Nutrient Stress: Macroalgal Primary Production and Food Web Structure

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Over the last few decades algal proliferation as a result of coastal nutrient-loading has affected coral reefs worldwide. At nearly 200 km off the Texas coast, the Flower Garden Banks National Marine Sanctuary is a unique coral community seemingly removed from the nutrient enrichment typical of coastal environments.

However, the oceanic reef subsists down-plume of the Mississippi River, which discharges large amounts of fertilizer and human wastewater into the Gulf of Mexico. Coral reef communities are especially susceptible to nutrient excess since these organisms are highly adapted to nutrient deficient, oligotrophic conditions.

Understanding community response to increased nitrogen inputs at the Flower Gardens is a priority since (1) baseline data is needed to understand possible nutrient stresses in the future, and (2) a reef removed from coastal influences is useful for comparisons with other Caribbean reefs systems.

To determine whether the Flower Gardens is susceptible to nutrient stress we have begun investigations into the role of light and nutrients in carbon production by photosynthetic organisms. We have also collected preliminary data describing the basic food web structure of the coral reef community. Our objectives include identifying dominant and potentially nuisance macroalgal species, comparing photosynthetic production of several dominant algae, and determining general trophic structure (who eats who?) of the reef community.

The dominant benthic producers in the community are symbiotic corals, macroalgae, and benthic cyanobacteria. Benthic cyanobacteria form a purplish-red mat, are slippery to the touch, and sporadically attach to coral polyps. From several field experiments, we have learned that macroalgal carbon production exceeds that of cyanobacteria and that herbivores do not appear to directly consume cyanobacteria.

Nevertheless, cyanobacterial mats play a crucial role in the nutrient dynamics of the system. Nitrogen isotopic analysis suggests that benthic cyanobacteria likely fix nitrogen (process of converting atmospheric nitrogen into ammonium, a plant fertilizer), which ultimately leaches into the water column and is assimilated by eukaryotic macroalgae. As there is evidently ample light for photosynthesis, even at 20 m depth, macroalgal photosynthesis is therefore controlled by nutrient availability. Further, there are indications that nitrogen limits the system to a greater degree than phosphorus.

As the Flower Gardens community seems to be nutrient limited, the stability of the ecosystem could be linked to nutrient inputs from the Mississippi River. However, both low ambient nutrient concentrations and nitrogen isotopic composition of primary producers at the Flower Gardens suggest new nutrients are produced by benthic cyanobacterial mats rather than transported onto the reef by advection from coastal zones.

In the summer of 1999 we hope to continue research into the extent of Mississippi River nutrient enrichment into Gulf of Mexico ecosystems by sampling algae at open ocean banks throughout the river plume area. At the Flower Garden Banks, we look forward to our continued collaboration with Dr. Quenton Dokken (Texas A&M University - Corpus Christi) and to investigating photosynthesis and production of deep-water algae using the submersible Deep Worker 2000.

Editor's Note: This article was written for the Sustainable Seas Expeditions 1999 field season. Investigations of the macroalgal communities and nutrient stress continue.