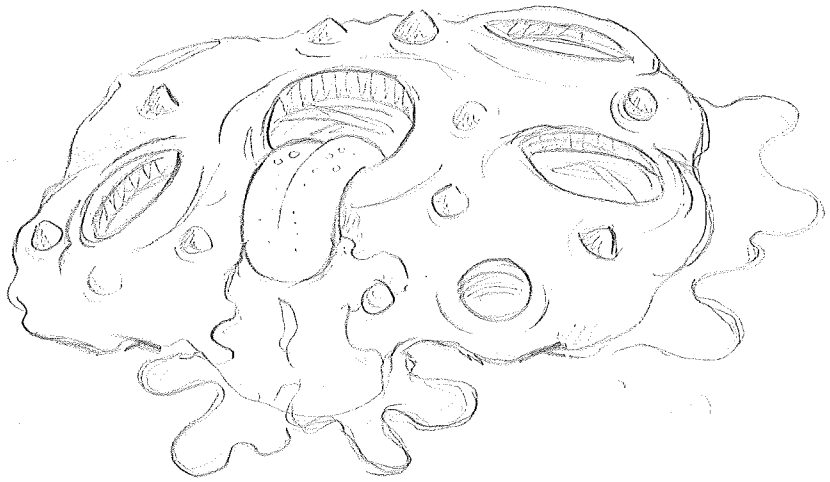
The Benefits of Living in Cryptic Habitats for Porifera, Tunicates, and Bryozoans.



Comments with Mr

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Big FSP 1981
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INTRODUCTION

Cryptofauna has been described as any organism which lives on unexposed substrate (Bakus, 1967). Encrusting Sponges, tunicates, and Bryozoans are often the dominant organisms living under corals on Jamaican reefs.

A variety of theories have been advanced to explain the environmental and evolutionary factors which cause ~~inf~~ invertebrates to live in cryptic habitats. One theory which had its share of adherents in the past was that crypsis is a way of escaping fish predation. (Bakus, 1964). This may not hold true in Discovery Bay; a recent study suggests that fish are only occasional predators of cryptic invertebrates (Proctor, unp.) which have been exposed. Other predators, such as urchins and small crustaceans may be of greater importance in preying on cryptic fauna. (Jackson, 1979). Sedimentation, which tends to clog canals and chambers of porifera (Bakus, 1968), and UV light-induced damage (Tokiel, 1980) are also effects which may select for the utilization of cryptic habitats. Both factors have been shown to cause extreme damage and even death to many cryptic tunicates and sponges, at least under laboratory conditions.

The purpose of our study was to identify the environmental factors which influence the

distribution of cryptofauna in Discovery Bay, and to determine the importance of their contribution to the overall effect. Predation, sedimentation, and incident UV light were three factors which were deemed both important and measurable. The following hypotheses were formed to test this idea:

1) UV light would be an important cause of mortality in cryptic fauna exposed in shallow water (.5-1.5m) but not in those exposed at depth (15m). This is due to the extinction coefficient for UV light, which states that light intensity decreases exponentially with depth.

2) Sedimentation would also be more important in the shallows than at depth. This is due to increased turbulence near the reef crest.

3) Predation by fish and urchins would be more noticeable at depth than in the shallows. This is because the effects of UV light and turbulence-induced sedimentation are mediated by the water column at 15m. Therefore, predation would be the major factor selecting for the cryptic habitat.

The habitat in which an organism lives mediates its morphological characteristics. With this in mind, comparisons between the structure of cryptic and exposed sponges were undertaken, with these hypotheses in mind.

1) Because cryptic sponges are protected from UV light and predation to a far greater degree than exposed porifera, there is no longer a great

advantage to maintain systems which screen UV light by pigments or prevent predation by production of toxins or fibrous networks. A greater portion of cryptic sponges should be fleshy, as opposed to porous and structured, and because many of the systems of defense which consume energy from the growth budget are absent, more effort may be devoted to growth. Regeneration time in cryptic sponges should be more rapid than exposed because of this, and because defense will emphasize repair rather than prevention.

2) Because of the different morphologies between the two groups, cryptic sponges should have a higher rates of wet and dry to ash weight. This is because their encrusting form and protected habitat require a smaller support structure, commonly spongin - which is reduced by exposure in a muffle furnace. There will be a smaller loss in weight after this treatment for cryptic sponges because of smaller amounts (relatively) of spongin, and fleshy encrusters will probably contain spicules, which do not disappear under this treatment.

The "Methods" section explains the details of how these hypotheses will be tested.

A. Sponge Regeneration - Methods

To determine the relative growth abilities of cryptic and exposed sponges, regeneration rates were studied. Encrusting sponges, growing both on and under coral slabs, were collected from the West Back Reef at depths of .5 to 1.5 meters. In the laboratory, square holes of .25 cm^2 were placed in the encrusting sponges by use of a razor blade. Each hole was scraped clean of any sponge tissue clinging to the substrate.

In small sponges of surface area less than 2.5 cm^2 only a single whole was made. In cases when a sponge was deemed large enough to be disturbed repeatedly, several holes were made in various portions of the organisms. It was felt that regeneration would not be impaired if the disturbed region was less than 10% of the total surface area.

Sponges were returned to the West Back Reef and allowed to remain *in situ* for five days. At the end of this period, the sponges were observed to determine the extent of regeneration. Regeneration was defined as the per cent of a hole covered by new tissue.

This study was not repeated at depth due to inclement weather and loss of Mooring Buoy 1 for several days.

B. ANALYSIS OF DISTRIBUTION OF SPONGE BIOMASS

To evaluate the difference in the percent ash weights of the total biomass of cryptic and noncryptic sponges, samples were collected in the field at a seventeen meter depth using scuba gear. In the lab these sponges were prepared for analysis of their wet, dry, and ash weights. Twenty ceramic crucibles were numbered and then heated in a muffle furnace at 600° C for five hours. The crucibles were then allowed to cool in a desicator and then weighed. Meanwhile, the six noncryptic sponges and the four cryptic sponges wereexamined and described, (see table B1). Two samples of four of the six noncryptic sponges were used while due to the lack of biomass for the remaining noncryptic sponge s and the cryptic sponges only one sample per specimen was used. The sponges were removed from their substrates and cleaned. They were cut up, rinsed, and then allowed to soak in distilled water overnight in an attempt to remove inorganic particulate matter. In the case of sample thirteen this proved to be a difficult if not unattainible task but after heating it was posible to remove the grains of $CaCO_3$ with the use of tweesers and a dissecting-scope; this was not possible to do though in the case ofsample eleven. The sponges were allowed to drain for one hour on a dry surface and then placed in the crucibles and weighed for wet weight, (see table B2). The samples were then dried at 90° C for thirteen and one half hours to remove all moisture in the same oven. The dry weights of the samples were likewise measured and recorded, (see table B2), before once again placing them in the furnace and subjecting them to 600° C for six and one half hours. After this time peeiod they were once again placed in a desicator and allowed to cool before being weighed. It was observed at this time that a few of the samples still retained color pigmentation and all of the sponges maintained their structural features. The respective ash weights were recorded but after consultation with colleagues(pers. com. Disco. Bay), it was decided that it was necessary to subject the samples to further heating and thus they were placed in the oven for another five and one half hours at 600°C. Final ash weights were made, (see table B2), and then the ash was examined and dissected using a microscope and pin.

The values measured for each of the samples were then processed. First the various percentages were calculated;: dry weight as apercent of wet weight, ash weight as apercent of wet weight, and ash weight as a percent of dry weight, (see table B2). The dry

ash weight values used were those after the total twelve hour period at 600°C . The arcsin transformation was used to insure that the percentages met the assumptions of the analysis of varience,(see table B.3). The means and standard deviations of both the actual data and the transformed data were compiled for the cryptic and noncryptic populations of sponges,(see table B.4). In defining these populations of sponges, sample eleven was not included in the evaluation. It was impossible to extract the fine particles of $CaCO_3$ from the sample.and therefore the values observed for this sample were skewwed. The Student's T-test was employed to determine the independence of the cryptic and noncryptic sponge populations with respect to the three different types of percent weights previously mentioned

METHODS C.

This study took place at Discovery Bay on the northern coast of Jamaica between February 23rd – March 4th 1981. SCUBA and snorkeling equipment were used to find and experimentally manipulate samples of cryptic sponges, tunicates and bryozoans living under coral rubble. The experiments were conducted at 2 sites one at 1.5 m depth in the West Back Reef and one at 15 m depth at mooring #1 off the West Fore Reef. At each site a group of five coral slabs (or fewer if they were heavily covered with cryptofauna) were placed in ~~several different~~ the following situations: 1) protected from fish and urchin predation but exposed to light, sediment and wave action in a fully enclosed 1cm mesh cage; 2) protected from urchin predation but exposed to fish grazing, light, sediment and wave action in a cage similar to 1 without a top (open cage) 3) fully exposed to all the environmental factors mentioned above by being overturned (see ~~Table C.3~~ Figure C.1). All slabs were placed with cryptic fauna facing up with the exception of the controles which were layed facing down. one controle was placed in each of the cages. The totally exposed rocks ~~at 15m~~ had 5 controls at 15m and ~~at 1.5m~~ one controle at one and a half meter.

An experiment was conducted exclusively at 1.5 m depth. A black enclosure (see figure ~~#3~~ C.1) was placed at the West Back Reef containing overturned cryptic fauna colonies and a controle. This experiment was designed to eliminate ~~predation~~, UV light and reduce sedimentation and wave action.

All ~~coral slabs~~ porifera, bryozoan and tunicate colonies

were sketched in the field before being subjected to experimental manipulations. These sketches noted size, color and general tissue damage of the colonies.

At the end of five days all slabs were collected and brought back to the laboratory for observation under a dissecting microscope. All colonies were classified according to their general structure, texture and color into 22 catagories (Table C-1) Presense of sediment, signs of predation and state of tissue was noted for each colony. Tissue state was examened to see if the tissue was intact or necrotic. If pumping was observed (using carmine) it was noted. Sedimentation was ranked as high (covering 50% or more of the organism and clogging pores), moderate (covering at least 20% of colony), or slight (only traces of sediment. Predation was classified as any colony that was totally missing or had bites taken out of it (Table C-2). Using this table comparasons of various treatments, depths and catagories were made.

We conducted a final experiment in which an Urchin Diadema was placed in a totally enclosed cage with cryptic fauna. This experiment was run for 24 hours to determin if Urchins actually graze on Cryptic fauna.

Results and Discussion-A. Sponge Regeneration

Results appear in Table A.1. A total of 9 species were found, 5 in cryptic and four in exposed environments. To test for a significant difference in regeneration rates between the two groups, a Mann-Whitney U-test was utilized. Significance was not proven ($p < .10$), but indicated that some difference did exist. A significant difference ($p > .05$) was found between growth rates of encrusting fleshy sponges and those whose form was more porous and rigid.

If sponge regeneration initially involves the immigration of adjacent tissue into a damaged area (Jackson, 1980); a sponge whose internal structure is not supported and contained by a spongin lattice may be able to accomplish this tissue migration with greater facility than one who is rigid. Ash weight analysis showed a greater proportional loss in biomass for fibrous sponges than fleshy ones. This indicates a high spongin content in porous sponges, as opposed to an interior support of siliceous spicules in fleshy sponges.

Sponges exposed to predators may utilize

Is this terminal or assumed?

toxicity as well as a porous form to reduce palatibility. This type of defense would stress prevention of predation rather than the rapid repair of damage. Cryptic sponges are found in sheltered habitats where predation pressure is not intense. They may have evolved a system in which the damage caused by the occasional predator is repaired. They may have avoided toxic and physical defense, and by occupying a protected niche, freed themselves to maximize growth by evolving allelopathic defense systems useful in competition for space on the limited cryptic substrate.

An informal survey of sponge populations on the West Back Reef, Fore Reef, and at depths of up to 120' at Rio Bueno shows a definite diversity, density and morphological ~~background~~ gradient. In the shallows, only a few species, mostly encrusters, were found, and 70% were fleshy. In water near 45 ft. in depth 10 species and 18 individuals of sponges, mostly erect and fibrous, were represented. On the wall, at depth, sponges were both extremely abundant, and large, and almost all seemed fibrous. It appears as if the combination of factors including UV light, sedimentation, and turbulence cause reduction in

sponge abundance and favor the selection of a decumbant, fleshy form. Deeper water provides a more hospitable environment for exposed sponges, while there is a fluctuation in cryptic sponge distribution only as the availibility of suitable substrates fluctuates. It was also found that there was a tendency for a dimorphism in growth forms to be present in cryptic and exposed sponges. The trend is for fleshy encrusting sponges to be found in cryptic environments and for large, ~~erect~~ erect, porous sponges to appear in the open. The fleshy sponges, inhabiting a sheltered niche, are not physically well defended - and as postulated, are able to rapidly repair the effects of partial predation. The exposed fibrous sponges have a well evolved predator-defense system, and thus are not exposed to heavy predation pressure. Why co-evolution has not produced a better sponge-eater remains to be answered.

Don:

Classification of sponges as "fleshy", "porous", etc. is too subjective. It might have been more informative to look at skeletons of the tested sponges and describe them according to types of spicules, spongin network,

TABLE: A.1. REGROWTH OF SPONGES: CRYPIC AND EXPOSED ENCRUSTING

SPECIES	DESCRIPTION	% REGROWN (figure for each hole)
A) CRYPTIC		
1)	Brown, fleshy and firm 2mm thick, oscula scattered and visible with binocular scope Size 4×3 cm	5, 10
2)	Flesh Colored, [redacted] rubbery 5-10 mm thick, Oscula 5mm wide. Size 8×5 cm	20, 10, 10
3)	Purple, firm and fibrous 2 mm thick 2×2 cm, no visible osculum	0
4)	Gray, rubbery, oscula 3mm wide, sponge 4 mm thick, size 2×3 cm	5, 10
5)	Green, 5-10 mm thick, porous no visible osculum 3×7 cm	0, 0, 15, 10
B) EXPOSED		
1)	Brown (dark) rubbery, 2mm thick no visible osculum 8×4 cm	5, 5, 10
2)	Purple-Gray - chambered, osculum not visible, sponge 3-5 mm thick	0, 0, 5
3)	Green fleshy, oscula 5mm wide 10 mm thick 5×2 cm	20 %, 10
4)	Brown, mottled with pink, fleshy w. fiber Oscula 3mm wide, 5-8 mm thick 3×4 cm	0, 5

The evaluation of dry and ash weights as percentages of total wet weight indicates that there is a marked difference in the structural components of cryptic and noncryptic sponges. The T-test analysis of the data shows that although there is no significant difference in the dry weights as a percent of wet weights., there is indeed a significant difference between the make up of the two types of sponges' biomass. In the noncryptic sponges the ash or skeletal weight component of the sponge comprised an average of 27.27 %, while this value for the cryptic sponges was only 13.26 %,(see tables B3,4,5,). The distinction between these two sponge populations was at a 99 % confidence level when comparing the values for ash weight as a percent of dry weight and 98 % confidence level for the value of dry weight as a percent of wet weight.

The range of values for the dry weight as a percent of wet weight found in the literature,(Rutzler unpublished, cited in Rutzler,1978) closely match the values found in this analysis; literature means from 13.3 % to 32.4 % compared with the means found in table B5. The ash weights as a percent of dry weights were very similar to the results found by Reiswig (1973) and Dayton (1974, cited in Rutzler) that range around 30% . From the literature it appears that these values of percnts of the various components of the total weight are reasonable results and thus the differences with respect to them between the two types of sponges should not only be looked on as significant but representative of cryptic and noncryptic populations.

The lack of difference in the dry weight as a percent o f wet weight for the two types of sponges confirms that the density of biomass for the two groups is approximately equivilent. The distribution of the biomass for cryptic and noncryptic sponges as a function of the various proportion of weight components on the other hand has been shown to differ,(see % ash weight, table). The implication is that the cryptic sponges are able to concentrate more of their productivity on the production and growth of organic material rather than skeletal material as the noncryptic sponges seem to do. The factor allowing these cryptic sponges to develop a less extensive skeletal architecture is not clear but probably relates to their particular habitat. The rate of sedimentation and the role of suspended particulate concentrations has been suggested by Reiswig (1971) to indirectly

control the degree of skeletal development by determining the sponge tissue architecture as open , closed, or intermediate packing. The extent of packing increases with less suspended material and in conjunction with this increase is an accompaning decrease in the development of skeletal extent. Alternatively it has been proposed that cryptic sponges utilization of the substrate allows them to develop as thin laminar forms that do not require as extensive a skeletal support structure. The adaption of rapid growth to quickly inhabit the limited, exposed substrate and thus displace other potential colonizers as postulated by Jackson (and al , 1980)may be the determining factor in the marked deficiency of skeletal components in these cryptic sponges. A final propositionfor the lower concentrations of skeletal matter and spicules in these sponges in the lack of predation pressure. The need for cryptic sponges to develop defenses against grazing through unpalatability may not be as pressing a matter as in the exposed noncryptic sponges. One or all of these habitat influenced factors may allow or encourage the development of a lower proportion of skeletal material with respect to the overall biomass production of the cryptic sponges.

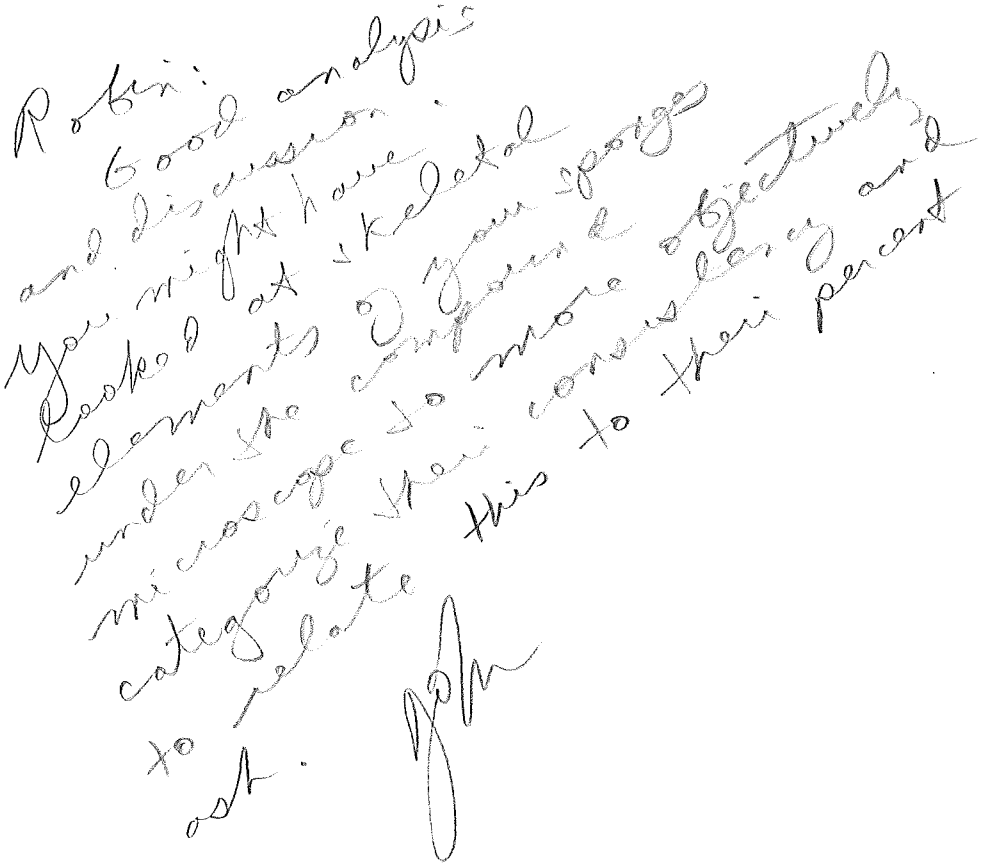


TABLE B1

DESCRIPTION OF THE CRYPTIC AND NONCRYPTIC SPONGE SAMPLES USED IN PERCENT FISH WEIGHT TESTS

A SAMPLES 1+2 : large, brown, erect, tubular sponge - approximately 1 foot in height and 3 inches in diameter; one major osculum; fibrous texture

B SAMPLES 3+4 : flat, disk shaped, brown sponge - approximately 6 inches in diameter, ½ to 1 inch thick; multitude of oscula; fleshy texture

C SAMPLES 5+6 : medium sized, orange, erect, tubular sponge - approximately 6 inches in height and 1 inch in diameter; one major osculum but peripheral side vent oscula as well; fibrous texture

D SAMPES 7+8 : fuzzy, brown, encrusting sponge; with a multitude of oscula; soft, porous, rubbery texture

E SAMPLE 9 : a thorny, horny, encrusting, small, black-brown-green colored sponge, mucus coated; multitude of oscula; rubbery texture

F SAMPLE 10 : small, brown, tubular, encrusting sponge; two oscula; rubbery texture

G SAMPLE 11 : small, yellow to flesh colored, encrusting sponge; multitude of oscula; soft, porous, rubbery texture - difficult to extract all $CaCO_3$ substrate particles from matrix

H SAMPLE 12 : yellow to flesh colored, small, encrusting sponge; found in crevasses; extreme multitude of oscula; soft, porous, rubbery texture

I SAMPLE 13 : small, brown-green, burrowing and incrusting sponge; multitude of oscula, soft porous texture; difficult to remove all $CaCO_3$ particles

J SAMPLE 14 : bright orange, flatten like sponge; one inch in diameter, few oscula, firm, fleshy texture

TABLE B.2 -16-

	Sponge	WET WEIGHT in grams	Dry WEIGHT(g) 90°C for 13.5 hours	Dry Ash Weight(g) 600°C for 6.5 hours	Dry Ash Weight(g) 600°C for 12.0 hours	% Dry Weight of Wet Weight	% Dry Ash Weight (12hr) of Wet Weight	% Dry Ash Weight (12hr) of Dry Weight
NON-CRYPTIC SPONGE SAMPLES	1	11.6886	1.6886	0.3442	0.3374	14.45	2.89	19.98
	2	10.4928	1.5455	0.3041	0.3018	14.73	2.88	19.53
	3	4.8066	0.8696	0.2175	0.2139	18.09	4.45	24.60
	4	5.2089	0.7840	0.2133	0.2081	15.05	4.00	26.54
	5	8.0063	1.2643	0.3861	0.3846	15.79	4.80	30.42
	6	3.5172	0.5718	0.1519	0.1520	16.26	4.26	26.23
	7	4.9554	0.4819	0.2316	0.2295	9.72	4.63	47.62
	8	6.0840	0.4851	0.1896	0.1819	7.97	2.99	37.50
	9	6.9926	1.2714	0.2080	0.1943	18.18	2.78	15.28
	10	2.9172	0.4183	0.1671	0.1046	14.34	3.58	25.01
CRYPTIC SPONGE SAMPLES	11	1.5608	0.1259	0.0960	0.0873	8.07	5.59	69.34
	12	0.3342	0.1420	0.0103	0.0092	42.49	2.75	6.48
	13	0.9201	0.0341	0.0260	0.0058	3.71	0.63	17.02
	14	0.4807	0.0307	0.0057	0.0050	6.39	1.04	16.29

	Sponge	% Dry Weight of Wet Weight	% Dry Ash Weight of Wet Weight	% Dry Ash Weight of Dry Weight
NON-CRYPTIC SPONGE SAMPLES	1	22.34	9.79	26.55
	2	22.57	9.77	26.23
	3	25.17	12.18	29.73
	4	22.83	11.54	31.01
	5	23.41	12.66	33.47
	6	23.78	11.91	30.81
	7	18.17	12.43	43.64
	8	16.40	9.96	37.76
	9	25.24	9.60	23.01
	10	22.25	10.91	30.01
CRYPTIC SPONGE SAMPLES	11	16.50	13.68	56.38
	12	40.68	9.55	14.75
	13	11.09	4.55	24.37
	14	14.64	5.85	23.80

Percent Weight Values angularly transformed using $\theta = \sin^{-1}(\sqrt{\%})$

B.4

$N = 10$

NONCRYPTIC SPONGES	ACTUAL MEAN $\bar{X}$	Actual Standard Deviation σ	MEAN OF ARC Sin TRANS. DATA	Standard Dev. of ARCSIN TRANS. DATA
% Dry Weight of Wet Weight	14.458	3.284	22.21	3.01
% Dry Ash Weight of Wet Weight	3.726	0.798	11.07	1.21
% Dry Ash Weight of Dry Weight	27.271	9.424	32.65	3.84

MEANS AND STANDARD DEVIATIONS FOR THE NONCRYPTIC SPONGES : SAMPLES 1-10

CRYPTIC SPONGES: N=3	ACTUAL MEAN ($\bar{X}$)	ACTUAL Standard Deviat. σ	MEAN OF ARCSIN TRANS. DATA	Standard Dev of ARCSin Trans. DATA
% Dry Weight of Wet Weight	15.165	18.304	22.14	16.16
% Dry Ash Weight of Wet Weight	1.473	1.12	6.65	2.59
% Dry Ash Weight of Dry Weight	13.263	5.885	20.97	5.40

MEANS AND STANDARD DEVIATIONS FOR THE CRYPTIC SPONGES : SAMPLE 12-14

TABLE B.5

	STUDENT T-TEST VALUES	Probability VALUES
Comparison of the cryptic and noncryptic Populations' % Dry weight of Wet weight	T = .00106	P > 0.9 two samples represent the same population
comparison of the % Dry Ash Weights of Wet weight of the cryptic and noncryptic Populations	T = 3.273	P < 0.02 distinct populations
comparison of the % Dry Ash weight of Dry Weight of the cryptic and noncryptic populations	T = 3.491	P < 0.01 distinct populations

RESULTS and DISCUSSION C.

Table #C.2 lists the results found for each test situation using the classifications used in table #1. Of all the cryptofaunal colonies exposed to fish predation in the open cages and to total predation on totally exposed slabs 46% of the shallow water colonies showed signs of predation where only 35% of the deeper colonies did. Since the colonies were initially sketched in the field without the use of a microscope, no quantitative analysis of amount of biomass lost to predation could be made. Predatory fish may have been wary of the open top cages, hence not feeding naturally on the colonies. So considering only the totally exposed coral slabs, 56% of the shallow colonies showed signs of predation verses 39% at 15 meter depth. This slightly stronger trend, with open cages excluded, shows a greater amount of predation in the shallow water site than in the W.S.R site. All control colonies remained intacted.

Signs of predation were considered any area where chunks of tissue were missing. These missing chunks are only circumstantial evidence which may have been caused by factors other than predation such as wave action tossing the rocks about. Fish predation however may have actually been greater at the WBR site since a larger fish population seemed to inhabit this area. It is interesting to note that Bluehead Wrasses and Parrotfish were immediately attracted to newly overturned coral slabs, taking nips at the Cryptofauna. However, after only a few minutes they usually moved on to another area.

There were no signs of sea urchin grazing on fully exposed rocks at either depth. However, some grazing was detected on an orange encrusting sponge in the cage that a Diadema was placed in. These results suggests that sea urchins may cause predation damage to some of the cryptofauna. Sea urchin grazing unlike fish predation removes strips of sponges down to the bear rock. Thus even if sea urchins only occasionally graze on colonies they could cause extensive damage. A longer test period may have shown more realistic sea urchin predation pressures on the colonies.

Three colonies of of Corella minuta, a clear tunicate, were totally removed from their substrate in the open-top cage at 1.5 meters. This finding may have been considered an effect of predation. However 2 colonies of the same species were also missing in the totally enclosed cages. It is possable that UV light caused tissue death and sloughing off of the colonies. Though wave action may have been the detrimental factor. Since this tunicate species was not found on a control or black cage slat, no conclusion can be drawn as to which factor was most more damaging to the tunicate. Its lack of pigmentation may make it more vulnerable to UV light than darkly pigmented species. Jokiel (1980) mentioned several species of cryptofauna that are UV tolerant because their dark pigments can absorb or reflect the harmful light. In sponges carotenoid pigments may serve as photoprotectors since excess solor radiation destroys these pigments before it will decompose the sponge's vital metabolic products (Aspects of Spone Biology 1976)

The proportion of colonies showing signs of tissue death in shallow water cages that were exposed to light was 8/91 or 9% . Tissue death in the dark cage was seen on 2/29 or 7% of the colonies . Both of these dead colonies were Didemnium tunicates from a coral slab that also contained 9 intact Didemnium colonies . The light exposed colonies showing tissue death were from four different cryptofaunal species, indicating a greater range of damage. The control colonies all remained intact.

Since only .02 % of the UV light reaching the waters surface penetrates to 15 meters (according to the extinction coeff. for unfiltered inshore water Riley and Skirrow, 1965). Thus there should be less tissue damage by UV light at this depth than at the 1.5 meter depth were 43.8% of the UV light can penatrate . At 1.5 meter depth, 9% of the colonies exposed to light (thus UV rays) showed necrotic tissue verses 5% at 15 meters . The tissue damage at depth may be explained by the high sedimentation associated with all necrotic tissue here.

The amount of tissue damage found at our 1.5 meter depth was not nearly as dramatic as that found by Jokiel in a 20 cm deep tank . Her results showed a loss of 80% of the rocks' coverage in only 3 days . Few cryptic sponges live in such shallow water that they would receive the amount of UV light that Jokiel's cryptic sponges were exposed to (89.6% of surface intensity). As was mentioned before only 43.8% UV light penatrates to 1.5 meter depth. Furthermore sediment suspended in the water column greatly reduces the amount

of UV light that can penetrate through the water.

Suspended sediment may have added some protection from UV light for the overturned cryptofauna, however it may also play a detrimental role. Many of the colonies had sediment clogging their pores after 5 days of being overturned. A long term study would be required to asses the impact of sedimentation. Our shallow water sample had a higher prevelance of sediment than the deeper water sample did. This could be due to a combination of higher wave action and a sandier bottom in the shallow WBR site. This higher sedimentation may lead in the long run to greater tissue damage.

There are a couple of interesting distributional trends that were found in our crypto-faunal samples. No bryozoans were found on the shallow coral slabs all eleven were found intact at 15 meters. The Didemnanium tunicates showed an opposite trend. There were none found at 15 meters and 15 found at 1.5 meters, only one hemispherical sponge (C and D) was seen at the Fore Reef site where as 13 were found in the shallow site.

More definitive results could have been obtained by with a number of improvements in our methods. A greater number of replicates would have provided more representative data. One of our shallow water open top cages was lost due to rough weather (what else is new!) reducing our sample size slightly. The enclosures we used did not permit us to distinguish the effects of UV light from sedimentation and wave action. A possible way to control for the effects of sedimentation and wave action would be to cover an enclosure with a UV transparent plastic sheet.

The only difference between this cage and the black cage should be the presence of UV light. A more precise ~~method~~ an necrotic assay for quantifying predation would also be helpful. These revisions in methods may have helped to reduce much of the circumstancial evidence that was relied on to obtain our results.

In order to determin the adaptive significance of living in cryptic habitats each cryptofaunal species should be tested for its particular sensitivity to various environmental stresses. Some species with little pigmintation may be especially vulnerable to UV light. Other species with reduced skeletal structure may be highly palatable and vulnerable to predation. Furthermore settling larvae of cryptofauna may be much more sensitive to wave action, UV light, sedimentation and/or predation than their adult form.

Barby and Betsy:
Good presentation and discussion of results. There are several places where you could have used statistics to test for significant differences between frequencies (or percentages).

John

Table #c.1 Classification of Cryptofaunal species

Description of Porifera:

A. Orange Encrusting
Thickness 1mm, osculi microscopic, colony size ranges from 1 cm^2 to 300 cm^2

B. ~~Porous~~ Transparent Encrusting
color ranges from clear or tan to purple or dark gray
osculi usually not seen
porous with a fibrous network, 5-10 mm thick

C. Orange ~~or Green~~ Hemisphere
- protuberances shaped  1mm in length bordering bottom
~~bottom~~ s
- groves forming hexagonal shapes about 1mm in diameter

D. Orange - ~~Yellow~~ Hemisphere
- irregular surface osculi visable about 5mm in diameter

E. Yellow Encrusting
- star shaped skeletal structures (vs. the random arrangement of B)

F. Fleshy Black Encrusting
- ~~About 12~~ osculi multi osculi

G. Bright orange to Red Sponge
- tightly packed fibers (causing light to reflect)

H. Brown Tubular Sponge
- star shaped skeletal structure, no tubular osculi

I. Clear white Tubular
- volcano shaped osculum

J. Light Pink
fibrous, osculi 2mm, 5mm thick, 8 x 3½ cm

K. Light Red Oval shaped
- white central osculum

L. Maroon Fleshy
osculo 5mm groped in center, 5mm thick

M. Yellow Fleshy
- no visible osculum

N. Dark Green Porous
multi osculo 5mm diameter, 1-10 mm thick

Table C1 (cont.)

Description of Porifera (cont.):

O. Bright Red Fibrous
1 m m thick, no visable osculia

Description of Tunicates:

A. Didemnum* sp.


- white, porous, 1-2 m m thick, colonial with common exhalant siphon

B. Red
- 2 siphons visable, 1 cm by ½ cm

C. Black Encrusting (1-2 m m thick)
- glassy, no siphons visable

D. Corella minuta*
- clear, no siphons visable

E. Maroon, colonial
mushroom shaped, stalk creamy red


F. Dark Red
- oval, 5-10 m m thick

G. Aplidia intexta*
- dark green, 7 cm in length, 1 cm in width, massive

Description of Bryozoans:
- all found were orange, red or brown, @ 2 m m thick

*personal communication with Ivan Goodbody on March 1st, 1951

Table #2 Description of the cryptofaunal species after the 5 day test period.

Treatment	(m) depth	Type of cryptofauna	State of tissue	Presence of sediment*	Signs of predation
Fully Exposed	1.5	Porifera: A (Total of 2 colonies)	3 colonies with necrotic tissue	moderate - high	3 colonies totally gone 1 with 5% of original colony remaining
		B (Total of 6 colonies)	1 necrotic 5 intact	" "	5 - present 1 - none
		(2 colonies) C	both intact	" "	none
		(one colony) O	intact	moderate	none
	1.5	(12 colonies) A	1 intact	slight	5 - totally gone 6 - damaged
		(2 colonies) B	2 - intact	" "	1 - two bites taken (20% of biomass) 1 - none
		(one colony) J	intact	" "	none
		(one colony) L	intact	" "	damage around perimeter
		(6 colonies) M	—	—	all 6 totally gone
		(one colonie) N	sloughing (necrotic)	high	none
		(3 colonies) O	intact	slight	none
		Tunicates: (18 colonies) B	intact	slight	15 - none 3 - small pieces removed
		Bryozoans: (3 colonies)	intact	slight	none
Open-top Enclosures	1.5	Porifera: A (1 colonies)	intact	moderate	none
		(4 colonies) B	intact	moderate	1 - present (though slight)
		(one colonie) C	intact	moderate	none
		(2 colonies) ~~(one colony)~~ E	both intact	1 - none 1 - high	both - none
		Tunicates: A (one col.)	no response to touch pores not well defined	none	none
		(3 colonies) D	—	—	3 - totally gone

* high = covering over 50% of the organism and clogging its pores. Moderate = covering ~20% of colony

Table #2 (cont.)

Treatment	(m) depth	type of cryptofauna	total No. of colonies	State of tissue	Presence of sediment	Signs of predation
Open-Top enclosure	15	Porifera: A	~~#~~ 6	5-intact 1-Sloughing	5-none 1-high	6-none
		B	3	1-losing pigment along periphery 1-intact	1-moderate 1-slight	1-totally gone
		M	1	necrotic	slight	present
	Control	M	1	intact	none	none
Closed enclosure	1.5	Porifera: ~~#~~	~~#~~	~~#~~ intact 1-pumping	slight	none
		A	1			
		B	6	all pumping and intact	slight-moderate	1-possibly slight
		C	4	2-pumping 4-intact	high (esp. along edges)	none
		D	2	pumping	high	none
		F	1	pumping	high	none
		M	2	necrotic (turning green)	slight	none
		Tunicates: A	1	degerating inhalant siphons	slight	none
		C	.1	intact pumping	slight	none
		D	2	—	—	both totally gone
		G	1	Pumping (sporadically)	slight	none
	Control	Porifera: A	3	all intact	moderate	none
		B	1	intact	moderate	none
		C	1	intact	high	none
		D	1	intact and pumping	slight	none

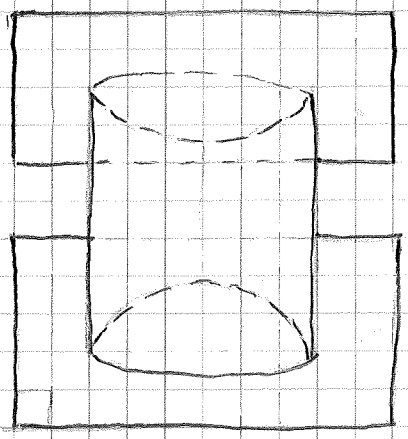
Table #2 (cont.)

Treatment	Depth (cm)	Type of cryptofauna	Total no. of colonies	State of tissue	Presence of sediment	Signs of Predation
Closed enclosure	1.5	Porifera: A	2	intact	slight	none
		B	1	intact	slight	none
		L	1	intact	slight	none
		N	1	necrotic	high	none
		O	1	intact	slight	none
		Tunicates:	5	intact	slight	none
		Bryozoans:	2	intact	slight	none
Black enclosure	1.5	Porifera: A	3	intact	slight	none
		B	8	intact 1 pumping	slight-moderate	none
		F	2	intact	none	none
		Tunicates: A	11	1 slight pumping 8 intact and responsive when touched 2 degenerating pores	slight	none
		B	2	retracted when touched -intact	none	none
		control / Porifera: B	2	2-intact 1-pumping	slight	none
		Tunicates: A	1	retracted when touched -intact	slight-none	none
Controls	1.5	Porifera: B	3	1-Pumping 3-intact	none	none
		C	1	intact	slight	none
		Tunicates: A	1	intact	none	none
		B	1	retracts when touched	slight	none
		C	1	intact, retracts when touched	none	none

Table #2 (cont.)

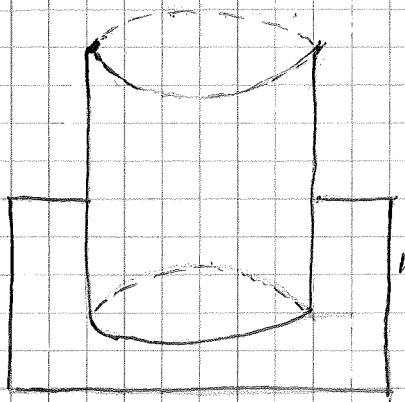
Treatment	depth (m)	type of cryptofauna	total no. of colonies	State of tissue	Presence of sediment	Signs of predation
Control	15	Porifera: A	13	intact 2 pumping	10 none 3 slight	12 none 1 slight
		B	6	intact 2 pumping	4 none 2 slight	5 none 1 slight
		D	1	intact	none	none
		G	2	intact	none	none
		H	3	intact	none	none
		I	1	intact	none	none
		K	1	intact	none	none
		M	1	intact	none	none
		Tunicates: E	1	retracted when touched -intact	none	none
		F	3	all retracted when touched -intact	none	none
		Bryozoans:	6	all intact	slight	none

Table #3 Enclosures
Figure C.1



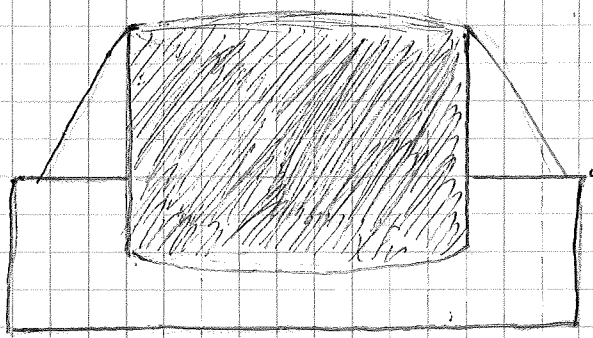
1cm Plastic mesh top, bottom and sides

Totally Enclosed prevents fish grazing and urchin predation but exposed to sedimentation, wave action and light



1cm plastic mesh bottom and sides

Open Top Enclosure
protected from urchin grazing but exposed to light sedimentation and wave action



1cm plastic mesh bottom and sides same as open top enclosure but twice the diameter
dark plastic garbage bags tied to inside of of mesh and over the top of the cage

Black Enclosure
protects against light and predation reduces sedimentation and wave action

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