Interactions amongst invertebrates, epiphytes, and seagrasses in tropical intertidal meadows

Thesis submitted by
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Contributions of others

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Matthew Knott and Basil Byrne sorted seagrass core samples from the plots at Picnic Bay and Cockle Bay.

Joe Holtum provided the spectrophotometer.

Identification of anemones was by Daphne Fautin of the University of Kansas. The identifications of *Alaba virgata* and *Electroma* were confirmed by Winston Ponder of the Australian Museum. The tiny jellyfish that walked along my seagrass leaves were identified as *Staurocladia* by Lisa Gershwin of James Cook University.

Abstract

Interactions amongst invertebrates, epiphytes, and seagrasses were studied in intertidal meadows near Townsville, Australia. Data were collected to test the assumptions of the prevailing model of seagrass-epiphyte-grazer interactions. That model assumes that epiphytes have the potential to limit seagrass standing crop, but that invertebrate grazers limit epiphytes, and therefore indirectly benefit the seagrass. Furthermore, it is generally assumed that the community of epifaunal invertebrates is largely composed of epiphyte grazers, especially small gastropods and peracardian crustaceans, and that direct consumption of the seagrass is of minor importance.

One intertidal plot, 100 m^2 was established in each of three meadows; Shelly Beach, Cockle Bay and Picnic Bay. Samples of seagrass, invertebrates and epiphytic materials were taken at one to two month intervals over two years. Leaf samples were taken to estimate epifaunal invertebrate densities and epiphytic loads from the same leaves. The percent coverage of the leaves by epiphytic material was estimated, and the material was scraped from the leaves to estimate its ash-free dry weight (AFDW). The seagrass leaf area index (LAI), below ground dry weight (BGDW), and shoot or leaf density in each plot were estimated from core samples.

In June 2002, a sudden migration of the sea hare *Bursatella leachii* into the plot established at Shelly Beach was associated with a rapid reduction in epiphytic loads on *Halophila ovalis*, but not *Halodule uninervis*. Unexpectedly, the LAI of *H. ovalis* declined by two-thirds, while that of *H. uninervis* remained unchanged. It was hypothesised that the reduction in *H. ovalis* LAI was due to the sudden exposure of the leaves to high levels of irradiance, resulting in photodamage and photoinhibition. To test that hypothesis, a shading experiment was performed. Plots, 0.5 m^2, were shaded with 70% shade cloth over 29 days, to adapt the seagrass to low light conditions, and were then exposed to ambient light. Chlorophyll concentrations increased significantly under shade, then fell to control levels in 4-10 days of exposure in both *H. ovalis* and *H. uninervis*. However, the former species did not show any significant increase in chlorophyll per area of substrate under shading, but appeared to trade-off increased chlorophyll production with a decrease in LAI and leaf density. There were no

significant differences directly related to the treatments other than the changes in chlorophyll concentrations and an increase in leaf length due to shading of *H. uninervis*.

During two years of sampling, occasions of high epiphytic loads, AFDW >2.0 mg/cm^2, on *Halodule uninervis* were followed by declines in shoot densities, BGDW, and LAI in the plots at Shelly Beach and Cockle Bay. However, within plots there were positive correlations between epiphytic cover and LAI. Those relationships suggested that *H. uninervis* benefited from epiphytic cover, up to a threshold, possibly because of protective effects against high irradiance. There may also have been reciprocal effects, such that increases in the seagrass canopy promoted development of epiphytic cover, which may have acted as a density-dependent limiter of *H. uninervis* production.

The litiopid gastropod *Alaba virgata* was the commonest epifaunal epiphyte-grazer, especially at Shelly Beach. Its densities were negatively correlated with epiphytic cover. The positive relationship between epiphytic cover and *H. uninervis* LAI suggested that *A. virgata* was likely to have an indirect negative impact on the seagrass, contrary to the prevailing model of seagrass-epiphyte-grazer interactions. Likewise, the commonest amphipod, *Ericthonius*, had densities that were negatively correlated with epiphytic cover at Cockle Bay and Picnic Bay, but appeared most likely to have a negative impact on the seagrass.

The epifaunal communities were numerically dominated by suspension feeders; including the amphipods *Ericthonius* and *Podocerus*; the bivalve *Electroma*, and Anemones. Total epifaunal abundance was negatively correlated with seagrass LAI in each plot. Those relationships likely reflected a negative impact of the seagrass canopy on water flow, and thus food resources for suspension feeders. Therefore, epifaunal abundance and epiphytic cover had inverse relationships to seagrass LAI. A path analysis showed that a bottom-up model with separate effects from seagrass LAI to total epifaunal abundance and to epiphytic cover fit the data well. That analysis used data from all plots in a multigroup design, and suggested that the same processes were occurring in each of the plots despite other major differences among them.

There was conspicuous evidence of damage by invertebrate herbivores to the leaves of *Halophila ovalis*. The areas damaged were measured using image analysis techniques on leaf samples. Those animals found to be consuming seagrass included; a nerite gastropod, *Smaragdia souverbiana*; an undescribed species of sacoglossa; an amphithoid amphipod, *Cymadusa* sp.; and the sphaeromatid isopods *Cymodoce* spp. *H. ovalis* declined at Shelly Beach during the course of the study, and *Halodule uninervis* became more abundant, in a pattern suggesting successional change. However, changes in *H. ovalis* LAI and BGDW were correlated with measures of damage that were most likely caused by crustacean feeding.

The prevailing model of seagrass-epiphyte-grazer interactions does not provide a suitable description of those interactions in the intertidal meadows studied near Townsville. There was little evidence that epiphyte grazers would benefit the seagrass by removing epiphytic cover. On the contrary, there was evidence of negative impacts by exposing the leaves to high levels of irradiance, which are commonly experienced in tropical intertidal habitats. Suspension feeders, not epiphyte grazers, dominated the epifaunal community, which therefore had a very different relationship to the seagrass and its epiphytic cover from that anticipated in the current literature. Also unanticipated, consumption of seagrass appeared to play an important role in successional development. From this study, new models are proposed that will hopefully provide a better understanding from which to test and analyse interactions amongst invertebrates, epiphytes and seagrasses in tropical intertidal meadows.

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