



Pelagic-Benthic Coupling

Abyssal Time-Series Studies at Station M



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The most recent and extensive study in the lab was conducted over a period of 16 years from 1989 to 2004 at "Station M" (34deg 50'N, 123deg 00'W; 4,100 m depth) 220 km west of the central California coast. Another recent study examined the benthic community dynamics at the Hawaii Ocean Time-series station ALOHA between Dec 1997 and Jan 1999.

The Sta. M study represents the most detailed investigation of any abyssal area in the world ocean. Over this time period, we monitored continuously the flux of sinking particulate matter through the benthic boundary layer (bottom 600 m of the water column and sea floor) and employed time-lapse photography to record dynamic benthic processes. We and our colleagues have made seasonal measurements of particulate, suspended, and dissolved organic and inorganic fractions through the water column and in the sediments as an estimate of potential food supply to the benthos. We have also monitored sediment community oxygen consumption as an estimate of food consumption by the benthic community.



Camera Sled



Sea cucumber (*Scotoplanes globosa*)

The sea floor at Sta. M is characterized by silty-clay sediments with little topographic relief (<100 m over 1600 square km). Surface waters of the California Current overlying this site have well-developed spring plumes of chlorophyll that persist into summer and exhibit interannual variability. This temporal signal in surface production is observed throughout the water column and into the sediments.

Measurements at Station M were made with a variety of instruments. Sinking particulate matter (mostly dead phytoplankton and detritus) was measured with sediment traps at 50 and 600 meters above bottom. Current flow measurements were made using current meters at 2, 50, and 600 meters above bottom. The activities of mobile sea floor-dwelling animals (e.g. brittle stars, sea cucumbers, sea urchins) and the periodic occurrence of detrital aggregates (food for the animals) on the sea floor were observed using a time-lapse camera tripod. Photographic transects of the study site were taken using a sled equipped with a camera that was towed behind a research ship. Oxygen consumption (a

measure of biological activity) of the organisms living in the sediment was measured using a Free Vehicle Grab Respirometer (FVGR) with grabs that retrieve the sediments for faunal examination and chemical analyses. Core samples of the sea floor were also collected using the submersible Alvin with specially designed core respirometers. Oxygen consumption measurements were also taken using the [ROVER](#), an autonomous underwater vehicle.

The most significant findings of these studies at Sta. M are listed below:

1. Sinking particulate organic matter fluxes through the benthic boundary layer showed seasonal peaks in summer and fall with considerable interannual variability.
2. Sinking particulate organic matter fluxes at 600 m above bottom were correlated with the Bakun upwelling index, revealing a time lag of approximately 50 days between these climatically mediated events at the surface and the fluxes at 3500 m depth.
3. Phytodetritus reaching the sea floor and collected with Alvin in 1994 varied temporally in composition from a dominance of chain-forming diatoms in August to phaeodarians in September.
4. This phytodetritus formed a "carpet" over the sea floor from July through November 1994 in contrast to previous years when the detrital cover was less pronounced.
5. There was a lack of consistent correlation between the distribution and abundance of epibenthic megafauna (i.e. echinoderms) and the presence of detrital material on the sea floor.
6. Concentrations of total and organic carbon, total nitrogen, chlorophyll and phaeopigments in detrital aggregates collected on the sea floor were similar to those concentrations in the sinking particulate matter collected 50 m above bottom in sediment traps but higher than those in the surface sediments.
7. Annual oxygen consumption associated with detrital aggregates represented a minor contribution (0.34%) to the annual sediment community oxygen consumption estimated at Sta. M in 1994-1995.
8. A 7-year study of food supply [sinking particulate organic carbon (POC)] and food demand [sediment community oxygen consumption (SCOC)] at Sta. M revealed a long-term deficit in food supply. The POC:SCOC ratio decreased by 52 to 59% between 1989 and 1996. A possible explanation for this trend is the documented sea surface temperature increase and concomitant plankton biomass decrease in the eastern North Pacific, resulting in an apparent reduction in POC export from surface waters to the deep ocean.
9. New results have linked climate fluctuation, food supply, and shifts community structure at an abyssal time-series station in the NE Pacific (Ruhl H. A., & Smith K. L., *Science*, **305**: 513 (2004)).

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