value to index trophic status in German rivers: Dominant, but not relevant?

Ute Mischke

Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Dept. of Shallow Lakes and Lowland Rivers, Müggelseedamm 310, 12587 Berlin, Germany; mischke@igb-berlin.de

INTRODUCTION

A new approach to assess running waters by phytoplankton was introduced by Mischke et al. (2005) on behalf of the Water Working Group of the German Federal States (LAWA) to implement the European Water Framework Directive (WFD). Centric diatoms with 82 taxa dominate strongly the potamoplankton in German large rivers with 60–96 % of total biovolume. 48 diatom taxa contribute to the indicator list and their specific index-values and thus expand the phytoplankton metrics for river assessment (Mischke et al. 2005). Some of these taxa can exclusively be determined by slide preparations. In the first assessment approach, identification of centric species was recommended by a composite method combining quantitative cell counts in size-classes by the Utermöhl technique with relative abundances by slide counts. Still slide preparations of 6 samples per year and calculations of transfer data are an enormous effort in time and costs. For reasons of practicability, the indicator strengths of 16 indicator species had to be evaluated during a national test (Mischke 2006).

MATERIAL & METHODS

The underlying data bank is based on monitoring results from biological, hydrological and chemical data of more than 280 river sites with 25 000 sampling dates collected in the years 1976 to 2005 (Mischke et al. 2005, Mischke 2006). Diatom records are 40 % of all 210 000 findings. The biological matrix is the German operative phytoplankton taxa list (Mischke & Kusber 2006). New national method instructions are in use for sampling frequency (6x/year), for counting strategy and for a given taxonomic level of determination (Mischke et al. 2005; Mischke & Behrendt 2007) since 2005. In former years differing monitoring programs were in use in the 16 German Federal States.

Level of diatom taxa determination

Because of differentidentification approaches for diatom taxa, the data collection is unreliable for the various taxa. For example, in the River Weser diatom taxa are frequently analysed to the species level by diatom slides, but for other sites there are solely Utermöhl-records based on Lugol-fixed samples available. Utermöhl-records are generally identified to the genus level or the size class; in a few cases they can be identified to the species level, if they exhibit morphological characters recognizable in the sedimentation chambers like those for *Aulacoseira granulata* (Ehrenb.) Simonsen (e.g. terminal spines). For other species characters are in debate (e.g. for *"Stephanodiscus hantzschii")* whose identity in Utermöhl-records was only sporadically proven by slide preparation or REM.

Boundaries to determine trophic status of rivers and species distribution

Boundaries of chlorophyll a- and total phosphorous concentrations were set for the 5 status classes (Mischke & Behrendt 2005; Mischke 2006). They were used to determine the trophic status of the river sites. For trophic distribution analysis the species proportion to total biovolume (%) was used and zero values (no findings of a taxon in a one-year-data-set) were omitted.

Calculating the assessment results of German river phytoplankton index

For calculating the status of plankton-dominated rivers the software PhytoFluss.mdb was used. The result of the assessment method is the mean of single results (Mischke & Behrendt 2007) evaluated by the metrics "biomass" (Chl a), "Pennales", "Cyanobacteria"; "Chlorophytes" and TIP (index with indicator taxa list). For phytoplankton the following river types are to be applied:
Large streams with high (10.1 & 20.1) or with low (10.2 & 20.2) specific run-off (< respectively > 10 l s^{-1} km^{-2}).

Lowland sandy streams with a catchment area of 1 000–5 000km^2 (15.1 & 17.1) or 1 000–10 000km^2 (15.2 & 17.2).
Large high land streams with catchment area >5 000–10 000 km^2 (9.2).

The definition of special boundaries and reference conditions for each river type (e.g. hydrological and morphological characters) takes into account the different reactions of phytoplankton to the same nutrient concentration (Mischke et al. 2005). The scale of the trophic status as of the biological index is in the range of 0.5–5.5: <1.51 = "very good status"; 1.51–2.50 = "good status"; 2.51–3.50 = "moderate status"; 3.51–4.50 = "low status"; >4.50 = "bad status".

RESULTS

From the 48 diatom indicator taxa of the metric TIP (version Mischke et al. 2005), 16 species were selected, which can be definitely identified only by additional slide preparations. In Table 1 the number of the available annual means per taxon is listed to identify the more common species with more than 25 findings. These 9 common species were analysed along a trophic scale including the extended data set of the German national test in practice in the year 2005 to evaluate their effect on the total assessment result and their distribution along a trophic scale.

Table 1. List of diatom species identifiable only by slide preparation to test for indicator value in the assessment of rivers. Number of annual means for statistic analysis for each river type (is highlighted when more than 25 findings are available). For definition of river types see Material & Methods.

Taxon name	Number of annual means for German river types					
	Sum N	**10.1+20.1**	**10.2+20.2**	**15.1+17.1**	**15.2+17.2**	**9.2**
Cyclostephanos delicatus (Genkal) Casper & Scheffler	**63**	12	9	22	1	19
Cyclostephanos dubius (Hust.) Round	**159**	26	49	39	7	38
Cyclostephanos invisitatus (M.H.Hohn & Hellerman) Stoermer, E.C.Ther. & Håk.	**129**	20	45	27	6	31
Cyclotella atomus Hust.	**122**	20	45	20	5	32
Cyclotella ocellata Pant.	**47**	11	9	9	3	15
Cyclotella pseudostelligera Hust.	**117**	12	46	22	6	31
Cyclotella stelligera Cleve & Grunow	**42**	2	8	16	1	15
Cyclotella striata (Kütz.) Grunow	**2**	0	1			1
Stephanodiscus Ehrenb.	**61**	13	26	6	6	10
Stephanodiscus hantzschii Grunow	**176**	22	60	39	11	44
Stephanodiscus minutulus (Kütz.) Cleve & Möller	**149**	30	47	31	7	34
Stephanodiscus neoastraea Håk. & B.Hickel	**97**	28	32	17	5	15
Thalassiosira weissflogii (Grunow) G.A.Fryxell & Hasle	**90**	10	47	4	5	24

Effect on total assessment result

In Fig. 1 two assessment results according to the calculations of Mischke & Behrendt (2007) are compared for each site, which differ only in the number of indicator taxa for the metric TIP:

1) Excluding those diatom species which are identifiable only by slide preparation (Table 1),

2) Inclusion of these species and by using taxon trophic values of the metric TIP from the first method approach (Mischke et al. 2005).

Pooling all river types, the whole range of index values are presented in the data set (Fig. 1). Linear regression analysis revealed a very high correlation coefficient (R2 = 0.996). The slope of the regression is near to the ideal value of 1. Both facts indicate the small influence of centric diatom taxa on the assessment result except for 14 cases (2.9 %).

Distribution of common centric diatoms along a trophic scale for rivers

For distribution analysis 21 combinations of taxa along a trophic scale in 4 river types were analyzed statistically (Table 2). Frequencies of species findings were low (10–40 %), maybe due to assigning them in part to higher taxa level. No correlation was significant, except for *C. invisitatus* in small lowland rivers. For few examples the scattering of data are shown in Fig. 2. Opposite indication preferences are detectable for *C. invisitatus* in different river types (see 15.1+17.1 and 9.2), as well as for *Stephanodiscus hantzschii* and for *Cyclostephanos dubius* (latter not shown).

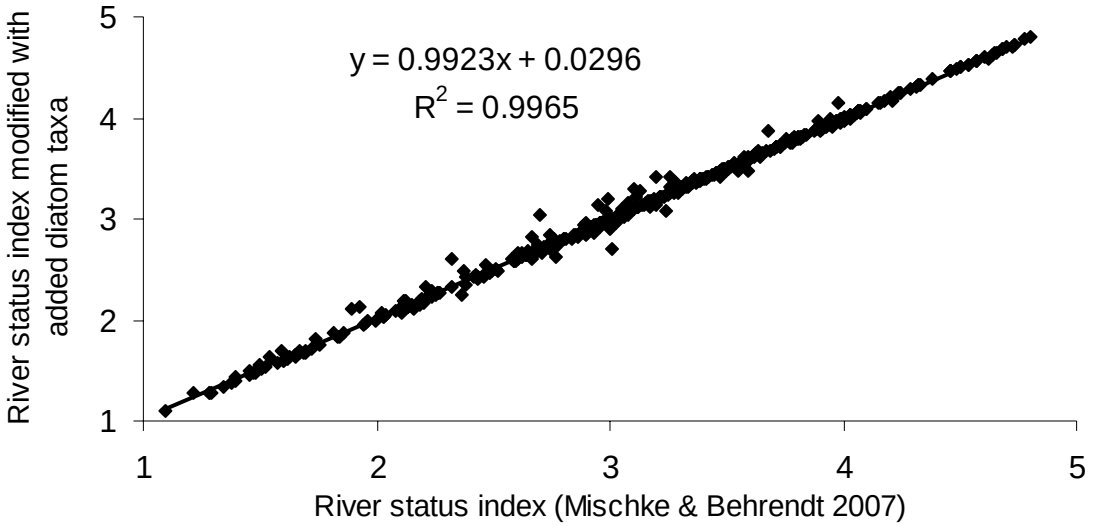

Fig. 1. Influence of added diatom indicator taxa (see Table 1) to total assessment result (N = 486).

Table 2. Correlation coefficients (r^2) between taxon proportion (%) and trophic status in the river types, when annual values are >25 (see Table 1). For definition of river types see Material & Methods.

Name of common taxa	10.1 & 20.1	10.2 & 20.2	15.1 & 17.1	9.2
Cyclostephanos dubius (Hust.) Round	0.01	0.10	0.01	0.03
Cyclostephanos invisitatus (M.H.Hohn & Hellerman) Stoermer, E.C.Ther. & Håk.		0.00	**0.52**	0.27
Cyclotella atomus Hust.		0.05		0.05
Cyclotella pseudostelligera Hust.		0.03		0.14
Stephanodiscus Ehrenb.		0.01		
Stephanodiscus hantzschii Grunow		0.04	0.12	0.14
Stephanodiscus minutulus (Kütz.) Cleve & Möller	0.04	0.00	0.00	0.03
Stephanodiscus neoastraea Håk. & B.Hickel	0.04	0.00		
Thalassiosira weissflogii (Grunow) G.A.Fryxell & Hasle		0.14		

DISCUSSION

Those centric diatom species, which can be identified only by slide preparations, contribute very little to the total phytoplankton assessment result. The omission of this data does not influence the results systematically. To rule out that this observation was not only caused by a too low mathematical weighting of centric species within the total assessment calculation, the trophic indication power was checked for all common centric species individually in the extended German data set. None of the checked diatom species exhibit a strong correlation to trophic status. Most taxa were non-specifically distributed and near the mean of trophic status different in each river type data set. Furthermore, zero values (no findings of a taxon in a one-year-data-set) were already excluded from the correlation analysis, which would further increase data scattering and reduce correlation trends. Correlations to trophic status were also low when using taxa biovolume ($mm^3 \cdot l^{-1}$; not shown here) instead of taxa proportion (%).

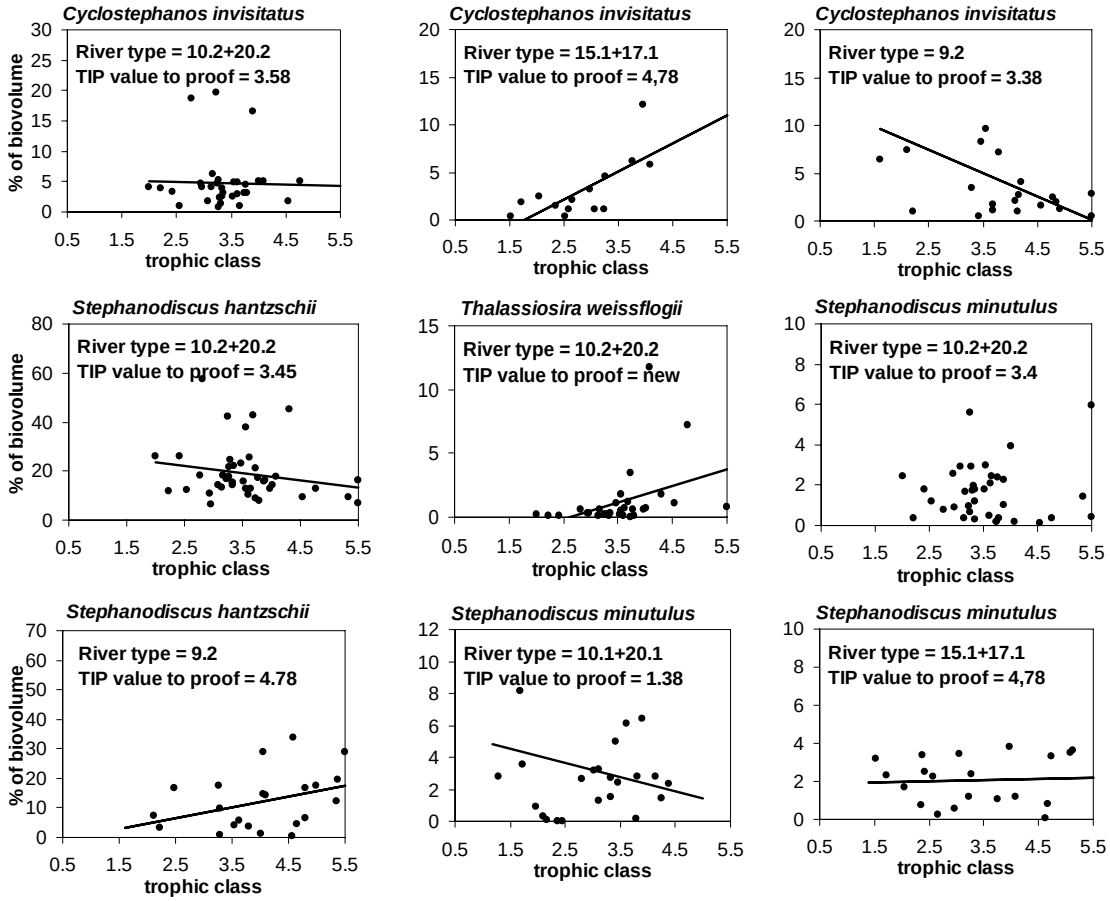

Fig. 2. Correlation of taxa proportion (%) to trophic class index in different river types. The trophic indicator value of TIP (Mischke et al. 2005) is given for comparison with the extended data set.

In summary, the identification of centric diatom species requires almost half of the investigation time in the first composite approach of the assessment method (Mischke et al. 2005), but contributes little to the result. Thus, the omission of the species level of centric diatoms is justifiable in the revised method description (Mischke & Behrendt 2007). Leaving them out by relying on Utermöhl method only, other recognizable diatom taxa still contribute to the assessment.

Since the former variability in methods caused an unequal deep level of taxon determination in the underlying data, further and more reliable investigations are needed. Some German Federal States continue to investigate pelagic river diatoms on species level, so a larger data set will be collected in the next years.

REFERENCES

Mischke, U. 2006: Bundesweiter Praxistest eines Bewertungsverfahren für Phytoplankton in Fließgewässern Deutschlands zur Umsetzung der EU-Wasserrahmenrichtlinie – Verfahrensvereinfachung und -überprüfung mit Handbuchentwurf - LAWA-Projekt O 3.05. IGB. 68 pp. – Berlin-Friedrichshagen.

Mischke, U., Behrendt, H., Köhler, J. & Opitz, D. 2005: Report: Entwicklung eines Bewertungsverfahrens für Fließgewässer mittels Phytoplankton zur Umsetzung der EU-Wasserrahmenrichtlinie. LAWA 03.05 IGB Berlin. 99 pp. – Berlin.

Mischke, U. & Kusber, W.-H. 2006: Die harmonisierte Taxaliste des Phytoplankton. Excel list with remarks. Update Sept 2006. [online]. – [cited 2007-10-01]. Available from <http://www.igb-berlin.de/abt2/mitarbeiter/mischke>.

Mischke, U. & Behrendt, H. 2007: Handbuch zum Bewertungsverfahren von Fließgewässern mittels Phytoplankton zur Umsetzung der EU-WRRL in Deutschland. 88 pp. – Berlin.

Mischke, U. & Behrendt, H. 2005: Vorschlag zur Bewertung ausgewählter Fließgewässertypen anhand des Phytoplanktons. – Pp. 46-62 in: Feld, C. K., Rödiger, S., Sommerhäuser, M. & Friedrich, G. (ed.): Typologie, Bewertung und Management von Oberflächengewässern. Limnologie aktuell **11.** – Stuttgart.