Spatial variability and covariability of chlorophyll
and zooplankton on the Great Barrier Reef.

Thesis submitted by
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ABSTRACT

The work described in this thesis has two objectives: to quantify the spatial variability of phytoplankton biomass, zooplankton biomass and zooplankton community structure over spatial scales from 10-1000 km in relation to the large-scale structure of the Great Barrier Reef, and to quantify the covariability of zooplankton biomass and community structure with phytoplankton biomass in Great Barrier Reef shelf waters.

Near-surface chlorophyll concentrations and zooplankton assemblages were concurrently surveyed between 14° and 22.5°S on the Great Barrier Reef, Queensland, between Jan 1987 and Feb 1989 using underway continuous sampling techniques. Chlorophyll concentrations, ranging from 0.08 to 1.57 ug l^{-1}, were highest near the coast and lowest in the Coral Sea, with little difference between the inner and outer parts of the shelf. Mean concentrations of chlorophyll increased with latitude, from 0.31 ug l^{-1} between 9.5°-16.5°S to 0.76 ug l^{-1} between 20°-21°S. Chlorophyll concentrations on the outer shelf were higher in the wet season than in the dry season, a change attributed to seasonal differences in nutrient supply.

The spatial variability of chlorophyll was characterised using two techniques; the chlorophyll coefficient of variation which characterised the magnitude of chlorophyll spatial variability in discrete intervals, and time series analysis which characterised the distribution of variability across a continuum of spatial scales. The chlorophyll coefficient of variation characterised the extent of spatial variability over the length scales 15 m to 8000 m. Close to individual reefs small but sharp changes in chlorophyll concentration were commonly observed. The localized reef-associated increases in chlorophyll spatial variability appear to result from the movement of chlorophyll enriched water off reefs. The high chlorophyll variability close to the coast was attributed to a steepening of the onshore-offshore chlorophyll gradient in shallow waters.

Time series analysis techniques characterized the distribution of spatial variability of chlorophyll over a continuous range of spatial scales; from 0.5-10 km. The distribution of chlorophyll and temperature spatial variability over these scales did not differ regionally. This large-scale uniformity of the distribution of chlorophyll spatial variability stands in contrast to the marked regional differences in reef structure and density, features thought to affect water movement and thence chlorophyll spatial variability.

Zooplankton samples, integrated over 8 km subtransects, were collected concurrently with chlorophyll measurements. Both zooplankton biomass and overall abundance decreased offshore, but neither changed significantly with latitude or with season. Copepod abundances were positively correlated with chlorophyll concentration at both small (8, 16 and 32 km) and regional (100-200 km) scales. Zooplankton biomass exhibited the same cross-shelf trend as chlorophyll concentration, but was not well correlated with chlorophyll concentration at small or regional scales.

Individual taxa differed in their cross-shelf patterns of abundance, but at the sampling scale (8 km), none were significantly correlated with chlorophyll or its spatial variability. At the regional scale (100-200 km) there was good correspondence between mean abundances of most herbivorous zooplankton and the mean chlorophyll concentration.

Zooplankton taxa fell into three distinct cross-shelf communities; inshore, outer shelf, and shelf edge. These communities tended to be restricted to particular geographic regions, the Great Barrier Reef lagoon, the reef matrix and the East Australian Current respectively, and were latitudinally coherent. The inshore community was dominated by small herbivorous copepods, the outer shelf community by omnivorous copepods and the shelf edge community by small carnivorous copepods. The abundance of the inshore community, largely small herbivorous copepods, paralleled the cross-shelf gradient of surface chlorophyll concentration, suggesting a causal link. This inference was reinforced by the atypical situation in the Pompey zone. There, the highest chlorophyll concentrations were found on the outer shelf, and were matched by high densities of the normally inshore herbivorous zooplankton. The factors controlling the other two communities were not clear.

Local relationships between chlorophyll concentration and zooplankton were investigated more directly using observations made after a cyclonic disturbance of inshore waters. Chlorophyll concentrations changed little during the two week post-cyclone sampling period, and were similar to concentrations in inshore samples taken at other times. Conversely zooplankton standing crop and abundance increased significantly within two weeks post-cyclone, although no change in community structure occurred. The zooplankton changes suggested that zooplankton abundance was food limited in inshore waters.

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DECLARATION

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