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HUMIC SUBSTANCES AS LIGANDS FOR IRON AND OTHER METALS IN SEAWATER

Preliminary measurements showed that iron is complexed with humic substances (HS) in waters from coastal and oceanic origin. The limited data set for iron-HS species in ocean waters is here expanded using samples from the Southern Ocean. Reference material fulvic and humic acids were used for calibration of the HS concentrations which were linked to Fe-HS binding capacities by titrations with iron. Comparative measurements using complexing capacity titrations with detection by cathodic stripping voltammetry showed that the Fe-HS species account for a major proportion of the iron binding ligands in the marine system. Experiments investigating the dissociation of labile Fe-HS in the presence of EDTA showed that ligand competition for iron reaches equilibrium in a time span of hours. These kinetics are faster than expected for these highly stable complexes. The reaction kinetics to exchange iron for copper and zinc are also very rapid, reaching equilibrium within seconds. Using the competition between these metals and iron it was possible to determine the complex stability of humic acid and fulvic acid with copper and zinc in seawater.

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A NOVEL METHOD IN DIETARY STUDIES USING ECOTOXICOLOGICAL DATA

Aquatic top predators such as common terns and harbour seals acquire organic contaminants directly from water or indirectly via food. To assess bioaccumulation of contaminants in an estuarine environment, a pilot survey was conducted in the contaminated Westerschelde (south-west Netherlands) in 2005. In 2007 and 2008 more detailed surveys were conducted. A variety of samples were taken ranging from sediment and suspended matter to different types of biota, such as shrimps, worms, shellfish, comb jellies, several species of fish, common terns and harbour seals. Isotope signatures (delta13C/delta15N) were measured in all samples. Trophic levels were calculated using the cockle (Cerastoderma edule) as baseline measurement. The chemical results show that contaminants such as PCBs, PBDEs, HBCD and PFOS are easily transferred and biomagnify in most prey species. By combining trophic levels and contaminant concentrations a further insight can be gained into trophic relations in estuarine environments.

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DERIVATION OF THE MAXIMUM ALLOWABLE TEMPERATURE AS A STANDARD FOR THE GOOD ECOLOGICAL STATUS OF DUTCH LARGE RIVERS

Non-optimal temperature conditions may negatively affect diversity of ecosystems. The European Water Framework Directive (WFD) requires a Good Ecological Status (GES) for surface waters in terms of plant and animal species composition and abundance. To support this GES, standards for physico-chemical parameters that ensure a GES must be derived, including temperature. RIVM recommends the maximum temperature standard for the GES of Dutch large rivers to be set at 25°C based on literature and measurement data for benthic invertebrate fauna and fish. For springtime a lower maximum temperature of 20°C is recommended to ensure reproduction and growth of organisms. The standard recommended here, applies to the GES for natural waters and is lower than the current standard of 28°C, which does not take into account the demands of the WFD. A standard for non-natural waters (such as the Dutch large rivers) will be derived by the water managers, using the recommendation for GES as a starting point. The ecological standards are presently composed of plant and animal species composition and abundance. Possibilities of adding also some functional parameters are discussed.

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CAN *OCHROMONAS SP.* , A MIXOTROPHIC CHRYSOPHYTE, CONTROL TOXIC AND COLONY-FORMING CYANOBACTERIA

Grazing experiments with *Ochromonas*, a mixotrophic chrysophyte, were performed in the laboratory to test whether this flagellate can control cyanobacteria. We investigated three *Microcystis aeruginosa* strains that varied in toxicity and morphology and also one filamentous cyanobacterium, *Pseudoanabaena*. Furthermore, we analyzed the co-occurrence of *Ochromonas*, and *Microcystis* in natural systems. *Ochromonas* was able to feed on all four cyanobacteria tested, and showed high growth rates on all of them by reducing the net growth rates of the cyanobacteria significantly. Further, we observed that after four days of incubation with *Ochromonas* the total microcystin content in the *Microcystis* strains was reduced by more than 90% compared with the controls. Analysis of the field data from 460 Norwegian lakes showed that *Ochromonas* occurred in almost all lakes, while the distribution of *Microcystis* was linked to higher TN, TP, temperature and pH. *Ochromonas* occurred in 99% of the lake samples, while *Microcystis* was found in only 7%. *Ochromonas* co-occurred in 94% of the samples in which *Microcystis* was present and the interaction of both species might therefore be important in natural systems

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P.I.V. PATCH WORK – ANALYSIS OF SURFACE FLOW AROUND PATCHES OF SALTMARSH VEGETATION

In the past decade the effects of saltmarsh vegetation on currents and waves have been studied in flume tanks. In flumes, water is forced through the vegetation. In the field water may either flow through or around a patch. We tested the effect of patches of vegetation on hydrodynamics in a large-scale engineering facility. Due to the large spatial heterogeneity, measurements with current meters give limited information about the shape and size of wakes. We used large-scale Particle Image Velocimetry (PIV) to analyse the surface flow. In very shallow water, the wake behind a patch of *Spartina anglica* is surprisingly long. The limited water depth restricts the formation of Kelvin-Helmholz instabilities that would break up the sharp velocity gradients in deeper water. The PIV technique was valuable in highlighting the complex flow structures around emergent vegetation. Particularly with submerged vegetation, large differences exist between the surface flow and near-bed flow. Surface flow PIV is a valuable addition to analyse spatial flow patterns, but is not a substitute for conventional flow measurements.

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ZOOPLANKTON GRAZING MEDIATES INTRASPECIFIC INTERACTIONS IN MICROCYSTIS POPULATIONS

We conducted two laboratory experiments to investigate intraspecific interactions within Microcystis populations and the impact of zooplankton grazing on these interactions. In a first experiment, we investigated defences induced by infochemicals of Daphnia magna in Microcystis strains that differed in important ecologically relevant traits. In a second experiment, we studied interactions between Microcystis strains in mixed populations in presence and absence of Daphnia magna. The relative abundances of the strains were followed through time using Denaturing Gradient Gel Electrophoresis, and the growth rate of each strain in the populations was compared to its monoculture growth rate to determine the sign and magnitude of the interactions. Our data suggest that zooplankton has a relatively weak and strain-specific influence on the growth rate, microcystin production and colony formation of Microcystis strains compared to inter-strain differences in these traits. Grazing also impacted the interactions between strains in important ways. The presence of Daphnia resulted in weaker competitive interactions between strains and in strain-specific cases of facilitation. We interpret these results in the light of the maintenance of genetic diversity in cyanobacterial populations.

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LINKING PHYSICAL PROCESSES TO HIGHER TROPHIC LEVELS: RESULTS FROM COUPLING HYDROLOGICAL, BIOGEOCHEMICAL AND SIZE-BASED FOOD WEB MODELS

To predict changes and improve understanding of North Sea ecosystem structure and function, the General Estuarine Transport Model (GETM, see www.getm.eu) has previously been coupled to the Biogeochemical Flux Model (BFM, the successor to ERSEM, see www.bfm.cmcc.it). The BFM model incorporates the cycles of C,N,P,Si and has a functional group approach. The highest trophic level included in the BFM model is zooplankton (5 functional groups), while phytoplankton (4 groups) and benthos (5 groups) are also represented. Application of the coupled model provides 3D spatial and temporal fields of biomass per functional group in the North Sea. Depth-integrated biomass fields