# Investigations on Black Coral in Salt River Submarine Canyon, St. Croix, U.S.V.I.

## Final Scientific Report 80-12

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# Investigations on Black Coral in Salt River Submarine Canyon St. Croix, U.S. Virgin Islands

by

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U.S. Virgin Islands
NULS-I Mission 79-5 and
80-12

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ABSTRACT:

An initial survey was conducted during NULS-I Mission 79-5, October 1-11, 1979. Approximately 300 black coral colonies of both local species, Antipathes salix and Antipathes pennacea, were measured and tagged. Vertical distribution and abundance were also determined. During a second mission, 80-12, November, 1980, colonies were remeasured to produce information on growth parameters and mortality.

The Von Bertalanffy growth parameters for A. salix were $L_{oo}$ = 54.9 mm (basal diameter), $t_o$ = .346 years and k = 0.0159. Natural mortality was determined to be 4.1% per year. Since this area of investigation is protected from harvest by the Hydrolab operation, this is considered to be an estimate of natural mortality (m = 0.0413).

Average density was 375 colonies per hectare and the highest abundance was found below 30 m. Depth maximum abundance was found to be 30.6 m for A. salix and 32.3 m for A. pennacea on the west wall of canyon, and 36.6 m for A. salix and 41.2 m for A. pennacea on the east wall.

## INTRODUCTION:

Although precious corals have been harvested since antiquity, management potential was only realized in the last few years (Grigg, 1977). Grigg's (1971) work with the Hawaiian black coral fishery, which was under heavy exploitation (Poh, 1971), has provided the first fishery management opportunity for this resource.

In the U.S. Virgin Islands increased tourism has created a burgeoning market for black coral to be used in jewelry. There are an estimated 50 jewelers that incorporate black coral into their product. These individuals are currently supplying their needs from foreign and/or illegal domestic sources. Virgin Islands Law No. 4849 prohibits harvesting of all corals from the waters of the U.S. Virgin Islands.

The purpose of this study was to gather information to assist the local government in determining if the fishery could be opened to legal exploitation.

The information gathered was used to furnish first approximations of the basic population parameters of growth and total mortality. Data was also collected on colony distribution and abundance.

SITE DESCRIPTION:

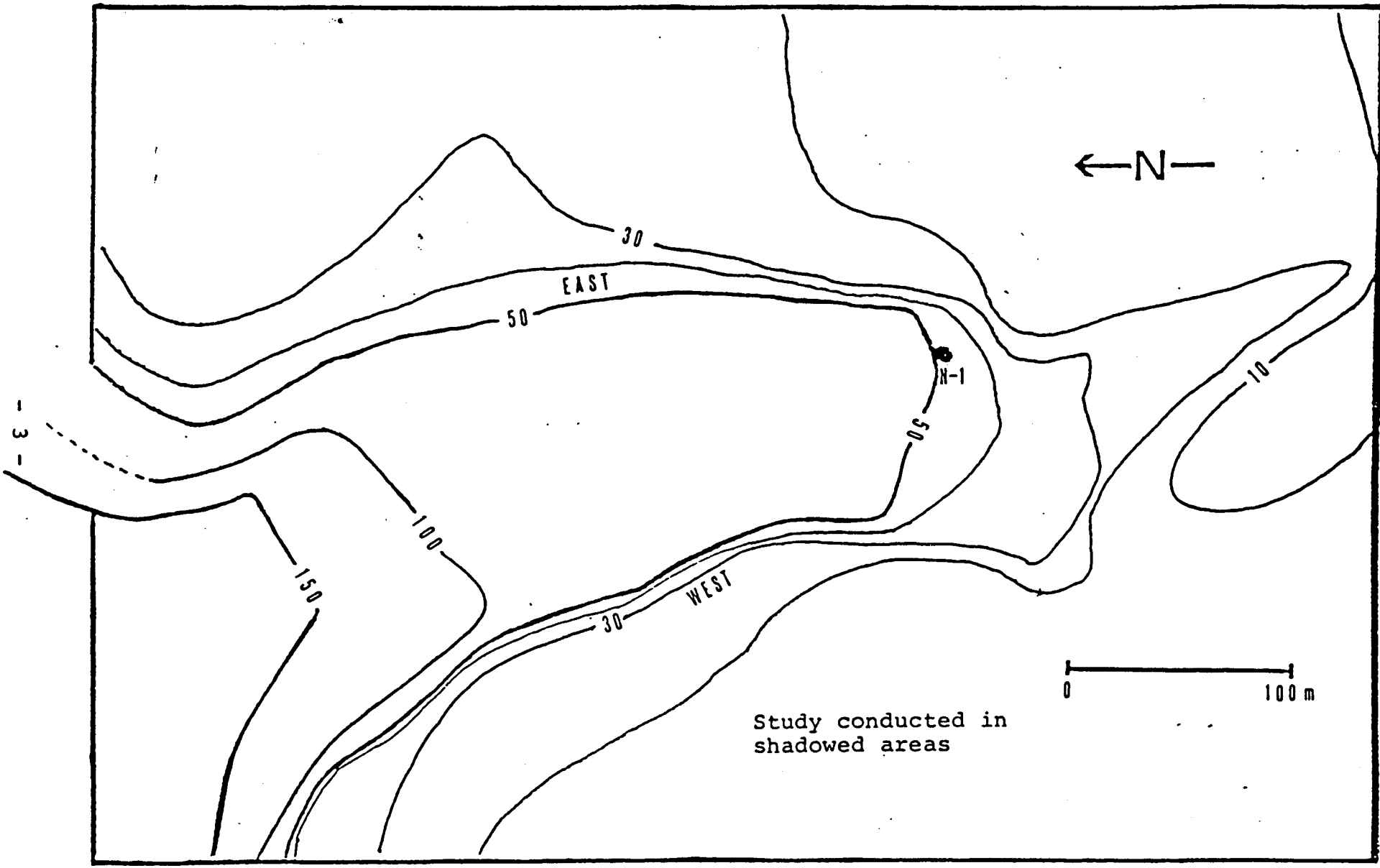
This study was carried out utilizing saturation diving techniques from NOAA's Underwater Laboratory System-I (NULS-I) situated in 15 meters of water near the head of the Salt River submarine canyon on the north coast of St. Croix, U.S. Virgin Islands. The canyon head is at the barrier reef which fronts the Salt River estuary. It extends north-northwest for 450 m, across the St. Croix insular shelf downward to a depth of 3,500 m, where it joins the larger Christiansted canyon (NULS-I Operations Manual).

The east and west walls of the canyon are morphologically quite different. The west wall is very steep, with overhanging cliffs cut by sediment-filled tributaries, while the east wall is much more gradually sloping, with a cobble-border substrate. Distribution of these species of black corals has been shown to be affected by the angular orientation of the substrate (Oakley, 1981).

This study was conducted along the east and west canyon walls from a depth of 15 to 46 meters (Figure 1).

Fig. 1.
Study Area in Salt River Canyon, St. Croix

Map



**TECHNIQUES:**

Site selection on the east and west walls was determined by depth contours of between 50 and 150 feet and an outward boundary line that was placed during previous missions.

Within the study sites an attempt was made to measure and tag each individual colony. During the second mission, approximately 20 percent more colonies were found than during the first mission. It is now assumed that at least 90 percent of all the colonies have been tagged.

The basal diameter of each colony was measured at its thickest point using vernier calipers, while the height and width was measured with a tape measure. These latter measurements are greatly affected by water movement since both species apparently lack the morphological rigidity which has enabled Grigg (1977) to utilize these whole colony measurements for growth analysis. Consequently, most of the subsequent analysis has emphasized basal diameter measurements. After measurements were obtained, numbered plastic tags were tied onto the colonies for identification purposes. Tag loss during the project is assumed to be zero.

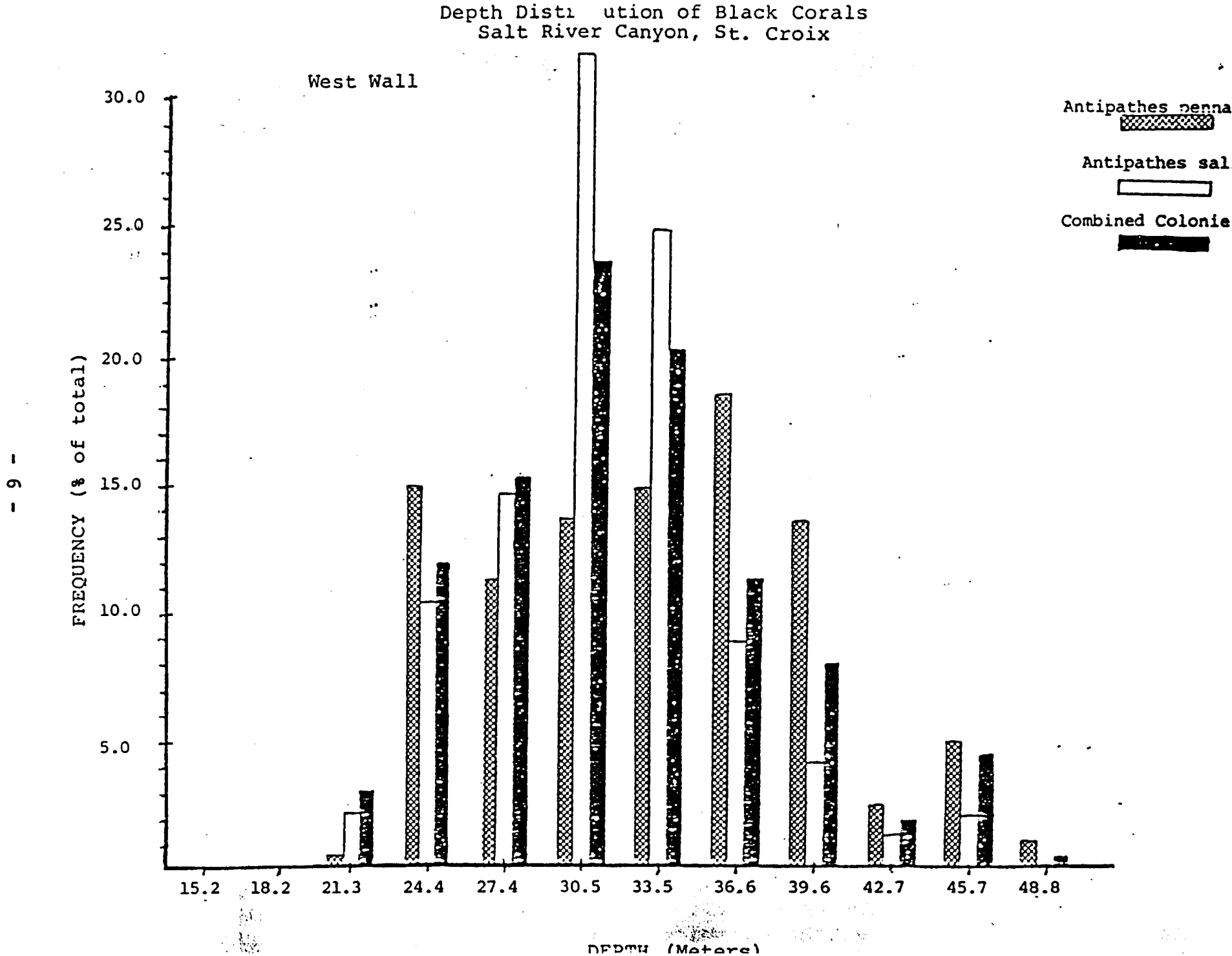
RESULTS:

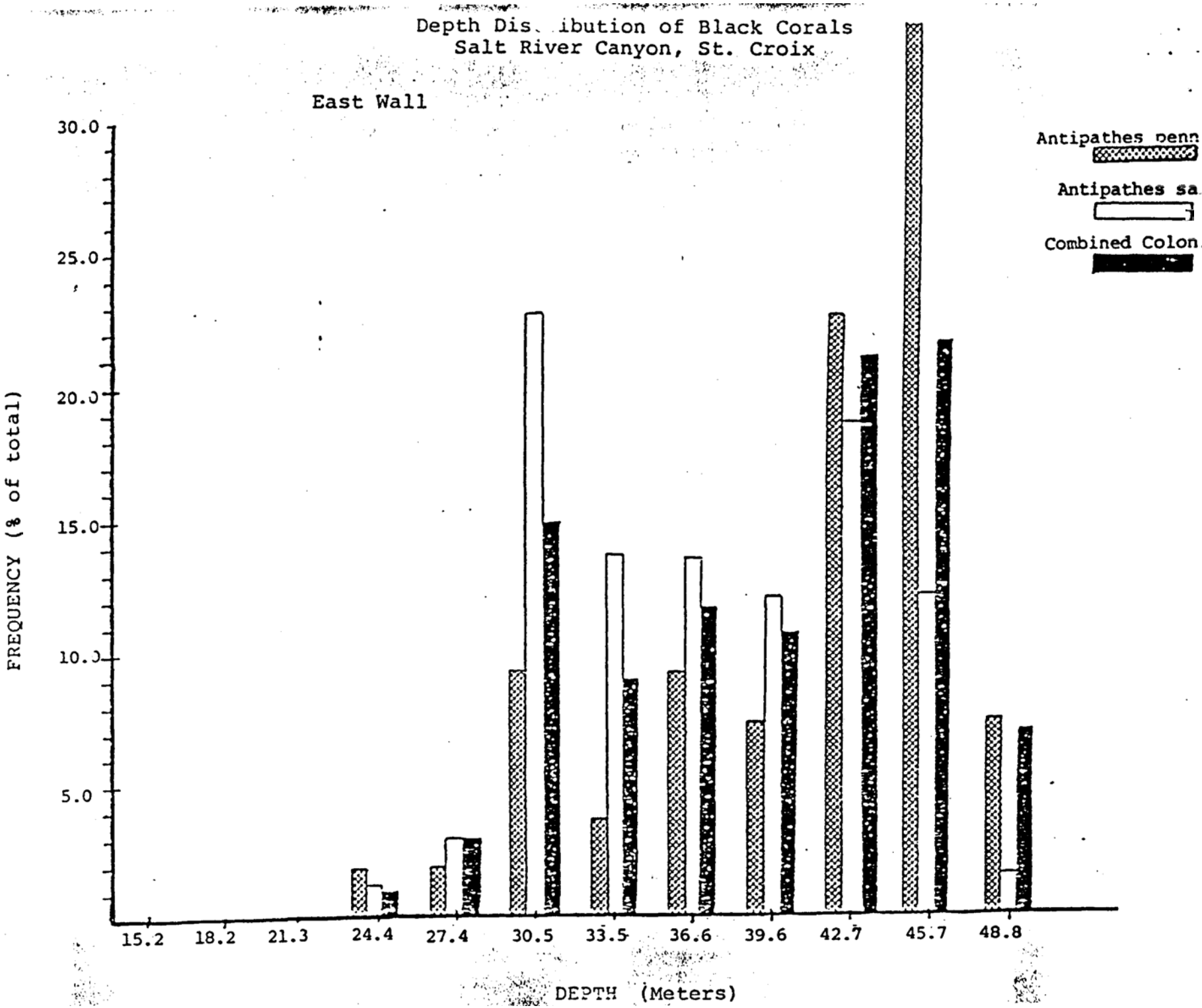
Distribution and Abundance

Basal diameter of 210 colonies of Antipathes salix were measured. One hundred forty-five (145) were tagged and remeasured during the second mission. One hundred thirty four (134) colonies of Antipathes pennacea were measured and 90 were tagged and measured during the second mission.

The depth of peak abundance (Figures 2 and 3) of A. salix was 30.6 m (SD = 4.7) on the west wall and 36.5 (SD = 5.95) on the east wall. This difference was significant at the 0.01 level (df = 208, t = 7.915). For A. pennacea the depth of peak abundance was 32.3 m (SD = 6.5) on the west wall and 41.2 m (SD = 6.02) on the east wall. This difference was also significant at the 0.01 level (df = 132, t = 7.968). The mean depth for A. pennacea was 35.3 m (SD = 8.3) while the mean for A. salix was 32.3 m (SD = 5.8). This difference was significant at the 0.01 level (df = 343, t = 3.88).

The natural mortality rate suggested from this study was .04. Grigg felt that natural mortality was between .05 and .09 with the Hawaiian A. dichotoma. Our results are consistent with these.


Depth Distribution of Black Corals
Salt River Canyon, St. Croix
West Wall
Antipathes penna
Antipathes sal
Combined Colonie
FREQUENCY (% of total)
30.0
25.0
20.0
15.0
10.0
5.0
15.2
18.2
21.3
24.4
27.4
30.5
33.5
36.6
39.6
42.7
45.7
48.8
DEPTH (Meters)


Depth Dis. ibution of Black Corals
Salt River Canyon, St. Croix
East Wall
Antipathes penn
Antipathes sa
Combined Colon
FREQUENCY (% of total)
30.0
25.0
20.0
15.0
10.0
5.0
15.2
18.2
21.3
24.4
27.4
30.5
33.5
36.6
39.6
42.7
45.7
48.8
DEPTH (Meters)

Abundance for both species was calculated by determining the area of each 10-foot contour using the graphics tablet program on an Apple computer. The results are given in Tables 1 and 2. The average density for both walls is 375 colonies per hectare.

Growth

The average size basal diameter for Antipathes salix in year one of the study was 11.06 mm (SD = 7.68). This increased to 11.76 mm (SD = 7.67) by the second year. For Antipathes pennacea the mean diameter was 11.07 mm (SD = 6.5) in year one and 11.88 mm (SD = 6.5) in year two. This difference in yearly mean sizes is not statistically significant when tested with a t-test. For the purposes of this study only the growth and mortality rates of Antipathes salix were determined due to the facts that there were fewer observations of A. pennacea and the observed growth was extremely variable. Also, Antipathes salix is historically the major commercially sought species.

The size frequency data on the basal diameter of 184 individual colonies of Antipathes salix (Figure 4) was analyzed by probit analysis (Harding, 1949) for the presence of size classes.

Table 1. Areas of Depth Contours in Study Site

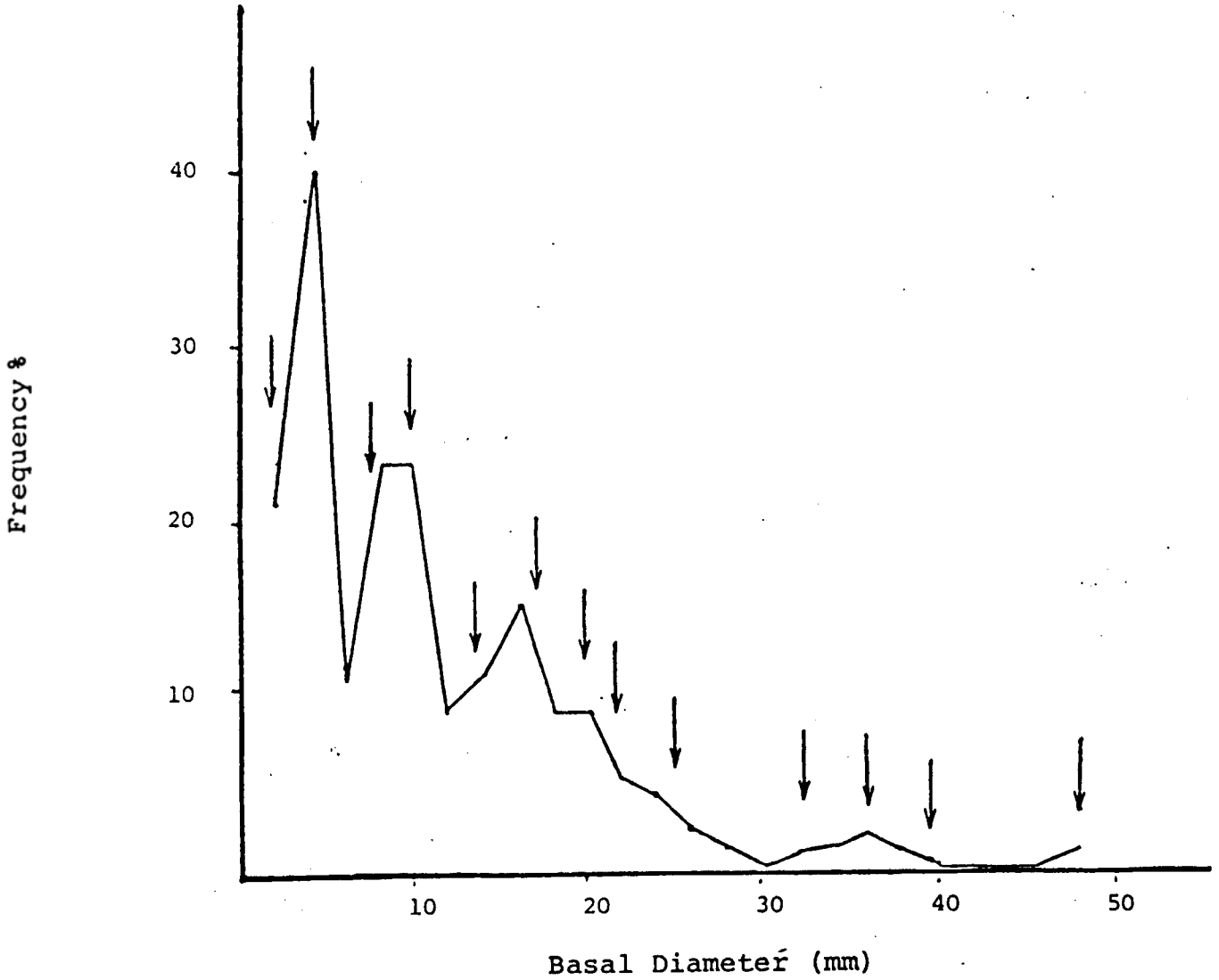
| Depth Contour (feet) | Area $M^2$ West Wall | Area $M^2$ East Wall |
|---|---|---|
| 50-60 | 519 | 1,027 |
| 60-70 | 269 | 443 |
| 70-80 | 351 | 463 |
| 80-90 | 396 | 520 |
| 90-100 | 398 | 548 |
| 100-110 | 390 | 572 |
| 110-120 | 653 | 611 |
| 120-130 | 695 | 650 |
| 130-140 | 422 | 655 |
| 140-150 | 521 | 584 |
| Total | 4,614 | 6,073 |

Table 2. Black Coral Density in Colonies/Hectares on Study Site

| | West Wall | East Wall | Combined |
|---|---|---|---|
| *Antipathes pennacea* | 175 | 87 | 125 |
| *Antipathes salix* | 314 | 92 | 196 |
| Combined | 570 | 227 | 375 |

**Figure 4**

Size frequency distribution for Antipathes salix
Arrows denote size classes determined by probit analysis



The results of growth on colony height and width for both species of Antipathes is shown in Figure 5.

Growth was determined by plotting the basal diameter in 1979 against the 1980 measurements using the standard Walford plot (Walford, 1946). The parameters of the Von Bertalanffy growth equation were derived.

$$L_t = L_{oo}(1-e^{-k(t-t_o)}) \qquad (1)$$

where $L_t$ = basal diameter at time t $L_{oo}$ = asymptotic basal diameter e = base of natural logarithm
$t_o$ = time at which basal diameter was zero
k = Brody growth coefficient

The parameters for the Von Bertalanffy growth equation are $L_{oo}$ = 54.9 mm, $t_o$ = .346 years and k = .0159. Using these parameters a growth curve was constructed which describes the growth of Antipathes salix (Figure 6).

A regression of colony height and basel diameter was found to be linear with an equation of:

**Figure 5**

Height, Width and Growth of Antipathes salix and Antipathes pennacea during one-year period.

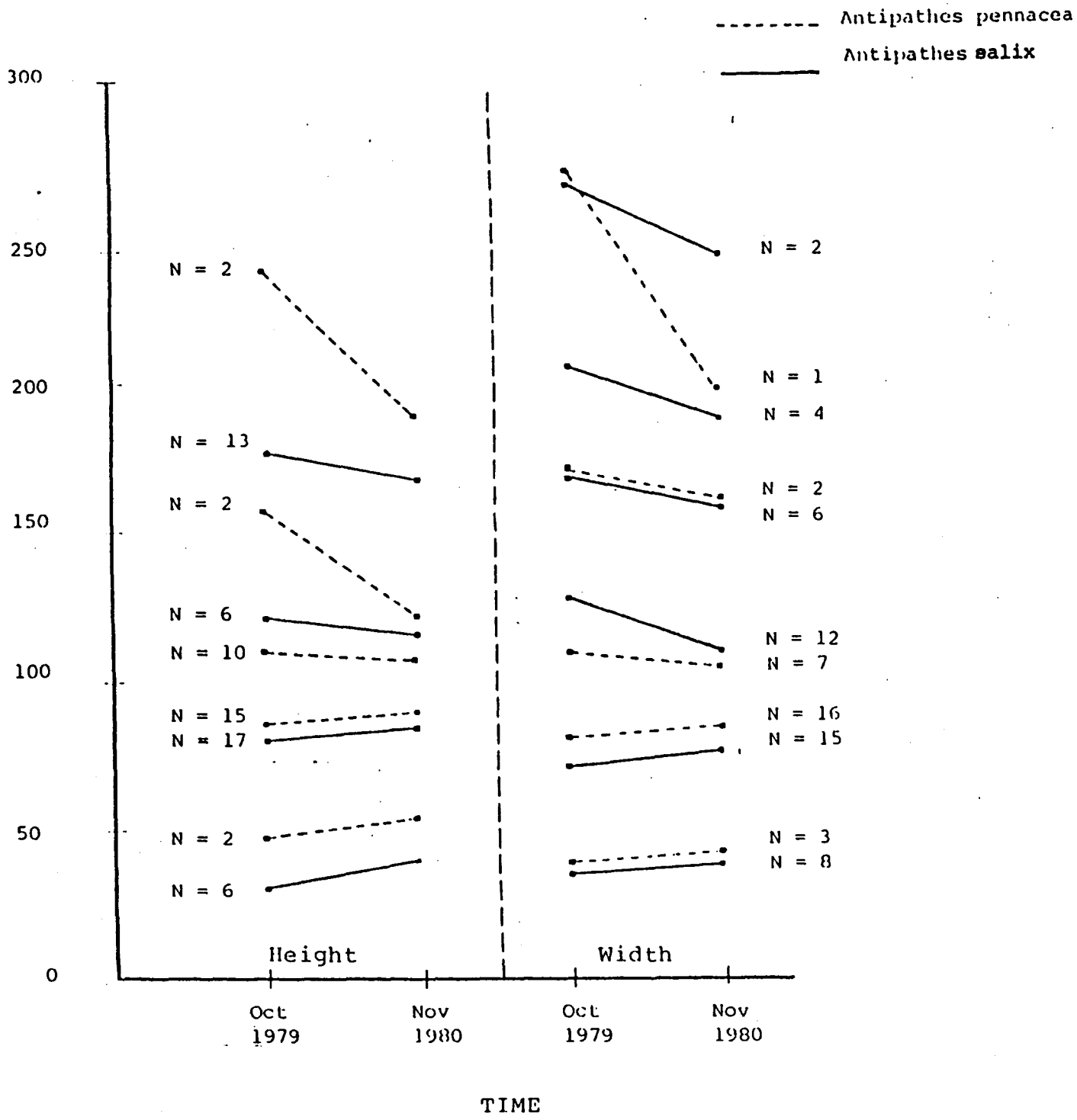
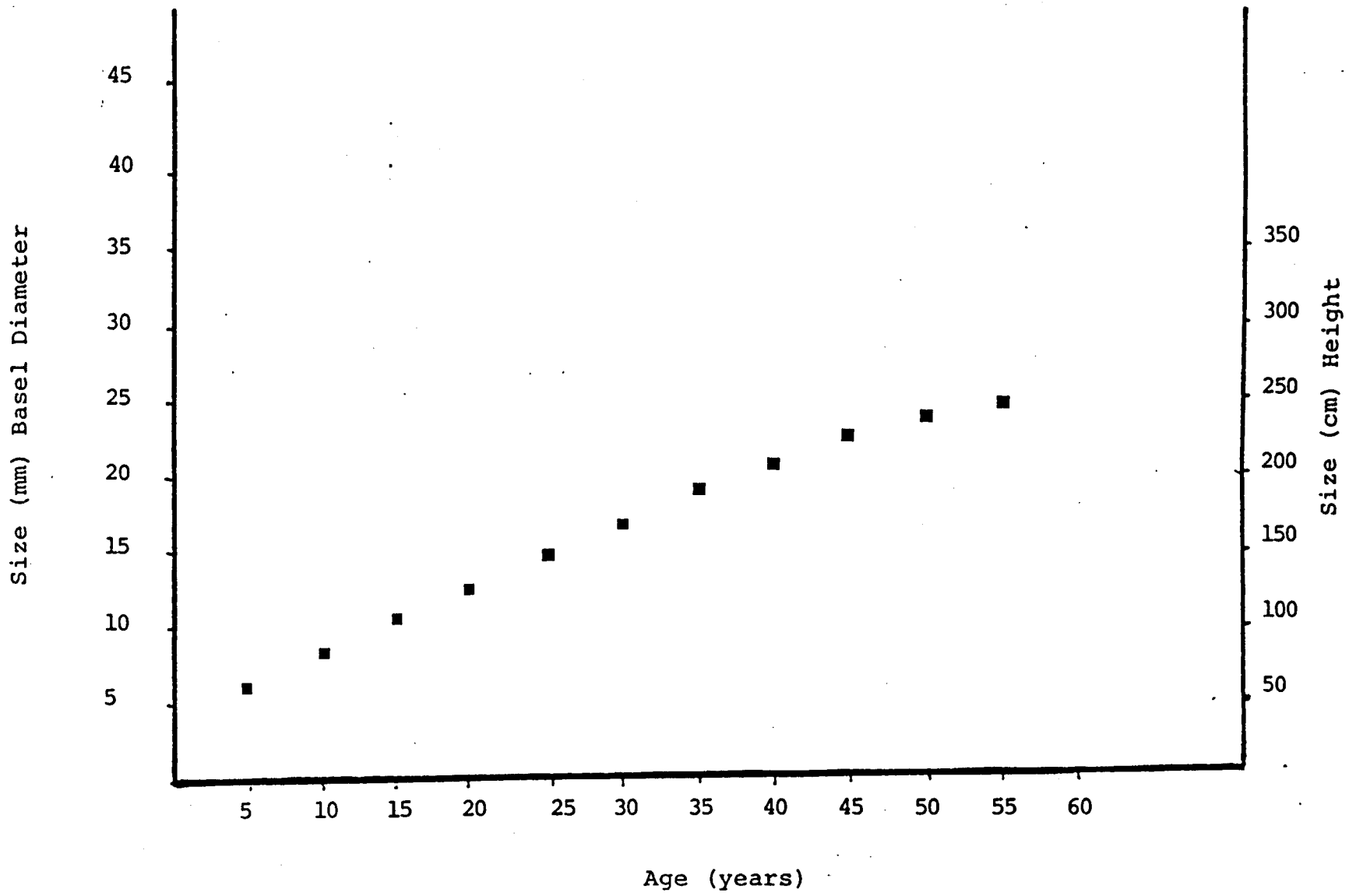


Figure 6

Growth curves of Antipathes salix



$$H = a + D(b) \qquad (2)$$

where H = colony height D = basal diameter a and b = constants

The linear regression for this relationship produces values for (a) to be 26.11 and for (b) to equal 6.9.

Mortality

Annual mortality rates (M) were estimated from equation $N_t = N_{t-1}$

$$(e^{-Mt}) \qquad (3)$$

where: N is the number of individuals surviving from time t-1 to t.

The method employed is outlined in Olsen and Koblick (1975). Briefly summarized it consists of deriving size class means and standard deviations from a polymodal frequency distribution by probit analysis. A z score is derived and number of individuals is then calculated using a table of normal probabilities and the frequency of individuals in the modal size classes.

This technique provided an estimate of 193.9 individual colonies of Antipathes salix as compared to the actual number in the sample which was 184, or within 5 percent of the actual figure.

The recapture data indicated that these size classes are not age classes so that it became necessary to back calculate the mean age of each size class from the Von Bertalanffy equation which was transposed to calculate age; given the modal size class average $L_t$

$$t = ((\ln(1-l_t/l_{oo}))/k) + t_o \qquad (4)$$

The interval between size classes was then calculated. This interval was divided into M from equation 3, the annual rate of natural mortality. The parameter M was then calculated from equation

$$M = (\ln(N_i/N_{i-1}))/t \qquad (5)$$

where N is the number of individual colonies estimated in the i and (i-1) size classes and t is the interval in years between those classes.

Table 3. Calculations of Natural Mortality (M) from Size Frequency Data

| Interval No. | Basal Diameter (mm) | Age In Years | No. In Size Class | Length of Interval (Yrs) | Mt | M |
|---|---|---|---|---|---|---|
| 1 | 1.5 | 2.1 | 13.4 | | | |
| | | | | 3.04 | -1.182 | -.388 |
| 2 | 3.9 | 5.1 | 43.7 | | | |
| | | | | 4.15 | .806 | .194 |
| 3 | 7.2 | 9.3 | 19.5 | | | |
| | | | | 2.85 | -0.849 | -.298 |
| 4 | 9.3 | 12.1 | 45.6 | | | |
| | | | | 5.00 | 1.072 | .214 |
| 5 | 12.8 | 17.1 | 15.6 | | | |
| | | | | 5.70 | -0.321 | -.056 |
| 6 | 17.0 | 22.8 | 21.5 | | | |
| | | | | 3.00 | .394 | .131 |
| 7 | 18.8 | 25.8 | 14.5 | | | |
| | | | | 5.50 | .546 | .099 |
| 8 | 21.8 | 31.3 | 8.4 | | | |
| | | | | 7.50 | .934 | .125 |
| 9 | 25.5 | 38.8 | 3.3 | | | |
| | | | | .70 | -0.029 | -.001 |
| 10 | 32.5 | 39.5 | 3.4 | | | |
| | | | | 14.10 | .435 | .031 |
| 11 | 37.0 | 53.6 | 2.0 | | | |
| | | | | 7.90 | .000 | .000 |
| 12 | 40.0 | 61.5 | 2.0 | | | |
| | | | | 7.80 | .788 | .016 |
| 13 | 48.0 | 69.3 | 1.0 | | | |

$\bar{X}$ = .0413

SD = .141

The results shown in Table 3 produced estimates of natural mortality which ranged between -0.388 and 0.214. The first size class was discarded because it includes obvious recruitment. The average of the remaining 11 intervals was 0.0413/yr (SD = 0.141).

DISCUSSION:

Grigg (1965) concluded that light is the principle factor which controls the depth distribution of Hawaiian Antipathes grandis. During this study, the minimum depth in which black coral colonies were observed was 65 feet. As Grigg concluded, light is believed to be the determining factor affecting this minimum depth.

The variation in depth distribution between the east and west walls in Salt River Canyon, St. Croix is most likely due to the different topography of the walls. The west wall is very steep with a good deal of suitable habitat at all depths, while the east wall has discontinuous habitat areas. It is more gradually sloping with a cobble-boulder substrate.

Planned future studies will concentrate further on abundance of black coral colonies around the St. Croix

shelf. Collecting permits have been obtained to harvest a small sample of colonies which can be aged by ring count in order to calibrate the growth curves and which can also be used to obtain yield data.

The results of growth on height and width are shown in Figure 4. Only a small amount of growth was seen in the smaller animals, while negative growth was seen in the larger animals. This is believed to be caused by the fact that three hurricanes, Frederik, David and Allen, passed very close to this area and heavy wave action and currents, as well as considerable siltation, may have eroded the colonies. The smaller colonies have less surface area to be eroded and also have faster growth rates, which would explain the positive growth they showed. The larger colonies have a greater amount of surface area to be affected by wave action and strong currents, and also have a slower growth rate. They would take much longer to recover from the affects of storms.

The average observed basal diameter growth rates were .7 mm for Antipathes salix and .81 mm for Antipathes pennacea. These figures compare favorably with the results of Oakley (1981) in Jamaica who showed an average yearly growth rate of .92 mm/year basal diameter.

These growth results are also similar to Grigg's (1976) study of Antipathes dichotoma in Hawaii. Grigg predicted that a colony of 2 m height would be 40 years old. This figure is very close to our results. Oakley (1981) measured colonies on a shipwreck which sunk in 1944. He estimated that a 35-year-old colony of Antipathes pennacea would have a basal diameter of 32 mm and a height of 199 mm. Our results would indicate that a similar aged colony of Antipathes salix would have a basal diameter of 23.3 mm and 186 mm height. We feel that these results are comparable, particularly if the growth rate during the study period was slowed by storm effects.

CONCLUSION:

The study of a very slow growing animal such as a black coral can be made extremely difficult by year-to-year variations in growth rate. A third mission would improve the results, then three data points over three years for growth and mortality should produce the necessary information for a very accurate picture of the dynamics of black coral. Major conclusions based on this study are:

1. Mean depth for Antipathes pennacea (35.3 m) was significantly deeper than Antipathes salix (32.2 m).

2. Vertical distribution and abundance varied from east and west walls due to differing topography and bottom substrate. The peak abundances occurred at 100 feet on the west wall and at 140 feet on the east wall. The density for the entire study site was 375 colonies/hectare. The average size colony had a 11.8 mm basal diameter.

3. Growth parameters were derived using Von Bertalanffy growth equation for the basal diameter of Antipathes salix. These parameters were $L_{oo}$ (asymtotic size) = 54.9 mm, k (Brody growth coefficient = 0.0159, and $t_o$ (time at which size equals 0) = .346 years.

4. Growth appeared to be slow and in larger colonies. The height and width showed negative growth. This is believed to be caused by three hurricanes which passed by the area during the study times.

5. Mortality estimates were based on size class means and frequency distributions. The average natural mortality determined was 4.13% per year (sd = 0.141) as determined from the size frequency data and .01% from the recapture data.

ACKNOWLEDGMENT

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## APPENDIX A

### PERSONNEL Mission 79-5:

Aquanauts - David A. Olsen, Principal Investigator
Brian Friedman Kenneth Turbe

Surface Support - Michael O. Sheen
William Jones

### Mission 80-12:

David A. Olsen
Brian Friedman
Gerald McCrain

Surface Support - Henry Saludes
Kathleen Hall

### Staff:

Rick Rounds
Kevin McCarthy Rod
Catanach William
Shane, M.D. Barry
Walden John Fish

## APPENDIX B

The data and results obtained during this mission will be the basis to produce management objectives for the black coral fishery. It is hoped that a third and final mission may be made to more accurately determine growth and use structures of black coral. This information would then be published in a scientific journal as a Management Plan for the Virgin Islands Black Coral Fishery.