SPATIAL HERBIVORY ON *THALASSIA TESTUDINUM* KÖNIG IN A CARIBBEAN CORAL REEF

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ABSTRACT

Thalassia testudinum leaves were used to evaluate the relationship between herbivory by parrotfish and distance from a reef crest where these fish reside. It was hypothesized that herbivory would be greatest nearest the reef crest where parrotfish densities are highest. To compensate for increased herbivory rates in this area, it was proposed that the leaves nearest the reef crest would have the highest growing rate. Neither of these predictions were found to be significant, however, suggesting that there is not a sufficient gradient in parrotfish intensity to cause a great effect on herbivory or leaf palatability differences. *Thalassia* herbivory was also used to comment on the effectiveness of Damselfish (*Pomacentrus planifrons*).

INTRODUCTION

The effects of herbivory on *Thalassia testudinum* König has been much studied (Hay, 1981a, Ogden 1976, Ogden 1978). It has been shown that *Thalassia* herbivory is due mainly to fish, rather than urchin, grazing except in areas that are severely overfished (Hay, 1981b), and Ogden (1976) has found that *Thalassia testudinum* is a favorite food source of parrotfish. These findings led me to wonder about what factors affect the amount of parrotfish herbivory on *Thalassia* leaves.

Parrotfish mainly inhabit the reef crest area of the west Back Reef in Discovery Bay, Jamaica and swim out to feed on the *Thalassia*. The greatest parrotfish density would therefore be nearest the reef crest and decline with increasing distance from this area. The amount of parrotfish herbivory on *Thalassia* should therefore reflect this change in fish intensity. Based on this reasoning, I hypothesized that herbivory on *Thalassia* by parrotfish will

decrease with increasing distance from the reef crest.

Another aspect of this herbivory is the adaptations the plant has undergone to withstand this differential grazing. It has been shown that Thalassia leaves and algae manufacture secondary compounds in deeper depths due to the greater impact of herbivory in areas of decreased light intensity (Hay, 1983). Since depth increases were accompanied by increases in distance from shore, it was not possible to say if the greater herbivory at greater depths was due only to depth differences, distance differences, or some combination of the two parameters. My study sites involved virtually no depth changes (<.25m). Hence, by observing the amount of herbivory on leaves characteristic of each site, I can determine if distance does play a role in secondary compound production.

The third phase of my experiment deals with the ability of Damselfish to reduce herbivory of Thalassia which grow within their territories. Threespot Damselfish (Pomacentrus planifrons) are known to be extremely territorial to fishes and urchins. An entire mound of coral will often be inhabited by a single Damselfish, yet its visual range is limited to the area surrounding the actual crevice the fish inhabits. By placing leaves around the periphery of the mound coral and observing herbivory on these leaves, an estimate of the effectiveness of Damselfish territory defense can be made.

SITE DESCRIPTION

Data collection was made from the West Back Reef of Discovery Bay, Jamaica. The waters in this area are of high salinity and are thus favorable growing conditions for this plant. Thalassia grows in

this region in large patches, and it is from these areas that leaf blades were marked and collected.

METHODS AND MATERIALS

Herbivory as a function of distance

A total of 100 Thalassia leaves were picked from one general area approximately 10 metres from the reef crest. These leaves showed no signs of herbivory and all had red encrusting coralline algae growing on them in varying amounts. The leaves were then placed in plastic bags containing fresh seawater and transferred to the wet lab where they were normalized in length by slicing the leaf across with a razor blade at 11 cm. measured from the leaf tip. Twenty leaves were placed in each of five sites: Site 1 is located 10 metres from the ridge of corals which is rich in Damselfish territories. The remaining four sites are 20, 30, 40 and 50 metres from this coral ridge.

The 11 cm. Thalassia leaves were attached to existing Thalassia leaves in these five sites by placing a clothespin over the base of the transplanted leaf and approximately 11 cm. on the existing leaf (Figure 1). This clothespin apparatus has been shown to neither repel nor attract herbivores (Hay 1981a). The transplanted leaves were placed randomly within a circle of approximately 1 metre diameter. The center of this circle was marked with an eight inch piece of flagging tied to a small clump of Thalassia leaves. To facilitate location of these areas from the water surface, a small buoy attached to a cement block section placed two feet from the edge of the circle was constructed. These leaves were left out for varying periods of time and recollected. Herbivory in each of these sites was estimated by counting the number of parrotfish bites present on each of the 11 cm. sections. This varied for all treatments and are

recorded in the appropriate figure or table.

To test for differences in palatability between the leaves common to each site and the transplanted leaves chosen from a single area, another twenty clothespins were placed on existing unherbivized Thalassia leaves in each of these sites and left for the same period of time as the transplanted Thalassia leaves before being collected. Herbivory was recorded as the number of parrotfish bites on the top 11 cm. of these leaves. All work was done from 25|2|84 to 3|3|84.

Herbivory in Damselfish territories:

Four Damselfish territories were selected by placing a transect parallel to the ridge of corals and choosing two Damselfish territories to the left and right of Site 5. These territories were labelled Sites A through D, and twenty leaves prepared in the same way as for Sites 1 through 5 were placed in each of these Damselfish areas. The leaves were placed as close to the territories as possible, and the number of parrotfish bites present on the blades were recorded after 24 hours.

RESULTS

Table 1 represents the actual data obtained for Sites 1 through 5. All collections were made 24 hours after transplantation except in Sites 2 and 3 where collections were made after 36 hours. No significant difference was found between the amount of herbivory on transplanted leaves and leaves naturally growing in the area for each site (Mann-Whitney U test, $p > .05$).

No significant correlation was found between the amount of herbivory on transplanted or native leaves and the distance they were located from the reef crest (Figure 2; linear regression, $df = 3$, $p > .05$).

Table 1 Herbivory on individual *Thalassia* leaves. Trans (transplanted) and Nat (native or existing) leaf data is given. N's are listed at the bottom of each column.

SITE 1		SITE 2		SITE 3		SITE 4		SITE 5	
Trans	Nat	Trans	Nat	Trans	Nat	Trans	Nat	Trans	Nat
0	1	0	0	0	0	2	0	0	0
0	2	1	2	0	0	2	8	0	0
2	2	0	0	2	2	0	8	0	0
0	0	3	0	2	1	0	3	0	1
1	2	0	3	2	0	0	7	0	0
4	1	0	1	1	8	2	5	0	0
0	0	0	0	0	0	3	0	0	0
0	0	0	2	0	0	0	0	0	1
2	1	0	0	0	0	0	5	0	0
0	0	0	0	0	0	0	2	0	0
0	0	0	3	0	0	1	0	0	4
2	0	0	1	3		3	0	0	0
1	0	0	2	0		0	0	0	0
2	0	0	0	0		2		0	0
2	1	0		0		0		0	0
1	0	0		2				0	0
2	2			0				0	0
2				4				0	0
								0	0
								0	0
									0
									0
N:	18	17	16	14	18	11	15	13	20	22

The amount of herbivory on Thalassia leaves around Damselfish territories (Table 2) at 50 m. from the reef crest showed no significant difference from the herbivory on leaves from Site 5 nor from each other. (Mann-Whitney U test; $p \geq .05$). Collections from these sites were made 24 hours after transplantation.

DISCUSSION

Herbivory on Thalassia leaves did not decrease with increasing distance from the reef crest as was hypothesized (Figure 2). There are two possible explanations for this finding. First, a larger sample size may be needed (ie, more leaves in more sites), in which case the theory may still be valid. Second, I may have overestimated the changes in intensity of parrotfish with distance. Figure 2 implies that the distribution of parrotfish is even. This could be further explored by recording parrotfish densities by visual means in each of these areas.

The fact that there was no significant difference between native and transplanted leaves within sites supports this: if more predation pressure were being placed on Thalassia leaves closer to the reef crest, it is expected that they will compensate for this by having a faster growth rate than leaves farther from the reef crest (and predation). Leaves that are investing their energy into growth will have less energy to put into manufacturing secondary compounds, so that leaves near the reef crest are more palatable than leaves farther away. Since all transplanted leaves were taken from an area approximately 10 m. from the reef crest, they should be fast growers and more palatable than leaves farther out. Hence, one would expect a significant difference when comparing herbivory of the native and transplanted leaves at Site 5 (50 m. from the reef crest). However, this was not

Table 2. Herbivory on individual *Thalassia* leaves in Damselfish territories. N's are listed at the bottom of each column.

SITE A	SITE B	SITE C	SITE D
3	0	1	0
0	0	0	1
0	0	0	0
1	1	0	0
0	4	2	3
0	0	0	6
0	1	0	1
0	0	0	0
0	0	0	1
0	3	2	6
0	0	0	0
0	0	0	0
0	0	0	0
1	0	0	0
0	2	3	0
0	0	0	0
0	0	0	0
0	2	0	0
0	0		0
.	0		
N: 20	20	18	19

found for any of the sites, suggesting that all leaves are the same with respect to palatability within the 50m. area sampled.

There is one complication which arises from this, however. If one assumes that less herbivory should occur on less palatable leaves, there must be some visual cue to the fish to indicate this. Otherwise, all types of leaves would have an equal probability of being bitten initially, but more palatable leaves would be but a second, third, fourth time, etc., while unpalatable leaves would be left after the first bite. I did not find transplanted leaves that had several bites on them. This may be due to conditioning. If the fish are grazing in an area of unpalatable leaves, it may assume all such leaves in that area (including the transplants) are unpalatable, and be less likely to initially bite these leaves than it would in an area containing more palatable leaves. It is impossible to test this difference, however, since it arises out of the conditions of the experiment. I noticed no visual differences between leaves close to the reef crest (palatable leaves) and those farther away, so it is unlikely that the parrotfish saw any, either.

What is more plausible is that the fish bite leaves that contain a large amount of encrusting algae, which would be visually apparent to the fish. It would have been a tedious and inexact process to normalize for encrusting algae by scraping all picked Thalassia leaves with a toothbrush, so this variable was not controlled for in this experiment.

Herbivory on threespot Damselfish territories showed no significant difference between territories. This is as would be expected, since the Damselfish were of approximately the same size and kept relatively same-size territories. However, if the Damselfish were defending their territories by keeping other fish out, there should be significantly less

herbivory in these leaves than in Site 5, which was the same distance as the Damselfish territories from the reef crest. It would appear then that the Damselfish either are not defending their territories against parrotfish because they feed on a different food source or they are not capable of defending their territory effectively. Visual observations favor the latter explanation. Damselfish territories used in this study consisted of mound corals which contained a crevice that the Damselfish used as a refuge. Hence the only area visible to the fish was that immediately in front of and surrounding the crevice opening. Although the Damselfish did not stay within the crevice at all times (it was observed to venture out a few inches from its crevice when simply guarding its territory), it probably did not see all fish in its area, as is suggested by the observation that intruding fish in one spot in a Damselfish territory would be chased away at some times but not at others. These intruding fish may not have been the same species, however, and further testing could evaluate the effect of fish body size and coloration on the intensity of Damselfish territoriality. I also observed some parrotfish eating Thalassia in a Damselfish territory while the Damselfish was preoccupied with chasing another fish away from its area. This would also account for some of the observed herbivory on these leaves.

* * *

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Some of your statements and theories are confusing, especially re expectations on growth rate, palatability, and herbivore pressure. Your arguments are not quite the same as Hay's, which you should have discussed.

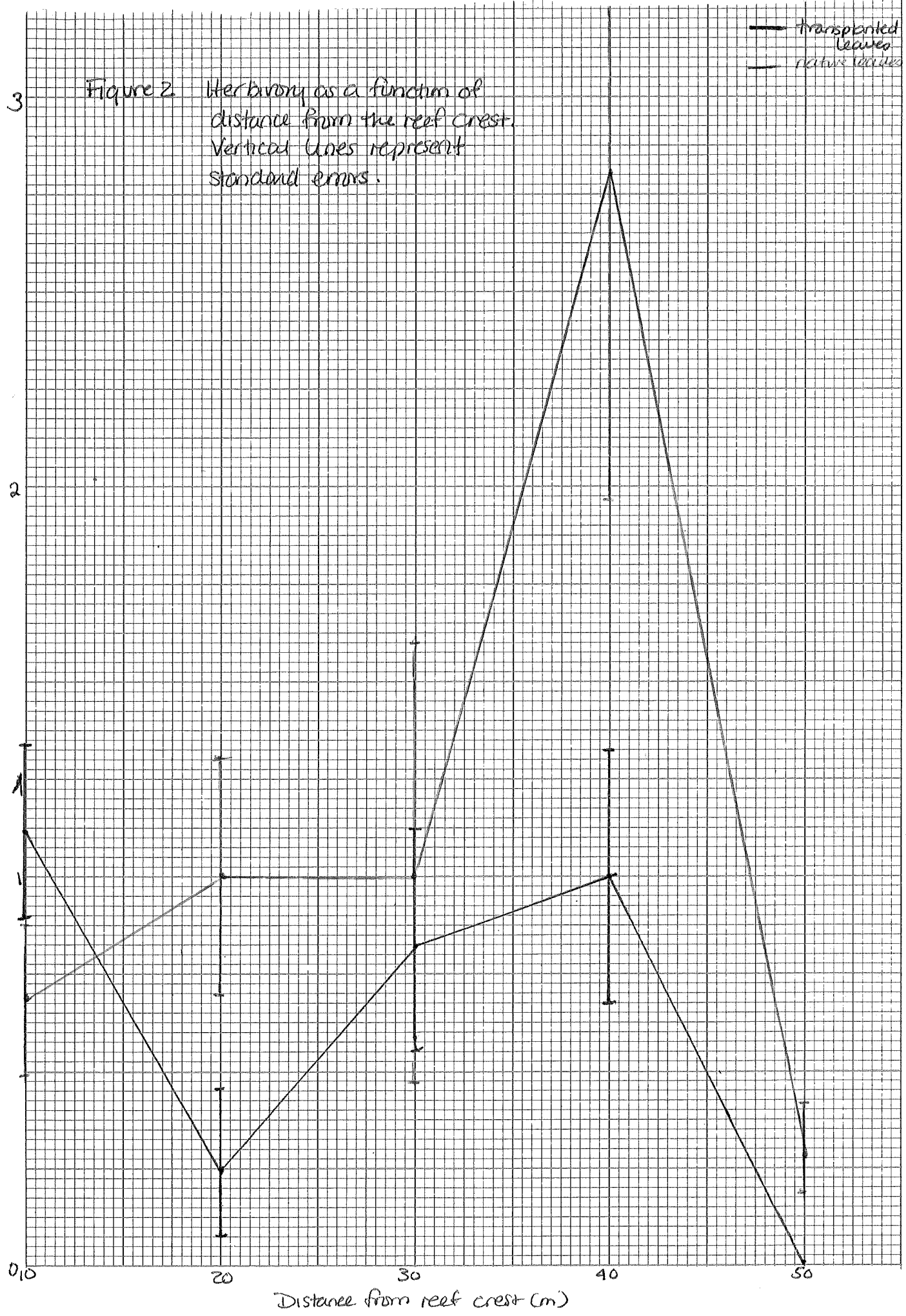

Figure 2. Herbivory as a function of distance from the reef crest. Vertical lines represent standard errors.

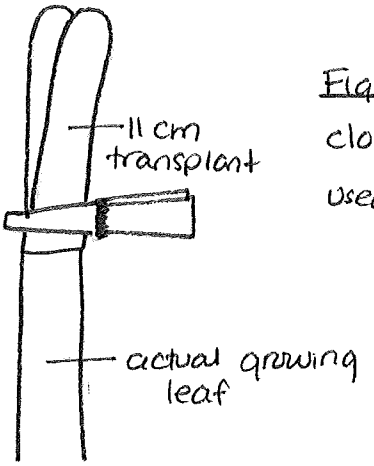

Figure 1 Diagram of clothespin apparatus used.

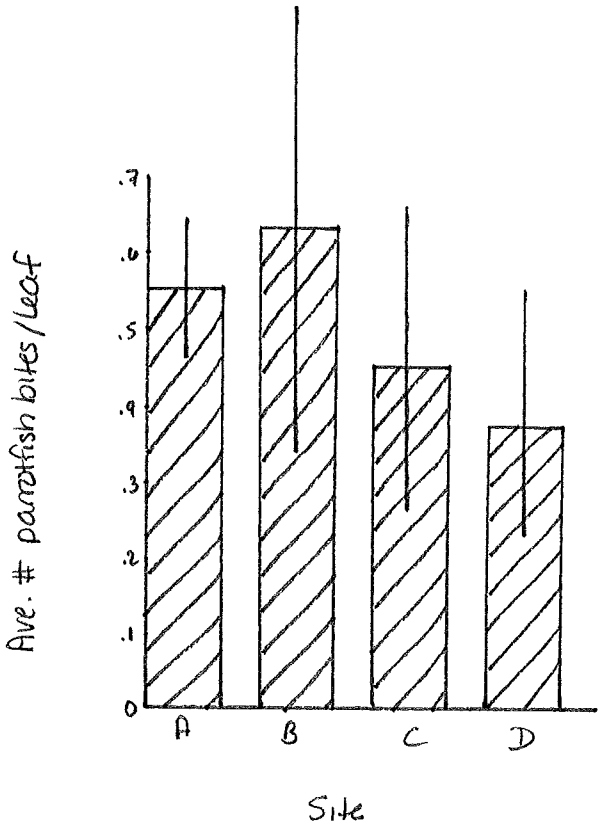

Figure 3 Herbivory for each of the four Damselfish territories. Vertical lines represent standard errors.