Theme Session A
Incorporating microbial dynamics in studies of shelf ecosystems

ICES CM 2008/A:01

The role of the microbial foodweb in ecosystem-based management

Michael R. Heath and John H. Steele

The present focus on ecosystem-based management (EBM) for fisheries has generated a number of studies on budgets for nutrient or energy flow through ecosystems, usually with emphasis on the higher trophic levels. Some end-to-end studies use the ratios of fish yield to net primary production as a system index, but this ratio is very variable and can reflect differences in the factors determining nutrient recycling within the lower trophic levels, rather than stresses on the upper trophic components. We argue that explicit consideration of these physical, biogeochemical, and ecological processes is essential if we are to understand the constraints on overall system productivity and the causes of changes in this productivity. We illustrate these issues with comparative analyses of the Georges Bank and the North Sea ecosystems.

Contact author: John Steele, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA [tel: +1 508 289 2220, fax: +1 508 457 2184, e-mail: jsteele@whoi.edu].

ICES CM 2008/A:02

The prokaryote to eukaryote ratio in plankton of the surface ocean

William K. W. Li

The coexistence of the three domains of life in marine plankton indicates extreme evolutionary and ecological diversity in the pelagic realm. The paradigmatic dichotomy between prokaryotes (domains Bacteria and Archaea) and eukaryotes (domain Eukarya) is suffused with meaning and mythology. Fundamental debate on the validity of the term "prokaryote" centres on molecular organization and evolution, but little consideration is given to ecology. Here, an empirical examination is made of the prokaryote to eukaryote ratio in the surface ocean. The allometric scaling of the numerical abundance of organisms to body size according to a –3/4 power law indicates that more than 99% of plankton are smaller than 20 μm in size. Extensive observations of picoplankton and nanoplankton in numerous contrasting ocean provinces suggest that the prokaryote to eukaryote ratio may contain latent information on large-scale geographic patterns of community structure.

Keywords: picoplankton, nanoplankton, prokaryotes, eukaryotes, microbes.

Contact author: William Li, Department of Fisheries and Oceans, Ecosystem Research Division, Bedford Institute of Oceanography, PO Box 1006, Dartmouth, Nova Scotia, Canada B2Y 4A2 [tel: +1 902 426 6349, e-mail: LiB@mar.dfo-mpo.gc.ca].

ICES CM 2008/A:03

Transformation of dissolved organic matter and its diverse effect on higher trophic level

Markus Schartau, Anja Engel, and Franciscus Colijn

A considerable amount of primary production by marine phytoplankton is released to seawater as dissolved organic matter (DOM) via exudation and leakage processes. The labile fraction of DOM can either directly serve as a source of energy and nutrients or is transformed to particulate matter by abiotic gel particle formation. Principally, both pathways induce diverse effects on higher trophic levels, as they: (i) affect the growth of bacteria and photo-autotrophic nanoplankton, which directly affects the microbial foodweb, and (ii) enhance the formation of aggregates, which provide pelagic microhabitats but also accelerate the export of organic matter to the benthos. Reliable biogeochemical flux estimates of these distinct pathways will crucially depend on our understanding of small-scale processes. Here, we show examples that address the microbial turnover of organic matter and how it is related to primary and secondary production in the North Atlantic and at sites in shelf regions. Recent findings on the sensitivity of microbial processes to changes in temperature and pH will be incorporated. Ecosystems in coastal and shelf regions are most sensitive to anthropogenic impacts, as they are susceptible not only to global changes but also to regional changes. We will therefore give an outlook on how to improve monitoring, experimental, and modelling strategies to better account for microbial foodweb dynamics when assessing climate change effects on ecosystems in coastal and shelf regions.

Keywords: DOC, DOM, microbial transformations, fate of organic matter, role in foodweb.

Contact author: Franciscus Colijn, Institute for Coastal Research (GKSS), Max Planck Strasse 1, 21502, Geesthacht, Germany [e-mail: colijn@gkss.de].

ICES CM 2008/A:05

Use of the FlowCam for plankton abundance estimation in the field and for experimental settings in the laboratory

Florian Matthias Hantzsche, Maarten Boersma, and Friedhelm Schroeder

Despite years of progress in our knowledge of the processes that govern planktonic communities, we are essentially still using the same techniques to quantify densities of planktonic organisms as 100 years ago. The development of automatic measuring systems is still in its infancy, and although fluorometric probes, pigment analyses, and flow cytometry help the identification of the main groups in the phytoplankton, to date there are no real alternatives to microscopic counting when it comes to the identification of single phytoplankton species. The recently developed FlowCam, a combination of a flow cytometer and a microscope, might at least partly solve this problem. In our study, we tested the FlowCam for the long-term sampling station Helgoland Roads, Germany, focusing on phytoplankton and microzooplankton. We studied the applicability and reliability of the FlowCam, especially in cell abundance and plankton composition, compared with daily routine microscopic observations. Because of the combination of the different methods in the FlowCam, the instrument is better than the human eye at combining fluorescence and morphological signals. This is exemplified by our work on algae cultured under different nutrient conditions. The FlowCam can distinguish these cells with an overall reliability of 80%. We envisage that, once properly tested and adapted for (semi-)automatic counting, which would involve automatic changing of flow-cells and lenses as well as the incorporation of imaging software, the FlowCam will be a very useful addition to the instruments we have available to study life in the world's oceans.

Keywords: FlowCam, phytoplankton, microzooplankton, community structure, monitoring.

Contact author: Florian Hantzsche, Alfred- Wegener Institut- Biologische Anstalt Helgoland, Ostkaje 1118, 27498 Helgoland, Germany [tel: +49 4725 819 3361, fax: +49 4725 819 3369, e-mail: florian.hantzsche@awi.de].

ICES CM 2008/A:06

Water masses, shelf influences, and depth distributions of Arctic microbial species

Connie Lovejoy, Mary Thaler, and Ramon Terrado

Small organisms in the ocean include not only phytoplankton and bacteria, but diverse bacterial grazers and archaea. Local and global climate processes have a direct effect on the vertical stratification and circulation patterns in shelf and offshelf marine waters, which strongly influences the timing and magnitude annual phytoplankton production. Using molecular biology techniques we are now able to identify species and ecotypes not only of phytoplankton but of the entire community of micro-organisms and it is becoming practical to match community composition with biomass, oceanic processes, and biogeochemical pathways. We show from our recent work in Arctic seas that microbial communities change not only with depth but also with region, and that microbial species mostly track their water mass of origin. For example, below the photic zone some water masses are richer in bacterivores while others are dominated by likely parasites, suggesting different fates for fixed carbon passing through these depths. We suggest that most changes in microbial community composition can be linked to complex oceanic current patterns and advective processes. These changes may well determine the reproductive success of larger organisms and the carrying capacity of an ecosystem because many marine fish and invertebrates have multiple free-living life stages dependent on particular food types.

Keywords: phytoplankton, microbial communities, pelagic–benthic coupling, advection.

Contact author: Connie Lovejoy, Dept Biologie, Université Laval, Québec, Canada G1V 0A6 [tel: +1 418 656 2007, fax: +1 418 656 2339, e-mail: connie.lovejoy@bio.ulaval.ca].

ICES CM 2008/A:07

Pelagic microbes: Producers, remineralizers, and conduits of organic matter towards larger organisms

Louis Legendre and Richard B. Rivkin

Microbes (organisms smaller than 200 μm) include viruses, phytoplankton, bacteria, archaea, and protozoa (flagellates and ciliates). They dominate the production and cycling of organic matter in pelagic systems. This paper discusses the way in which the combined action of bottom-up (i.e. environmental, resource availability) and top-down (i.e. foodweb, resource cycling) processes focuses inorganic and organic

compounds towards microbes, allowing them to transform and redirect them towards remineralization (and the production of inorganic elements) and the remainder of the pelagic foodweb. It is shown that microbes are key components of the pelagic foodweb because of their high metabolic rates and their unique position in the foodweb, which gives them access to resources from both the bottom and the top of the foodweb. As a result, microbes use almost all dissolved resources and a significant fraction of particulate resources, and they monopolize most external and internal resources. Because of their high share of resources, microbes are the main producers of organic matter, remineralizers, and conduits towards other pelagic organisms.

Contact author: Louis Legendre, Villefranche Oceanography Laboratory, 06230 Villefranche-sur-Mer, France [e-mail: legendre@obs-vlfr.fr].

ICES CM 2008/A:08 Poster

Variability in chlorophyll and phytoplankton composition in an estuarine system. Case study on the Tajan River

Maryam Shapoori and Arash Javanshir

The spatial and temporal variability of phytoplankton abundance (in terms of chlorophyll *a* and cell number), inorganic nitrogen, and suspended particulate matter (TSS), was determined over the period of a year in the Tajan River mouth in the south Caspian Sea basin, north of Iran. Chlorophyll *a* concentrations showed a strong seasonal variation, ranging from 0.6 to 94 mg m^{-3} (average 23.5 mg m^{-3}). Chlorophyll patterns were unimodal for stations 1, 2, 3, and 6, bimodal for stations 4 and 5. Diatoms and Bacillariophyceae were the dominant groups in this shallow and unstratified system throughout the year. Nitrate concentrations were seasonally related to river flow and spatially related to sources of sewage input. Lower river inputs and long water residence times during summer initially promoted the accumulation of phytoplankton, but the resulting low dissolved inorganic nitrogen (DIN) concentrations limited phytoplankton growth. Chlorophyll *a* and DIN values obtained in the present study were comparable to those reported 10 years ago for the Tajan mouth.

Keywords: chlorophyll *a*, Caspian Sea, primary production, phytoplankton dynamics, diversity.

Contact author: Arash Javanshir, Science and Research Branch, Islamic Azad University, Hesarak, Tehran, Iran [e-mail: arashjavanshir@hotmail.com].

ICES CM 2008/A:09 Poster

Changes in the spring bloom phytoplankton dynamics in the northeast of Scotland

E. Bresnan, S. Hay, S. Hughes, S. Fraser, and M. Heath

The phytoplankton annual cycle in Scottish coastal waters is characterized by a burst of diatom growth in late spring/early summer followed by an increase in dinoflagellates over the summer months. Eleven years of phytoplankton monitoring at Stonehaven (56º57.8′N 2º6.2′W) has shown an observed change in the timing and dominant species during the spring bloom. Very dense blooms of *Chaetoceros* which dominated the phytoplankton in May/June from 1997 to 2001 are no longer observed. *Skeletonema* is becoming more abundant and occurring earlier in the year. A more cyclical pattern has been observed in the interannual variation of some toxin-producing species such as *Alexandrium* and *Dinophysis*. Analysis of chlorophyll data shows two distinct periods (1997–2001 and 2005–2007) where the midmonth chlorophyll maximum exceeds 2.5 µg l^{-1} and another from 2001 to 2004 where the midmonth maximum does not exceed this concentration.

Keywords: spring bloom, diatoms, *Chaetoceros*, *Skeletonema*, *Alexandrium*, *Dinophysis.*

Contact author: Eileen Bresnan, Fisheries Research Services Marine Laboratory, 375 Victoria Road, Aberdeen AB9 11DB, Scotland, UK [tel: +44 1224 876544, fax: +44 1224 295511, e-mail: e.bresnan@marlab.ac.uk].

ICES CM 2008/A:10 Poster

Observation of *Mediopyxis helysia* in Scottish waters

Tracy McCollin

In April 2005 a diatom, provisionally identified as *Mediopyxis helysia*, was observed in low abundances in samples from Stonehaven, in the northeast of Scotland (56°57.8′N 2°6.2′W). This recently described diatom has previously been recorded as a new species in the Gulf of Maine, the German Bight, and the Bay of Fundy in 1996, 2003, and 2002, respectively. It was observed in samples taken between April and September 2005 at the Stonehaven site. Although the diatom is large it may not have been detected previously as it has been observed in very low abundances. Historically it could also have been recorded as an unidentified diatom species. *Mediopyxis helysia* is currently included in the target list of species monitored at sites around the Scottish coast to improve our knowledge of the distribution of this species in Scottish waters.

Keywords: *Mediopyxis helysia*, phytoplankton, diatoms, North Sea.

Contact author: Tracy McCollin: Fisheries Research Services, Marine Laboratory, PO Box 101, 375 Victoria Road, Aberdeen AB11 9DB, UK [tel: +44 (0)1224 876544, fax: +44 (0)1224 295511, e-mail t.a.mccollin@marlab.ac.uk].