PARROTFISH GRAZING ON THALASSIA TESTUDINUM

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INTRODUCTION

A bed of grey-green, algae-encrusted seagrass can hardly be called the most dynamic, visually fascinating aspect of the highly diverse and multicolored Jamaican coral reef. Yet, the *Thalassia testudinum* beds which cover much of the sandy-bottomed lagoon behind the East and West reefs at Discovery Bay are responsible for much of the primary production of the reef ecosystem; they play an important role in shaping the community structure as well.

Since seagrass beds are a dominant feature of coastal environments throughout the world, numerous studies have been done on their productivity (Dow, 1970), their relationship with associated fauna (Ogden, 1971, and Kikuchi, 1974), and the importance of the epiphyte community which flourishes on the seagrass blades (Humm, 1964, and Harlin, 1980), etc. These studies have generally emphasized the importance of seagrass beds in shaping community structure by :

a) providing a substrate for algae and microorganisms to grow on in a substrate-limited environment;

b) providing a physical shelter and structural habitat for various micro- and macroorganisms;

c) providing a food resource directly -- or indirectly, through either the detritus food chain, or through grazing on photosynthetic algae which encrust the blades.

This last point is possibly the most interesting and least understood: Kikuchi writes, "Concerning trophic relationships, a scarcity of seagrass grazers is a remarkable feature of this community. Most herbivores graze on macro- and microalgae associated with seagrass leaves". (Kikuchi, p.167) Thus a large part of the primary productivity of extensive seagrass beds is actually cycled through the ecosystem via the detritus food chain, and not directly consumed.

The scarcity of seagrass grazers may be largely due to the fact that most marine animals lack the enzymes needed to digest the cellulose in the grass (Kristensen, 1972 in Kikuchi,1980). A significant exception to this is the green turtle (Chelonia mydas), whose diet is 87% seagrass (Gilbert, lecture). Several species of urchin (specifically Trineustes and Diadema here at Discovery Bay) also graze heavily on seagrasses, although it is suspected that their assimulation efficiency of the grass is very low-- on the order of 10% -- and they derive most of their energy from the epiphytic growth on the blades.(Kikuchi, 1980).

What interested me here at Discovery Bay was the Parrotfish grazing on Thalassia. Since in all studies carried out in temperate zones, no significant seagrass grazing by fishes has ever been reported, the incidence of Parrotfish grazing here raises several questions:

a) Are the fish deriving benefit primarily from the grass itself, or from the epiphytes which cover it?

b) How do grazing fish (and urchins) affect patterns of zonation (i.e., forming bare "halos" around patch reef, etc.) ?

c) Is the Parrotfish turning to seagrass as a more available alternate food source, or does it possibly possess digesting enzymes which would allow it to utilize Thalassia as a primary food source? In either case, the grazing of seagrass by almost exclusively Parrotfish among the fishes seems to be one way of resource partitioning on the reef.

The latter question is more speculative, and would involve long-term, complex investigation to answer completely. The second question was the subject of a project done by Tom Sasek, '79, with some interesting results. I proposed to continue (with a few alterations) the study done by Jim Lambardo, '80, entitled "Grazing Pressure on Epiphytic Community of Thalassia testudinum". In order to answer the first question (above), Jim conducted a colonization experiment, as well as setting up lab and field experiments designed to offer macroconsumers a choice between algae-encrusted and scraped blades. He analyzed the results to the latter part in the form of percentages of each type of blade with urchin or fish damage. His results were significant, but since his sample size was quite small, it seemed worthwhile to try to expand this part of the project, concentrating on getting as much data as possible on fish preference for encrusted or scraped blades. This is the most practical way we have of determining whether or not the fish are actually utilizing the seagrass itself, or whether most of the plant-herbivore energy flow is, in this case, through the encrusting coralline algae.

Even if fish select only leaves with epiphytes, it doesn't mean that they are not also utilizing the seagrass.

METHODS

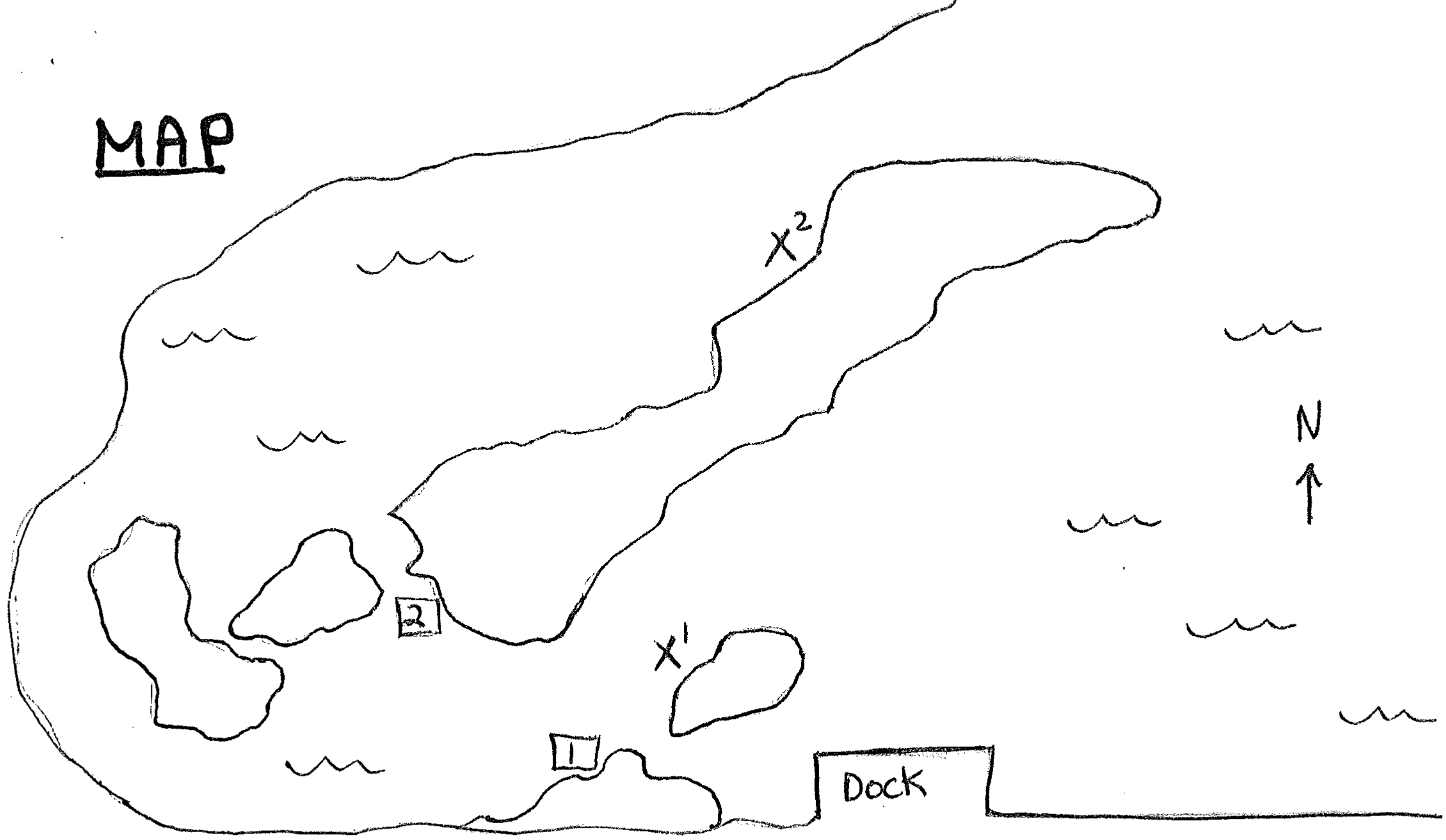
I conducted two types of in situ experiments over the period Feb. 24 to March 3. Efforts to catch a Parrotfish were futile, so no lab set-up was arranged. Instead, observation of Parrotfish feeding out behind the Mangrove area proved most interesting, informative, and enjoyable.

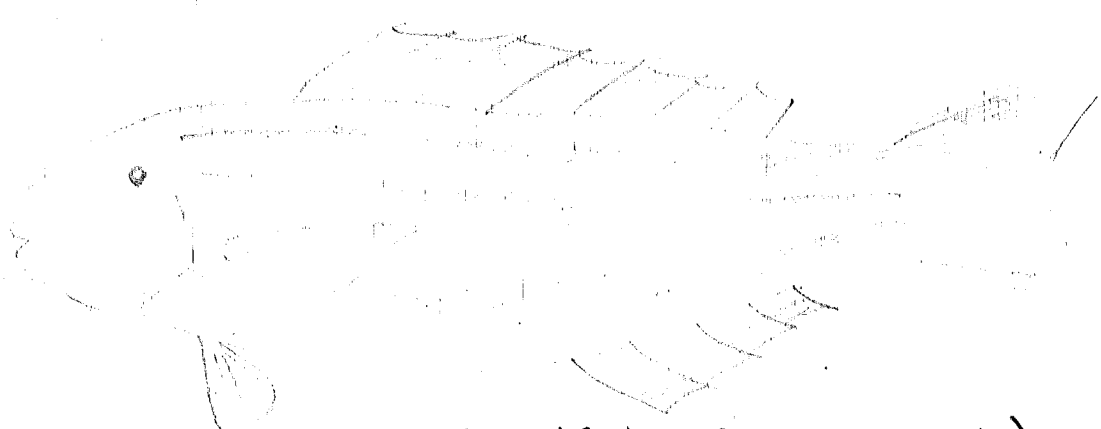
The first experiment I did involved marking and scraping Thalassia blades without removing them from their natural state at all. Working in a shallow area with snorkling equipment, I tied up to half a dozen blades together with red marking tape, and then scraped about half the blades in each bunch using a razor blade and glass slide underwater. The tips of all blades (scraped and unscraped) were then sliced off, since they were often either decaying, or already had bites on them. Blades with any fish bites at all previous to marking were avoided, of course, but the sites I chose to mark plants in showed evidence of generally intensive fish grazing. The first site was by a patch reef located directly shorewards form the forked stick that marks the canoe channel on the West reef. I marked a total of 37 blades -- 15 of them scraped clean -- on Feb. 24, and collected them to examine for bites in the lab three days later.

The second site was behind the Mangrove area (adjacent to X^2 on map). 37 blades were marked -- 20 of them scraped -- on March 1. They were cut and brought back to the lab on March 3.

The second method I used involved marking and scraping blades in the lab, then fastening bundles of 2 - 6 blades into slits cut with a diving knife into a large board. The first board I prepared had 27 bundles, with 40 blades scraped completely clean of epiphytes, and 91 blades left encrusted. Each blade was trimmed to 15 cm by removing the base and the tip; this was a way of approximating equality of age and accessibility among all blades. None of the blades used had bites on them prior to the experiment. This board was set behind the rock at X^1 (see map) and held down with a cinderblock. After three days I moved it to the spot marked X^2, as this spot appeared to be more heavily grazed by Parrotfish.

A second board was prepared in the same way as above, except 50 blades were scraped only on the top half, and 50 only on the bottom half. This experiment was designed to test whether or not the accessibility of the tip played a role in fish choice. If it did, presumably one would find more bites on scraped tips than on scraped bottoms (where one would not expect to find any bites at all). This board was set out behind a rock near the dock ($\boxed{1}$ on map), and moved further into the Mangrove area ($\boxed{2}$) two days later. Both boards were brought back to the lab on March 3 to analyze the data.





Striped Parrotfish (Scarus Croicensis)

DATA COLLECTED FROM TAPE-MARKED PLANTS

Seagrass marked and scraped by patch reef in West backreef on Feb. 24, collected Feb. 27 : noted number of fish bites on each blade, and incidence of urchin damage.

ENCRUSTED BLADES

1. 3
2. 1
3. 4
4. 1
5. 1
6. 3
7. 3
8. 0
9. 4
10. 2 + urchin
11. 1
12. 2
13. 0
14. 5 + urchin
15. 1
16. 7
17. damaged
18. 0
19. 2
20. 3
21. 1 + urchin
22. 0 + urchin

SCRAPED BLADES

1. 0
2. 0
3. 0
4. 1
5. 0
6. 0
7. 2
8. 0
9. 0
10. 0
11. 0
12. 0
13. 0
14. 0
15. 2

Seagrass marked and scraped behind Mangrove area on March 1, collected March 3.

ENCRUSTED BLADES

1. 1
2. 2
3. 6
4. 3
5. 4
6. 4
7. 3 + urchin
8. 2 + urchin
9. 2
10. 3 + urchin
11. 2
12. 1
13. 3
14. 2 + urchin
15. 9
16. 3
17. 2

SCRAPED BLADES

1. 0
2. 0
3. 0
4. 0
5. 0
6. 0
7. 1
8. 2
9. 1
10. 0
11. 0
12. 0
13. 0
14. 0
15. 0
16. 0
17. 0
18. 0
19. 1
20. 0

TABLE 1 :

Compilation of data from tape-marked plants showing A) total number of fish bites on scraped and unscraped blades; B) the percentage of blades in each category bitten by fish; c) the average no. of fish bites per blade.

	WEST BACKREEF		MANGROVE	
	Encrusted	scraped	Encrusted	Scraped
total number of fish bites	45	5	52	5
% of blades bitten	82%	20%	100%	20%
average no. of fish bites per blade	2.0	.33	3.0	.20

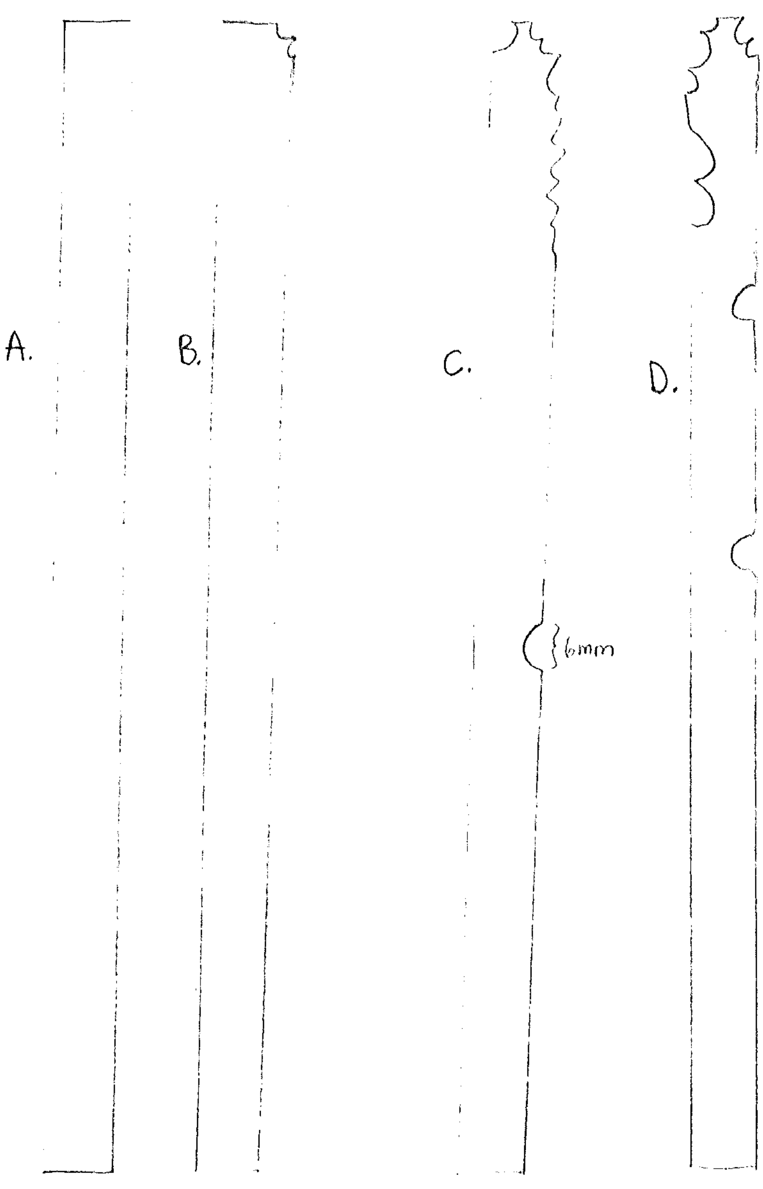


FIG. 1

A. 15cm scraped T. testudinum blade, no bites.

B. Scraped blade (#8 from Mangrove area) with 2 small bites near tip.

C. Encrusted blade (#7 from Mangrove area), with 2 nibbles on tip, considerable urchin damage, and one large bite about half way up from base.

D. Encrusted blade (#15 from Mangrove area) with 9 fish bites.

DATA COLLECTED FROM PLANTS ON BOARD

27 bundles of 15cm blade segments, either left wholly encrusted or scraped completely. 3 days in near Mangrove area, 3 days in far Mangrove area (X^1 & X^2 on map). Collected on March 3. No urchin damage at all, as the urchins did not crawl onto the board.

<u>BUNDLE # 1</u>
encrusted: 1. 5 2. 10 3. 1 4. 5
scraped: 1. 0 2. 0

\# 2
encrusted: 1. 8 2. 6 3. 9 4. 10
scraped: 1. 0

\# 3 1. 12 2 4 3. 4 4. 6
encrusted:
scraped 1. 0

\# 4
encrusted: 1. 10 2. 9
scraped: 1. 0 2. 1

\# 5
encrusted: 1. 16
scraped: 1. 0

\# 6
encrusted: 1. 6 2. 4 3. 0
scraped: 1. 0

\# 7
encrusted: 1. 5 2. 2 3. 5 4. 4
scraped: 1. 0 ~~1~~

\# 8
encrusted: 1. 2
scraped: 1. 0 2. 0

\# 9
encrusted: 1. 1 2. 3 3. 0
scraped: —

\# 10
encrusted: 1. 9 2. 2 3. 5 4. 0
scraped: 1. 0 2. 0

\# 11
encrusted: 1. 4 2. 8
scraped: 1. 0

over →

#12
encrusted: 1. 0 2. 2
scraped: 1. 0 2. (damaged)

#13
encrusted: 1. 6 2. 1 3. 8
scraped: 1. 0 2. 0 3. 1

#14
encrusted: 1. 4 2. 4 3. 3 4. 1 5. 0 6. 1
scraped: —

#15
encrusted: 1. 4 2. 2 3. 2 4. 2
scraped: 1. 0

#16
encrusted: 1. 4 2. 9 3. 0 4. 0
scraped: 1. 0

#17
encrusted: 1. 4 2. 10 3. 0
scraped: 1. 0 2. 0

#18
encrusted: 1. 1 2. 0 3. 1 4. 3
scraped: 1. 0

#19
encrusted: 1. 4 2. 6 3. (damaged) 4. 4
scraped: 1. 0 2. 0

#20
encrusted: 1. 8 2. 4 3. 2 4. 6 scraped: 1. 1

#21
encrusted: 1. 0 2. 0 3. 3 4. (damaged) 5. 6 6. 0
scraped: 1. 0

#22
encrusted: 1. 1 2. 0 3. 4 4. 2 5. (damaged) 6. 7
scraped: 1. 0

#23
encrusted: 1. 1 2. 6 3. 3 4. 1 scraped: 1. 0 2. 0

#24
encrusted: 1. 1 2. 2 scraped: 1. 0 2. 0

#25
encrusted: 1. 2 2. 0 3. 1 scraped: 1. 0 2. 0

#26
encrusted: 1. 2 2. 0 3. 3 4. 5 5. 4 scraped: 1. 0

#27 1. 5 2. (damaged) scraped: 1. 0 2. 0 3. 0

TABLE 2:

Summary of data from artificial *Thalassia* bed. Includes information on total number of bites on blade tip, and percentage of all bites located on tip.

	Encrusted	Scraped
total no. of bites	340	3
% blades bitten	84.5%	7.5%
ave. no. bites per blade	3.7	.075
total no. of bites on tip	95	1
% bites on tip	28%	(33%)

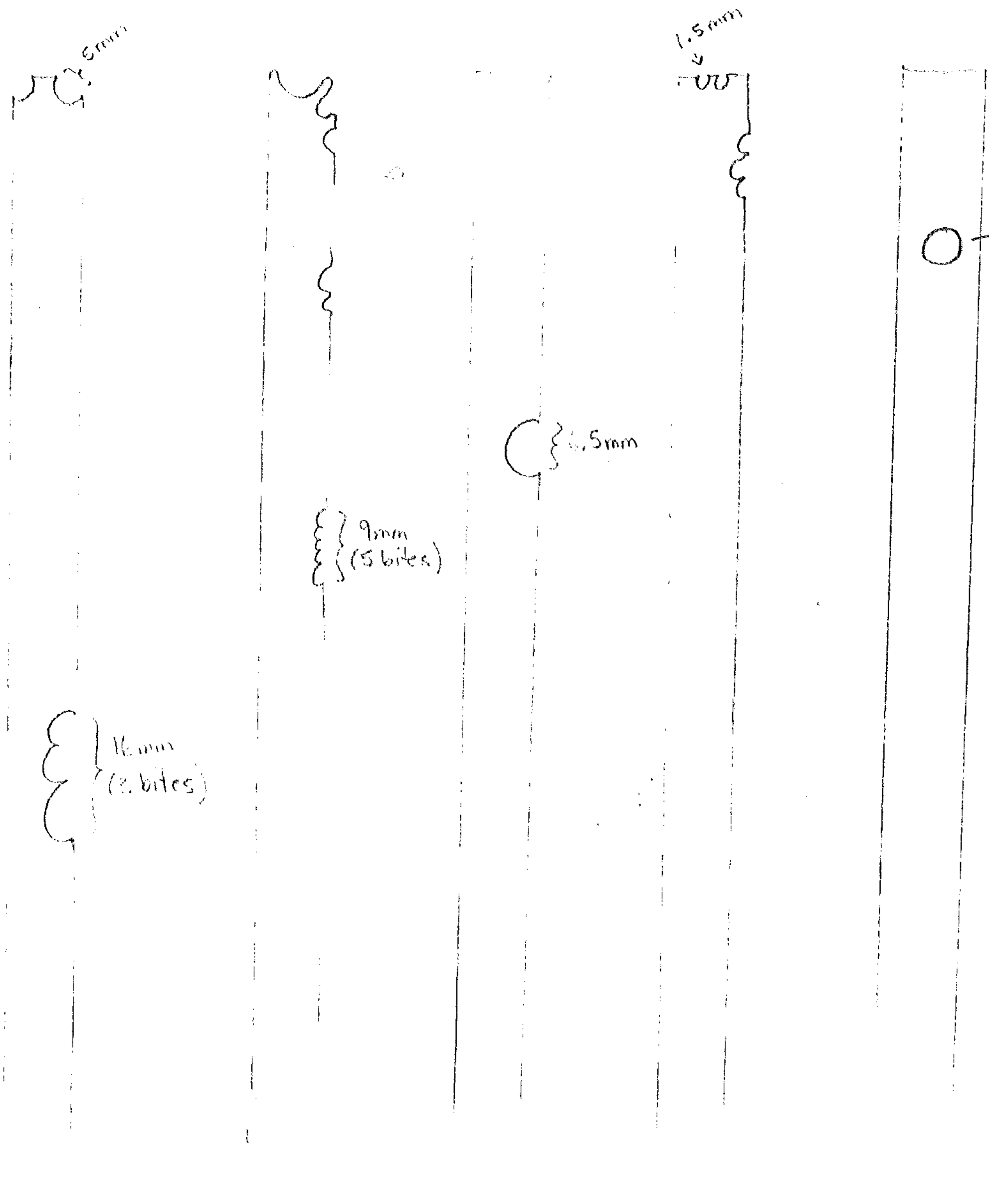


FIG. 2

Illustration of blades in first bundle.

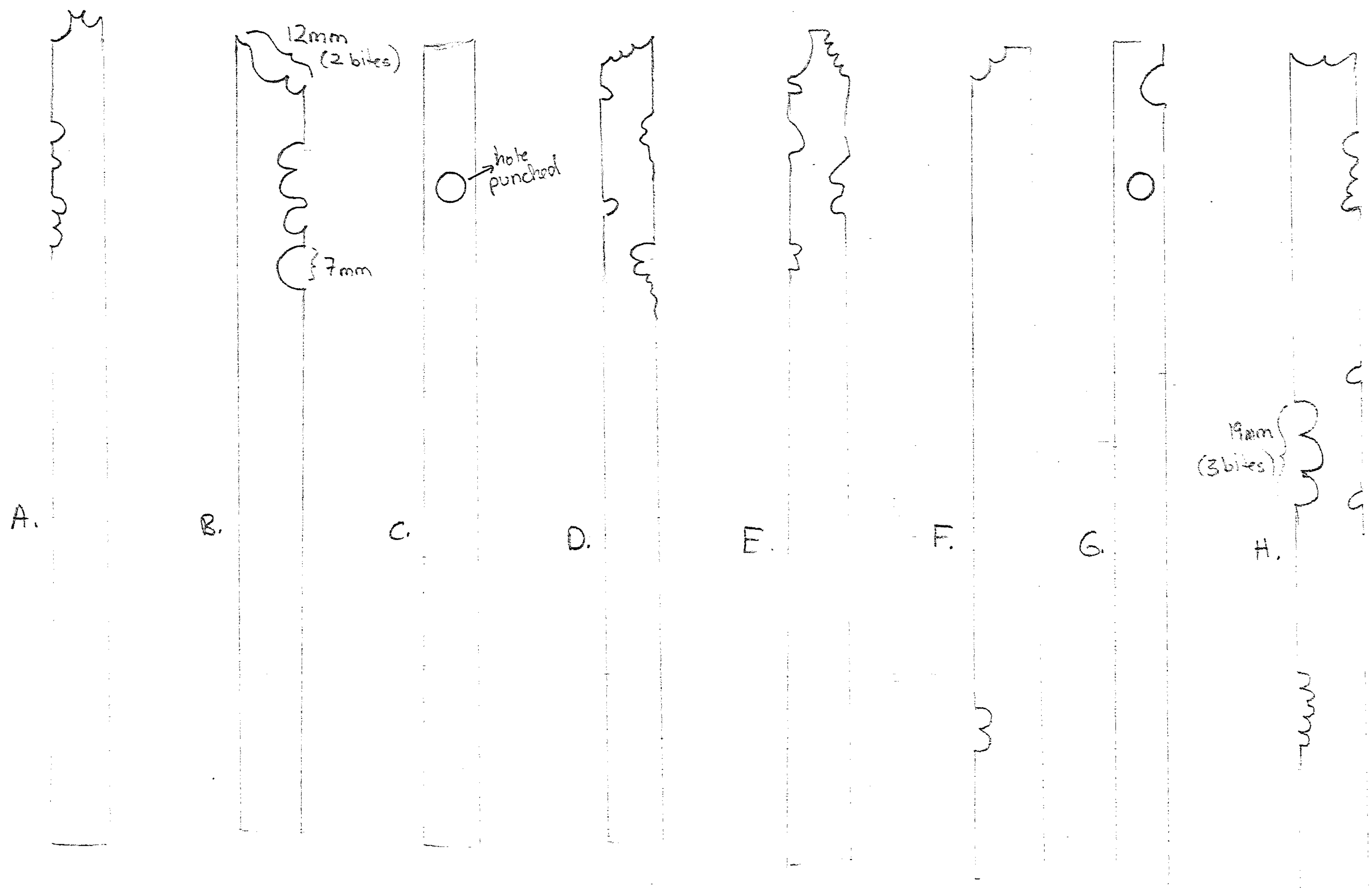


FIG. 3 : Illustration of blades : A – E are from bundle # 2
F. is blade 4 of bundle # 3; note bites near base
G. is scraped blade 2 of bundle # 4, with one bite
H. is blade 1 of bundle # 5; most bites found on one blade (16)

RESULTS AND DISCUSSION

In three out of four experiments (tape- marked on WBR, tape-marked behind Mangrove, artificial bed with wholly-scraped leaves), the results showed significantly more bites on encrusted blades than on clean ones. ** The fourth experiment, designed to test accessibility of the tip as a factor in fish choice, was unsuccessful, since in four days not one fish bit at the artificial bed. Instead, it became quite heavily covered by silty sediment (due to its location) and the encrusted halves of the blades became fuzzy with filamentous green algae overgrowing the encrusting corallines.

Observation in the water made it clear why the artificial Thalassia beds received no bites for several days: Damselfish established their territory in the cinderblocks used to hold down the boards. I saw schools of Parrotfish grazing on the seagrass near my artificial beds, but when they tried to nibble the blades protruding from the board, the Damselfish persistently shot out of the cinderblock to chase the Parrotfish away. Therefore, I attribute the total absense of bites in the one artificial bed to the defense of the Damselfish. This led to a couple of interesting speculative results: One might assume that Thalassia growing within any Damselfish territory will be undergrazed. This might allow for an increased biomass and diversity of epibiota on the protected blades. Jim Lambardo's colonization experiment showed that when

** This directly refutes the results of an experiment on fish preference performed by Ogden and Murdoch (see p.107 of Aquat. Bot.,2 : 1976). An 18-hour field preference test showed equal percentages of T. testudinum with epiphytes and without epiphytes were eaten by the Parrotfish. I doubt the validity of this experiment, since all foods offered the fish, including the seagrass, showed 80-92% consumption, except for two species of distasteful algae, which were "avoided" by the fish eating 41 and 23% of these alga, nevertheless.

grazers were excluded, there was a significant increase in filamentous green algae, polychaete worms, and other microorganisms found on the blades. My experiments accidently provided a clue to one type of grazer exclusion (i.e. Damselfish defense) which can occur -- at least on a small scale -- in nature.

Now the plot thickens. One of my artificial seagrass bed experiments was saved from Damselfish sab~~b~~otage by the intrusion of a small scorpion fish. I found the scorpion fish peering out of the cinderblock on the morning of March 3. For the next 15 minutes the Damselfish tried furiously to chase the scorpionfish out of the block, while ten to twenty striped Parrotfish scraped and nibbled at the blades on the board.

I had no trouble with Damselfish in the experiments where the plants were simply marked with red tape. However, this method was not easy to carry out, since it is difficult to scrape blades underwater on a windy, wavy day (of which there were several). The results were good enough to merit using this procedure for further studies, though. Damselfish aside, the artificial beds did have the advantage of being prepared in the lab, so that the blades could be more thoroughly scraped and evenly measured and trimmed.

Parrotfish seemed to be most actively grazing during the latter half of the afternoon. Their grazing behavior provided additional evidence that they are utilizing primarily the epiphytes, and not the grass itself: Small Parrotfish often didn't bite the Thalassia at all; they simply scraped off the encrusting algae, leaving a pattern of short green striations on the blade. The larger fish would usually

see comment on p. 3 a good observation

bite off part of the grass along with the algae.

I tried to observe whether or not the fish seemed to be biting off only the tips, or whether the tips seemed to be more accessible. Since many of the blades are tangled and bent over, the fish often bite somewhere along the edge of the blade. A few of my samples had bites quite close to the base. However, when I ran a Chi Square test on the number of bites on the tips versus total number of bites, I found that the preference for tips was highly significant ($p < .0001$). This indicates that a) tips are more accessible; b) tips are older and more encrusted with algae, therefore the fish prefer them; or c) both of the above. b) seems the most likely; in order to prove a) or c) further experimentation is needed.

good

The results I obtained indicate that the Parrotfish almost always choose algae-encrusted blades over scraped ones. We can assume that this means the fish are deriving most of their nutrition from the epiphytic growth on the blades, rather than from the Thalassia itself. The observation of young fish scraping at the blades without biting strengthens this assumption.

p. 3 re comment

OK

The ecological implications of this are at least twofold: First of all, almost all of the high primary productivity of the Thalassia beds must be cycled through the system via the detritus food chain, since very little of it is being utilized directly by herbivores.

Secondly, although the Parrotfish obviously widens its resource base by being the only fish to graze extensively on Thalassia, it does not constitute an exceptional example of sharp niche differentiation. This would be the case only if the fish had evolved special cellulose-digesting enzymes or symbionts which would allow it to feed exclusively on seagrass.

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