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Uptake of ^{15}N Labeled Dissolved Organic Nitrogen by Plankton Communities in the Baltic Sea

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Background

Anthropogenic activity has resulted in increased nutrient inputs to marine ecosystems and eutrophication[1]. For the Baltic Sea a four fold increase in nitrogen concentration has been estimated for the 20th century by Larsson et al. 1985[2] and since then stayed rather constant in the open sea part, but further increases are noted in coastal waters [3,4]. The input of nitrogen today accounts for approximately 1 mio t N per year[4] and the average amount of DON (dissolved organic nitrogen) of the total N pool can make up to 70% [5]. The main sources of DON are riverine inputs[5] which is reflected in higher DON concentrations in estuaries and coastal areas. Nevertheless, bioavailability of DON is not yet well understood[6]. Previous studies have suggested that DON is used not only by bacteria but also by phytoplankton[7,8,9]. Presumably, DON needs to be considered in the management of nitrogen in the Baltic Sea. In this study, we compared the DON concentrations and uptake rates of labile DON compounds (urea and dissolved free amino acids-DFAA) in estuarine, coastal and open waters of the Baltic Sea (see figure 1 & 2). We therefore quantified the uptake of ^{15}N labelled urea and ^{15}N labelled DFAA into different fractions of the plankton community.

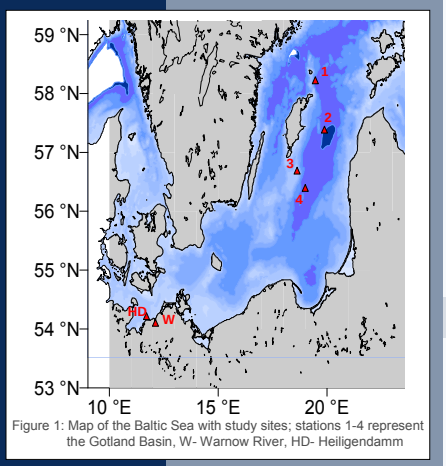

Figure 1: Map of the Baltic Sea with study sites; stations 1-4 represent the Gotland Basin, W- Warnow River, HD- Heiligendamm

Results- Characterization of stations

How much nitrogen is there?

- In the Gotland Basin and Heiligendamm no DIN is detectable and salinity varies between all study sites (figure 2).
- Total nitrogen (TN) in Warnow River is three times higher than in the other two stations, although particulate organic nitrogen (PON) makes up 20-22% of TN at all sites (figure 4).
- The Warnow River has more than twice as much DON (49± 5,68 µM N) as the other two stations (22,2 µM N & 21,4 µM N).

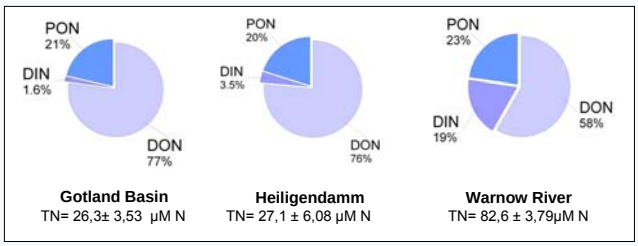

Figure 4: Composition of total nitrogen (TN) in % in surface waters of the Gotland Basin, Heiligendamm and the Warnow River ; PON = particulate organic nitrogen; DIN = dissolved inorganic nitrogen, including NH^{4+},NO^{3-}, NO^{2-}; DON= dissolved organic nitrogen

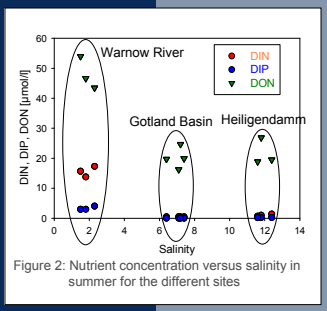

Figure 2: Nutrient concentration versus salinity in summer for the different sites

Conclusions

- **The percental uptake of Urea and DFAA into the smaller size fraction (<2,7µm) is substantial, which is consistent with previous studies in the Baltic Sea (Tamminen et al., 1996; Jørgensen, 1999; Veuger, 2004).**
- **At all three sites we found high uptake rates of DFAA and Urea, although they were very different in nutrient concentration and salinity.**
- **Our results suggest that in DIN depleted surface waters, DON can be an essential N source for the whole plankton community.**

Material & Methods

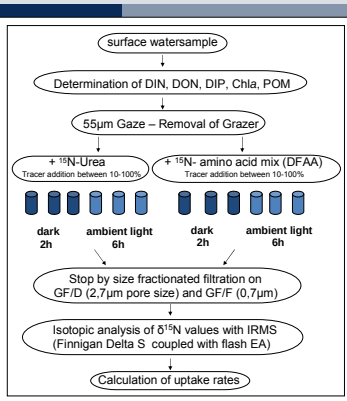

Figure 3: Experimental design for all 3 Sites

- We determined potential uptake rates due to constant tracer additions but variable concentrations.
- Size fractions are assumed to contain on the one hand bacteria and small phytoplankton (<2,7µm) and on the other hand large phytoplankton (>2,7µm).

Acknowlegdements

I wish to acknowledge the invaluable support and patience of my whole team. I thank Claudia Fellerhoff for the Organisation of the PENCK cruise. This project was founded by EU- BONUS+ Project "Assessment and Modelling Baltic Ecosystem Response" (03F0485A)

Results

Who is using DON ?

- 70% of urea is taken up by the larger fraction (>2,7µm) in Warnow River.
- The smaller fraction (<2,7µm) takes up more urea (60%) and DFAA (80%) than the larger fraction.
- There is no difference between sites concerning the relative DFAA uptake in the fractions.

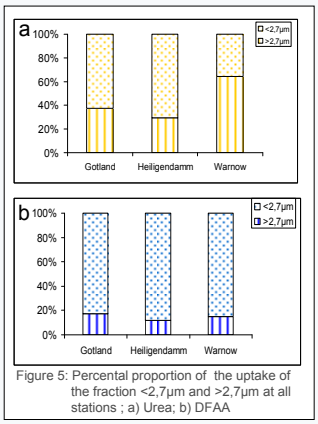

Figure 5: Percental proportion of the uptake of the fraction <2,7µm and >2,7µm at all stations ; a) Urea; b) DFAA

How much DON is taken up?

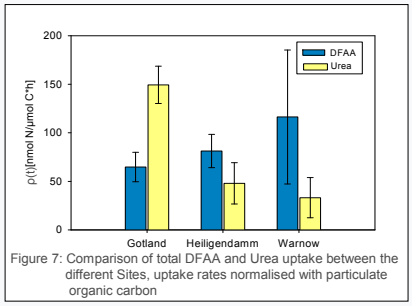

Figure 7: Comparison of total DFAA and Urea uptake between the different Sites, uptake rates normalised with particulate organic carbon

- The DFAA uptake: 64-116nmol N/µmol C*h does not vary significantly (p>0,05) between sites.
- The uptake rates of urea in the Gotland basin (150 nmol N/µmol C*h) are significantly larger than the rates in the Warnow River and Heiligendamm (40-50 nmol N/µmol C* h).
- The Gotland Basin and the Warnow River show urea uptake rates which are significantly different from DFAA uptake (p<0,001).
- Comparing the non biomass-normalized uptake rates, DFAA 1,26 -4,66 µM N/ h and Urea 0,88 – 4,45 µM N/ h are far in excess of literature data (DFAA & Urea 5 -200nM N/h in Randers Fjord, Denmark)[9].

Does DON concentration influence the uptake ?

- We did not find a correlation between the DFAA and urea uptake and DON concentration. This is in accordance to to findings of other studies [5, 9].

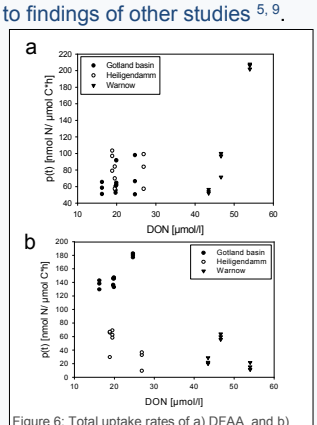

Figure 6: Total uptake rates of a) DFAA and b) Urea as a function of DON concentration

References

[1] Gruber, N., & Galloway, J. N. (2008). An Earth-system persepective of the global nitrogen cycle. NATURE, 451(17), 293-296.
[2] Larsson, U., Elmgren, R., and Wulff, F. 1985. Eutrophication and the Baltic Sea: causes and consequences, Ambio, 14, 9–14,
[3] Voss, M., K.-C. Emeis, S. Hille, T. Neumann, and J. W. Dippner. 2005a. Nitrogen cycle of the Baltic Sea from an isotopic perspective. Global Biochemical Cycles 19: 1-16
[4] HELCOM. 2007. Towards a Baltic Sea unaffected by Eutrophication. HELCOM Overview 2007
[5] Stepanauskas, R. n., & Leonardson, L. (1999). Bioavailability of wetland-derived DON to freshwater and marine bacterioplankton. Limnology and Oceanography, 44(6), 1477-1485.
[6] Berman, T., & Bronk, D. A. (2003). Dissolved organic nitrogen: a dynamic participant in aquatic ecosystems. AQUATIC MICROBIAL ECOLOGY, 31, 279-305.
[7] Tamminen, T., & Irmisch, A. (1996). Urea uptake kinetics of a midsummer planktonic community on the SW coast of Finland. MARINE ECOLOGY PROGRESS SERIES, 130, 201- 211.
[8] Jørgensen, N. O. G., Kroer, N., Coffin, R. B., & Hoch, M. P. (1999). Relations between bacterial nitrogen metabolism and growth efficiency in an estuarine and an open-water ecosystem. Aquatic Microbiological Ecology, 18, 247–261.
[9] Veuger, B., Middelburg, J. J., Boschker, H. T. S., Joop Nieuwenhuize, Rijswijk, P. v., Rochelle-Newall, E. J., et al. (2004). Microbial uptake of dissolved organic and inorganic nitrogen in Randers Fjord. Estuarine, Coastal and Shelf Science, 61, 507–515.