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and

Garriet W. Smith

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Shawn W. Polson

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Biology Faculty
Camden County College
New Jersey

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A LONG-TERM STUDY OF BIOMASS FLUCTUATIONS WITHIN THE SEAGRASS COMMUNITIES SURROUNDING SAN SALVADOR ISLAND, BAHAMAS

Shawn W. Polson
Department of Microbiology and Molecular Medicine
Clemson University
Clemson, SC 29634

Garriet W. Smith
Department of Biology
University of South Carolina
Aiken, SC 29801

ABSTRACT

Seagrass beds are widely recognized as important components of coastal ecosystems. Three species: *Thalassia testudinum, Syringodium filiforme,* and *Halodule wrightii* populate the seagrass beds of San Salvador Island. All species show considerably lower growth rates than those adjacent to more nutrient rich areas of the Caribbean. Previous research has linked this to low levels of available phosphorus in the carbonate sediments surrounding the island. Core samples were taken from seagrass beds around the island for over ten years. Samples were collected twice a year, summer and winter, at the two primary sites, Graham's Harbor and French Bay. These samples were separated by species and were further subdivided into above-sediment and below-sediment biomass. Samples were then dried and weighed. Results have suggested seasonal cycling in *T.* testudinum biomass. Correlations between high phosphorus content and increased biomass were also evident.

INTRODUCTION

Seagrass meadows perform many functions in coastal areas. The root-rhizome system of seagrasses is the location of many nutrient interactions between microbes, the plants, and the surrounding sediments (Wong and Smith, 1994; Wehner and Smith, 1994; Morgan and Smith, 1992; Smith, *et al* 1984; Smith and Hayasaka, 1982). The chemical composition of the sediment is often altered by these interactions (Kaplan *et al,* 1990). These root-rhizome systems are also instrumental in preventing the removal of sediments by tidal forces (Fonseca, 1989; Fonseca and Fisher, 1986). Seagrasses are also important as both primary and secondary producers in coastal areas (Thayer *et al,* 1984; Zieman, 1982).

There are three species of seagrass indigenous to San Salvador Island, *Syringodium filiforme, Thalassia testudinum,* and *Halodule wrightii. S. filiforme* and *H. wrightii* are members of the Manatee Grass family, Cynedoceaceae. *T. testudinum* is a member of the Turtle Grass family Hydrocharitaceae. *T. testudinum* tends to be prevalent in established seagrass meadows and is the dominant seagrass species of the Caribbean Basin (Zieman *et al,* 1989)

The waters off of San Salvador Island, Bahamas, tend to be oligotrophic, and the associated carbonate sediments are generally nutrient-poor (Gerace *et al,* 1997). Under these conditions, seagrasses tend to display stunted growth patterns (Zieman *et al,* 1997). The retarded production in San Salvadoran seagrasses are largely due to limited phosphorus availability (Short *et al,* 1985; Short *et al,* 1990).

In this study we will present a five-year extension of the data first reported by Smith *et al* in 1995. This extension will be limited to biomass parameters at the Graham's Harbor and French Bay Sites. Correlations within the data set to environmental variables will then be assessed.

MATERIALS AND METHODS

Site Descriptions

The Graham's Harbor site is located on the leeward side of the island near the far northern tip. This site is additionally sheltered by an expanse of relatively shallow water and a series of geographic barriers including North Point to the east and a series of coral reefs and cays to the north and west. As a result of these factors this is a relatively low-energy site, in respect to tidal, current, and wind activity. The site is located at a depth of two to three meters below mean tide and is about 150m from shore. Samples were collected at this site twice a year (winter and summer) from July 1988 until August 1998, except for the summer of 1995.

The French Bay site is located on the windward, far southern extreme of the island. French Bay has relatively few physical barriers and opens directly onto the North Atlantic Ocean. The sampling site is immediately adjacent to an old government dock and is within 25m of shore. Water depth averages about one meter below mean tide. Sampling at French Bay occurred in July 1988, and during the summer and winter of each year between December 1989 and August 1998, except for the summer of 1995.

Sample Collection

A 20 meter transect with a randomly determined starting and ending point was laid within the boundary of each sampling site during each sampling period. Three core samples ($0.02m^2$ surface area, 20cm depth) were taken within one square meter of ten equidistant points along each transect. Seagrass was then separated from the surrounding sedimentary material and washed in 0.1N HCl to remove epiphytes. Each sample was sorted by species and each species was subdivided into above-sediment biomass (leaves, stems, fruits) and below-sediment biomass (roots and rhizomes). Sorted samples were then dried at 100°C for 48 hours, or until each sample appeared to be completely desiccated. Samples were then weighed on an electronic analytical balance.

RESULTS AND DISCUSSION

At both Graham's Harbor and French Bay *T. testudinum* was consistently the dominant species by biomass (figures 1, 2, 3, & 4). *S. filiforme* accounted for the second most biomass, at both sites. *H. wrightii* was largely absent from French Bay, and was fairly consistently the least abundant species at Graham's Harbor.

The below-sediment biomass was very consistently higher than the above-sediment biomass in all species. The above-sediment biomass also seemed to be more prone to large shifts in biomass from one sampling to the next. This pattern was most apparent at Graham's Harbor (Figure 1). These shifts can likely be attributed to the greater exposure of the above-sediment portions of the plants to currents and herbivory.

The consistent biomass data from Graham's Harbor (figures 1 & 2) would tend to indicate that this community is at a very stable equilibrium. Graham's Harbor may very well be at a climactic stage of development. French Bay, on the other hand, is much different. Larger fluctuations in biomass (figure 3 & 4) are often seen at this site. The absence of *H. wrightii* is a very noticeable difference between French Bay and Graham's Harbor. We feel this absence may be due to the high-energy nature of French Bay. The shallow root system of *H. wrightii* may prevent it from taking hold in the very active waters.

T. testudinum at Graham's Harbor seemed to be more likely to have high biomass during winter months, especially in the below sediment biomass. There was often a high biomass (winter) - low biomass (summer) cycle apparent (figure 2). A possible explanation for this may be the increased solubility of phosphorus in the cooler waters present during the winter months. The increased solubility may allow *T. testudinum* to increase its uptake of phosphorus during those months.

There was another interesting cyclic

feature apparent at French Bay. When *S. filiforme* biomass would decline after peaking, *T. testudinum* biomass would begin to rise (figure 4). Symbiotic bacteria capable of making large

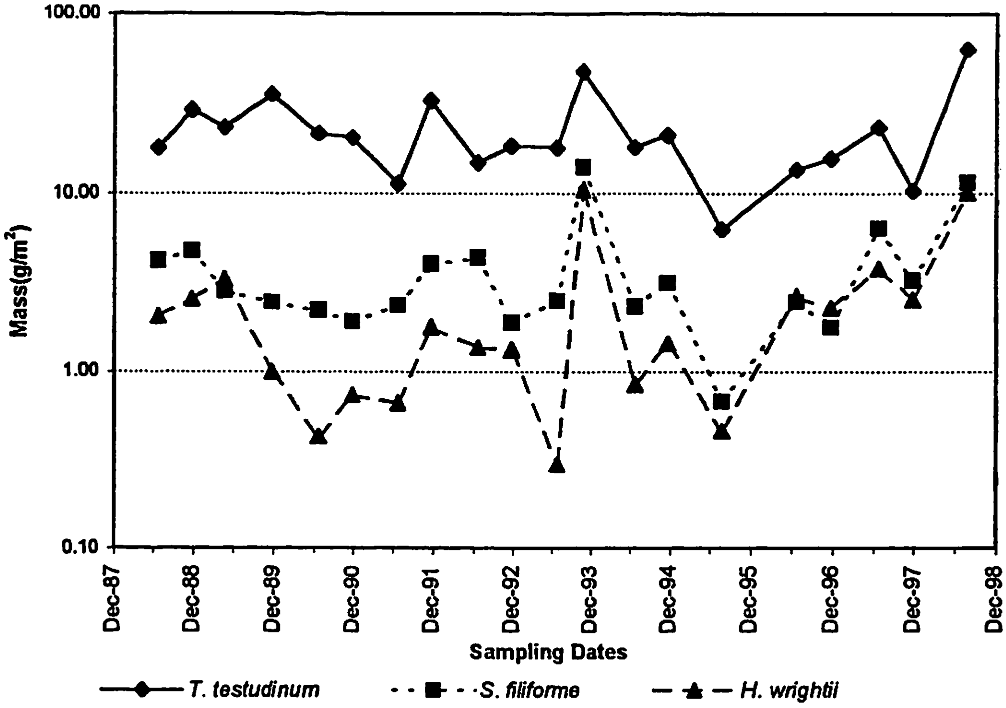

Figure 1. Average above-sediment dry-weight biomass for all species at Graham's Harbor.

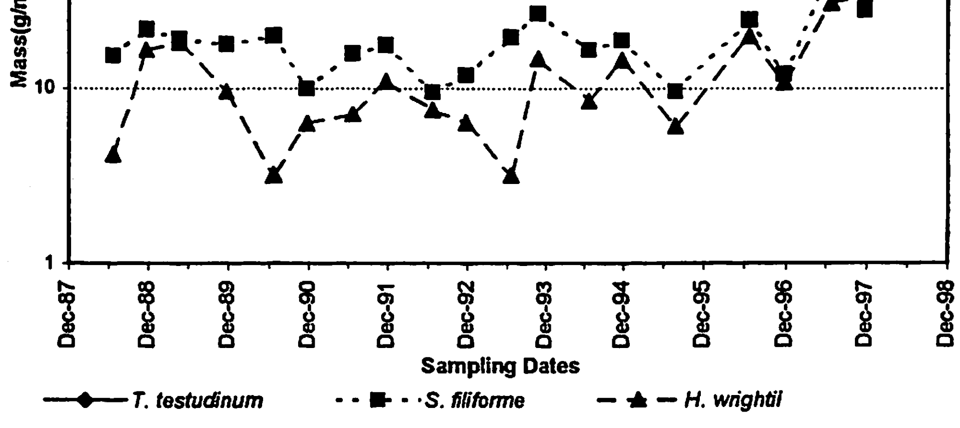

Figure 2. Average below-sediment dry-weight biomass for all species at Graham's Harbor.

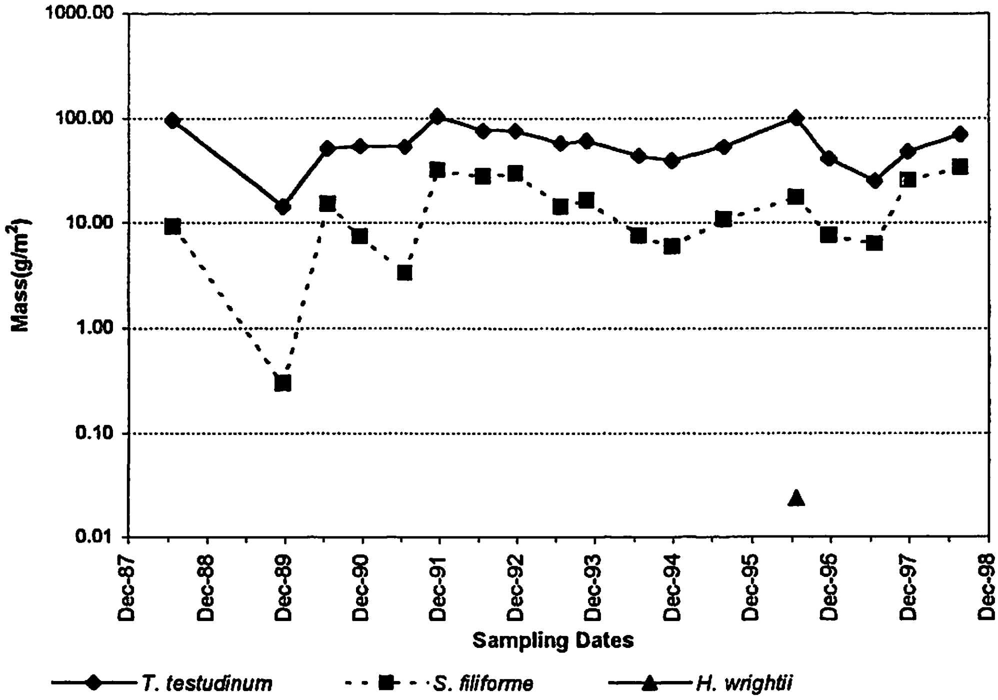

Figure 3. Average above-sediment dry-weight biomass for all species at French Bay.

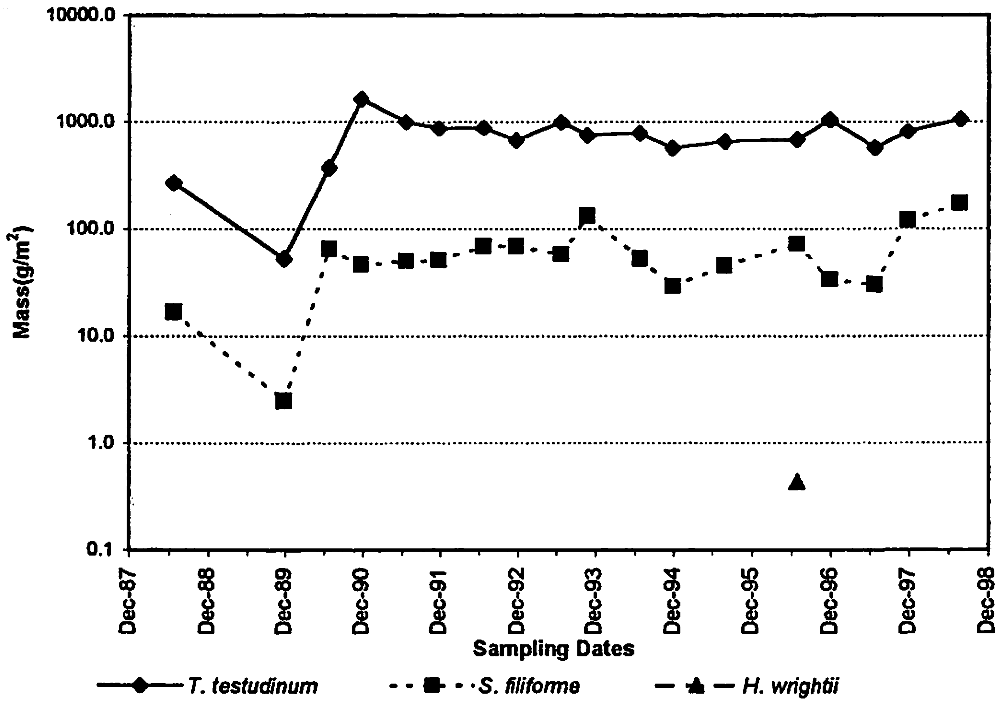

Figure 4. Average below-sediment dry-weight biomass for all species at French Bay.

amounts of phosphorus available are present in the rhizosphere of *S. filiforme* (Wehner and Smith, 1994). It is therefore possible that as *S. filiforme* biomass was reducing, these bacteria were freeing up phosphorus from the *S. filiforme* and making it available to the *T. testudinum*. Additionally, the decrease in *S. filiforme* would allow *T. testudinum* to increase because of reduced competition for space and resources. The results of such competition, especially for space, would be much more important at the very densely vegetated French Bay site.

When the biomass data is compared to earlier research on phosphorus content of the seagrass tissues at these sites (Harper and Smith, 1998) there is evidence that supports the research of Short et al (1990) indicating that phosphorus was the limiting nutrient. On numerous occasions, at both sites, in all three species, there were phosphorus spikes that were followed by biomass increases at the next sampling period. Among these were the phosphorus spikes that were noted in July 1991 and December 1996 in Graham's Harbor by Harper and Smith. These spikes were followed by biomass peaks in December 1991 and July 1997 (figures 1 & 2).

This work is an ongoing long-term study of the seagrass communities of San Salvador Island. Data collection will continue at both of these sites in the future. Attempts will also be made to obtain additional physical parameters (water temperature, nutrient availability, etc) for these sites that may allow for a more detailed analysis of the data set. In this manner we hope to not only gain an understanding of the community dynamics of seagrasses, but also to monitor an important benchmark to the overall health of the coastal areas of San Salvador.

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