

# **FORMATION OF MARINE BIOLOGICAL THIN LAYERS: RECRUITMENT OF ZOOPLANKTON**

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## **LONG TERM GOALS**

Christy Herren has been selected as an AASERT Fellow to conduct thesis research on bioluminescence in thin layers. The scope of this project is designed to bridge between the Alldredge/MacIntyre laboratory research on marine particulates and thin layers and the Case laboratory work in bioluminescence. Phytoplankton thin layers and accumulation of marine snow at density discontinuities have been shown to occur in many different regions. Current research strives to understand zooplankton attraction to or possible aversion of these dense aggregations of particles. Zooplankton distributions are interpreted as random patchiness, but current investigations are aimed at understanding behaviors of zooplankton on a microstructure scale that could better predict their movements in the water column.

## **OBJECTIVES**

This project has two components: laboratory and field experiments. Laboratory experiments will test whether zooplankton are attracted to or repulsed by bioluminescent marine snow. Both bioluminescent and chemical cues will be tested to determine if they cause zooplankton to aggregate in regions of concentrated phytoplankton or marine snow. Field experiments will determine associations between bioluminescent intensity, microscale turbulence, marine snow concentrations, fluorescence measurements, and zooplankton abundances in water column profiles in both open ocean and coastal waters.

## **APPROACH**

## Report Documentation Page

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Grazing experiments using phytoplankton-based marine snow containing bioluminescent and non-bioluminescent dinoflagellates will test zooplankton reactions to bioluminescent marine snow. Low-intensity light videography will be used to directly observe and quantify attraction or repulsion reactions. Finally, "thin layers" inoculated with bioluminescent or chemical cues, phytoplankton, or marine snow will be simulated in the laboratory in salinity-layered tanks. Zooplankton distributions, recorded by an infrared camera, will be determined in the tanks relative to the layers.

## **WORK COMPLETED**

Laboratory progress includes building prototype thin layer tanks during the first months of this grant to test longevity and mixing rates of the layers, and zooplankton natural behaviors in the tanks. A wide variety of zooplankton were tested to see which would be most appropriate for the tank experiments. A preliminary 24-hour behavior experiment was completed using *Calanus pacificus*, the most abundant local copepod in the Santa Barbara Channel. Analysis of the time-lapse videos is in progress. This analysis will statistically determine location and behavior of the copepods in the tanks over time.

Data from June 1995 in the Santa Barbara Channel is being pooled and analyzed to identify associations between bioluminescent organisms, marine snow, microscale turbulence, and zooplankton using a bathyphotometer (MOORDEX-3), marine snow still-camera profiler and temperature-gradient microstructure profiler (SCAMP). These detectors will be deployed together in the future to further test the hypothesis that marine snow and bioluminescence collect in certain areas of the water column depending on the turbulence levels. Tentative plans are made to attend several CalCOFI cruises with this equipment in 1998. A cruise is scheduled in East Sound, WA with other ONR-funded thin-layer researchers, including Alldredge and MacIntyre, in June, 1998.

## **RESULTS**

Distributions of bioluminescence intensity, microscale turbulence, marine snow concentrations, and zooplankton abundances were measured in the Santa Barbara Channel over three days in June, 1996. The MOORDEX-3 bathyphotometer was used to collect bioluminescence measurements. Zooplankton samples were collected by SCUBA divers with nets at preselected depths based on turbulence profiles collected by a temperature-gradient microstructure profiler (SCAMP). Preliminary analysis indicates that marine snow and bioluminescence peaks were co-occurring at the thermocline at two out of three stations examined. Zooplankton maxima were not associated with marine snow peaks, but eggs were found to be 4-60x more concentrated in the thermocline than at sampling stations above this region. The rate of dissipation of turbulent kinetic energy was below detection at the peak of bioluminescent intensity. This bioluminescent peak was located immediately below the surface wind-mixed layer, which penetrated to a depth of 7 m. Almost no bioluminescence was recorded in the surface mixed-layer where energy dissipation was highest.

## **IMPACT**

Patchiness is a common distribution pattern for pelagic plankton. Therefore, the oceanic pelagic zones should be increasingly viewed not as a homogeneous ecosystem, but as having important "microscale" structure. This patchiness requires observing plankton, the location of their food sources, and the physical forces and sensory attractions that shape their distributions with finer resolution than previous observations. If zooplankton are found to be attracted to thin layers, then the presence of organisms in regular occurrence at these layers could affect SONAR measurements if organisms with swim bladders or other sound-scattering structures are present in great numbers in these layers.

## **TRANSITIONS**

A small prototype bathyphotometer under development in the Case laboratory will be tested and used for profiling of bioluminescence to test if there is a correlation of bioluminescence with phytoplankton or marine snow thin layers. Information gained regarding biological fine structure of coastal waters can be anticipated to have value in Naval operations involving optical and acoustic measurements.

## **RELATED PROJECTS**

Portions of this research will be done in collaboration with ONR P.I.s Tim Cowles, Russ Desiderio, and Ronald Zaneveld of Oregon State University, Percy Donaghay and Jan Rhines of the University of Rhode Island, and Van Holliday of Tracor Applied Sciences. This group plans to continue investigation of the persistence of thin layers and the mechanisms which form them in East Sound, Washington as part of the ONR sponsored Thin Layers program. Ms. Herren will also present preliminary results at a special session on bioluminescence at the AGU/ASLO Ocean Sciences meeting in February, 1998.