ZOOPLANKTON PREDATION BY *PORITES* AND *MADRACIS*

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ABSTRACT

This paper concerns coral feeding on zooplankton. I hypothesized that *Porites* and *Madracis*, two genera of tentacle feeding corals, were partitioning the resource of zooplankton, a source of nutrients. I did capture efficiency experiments to determine if one coral could capture zooplankton better than the other. I used four types of zooplankton. The results were inconclusive. However, many observations of coral feeding were recorded.

INTRODUCTION

Corals satisfy their nutritional requirements primarily from three sources: their symbiotic zooxanthellae, detritus and zooplankton (Johannes, 1974; Goreau et al., 1979). This study concerns the relative efficiencies of zooplankton capture by two similar scleractinian corals, Porites and Madracis.

Coral growth is possible in a nutrient-free environment (Franzisket, 1969), showing the importance of zooxanthellae in overall energetics. Much of the corals' nutrients are tightly cycled between the zooxanthellae and the polyp (Goreau et al., 1979). Some nutrients, however, are exported in the forms of mucus, dissolved organic molecules and planulae. These losses have to be made up from sources outside the polyp-algal symbiosis i.e. from detritus or zooplankton. Johannes et al. (1970) states that zooplankton are unimportant in total coral energy requirements but may provide important nutrients. A fairly tight nutrient cycle with the corals' zooplankton prey feeding on denatured mucus has been proposed.

Nutrients are limiting in the ocean. The case for resource partitioning by corals in general is strong. Many different kinds of corals are found in close proximity to each other on the reef. They exhibit distinct feeding types described by Lewis and Price (1975). Surely, the mucus feeders take up a greater percentage of their nutritional requirements as small particulate matter than the tentacle feeders. This partitioning of resources would reduce interspecific competition. I hypothesized that even two tentacle feeders would be partitioning the zooplankton resource.

Do they co-occur?

METHODS

Examination of gut contents would be the most direct way to demonstrate resource partitioning in the corals. That method was not feasible, mostly due to my lack of SCUBA training. Therefore I decided to compare capture efficiencies between the two corals to demonstrate resource partitioning.

The two corals have approximately the same growth form and polyp size. The rate of contact with zooplankton driven by currents or change events into the corals would be about the same for a polyp of either species. If the two corals did not consume the same mixture of zooplankton, it would be a result of different capture efficiencies per contact. I hoped to show that the corals had different zooplankton capture efficiencies.

I used Madracis mirablis and Porites porites in my experiments.
I did my experiments at Discovery Bay Jamaica between Feb 21 and March 4 1981
Depths?
Lewis and Price (1975) classify both as tentacle feeders. The tentacles remain expanded all day, making experimentation easier. The corals that I used were collected at two dates during the experiment. They were maintained in flowing sea water during the week of the experiment.

I collected zooplankton approximately every day. Vertical tows done between 8 and 10 p.m., yielded the most numerous and diverse plankton. Air bubbled through the holding tank increased the lefetimes of the plankton but all were used within 24 hours after collection.

I separated four genera from the plankton samples. I chose the genera on the bases of abundance and size. The zooplankton form a rough size gradient. The smallest zooplankton that I used were calanoid copepods (less than 2 mm. long), the second smallest cumaceans (less than 4 mm. long), the third smallest anthropod shrimp (up to 8 mm. in length) and the largest mysids (up to 15 mm. long). Only apparently healthy individuals were used.

For my trials I placed the corals in pans of seawater. The pans were placed under a dissecting microscope. The coral was allowed to sit until it was fully expanded. I used three specimens of each coral during my trials. Once the coral was acclimated, I added a zooplankter over the coral with a reversed Pasteur pipet.

RESULTS

DATA

NUMBER OF CONTACTS WITH CORAL*

Zooplankton	MYSID		SHRIMP		CUMACEAN		COPEPOD	
Coral	A PORITES	B MADRACIS	C PORITES	D MADRACIS	E PORITES	F MADRACIS	G PORITES	H MADRACIS
	6	9	2	3	5	1	1	1
	3	3	2	6	2	8	1	1
	13	9	2	8	1	1	1	1
	10	3	11	11	1	3	1	1
	4	7	8	8	1	1	1	2
	6	9	5	8	2	9	1	1
	12	11	2	16	1	9	1	1
	14	12	18	8	2	7	1	1
	8	7	23	11	1	1	1	1
	12	9	9	9	2	1	1	1
MEAN	8.8	7.9	8.2	8.8	1.8	4.1	1	1.1

* The last contact resulted in successful capture

RESULTS OF STUDENT'S T-TEST

All the comparisons of Porites to Madracis ~~were~~ showed insignificant differences (significance being defined as 95% certainty) Comparison of E with F showed 90% certainty of difference, however

A was significantly different from E and G
B was significantly different from F and H
C was significantly different from E and G
D was significantly different from F and H
E was significantly different from ~~G~~ H

I counted the total number of contacts that the zooplankter made with the expanded polyps of the coral. The last contact was capture. If the zooplankton escaped, the trial continued until capture was final. Periodically I had to suck the zooplankton in with the pipet and reinject it over the coral. I also did a few trials with zooplankton not in the four classes presented in results There were not enough replicates to include them with the quantitative results. I tested the significance of any differences between the mean number of contacts per capture with the Student's T - test. I used 95% certainty as my level of significance.

I observed the progress of digestion of large prey (pieces of polychaete worms) in both corals. I fed five 2.5 cm. long pieces of polychaete worms to each coral. I poked at the pieces with a probe after 10 min, 30 min, 1 hr., 90 min., and 2 hr., to note the progress of digestion and to look for mesenterial filaments.

Qualitatively I looked at capture techniques and digestion of prey. Difference in diet might be reflected by differences in capture techniques.

DESCRIPTIVE RESULTS

MORPHOLOGY

Both *Porites* and *Madracis* colonies have branching forms. The *Porites* branches are about three cm. wide whereas the *Madracis* branches are less than a centimeter wide. Both species have polyps with expanded tentacle disks approximately .5 cm. in diameter. *Madracis'* polyp is golden brown and transluscent; *Porites'* is gray-brown and opaque. In *Madracis* the extended polyp has a fairly long stalk topped by the oral disk and tentacles. An extended *Porites* has an oral disk closer to the skeleton. The withdrawn states are similar. The tentacles of *Madracis* end in white bulbs. *Porites'* tentacles are simple elongated cones.

CONTACT BEHAVIOR

In *Porites* when a zooplankter rebounded from a polyp, a wave of tentacle contractions (grabs) swept the immediate area (1 cm^2). When a zooplankter contacted a *Madracis* tentacle, neighboring tentacles on other polyps would start to wave. I saw no generalized waving of tentacles when food was introduced into the water like those reported by Lewis and Price (1975).

Soon after a zooplankter was introduced over *Porites*, scattered polyps waved then withdrew their tentacles. The mouth also opened. The polyps were acting as if food too small to see was raining down upon them from the pipet.

Tentacles of both species apparently contain sticky nematocysts. I observed prey stuck to both species tentacles. After contact has been made with one or several tentacles, *Madracis* opens its mouth and moves its tentacles towards the mouth. *Porites* drops its oral disk, opens its mouth, and withdraws its tentacles towards its mouth. Most escapes occur as the tentacles are withdrawn.

PREY BEHAVIOR

Mysids immediately reversed direction with great speed when they came in contact with the coral. Their large size and speed made many contacts necessary for capture. It took the holding power of several polyps to capture a mysid. Usually the mysid contacted two or more polyps when it first touched the coral. In one case, the mysid tail stuck to a *Porites* tentacle. Before the mysid could break free, its struggles brought it in contact with more tentacles.

The shrimp I used were smaller but also very active. They could be subdued by one polyp if the contact was good. They often of their own accord, made repeated contacts with polyps, easily rebounding before a good contact was made. Often shrimp escaped when *Porites* withdrew its tentacles.

The cumaceans, although large were not very powerful swimmers They made fewer contacts vefore capture. The copepods, although active, were much smaller than the polyp. In every case but one contact with a tentacle was final.

PREY INGESTION

The smallest prey are ingested whole into the gullet of the corals. In *Madracis*, one or several tentacles would stuff the prey into its mouth about 30 seconds after capture. *Porites* directs from the tentacles to the mouth with mucus.

Larger prey such as shrimp are slowly engulfed in the mouth of *Madracis*. Sometimes two polyps pull on opposite ends of a zooplankter. The zooplankter ended up in one polyp. In *Porites* the larger prey remain on the tentacles. About a half hour after capture, tentacles from neighboring polyps have closed over the prey. After about an hour the prey starts to break down. Mucus sheets slowly convey the product to the mouth. A 3 cm. long fish fry was consumed in this manner over three hours. I never saw mesenterial filaments in either coral, although extra-polyp digestion was taking place in *Porites*.

DISCUSSION

I was unable to demonstrate partitioning of the zooplankton resource between the two corals. For one type of zooplankton, there was a 90% probability that the mean number of contacts were different for Porites and Madracis.

It is possible that there is no resource partitioning in zooplankton. Speciali ation along another gradient or disequillibrium in the reef could account for species diversity.

On the other hand, due to time considerations, I was unable to do more than ten replicates. A larger sample size might have shown significance in some cases. It is also possible that although these zooplankton are not caught with different efficiencies, others are. Broader tests would preclude this.

The differences in feeding behavior would tend to support the hypothesis of resource partitioning. It may be that the two feeding methods observed are of approximately equal efficiency. I would tend to say however that Porites would be the better predator for very small prey. Mucus is very effective for small items, The tentacles work well with small copepods but allow larger shrimp to escape. Also there is the feeding action of the polyps after zooplankton are added. It appears that something is showering down upon the coral and being consumed but it could just be a general anticipatory response to the presence of food.

I did show, however, that both corals captured smaller prey with greatee efficiency than larger prey. The most efficiently c captured prey, the calanoid copepods, represents 40% of the class' plankton hauls, suggesting that it would be a good prey item on which to specialize.

The results could just be showing the results of artificial stress on zooplankton with weaker plankton easier prey. I donnot believe this is true because I saw no loss in plankton viability over thecourse of the experiment and the plankton were still lively when I began the trials.

Digestion of prey external to the polyps was observed in *Porites*. The Extra-polyp digestion could be effected by unseen mesenterial filaments or by something exuded from the gut or tentacles. The latter hypothesis is supported by the fact that while the digestion is going on, tentacles from other polyps form a roof over the prey and several contracted polyps. This roof of tentacles could serve to slow the escape of a fluid.

Better results might be obtained by running the same trials but with more replicates and more types of zooplankton, concentrating on the smaller end of the spectrum. Stomach content analysis from reef corals coupled with observational data might be the most conclusive test.

Rick:
Good discussion. You could have done more and used fresher corals. You made the most of your observations, though.
John

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