INSTRUMENTATION IN SUPPORT OF RESEARCH ON BIO-OPTICAL THIN LAYERS IN COASTAL WATERS

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LONG TERM GOALS

My long term goal is to understand the functional roles of microzooplankton (20-200 microns) in the sea. It has been argued that on a timescale of days, the instantaneous grazing rate of zooplankton in toto is greater than the instantaneous rates of vertical and horizontal mixing by at least an order of magnitude, and is the same order of magnitude as the instantaneous rate of phytoplankton cell division. Hence, grazing is a critically important loss term in phytoplankton dynamics (Banse, 1992). Because microzooplankton are the major grazers of phytoplankton in pelagic food webs under most circumstances, their grazing impacts exert an important impact on phytoplankton losses in the sea. My specific interests are in the vital rate processes of feeding and reproduction (e.g., Gifford 1988; Gifford, et al. 1995) and in understanding their function as prey for higher organisms (e.g., Gifford and Dagg, 1988; Gifford 1993).

OBJECTIVES

The objective of the project is to acquire, install and learn to use state of the art microscopes and image analysis equipment. The equipment is to be used in support of ONR-funded research on the biological dynamics of thin layers of phytoplankton in coastal waters. The overall objectives of the research are to develop and apply methods which will allow us to define quantitatively the impact of a biological process, grazing, on the structure and persistence of thin layers of biological particles. Using the equipment acquired under this award, we have examined (1) the impact of microzooplankton grazing within and around thin layers of phytoplankton and (2) the fine-scale (sub-meter) distribution of microzooplankton and phytoplankton in the water column. The research is supported by the U.S. Office of Naval Research, Biological Oceanography program with

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equipment acquired through the Defense Universities Research Instrumentation Program (DURIP).

APPROACH

Cm-scale layers are first resolved in the field using a high resolution profiling package (Donaghay et al. 1992) equipped with a siphon system for bulk water collection. The system collects cm-scale measurement of conductivity, temperature, oxygen, pH, Eh, chlorophyll, light extinction, absorbance and scattering, depending on which sensors are mounted on it. Water samples are collected with the siphon at 10-50 cm intervals for analysis of chlorophyll, nanoplankton (2-20 microns) and microplankton (20-200 microns). Microzooplankton grazing is measured by experimental manipulation of water collected with the siphon using the seawater dilution technique (Landry and Hassett 1982; Gifford 1988).

Two subsets of samples are collected from discrete depths in the water column profiles: (1) 20-50 ml are preserved with cold 1% glutaraldehyde, stained with proflavine, drawn onto black nuclepore filters and autotrophic and heterotrophic nanoplankton are enumerated using epifluorescence microscopy; (2) 250-500 ml are preserved with 10% (vol/vol) acid Lugol's solution and autotrophic and heterotrophic microplankton are enumerated in settled samples by inverted microscopy.

WORK COMPLETED

Specific equipment purchased includes: a Nikon D-300 Inverted microscope equipped with optics for differential interference and epifluorescence; a Nikon Eclipse E-800 upright microscope also equipped with optics for differential interference and epifluorescence, and a 35 mm computer controlled camera system; an Optronics 3 CCD video camera that can be interfaced with both microscopes; IPLAB Spectrum Image Analysis software; 3 Power MacIntosh computer systems; and a Kodak 8650 dye sublimation printer. Equipment was acquired and installed between June and December 1996. While we are still on the learning curve for the image analysis system, it and the microscopes have been used to analyze samples of nano- and microplankton from high resolution water column profiles and from microzooplankton grazing experiments in our two study areas of the Pettaquamscutt Estuary, RI and East Sound, WA. Results of this research are summarized in a separate Annual Report. In addition, two Ph.D. students from the University of Rhode Island, Elena Martin, a hispanic American, and Karen Culver-Rymsza, an ASSERT student, have collected substantial amounts of data for their respective dissertation research using the equipment.

IMPACT

We have used the equipment to (1) document sub-meter scale layered distributions of nano- and microplankton in two coastal environments and (2) process samples from manipulative experiments which quantify the impact of microzooplankton grazing on the layers. The experiments demonstrate that in one case the layer is a locus of intense grazing activity, and hence functions to maintain the integrity of the layer. In the other case, maximum grazing activity was located above the layer, and may function to maintain the layer's upper boundary.

Although the existence of thin layers is now relatively well documented, their biota have not previously been described in detail and few measurements of physiological rates have been made within and around them. The grazing rates reported above are the first such measurements in thin layers. Because the layers scatter both sound and light, they are important in a number of other disciplinary areas in ocean including bio-optics and acoustics, as well as basic ecological research.

RELATED PROJECTS

The research is closely linked to other layer studies by P. Donaghay, T. Cowles, A. Alldredge, V. Holliday. R. Pieper, and J. Rines.

REFERENCES

Banse, K. 1992. Grazing, temporal changes of phytoplankton concentrations, and the microbial loop in the open sea. p. 409-440 in: P.G. Falkowski and A.D. Wood (eds.). *Primary Productivity and Biogeochemical Cycles in the Sea*. Plenum Press, N.Y.

Cowles, T.J. et al.1992.In situ characterization of phytoplankton from vertical profiles of fluorescence emission spectra. *Marine Biology* 115:217-222.

Donaghay, P.L. et al.1992. Simultaneous sampling of fine scale biological, chemical, and physical structure in stratified waters. *Arch. Hydrobiol. Beih*. 36: 97-108.

Gifford, D.J. 1988. Impact of grazing by microzooplankton in the Northwest Arm of Halifax Harbour, Nova Scotia. *Marine Ecology Progress Series*. 47: 249-258.

Gifford, D.J. and M.J. Dagg 1988. Feeding of the estuarine copepod Acartia tonsa Dana: carnivory vs. herbivory in natural microplankton assemblages. *Bulletin of Marine Science* 43: 458-468.

Gifford 1993. Protozoa in the diets of *Neocalanus* spp. in the oceanic subarctic Pacific Ocean. *Progress in Oceanography* 32: 223-237.

Gifford, D.J. et al. 1995. Grazing by microzooplankton and mesozooplankton in the high-latitude North Atlantic Ocean: spring versus summer dynamics. *Journal of Geophysical Research* 100: 6665-6675.

Landry, M.R. and R.P. Hassett 1982. Estimating the grazing impact of marine microzooplankton. *Marine Biology* 67:283-288.