

How to Read a Scholarly Science and Technology Article

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McGill Science Undergraduate Research Journal

Density-dependent succession in Caribbean seagrass communities

Sandra Binning*, Charalampos Mavromatis,
Department of Biology, McGill University, 1205 Avenue du Docteur Per

Abstract

It is important to understand the patterns of succession and competition in seagrass beds as a way of explaining recovery processes after disturbances. This project studies macroalgae-seagrass succession dynamics in the Caribbean, and tests the importance of interspecific density-dependence (competition) in predicting the successional sequence of species in a wave-disturbed ecosystem. Competition and gap disturbances seem to be the dominant factors influencing species coexistence in offshore regions whereas habitat partitioning driven by differences in depth, disturbance and wave action creates distinct zones of macroalgae and seagrass inshore. In general, density dependent processes across our study site were influenced by major physical gradients. This study has important consequences for predicting dramatic shifts in large-scale seagrass ecosystems, which act as ecological engineers and provide many ecosystem services.

First, read the *Abstract*.

It will summarize the entire article and give you a good idea if it is of interest to you. The *Title* should match what the *Abstract* and article mean to discuss.

Caribbean seagrass beds are found to alternate between disturbed states which lack vegetation, referred to as gaps, and a variety of successional states which may include both seagrass or macroalgal vegetation (Bell et al. 1999). Constant wave action keeps the area under periodic disturbance and promotes the migration of gaps throughout the beds (Kirkman 1985). The newly exposed sediments are left to be colonized by one of the various marine species, including the grasses *Thalassia testudinum* and *Syringodium filiforme*, as well as the rhizophytic algae *Avrainvillea longicaulis* (Patriquin 1975).

One well-studied seagrass ecosystem at Bath, Barbados was initially described as being dominated by large stands of *Thalassia*, which was believed to be the competitively dominant species in the seagrass community successional hierarchy (Den Hartog 1971; Patriquin 1975). However, recent studies by Tewfik et al. (2007) at the Bath seagrass beds

Discussion

Species interactions in seagrass ecosystems

Studies in community ecology often focus on the fundamental questions of what processes enable species to persist and what processes contribute to extinction. Here, we present a study on a dynamic marine ecosystem currently experiencing global declines for various reasons, many of which are unknown (Duarte 2002). Preliminary observations led us to believe that *Thalassia* was experiencing negative density-dependent effects of competition from the macroalgae species *Avrainvillea*, which has recently been established as a late colonizer in this system and is slowly replacing the seagrass at the level of our study site (Mavromatis et al. 2006). However, the effects of direct biotic interactions between these species were not consistent throughout the study site.

Although *Thalassia* grows better without macroalgae in the inshore transition area, removing the algae experimentally does not significantly increase the growth of seagrass. As a result, biotic processes cannot fully explain the patterns of species assemblage observed in this region; physical parameters must also contribute to the dynamics. The inshore transition zone appears to experience a species sorting effect such that habitat without algae maximizes the growth of *Thalassia*. Although competition may still be a factor influencing the presence of seagrass, habitat segregation between the species may better explain the distinct zonation observed between the seagrass and macroalgae zones since removal of algae marginally increases *Thalassia* growth.

The dynamics change in the offshore transition area. None of the three treatments showed significant differences, suggesting that habitat has less influence on species presence and persistence than biotic interactions such as competition. These results suggest that competitive interactions rather than habitat segregation may enable the persistence of seagrass and

After reading the *Abstract*, read the *Discussion* Section. It is near the end of the article.

It recaps the entire study. Now you know what the authors meant to prove and how the experiment ended.

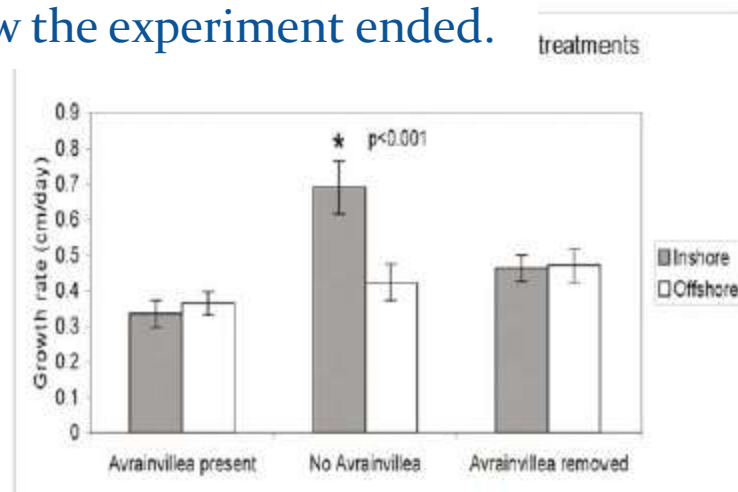


Figure 4. Treatment comparisons between all transects and treatments. Inshore transition zone areas with *Avrainvillea* naturally absent are significantly different (a) from all other means (b).

transects and zones, with the macroalgae and mixed zones experiencing higher levels of water current than the inshore seagrass zone. Since *Avrainvillea longicaulis* is thought to prefer areas of relatively low current and wave energy (Little & Little, 1999), this physical gradient may be a driving factor in

associated with gradients of physical parameters including depth, erosion, and explain the distinct zonation in our transects. A physical parameter that is known to suffer from erosion (Little, 1984) whereas in open sand areas that are more stable (Little & Little, 1999) due to the extensive cover of seagrass in the shallower part of the system. The difference between growth rates in these habitats.

areas since it is able to colonize newly opened space relatively faster than macroalgae. Differences in disturbance regimes between the macroalgal and seagrass zones may therefore contribute to the habitat segregation observed. Disturbances may play a different role in the mixed zone. Gaps may contribute to the coexistence of seagrass and algae by promoting the rapid turnover of species and preventing the competitive exclusion of *Thalassia*. In essence, biotic and abiotic processes work in conjunction with one another to enable the persistence of a diverse marine community.

Conclusion

Seagrass beds represent ecologically significant ecosystems that provide a number of vital services to marine coastal communities (Duarte 2002). Unfortunately, many seagrass beds are undergoing rapid changes in their structure and ability to persist as intact systems as a result of both direct and indirect anthropogenic disturbances (Duarte 2002). Even in the thirty years since Patriquin's studies (1972; 1975) at Bath, Barbados, remarkable changes in species assemblages, successional sequences and physical gradients have occurred that are causing a once extensive bed to be overrun with macroalgae. From this study, we were able to elucidate the relative contributions of abiotic and biotic processes in relation to the physical environment. Competition and disturbances seem to be the dominant factors influencing species coexistence in the mixed zone, whereas habitat partitioning driven by differences in depth, disturbance and wave action creates distinct zones of macroalgae and seagrass in inshore regions. Future research should focus on establishing the role of seagrass acting as ecological engineers, the scaling of seagrass recovery from disturbances, and the resistance of beds to physical phenomena such as sedimentation and eutrophication that were not tested during our experimen-

geneity, hydrodynamics, and benthic community structure: a scale-dependent cascade. *Marine Ecology-Progress Series* 171:59-70.

Then read the *Conclusion*. By reading the *Abstract*, *Discussion*, and *Conclusion* in that order, you will have a better understanding of the study itself. It makes the overall article simpler to grasp if you are new to reading scholarly articles.

- Barbados and Carriacou, West Indies, and its ecological and geological implications. Aquatic Botany* 1:163-189.
12. Roxburgh, S. H., K. Shea, and J. B. Wilson. 2004. The intermediate disturbance hypothesis: Patch dynamics and mechanisms of species coexistence. *Ecology* 85:359-371.
 13. Sousa, W. P. 1979. *Disturbance in marine intertidal boulder fields: The non-equilibrium maintenance of species-diversity. Ecology* 60:1225-1239.
 14. —. 1984. *The role of disturbance in natural communities. Annual Review of Ecology and Systematics* 15:353-391.
 15. Tewfik, A., E. Guichard, and K. S. McCann. 2007. *Acute and chronic physical disturbance facilitates landscape zonation and species composition within a tropical macrophyte bed. Marine Ecology-Progress Series, In Press.*
 16. Tilman, D. 1994. *Competition and biodiversity in spatially structured habitats. Ecology* 75:2-16.
 17. Watt, A. S. 1947. *Pattern and process in the plant community. Journal of Ecology* 35:1-22.

dependent processes across our study site were influenced by major physical gradients. This study has important consequences for predicting dramatic shifts in large-scale seagrass ecosystems, which act as ecological engineers and provide many ecosystem services.

Keywords

Succession: *Changes observed in an ecological community following a perturbation that opens up a relatively large space;* **Disturbance:** *Uncommon, irregular events that cause abrupt structural changes in natural communities and create opportunities for new individuals to become established;* **Interspecific density dependence:** *Interactions between individuals of different species that affect population demographic processes;* **Seagrass beds:** *Marine coastal ecosystems formed by various species of angiosperms. Seagrass beds provide an important habitat for an abundance of fish and invertebrate species, as well as many ecosystem services such as water filtration, carbon sequestration and erosion prevention;* **Gaps:** *Vegetation-free depressions within seagrass beds characteristic of regions experiencing moderate to severe wave action. They are typically crescent-shaped and migrate seaward.*

Introduction

Ecologists strive to explain the processes responsible for structuring natural communities in order to better predict how disturbances may alter these groupings of species, and how communities are reassembled following a perturbation. Dynamic disturbance regimes have long been recognized as important mechanisms regulating natural ecosystems (Sousa 1984) and promoting species diversity, especially by allowing subordinate competitors to colonize recently disturbed areas (Paine and Levin 1981). Although these theories have been used to explain the dynamics of seagrass ecosystems (Bell et al. 1999), recent observations suggest that more complicated

was initially described as being dominated by large stands of *Thalassia*, which was believed to be the competitively

Below the Abstract and Title is the Introduction page.

This is where the authors write about some of the current ideas in their field.

Here, the authors introduce their own theories.

Go here after reading the Conclusion Section.

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remains unknown whether habitat effects or density-dependence plays a greater role in maintaining the species assemblages observed. We can address this question by studying the dynamics of species interactions and physical parameters at the boundaries of three described vegetative zones.

The general goal of our study is to test the importance of interspecific density-dependent processes (competition) in explaining successional sequences in wave-disturbed seagrass ecosystems. We will more precisely test the hypotheses that (1) both habitat differences and direct species interactions produce the patterns of species assemblage observed and (2)

Methods and Materials

Study site

This study was based on observations and experiments on the seagrass community in Bath, Barbados (N 13° 11', W 59° 28') during May and June 2004. The study site covered an area of the seagrass bed 100m wide by 120m long. Three distinct vegetative zones were described in Mavromatis et al. (2006) and named based on the dominant cover of the region. The seagrass zone exists 20 to 40m offshore, and is followed by the macroalgal zone. The macroalgal zone extends from approximately 40 to 90m offshore, making it the largest continuous area of all zones. Finally, the mixed zone extends to 120m offshore (Figure 1).

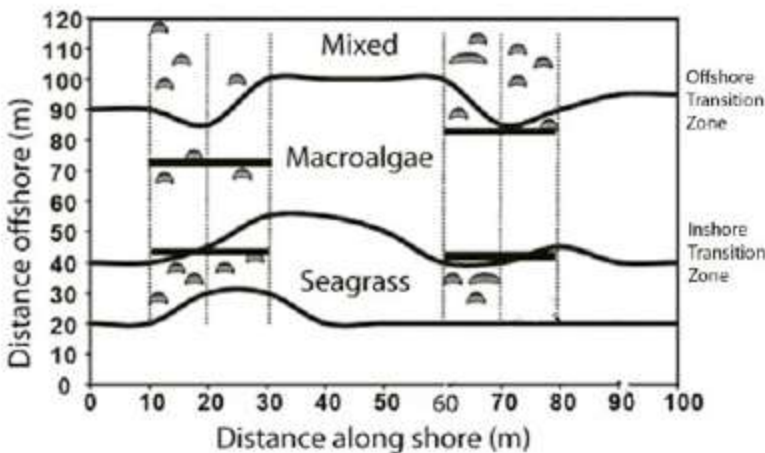


Figure 1. Diagram of the study area depicting 3 vegetation zones, 4 horizontal growth transects, 6 vertical physical gradient transects, and gaps (denoted by grey crescents). Figure modified from Mavromatis et al. 2006.

In order to address our hypothesis that both biotic and abiotic processes affect species assemblages in seagrass beds, we measured a series of physical characteristics of the study site including sediment type, water depth, erosion levels, and disturbance frequency (gap number) to see whether there were strong differences in these parameters between the three vegetation zones that might account for the patterns observed.

Then continue on and read the *Methods and Materials* section. This section explains their testing methods to prove or disprove their new theory.

For example, the *Methods and Materials* part might include 20 student *Participants* who listened to loud music *Devices* while *Proceeding* to answer 20 math questions to *Determine* if noisy music really impaired test taking. (In other words, *Methods and Materials* discuss who or what was tested with a device to discover what would happen in the end).

growth transect were analyzed for differences between inshore and offshore transition areas (2 transects per area, $n=18$). A one-way ANOVA indicated no significant difference in depth at the level of our transects ($p>0.05$). However, water depth was variable across the study site (Figure 3b).

Twenty-three gaps (vegetation-free depressions measuring ≥ 3 m wide, ≥ 2 m long and ≥ 1 m deep) were mapped across the study site (Figure 1): 9 were found in the seagrass zone, 5 in the macroalgae zone and 8 in the mixed zone. Gaps in the

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Following the *Methods and Materials* section, the *Results* of the experiment are discussed.

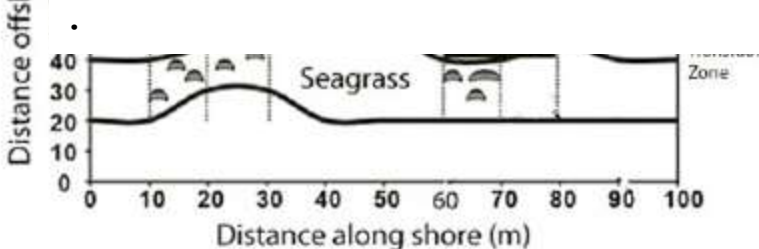


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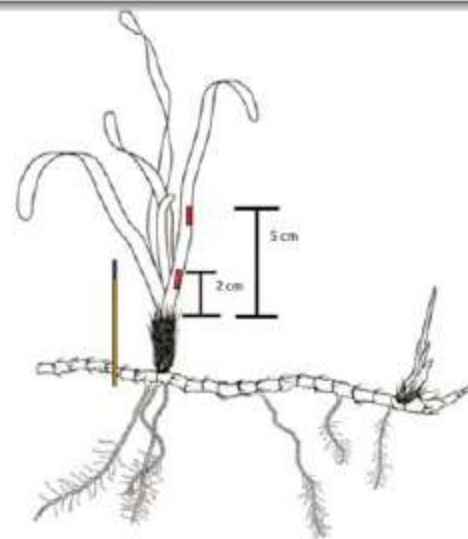


Figure 2. Diagram of blade identification and growth measurement procedure. Coloured toothpicks were inserted into the sediment and used to identify *Thalassia* blades. Leaves were stapled at 2 cm and 5 cm above the rhizome base, and after 3-6 days, measurements were taken from rhizome base to each staple to obtain measurements of blade growth and elongation.

Results

Abiotic patterns

Water movement intensity (erosion) was measured overnight using plaster of Paris cylinders (Guichard and Bourget 1998). A one-way ANOVA found that the offshore transition area experiences significantly higher levels of wave action and disturbance than the inshore region ($n=18$, $p<0.0003$) (Figure 3a).

Nine measures of water depth associated with each growth transect were analyzed for differences between inshore and offshore transition areas (2 transects per area, $n=18$). A one-way ANOVA indicated no significant difference in depth at the level of our transects ($p>0.05$). However, water depth was variable across the study site (Figure 3b).

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The *Results* section may have a lot of math and scholarly words, If you are not good at either, you can still understand the article because the text explains the math as does the *Discussion*, and *Conclusion*, sections you already read.

But you might want to re-read the article in order now that you better understand it.

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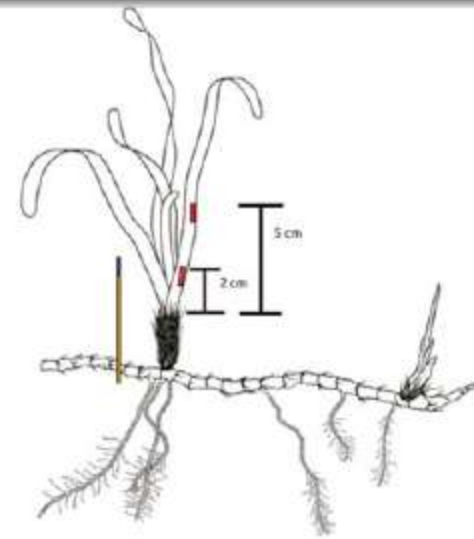


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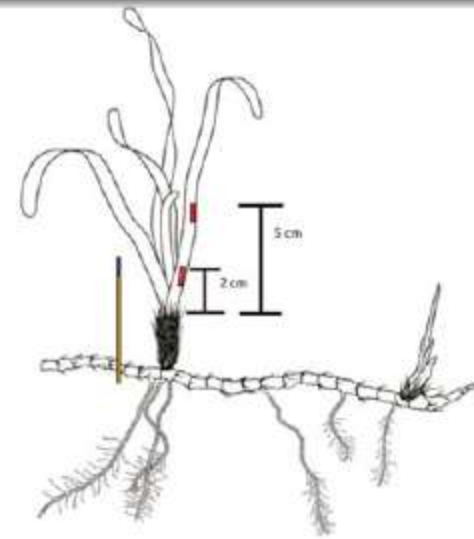
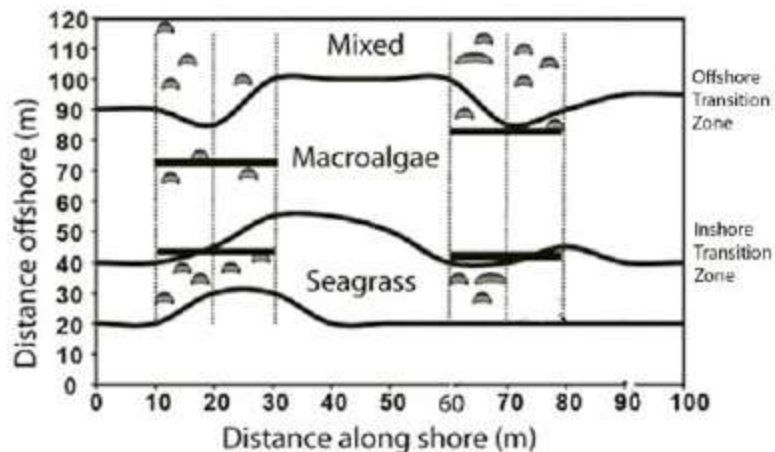


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Some sections may have a mathematical formula or statistical analysis you may not understand about, for example, the hydration of Asian elephants in a specific location. So the author will mention that based on the numerical analysis described, the amount of water these Asian elephants drink in early spring is 30 gallons a day, or 12% higher than normal and 15% higher than other elephants in other regions in that same month. This finding will be explained along with the math.

Remember:

- The *Abstract* and the *Title* best indicate the type of information found in the article.
- Read the *Discussion, Conclusion* and then the *Introduction sections* before reading the *Methods and Material* section (middle) or the *Results* part of the article. That is the more complex section. By first reading around it, you will not feel lost in the more intricate sections because you know how the experiment begins and ends.
- If you are not good in math, the formulae will be explained in a non-math way.

Scientific and Technical scholarly articles usually follow the same approach, even if you have to read it out of numerical order.

Once you understand it follows a certain outline, it becomes easier to read. This is what each part does, learning this makes it all the easier:

- *Abstract and Title:* The *Abstract* should match the *Title*. Then you will know what is being discussed.
- *Introduction:* ‘This is what people in my profession think about a subject, but here is my view.’
- *Methods and Material:* ‘To prove it, I have gathered participants or material and some testing equipment.’
- *Results:* ‘This is the raw data I collected from this experiment.’
- *Discussion:* ‘This is a complete summary of the experiment.’
- *Conclusion:* ‘ This is where I was right and where I was wrong and what might need to be done by me or others to make it possibly work. ‘

- ***How it looks***
- *Title and Abstract*
- *Introduction*
- *Methods and Material*
- *Results*
- *Discussion*
- *Conclusion*

- ***How it should be read***
- *Title and Abstract*
- *Discussion*
- *Conclusion*
- *Introduction*
- *Methods and Material*
- *Results*
- *Re-read properly*

The *McGill Science Undergraduate Research Journal* article used for this tutorial is accessible from the *Directory of Open Access Journals*
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- Binning, SA, Mavromatis, C and Guichard, F. 2007.
Density-dependent succession in Caribbean seagrass communities. *MSURJ* 2(1): 28-31.
http://msurj.mcgill.ca/vol2_1.php

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