

IMPACT OF GRAZING PROCESSES ON THE STRUCTURE AND PERSISTENCE OF THIN BIOLOGICAL LAYERS

Dian J. Gifford
Graduate School of Oceanography
University of Rhode Island
Narragansett, RI 02882-1197
Telephone: 401-874-6690
Fax: 401-874-6240
e-mail: gifford@gsosun1.gso.uri.edu

Percy L. Donaghay
Graduate School of Oceanography
University of Rhode Island
Narragansett, RI 02882-1197
Telephone: 401-874-6694
Fax: 401-874-6240
e-mail: donaghay@gsosun1.gso.uri.edu

Award Number N000149610291

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; 1989; Gifford 1993).

OBJECTIVES

The 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. Specifically, 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.

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 30 SEP 1997		2. REPORT TYPE		3. DATES COVERED 00-00-1997 to 00-00-1997	
4. TITLE AND SUBTITLE Impact of Grazing Processes on the Structure and Persistence of Thin Biological Layers				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) University of Rhode Island, Graduate School of Oceanography, Narragansett, RI, 02882				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 3	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

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).

WORK COMPLETED

To date we have collected fine-scale profiles and measured microzooplankton grazing on layers in two coastal locations, the Pettaquamscutt Estuary, RI and East Sound, WA. In the Pettaquamscutt Estuary during August 1996, a 50 cm thick layer dominated by the autotrophic flagellate, *Euglena proxima*, was centered at a depth of approximately 3.6 m. Phytoplankton pigment in the layer was 3 to 10 times higher than in water located above and below the layer. Microzooplankton grazing was measured in water collected from the center of the layer and its upper and lower edges. Grazing rates were approximately equal to phytoplankton growth rates at the three loci. Grazing rates were highly significant within the layer but not above the layer. (rates were not measured below the layer because a permanent anoxic boundary presumably renders them equal to zero).

In East Sound during June 1997, a 2 m thick layer dominated by a declining community of chain forming diatoms was centered at a depth of approximately 5 m. Phytoplankton pigment in the layer was dominated by phaeopigments, and was 6 times more concentrated than in water above and below the layer. Microzooplankton grazing was measured in water collected from within, above and below the layer. Phytoplankton growth rates were approximately equal to grazing rates at the 3 depths, but grazing was significant only above the layer. A fine-scale profile (50 cm sampling intervals) collected under different hydrographic conditions 3 days after the grazing experiments revealed three layers: (1) a 2 m thick surface layer consisting of the dinoflagellate *Dinophysis acuminata* and the silicoflagellate *Distephanus* sp.; (2) a 2 m thick layer of the noxious dinoflagellate *Alexandrium catenella* and small autotrophic nanoflagellates co-occurring with a peak of aloricate choreotrich ciliates which are their potential predators; and (3) a 1.5 to 2 m thick layer consisting of an assemblage of small autotrophic nanoflagellates, the bioluminescent autotrophic dinoflagellate *Ceratium fusus*, the chain forming diatoms *Thalassionema nitzioides* and *Chaetoceros debilis*, an unidentified assemblage of autotrophic dinoflagellates, and a potential microzooplankton predator on these organisms, the heterotrophic dinoflagellate *Gyrodinium* sp.

IMPACT

Our cm-scale profiles of bio-optical, physical, chemical and biological properties document the existence of sub-meter thick layers of phytoplankton and microzooplankton in two coastal environments. Manipulative 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, 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, D.J. and M.J. Dagg 1991. The microzooplankton-mesozooplankton link: consumption of planktonic protozoa by the calanoid copepods *Acartia tonsa* Dana and *Neocalanus plumchrus* Murukawa. *Marine Microbial Food Webs* 5: 161-177.
- 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.