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LA CHALUPA MISSION # 12
FINAL REPORT

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LA CHALUPA MISSION #12

FINAL REPORT

by

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PREFACE

In June 1974 the Puerto Rico Nuclear Center under contract to the Puerto Rico Water Resources Authority completed a research mission utilizing the underwater habitat, La Chalupa. The study site was located off the north coast of Puerto Rico in the Barrio Islote area. The habitat was located 900 meters offshore in 22 meters of water.

Seven scientists and technicians from the Puerto Rico Nuclear Center Mayaguez laboratory composed La Chalupa Mission #12 research and support team.

La Chalupa Mission #12 Team

Paul H. Davis, Research Associate II	Benthic Studies
*Joseph J. Kimmel, Research Associate II	Ichthyology
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*Roberto Castro, Scientific Associate II	Benthic Ecology
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*Aquanauts

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INTRODUCTION

The Islote area on the north coast of Puerto Rico, approximately 7.5 miles east of Arecibo, is under consideration as a nuclear power plant site (Figure 1). The Puerto Rico Nuclear Center (PRNC) has been contracted since 1973 to collect both physical and biological baseline data on the marine environment at this site. Programs have been initiated to investigate the ichthyofauna, benthic invertebrates and algae, phytoplankton, zooplankton, and the physical environment (refer to Environmental Report, North Coast Nuclear Plant no. 1, Ch. 2, section 2.7). The underwater habitat, La Chalupa, was made available for 16 days in May and June 1974. This facility allowed PRNC staff an opportunity to evaluate the ecology of the area from a different perspective -- the bottom of the ocean.

A team of two invertebrate zoologists, one ichthyologist, and one phytoplanktologist entered La Chalupa which was positioned approximately 900 meters offshore in 22 meters of water (Figure 2). The team had access to 4×10^4 m^2 of bottom for the duration of the mission. Within this area, different habitats were determined, observations were made, and samples were collected. The three other team members provided support for the aquanauts.

<u>Benthic Communities</u>. The invertebrate zoologists were primarily interested in the relative distribution of the dominant benthic flora and fauna. The ecological relationships of several commercially valuable organisms such as conch, lobster, and crabs were investigated. The bottom was first mapped and subareas were designated for sample collection. Several physical parameters (sedimentation, sediment transport, and currents) were considered in relation to animal distribution.

<u>Fish Sampling</u>. The PRNC-PRWRA ichthyology program began in June 1973. Fish traps, surface and bottom gill nets, spear guns, and rotenone fish poison had been used for sampling from the R/V Sultana. With the aid of La Chalupa most fishes could be observed, including those not previously captured, and their abundance and importance in the area estimated. At the same time, the efficiency of fish traps as a continuous sampling device was evaluated first hand.

<u>Phytoplankton Sampling</u>. The phytoplanktologist gathered data during the mission to provide supplemental information to the phytoplankton survey of the area in the form of: identification of populations and major species near the bottom; determination of changes which might occur in the populations as a result of tidal influences or time of day; and determination of a crude idea of productivity in the study area by use of cell counts, chlorophyll measurements, and dark-light bottle studies.

This was the first research team to use La Chalupa for continuous survey work within an existing program. Therefore, evaluation of the facility as a survey tool is presented in the final section.

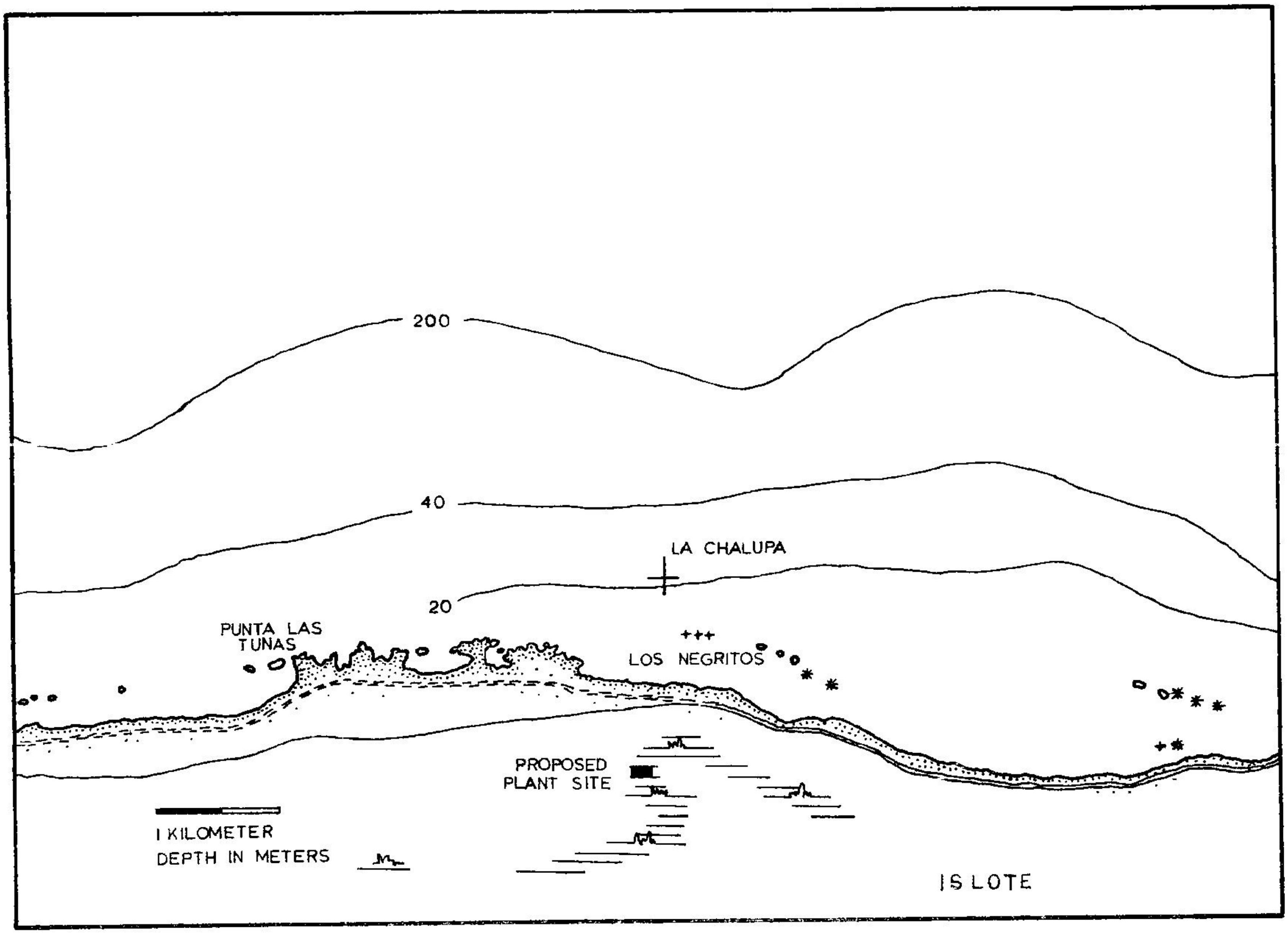


Fig. 1. Barrio Islote, Puerto Rico proposed nuclear power plant site with La Chalupa habitat position.

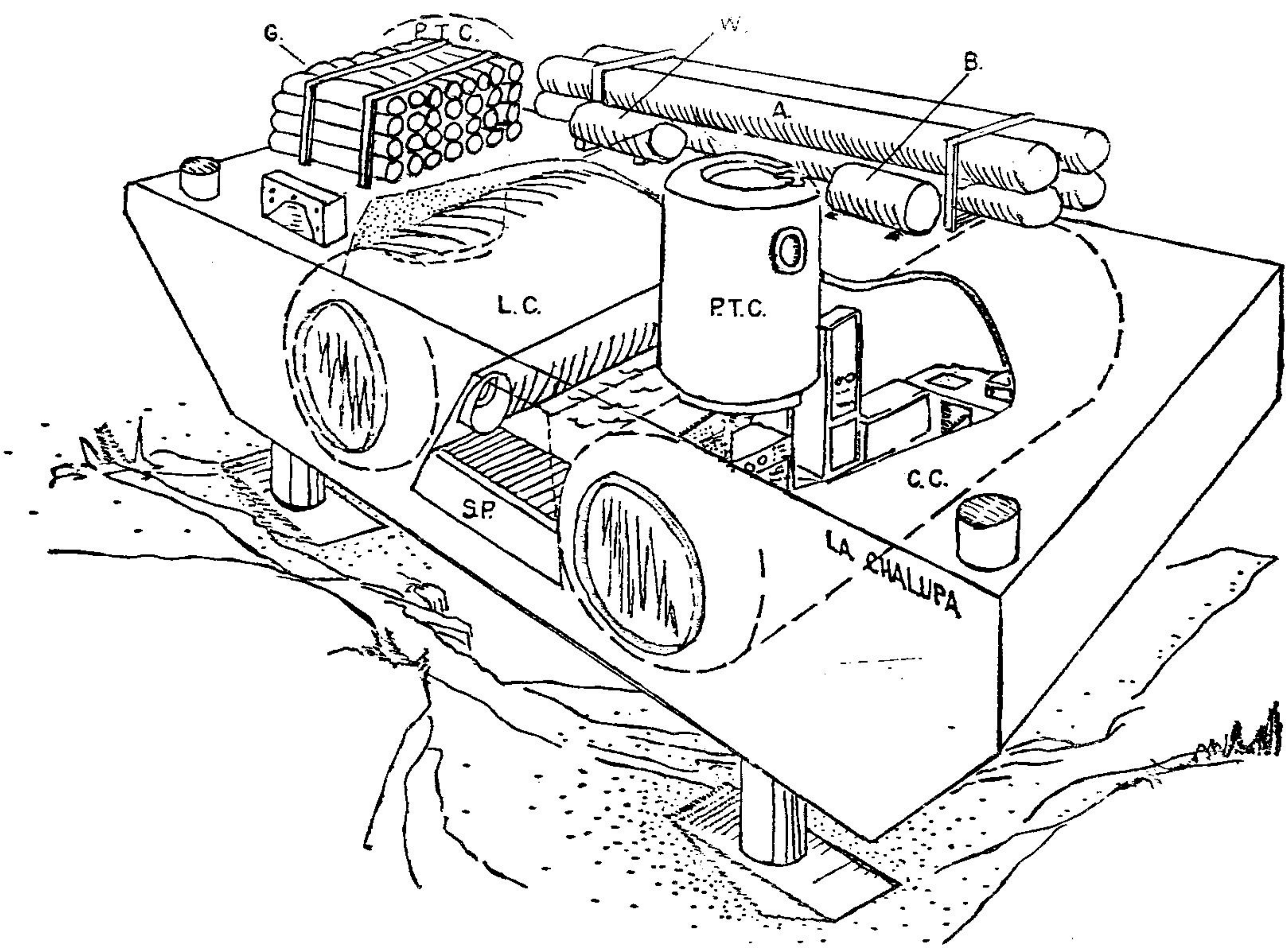


Figure 2. Drawing of "La Chalupa" undersea laboratory showing the position of the living compartment (LC), control compartment (CC), and subport (SP) within the barge structure. On deck the high pressure oxygen and nitrogen storage rack (G) is at the bow while the high pressure air (A), reserve water (W) and battery power (B), and two personnel transfer capsules (PTC) take up the remaining deck space. The structure is supported by four adjustable pneumatic legs.

I. BENTHIC COMMUNITIES

Methods and Materials

Four 100 meter transect lines of 1/8" nylon rope, marked at 10 meter intervals, were laid out from La Chalupa in north, south, east, and west directions. Iron rods were driven into the bottom to hold the lines down. Notes were taken on community changes, geographic features, and the abundance and habits of commercially valuable species. Additional observations were made on feeding habits, population relationships, habitat preferences, and diurnal/nocturnal activity. A Konica AT in an Ikelite housing made photographic records both of general areas along the transect lines and specific communities within the 1 m^2 quadrats.

Sediment samples were collected along the north-south transect lines to determine particle size and composition (Figure 3 and Table 1). These data were used to help determine sediment transport in relation to currents. Samples of the upper 3.5 to 5 cm of the sediment were collected in 125 ml screw cap vials. Sediment traps (3.7 x 37 cm upright plastic tubes) were attached to the bottom at three stations along the north-south transect lines. At each station, three traps were set in a triangle, 1 meter on each side. A few hard substrate samples were collected to determine its composition and possible origin (e.g., coralline algae layers, coral skeletons).

Four replicate biomass samples were taken from the area (Figure 3). Collections from each line were made with a 1/4 m^2 quadrat. A fifth station was established southeast of La Chalupa, and one 1/4 m^2 sample was collected there (Figure 3). Corals and gorgonians were also collected in different areas, especially on the west and north transect lines, for species identification.

The compass orientation of gorgonians was measured and compared to the prevailing currents (Table 2). Orientation was determined only for gorgonians that normally branch in one plane, and the height of these gorgonians was measured to obtain an average colony size (Table 3).

RESULTS

The area surveyed can be divided generally into three major communities: algal flat, sand flat, and rock outcroppings (Figure 3). Each of these community types has a typical invertebrate, fish, and algal population associated with it. However, the fish and some of the invertebrates actively move between communities.

Community Types

Algal Flat. The algal flat is a long band, parallel to shore approximately 200 meters wide at the north-south transect line. About 70% of the hard substrate is composed of calcareous red algae and shell fragments cemented together. There are a few large crevices and holes. The other 30% of the substrate is covered by sand pockets.

The dominant species in this area are the red algae Bryothamnion triquetum, the brown algae Dictyota spp. and Dictyopteris spp., the common basket sponge Xestospongia muta, and an octocoral Pseudopterogorgia acerosa. The area is covered mostly by red and brown algae, with some green algae present (Chamaedoris peniculum, Halimeda discoidea, and Valonia ventricosa). The sponges and gorgonians were conspicuous but rather scattered. The corals observed on the algal flat were Montastrea cavernosa, Dichocoenia stokesii, and some dead Manicina colonies. Two common epifaunal invertebrates were the arrow crab Stenorynchus seticornis and Condylactis gigantea, an anemone. Hiding places for large invertebrates are scarce in this area which may account for the lack of epifaunal invertebrates.

The algal flat seems to be relatively homogeneous, although a subtle zonation occurs. Reds predominate on the deep side of the flat, and browns predominate on the shallow side. A few large Sargassum sp. plants were observed at 18 meters depth at the end of the south transect line.

There are a few rock outcroppings and small ridges scattered around the algal flat, with the ridge in the southwest quadrant (Figure 3) being the most conspicuous. This ridge begins as an outcropping near the west transect line and gradually becomes a single ridge about 3 meters high. It diminishes gradually until it is about 30 cm high and then changes to a south-southwest and finally easterly direction, rising again to about 6 meters at the end. The area encircled by the ridge depresses toward the bottom, the outside being 20 meters deep and the depression itself 22 to 23 meters. There were numerous fishes along the ridges and a few lobsters (Panulirus argus) were observed in the deeper crevices.

To the south, the algal flat ended abruptly with a few high areas dropping steeply to the sand. The north end of the area exhibits a more gradual change in which the algae is slowly displaced by sand. There were a few gorgonians in this rock-sand interphase covered mostly by sand. A hard substrate was found 15 to 20 cm under the sand.

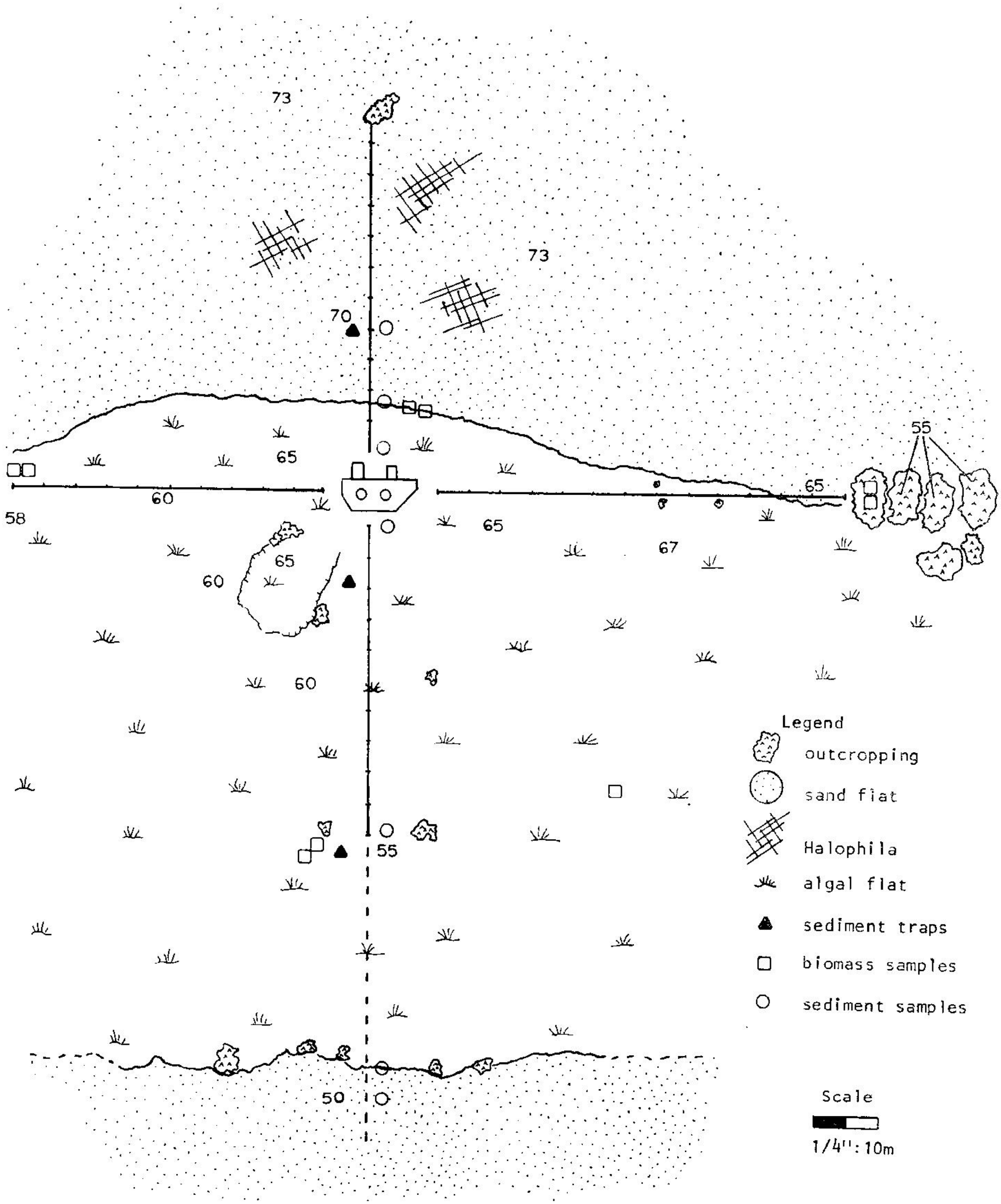
Biomass samples were collected at the ends of the east, west, and south transect lines and in the north interphase. This information is presented in Table 3-A.

Sand Flat. Two sandy areas were found, one north of the algal flat and the other south (Figure 3). The north sand flat began at the 17 meter mark of the north transect line and extended beyond it with a small rock outcrop at the end of the transect line. The south sand flat was 75 meters beyond the end of the south line. Sediment samples were taken and visual observations were made.

The most conspicuous species in the north sand flat is a sea grass Halophila baillonis which forms large scattered patches along the transect line. A Sabellid worm was observed during both day and night. Small sand dollar (Mellita sexiesperforata) skeletons were noted and small live specimens collected. A Portunid crab (Portunus floridanus), two unidentified nudibranchs, one Aphroditridae worm, and shells (all Olivella petiolita) were collected. During four night dives to the north area, the starfish Astropecten sp. was observed, and two individuals were noted eating a small M. sexiesperforata.

FIGURE 3.

General community map showing placement of sediment traps and areas of benthic sampling.



During these night dives Pennatulaceans, tentatively classified as Stylatula sp., were observed and collected. They were observed only at night. Shrimps were observed also.

Rock Outcrops. The outcroppings elevate above the bottom and have a species composition completely different from that of any other community in the study area. They are rather sparsely scattered over the area except at the end of the east transect line about 130 meters from La Chalupa. There a series of larger outcroppings (15 to 20 meters long) occur. The outcrops are on the algal flat, except for one found in the middle of the sand flat at the end of the north transect line. The outcropping substrate is similar to the algal flat, but crowded with boring sponges, holes, and crevices. Most of the outcrops are 5 to 10 meters in diameter and 2 meters high.

The most common invertebrates found on these outcrops were the scleractinian corals (Table 4). Most of the lobsters were observed in this habitat. There were some algae, mostly epiphytes, occurring in the spaces not covered by sponges or corals. Many brittle stars, mollusks, worms, and crustaceans were collected at rotenone fish stations. There were more invertebrates in these areas probably because of the shelter and the greater availability of food provided at the rock outcroppings.

The outcroppings at the end of the east transect line are wider and higher and largely covered by Sargassum sp., Crinoids, Pseudopterogorgia spp., and Eunicea laxispica. The two latter species were not observed on the other outcrops.

The north outcrop is surrounded by sand about 100 meters from the algal flat, approximately 3 meters high, 5 meters wide, and 10 meters long. More small algae than corals were observed, but most of the species of coral found on the other outcrops were present. The gorgonian Telesto riisei, the corals Stylaster roseus and Tubastrea aurea were also common. Tubastrea aurea and T. riisei were observed only on this outcrop. Other organisms observed there were the coral crab Carpilius corallinus, the lobster Panulirus argus, Serpulid worms among the corals, Sabellid worms, a feather-like hydrozoan also present on the algal flat, and a total of 16 species of corals.

Except for the east and north outcrops, where T. riisei was observed, no gorgonians were found growing on the outcrops, but there were many scleractinian corals. Most of the gorgonians were growing on the algal flat where only a few species of corals were seen.

Sediment Samples and Traps

The data obtained from the sediment samples are tabulated in Table 1. The cumulative percentages for the different sizes are plotted in Figure 4. The sand from the north sandy area had a median Phi diameter (Md Ø) of 2.85 compared to 1.95 from the south sandy area. Evidently, the median grain size increases gradually from north to south (Figure 5). If there is significant sediment transport, it seems to be moving from south to north. This probably is due to the effect of increased surge in the shallower waters of the south sandy area.

FIGURE 4.

Cumulative percentages of median grain sizes (Md Ø) of sediments from seven stations.

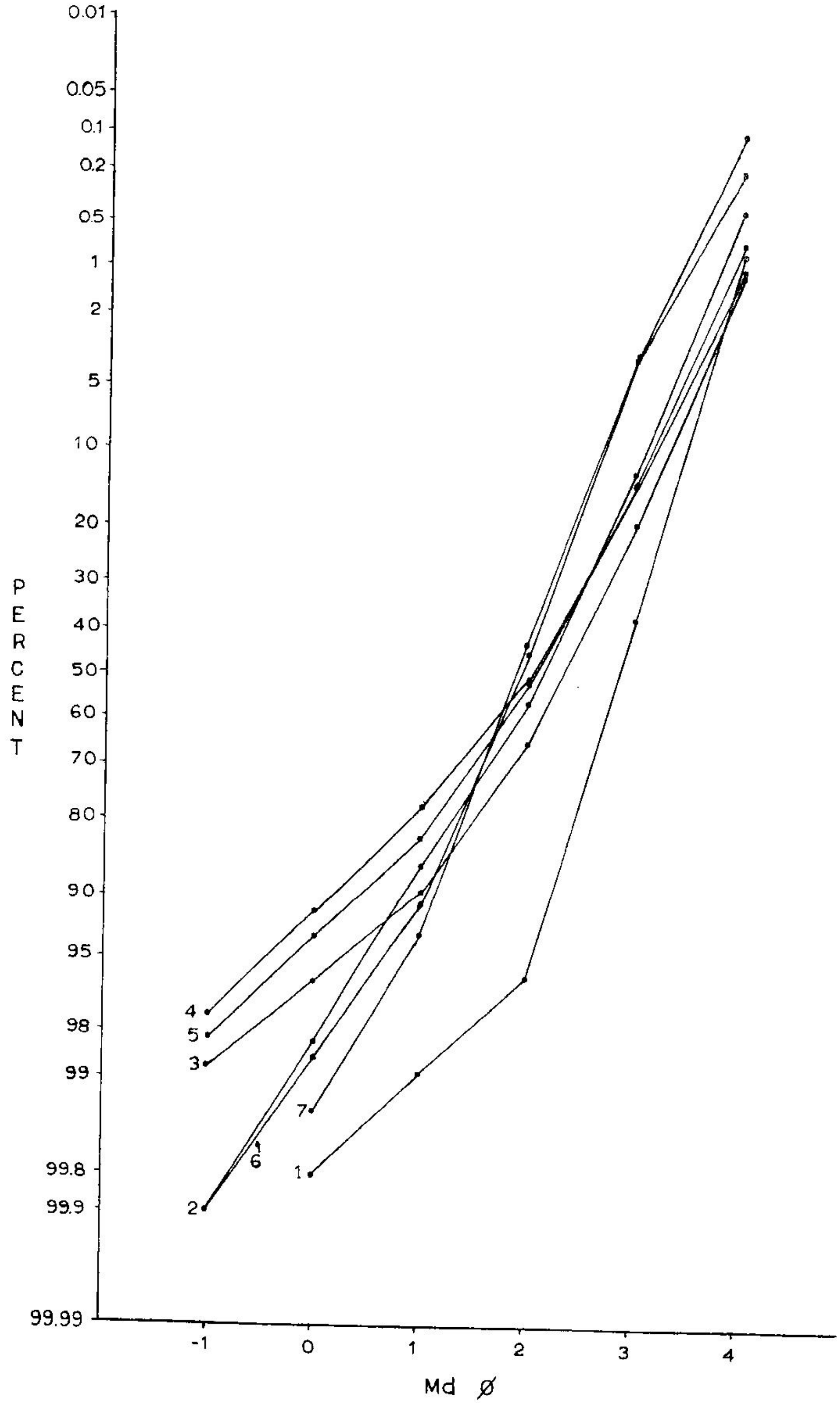
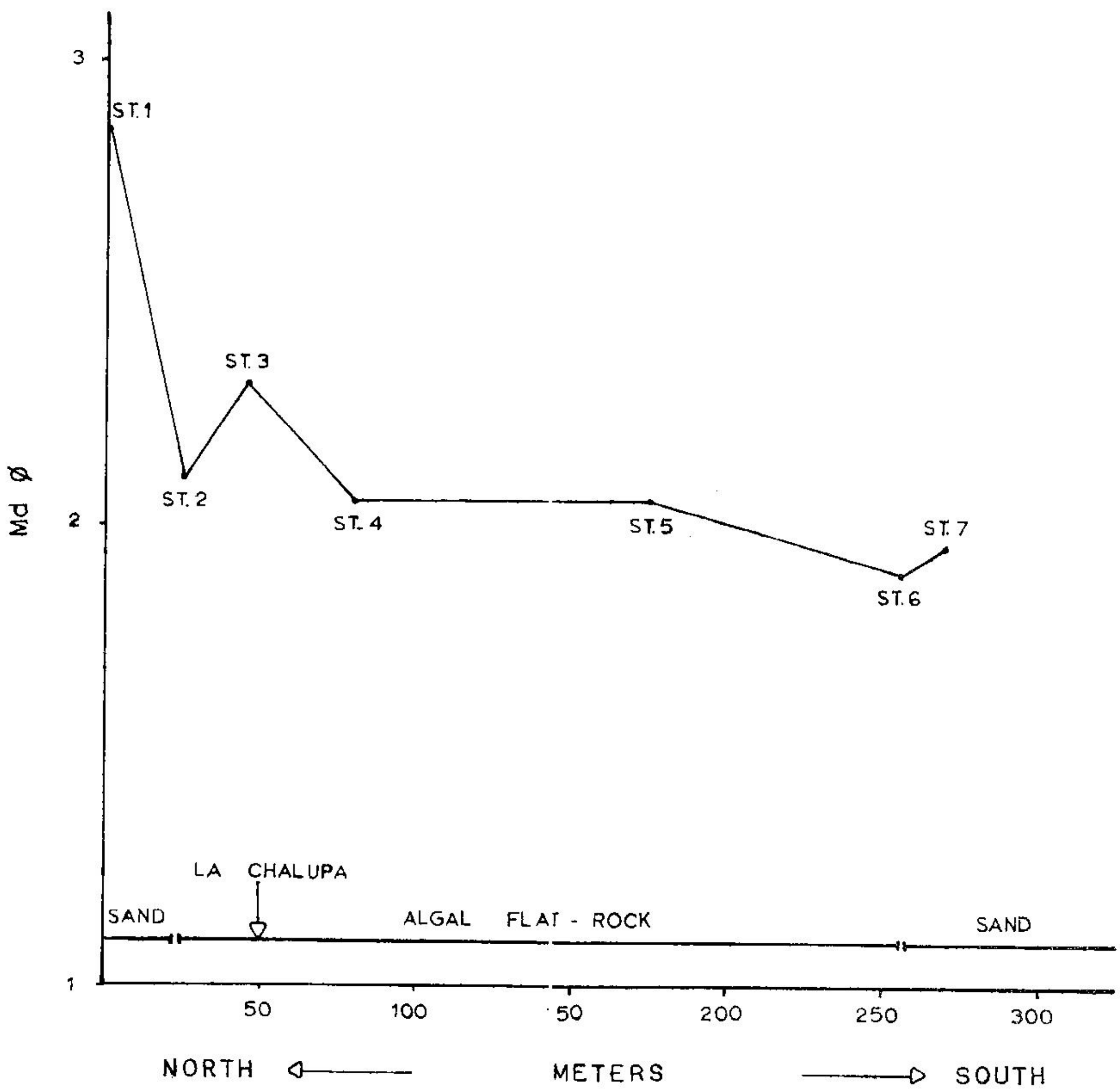


FIGURE 5.
Median grain size (Md Ø) of sediments from seven stations.



By the end of the mission there was no sediment in the traps. Furthermore, the traps remained empty for over three months after the mission was completed.

Gorgonian Orientation

The gorgonians branching in one plane seem to have a consistent orientation in their growth patterns (Table 2). The genus *Pseudopterogorgia* (of two species found, the more common was *acerosa*) was oriented in a 306° - 126° direction. The genus *Pterogorgia* (*citrina* being the more common of two species found) was oriented in a 304° - 124° direction. The genus *Eunicea* (*E. laxispica* and *E. tourneforti*, neither common) was oriented in a 302°- 122° direction. The surge may have more influence on gorgonians than the predominant currents. It is not unusual to have a strong surge at 22 meters depth on the north coast.

Commercially Valued Species

Ten conch shells (*Strombus gigas*) were found during the survey. Most appeared to be old, but two young specimens were found. Movement of the conchs around the algal flat was about one meter/hour. Many small *S. gigas*, *S. gallus*, and *S. costatus* shells were occupied by hermit crabs. No live specimens of *S. gallus* or *S. costatus* were found.

The spiny lobster *Panulirus argus* was found around the algal flat, especially under ledges between the algal flat and the sand and inside the larger outcroppings. An estimated population of six lobsters was consistently seen over the algal flat. The east side outcroppings harbored populations of 20 to 25 individuals. Surface diving in the Islote area prior to the mission uncovered two outcrops at 22 meters depth. A standing crop of 30 lobsters was found there.

DISCUSSION

The distribution of invertebrates in diverse habitats is partly controlled by biological factors such as food sources, protection, and competition. At Islote this is especially noticeable in the living habits of fish, lobsters, and corals and gorgonians. Populations of fish congregated around the outcroppings for shelter and food. Lobsters were found only in protective holes on the outcroppings or small ridges along the algal flat. They were usually found in the same place, except two lobsters (possibly in search of food) were caught in fish traps set at night on the algal flat away from the outcrops and ridges. Scleractinian corals were consistently found growing on hard substrate.

Of the 43 species of scleractinian corals reported for Puerto Rico by Almy-Carrión (1963), 17 (39%) were collected at Islote. Of the 17 species of corals found in the general area, only two species (*Montastrea cavernosa* and *Dichocoenia stokesii*) were observed on the algal flat. The distribution of corals over the algal flat suggests significant sediment transport in the area. Although the algal flat furnishes the rough, solid bottom required by the coral planulae for attachment, they are apparently soon covered over by the moving sediment. On the outcrops, the planulae are probably less affected by the sediment and have more opportunity to settle and grow.

Cary (1914) indicated that the planulae of most gorgonians are similar to those of corals in that they require a rough solid bottom for attachment. However, most of the gorgonians were found on the algal flat with a few on the east outcroppings. One factor influencing this distribution could be the nature of the substrate. Both the algal flat and the outcroppings are composed of hard calcareous material, but the outcroppings are crowded with boring sponges which loosen the substrate. This allows the gorgonians to be undermined and prevents them from establishing permanent settlements. Of 54 species of gorgonians reported by Ress (1973), only 10, or 18%, were found at Islote. Bayer (1961) reported 75 shallow-water species for the Atlantic, but only 9 were found at Islote.

II. FISH SAMPLING

Methods and Materials

Trapping. Four chevron fish traps, 36" x 18", two baited and two unbaited, were dropped from the R/V Sultana and placed for 2 to 4 day intervals at four different habitats. The traps were periodically inspected, and the contents were recorded. After the traps were hauled to the surface, the contents were bagged and preserved on ice until they could be frozen at the Islote field station. The traps were then moved to a new location and rebaited (Figure 6).

Censusing. Censusing involved swimming along a transect line and noting all the fishes within 2 meters of the line. Extensive visual observations were made from three transect lines laid over typical rock outcrops and algal flat areas. Other census work was done along each of the four 100 meter transect lines that extended north, south, east, and west from La Chalupa. On two occasions isolated rock outcrops were visited, and all the fishes observed were recorded.

Poisoning. Other fish samples from the rock outcrops, algal flats, and sandy areas were obtained with Pro-Nox fish poison. These samples were frozen in La Chalupa and subsequently taken to the PRNC fish laboratory in Mayaguez.

Laboratory Analysis. All specimens captured were identified and the standard length, weight, and sex recorded.

RESULTS AND DISCUSSION

Table 5 is a species list of trapped fish which also indicates numbers caught in baited as opposed to unbaited traps. Table 6 lists all species obtained or observed throughout the mission.

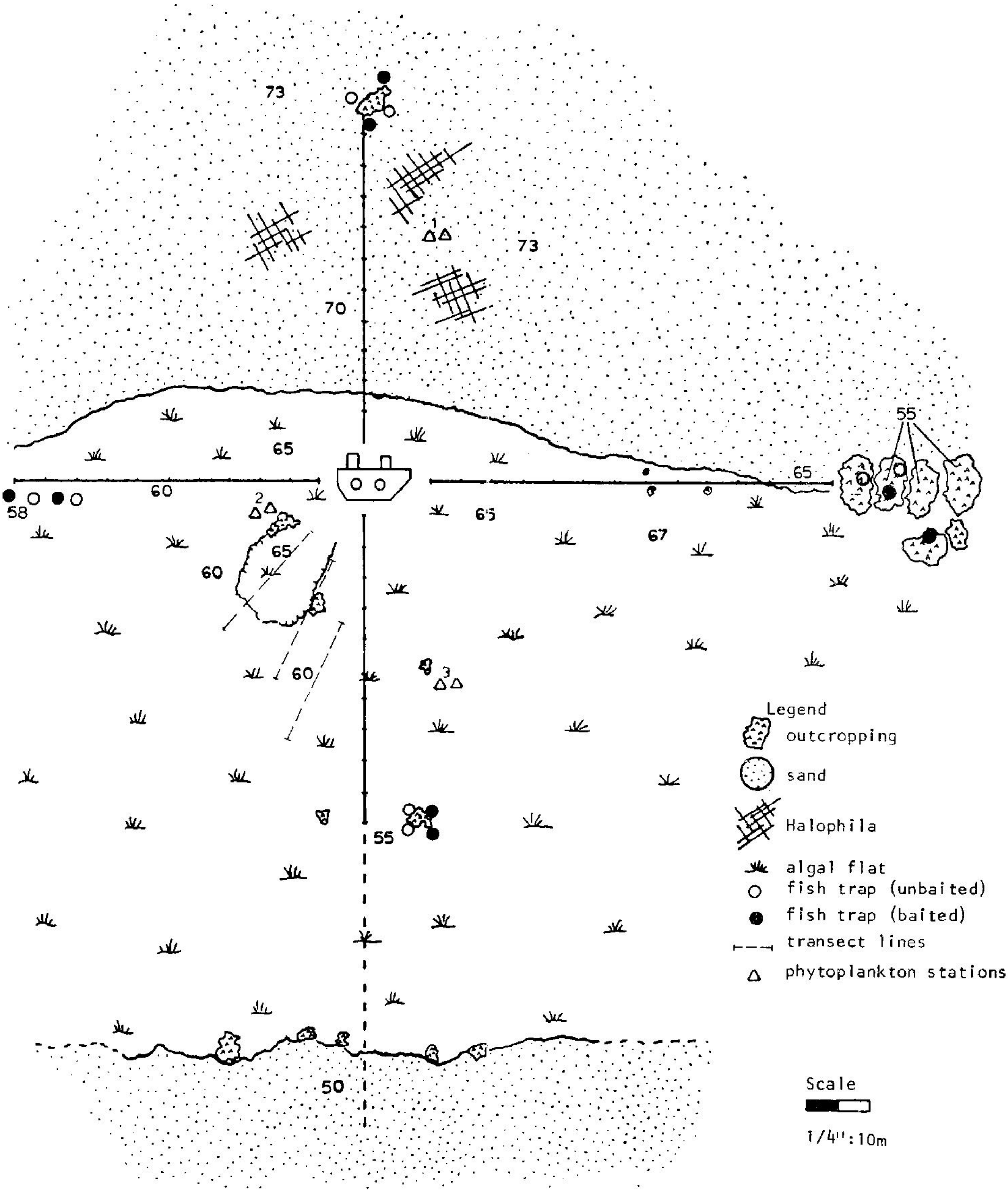
The sea floor is a combination of algal flats, sand flats, and rock outcrops (Figure 6). The habitats formed from these different bottom types offer protection and food to at least 112 species of fish. The algal flat, which is the most common bottom type, is underlaid by a honeycombed calcareous base which provides a substrate for the algal and sponge communities which in turn offer food and protection for the smaller fishes especially the wrasses (Labridae), damsel fishes (Pomacentridae), and small groupers (Serranidae), especially *Cephalopholis fulva* (Table 7).

Erratically scattered outcrops harbor the greatest diversity and number of fishes per unit area. Most of the larger fishes at Islote such as several species of snappers (Lutjanidae), grunts (Pomadaysidae), groupers (Serranidae) and squirrelfishes (Holocentridae) are associated with these formations.

The sandy areas, often with patches of the vascular plant *Halophila baillonis*, support primarily razorfishes (Labridae), sand tilefishes (Branchiostegidae), and flounders (Bothidae).

FIGURE 6.

General community map showing placement of fish traps, transect lines, and phytoplankton stations.



The pelagic fishes consist primarily of three or four species of the family Carangidae but also include the families Sphyraenidae and Scombridae. The carangids do not seem to require the protection of the bottom, but they apparently depend on the bottom for food as they were often seen cruising close to it in search of feeding opportunities.

The general distribution of fishes over the Islote area is patchy, with most individuals congregating around the outcrops. According to census data (Table 6), the wrasses (Labridae), especially Halichoeres poeyi, H. garnoti, and Thalassoma bifasciatum; the damselfishes (Pomacentridae), especially Eupomacentrus partitus; and the coney (Serranidae), Cephalopholis fulva, were the most abundant fishes over the algal flats and rock outcrops. The sandy areas were comparatively barren, as indicated by the census data. The most abundant species in this habitat were the razorfish Hemipteronotus sp. (Labridae), the sand tilefish Malacanthus plumieri (Branchiostegidae), and the flounders Syacium micrurus and Bothus lunatus (Bothidae).

Rotenone samples showed that there are many fishes in the Islote area that camouflage and/or conceal themselves so they were not detected by visual censusing. Among these were: Paraphidion schmidti and Ogilbia sp. (Ophidiidae); Doratonotus megalepis (Labridae); Moringa edwardsii (Moringuidae); Morophus punctatus (Ophichthidae); and Scorpaena bergi (Scorpaenidae).

The grunts (Pomadasyidae), squirrelfishes (Holocentridae), snappers (Lutjanidae), and groupers (Serranidae) were the most frequently trapped fish (Table 8). Although this is probably a good indication of the relative abundance of these fishes, it does not mean that they were more abundant than other species at Islote. The traps were apparently selective for certain size fish whose behavior patterns draw them to the kind of cover provided by the traps. The frequent extreme weather conditions at Islote probably make a protective shelter necessary for many species, and this need might be a factor in the fish traps' being more efficient than gill nets for regular Islote sampling. (The number of fish captured by trap averaged 28 but ranged from 1 to 93.) Water clarity seems to aid the fish in detecting gill nets such that the number of fish captured by this method does not adequately reflect relative abundance or species composition.

Samples collected with baited and unbaited fish traps indicated that bait is not necessary to attract fishes to the traps. In most cases, more fishes were caught in unbaited traps than in unbaited ones (Figures 7, 8, and 9). The fishes seem to be attracted more to the cover than to the food offered. On a sandy bottom a baited trap might attract more fish than an unbaited one, because food resources there are not as great as those on the algal flat or rock outcrops.

Unfortunately, the optimum soak time for chevron traps was not reached during the Chalupa mission. Munro et al. (1971) state that cumulative catch in traps tend toward an asymptote. In the Port Royal reefs off Jamaica a value close to the maximum is reached within 7 to 10 days. Preliminary observations made at Islote indicate that optimum soak time is less than 10 days.

Fig. 7 . The relationships between cumulative catch, unbaited and baited traps, and duration of soak of chevron fish traps located near the north transect line on a rock outcrop surrounded by sand at Islote, P. R.

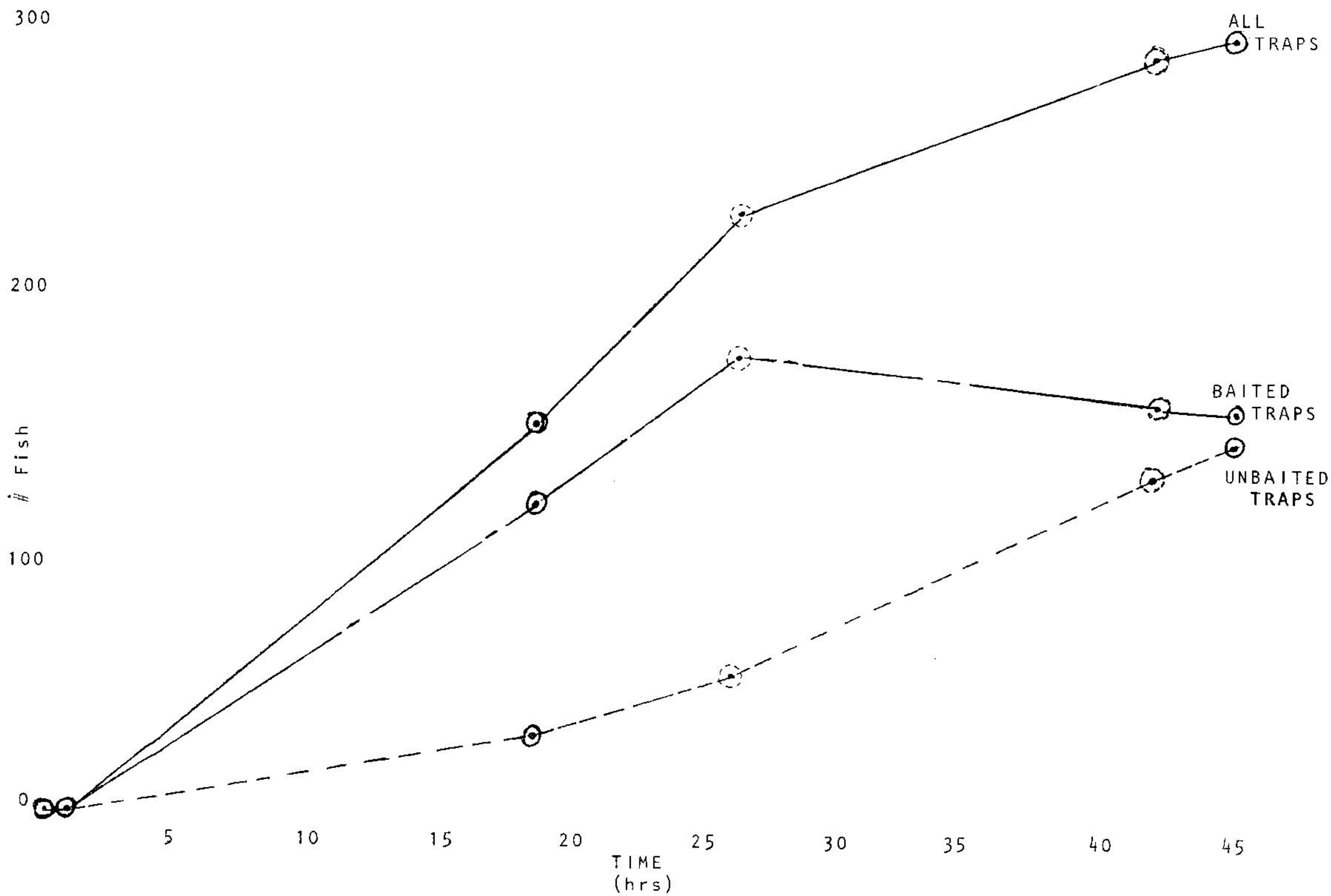


Fig. 8 . The relationship between cumulative catch, unbaited and baited traps, and duration of soak of chevron fish traps located near the east transect line on larger scale outcrops at Islote, P.R.

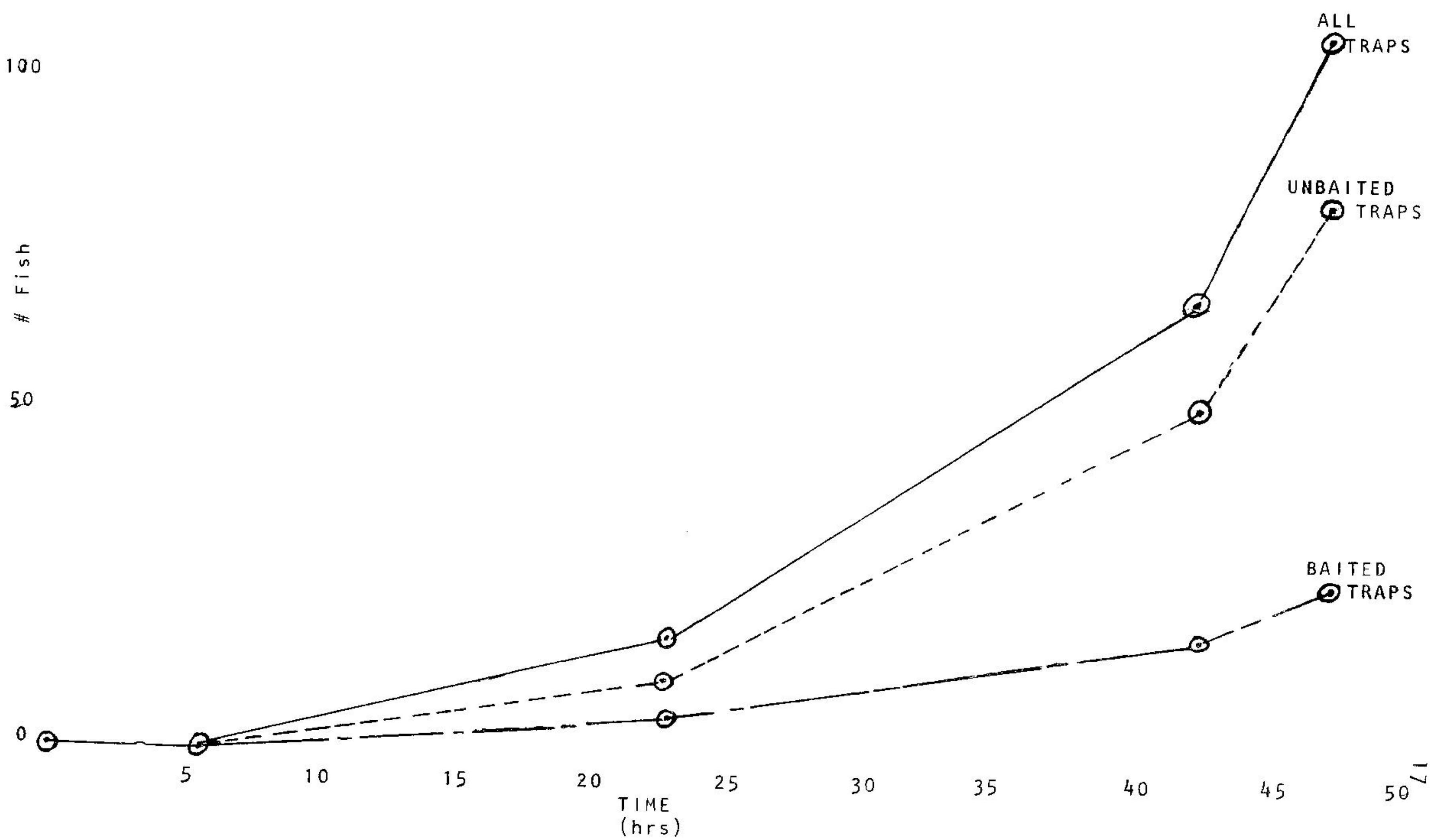
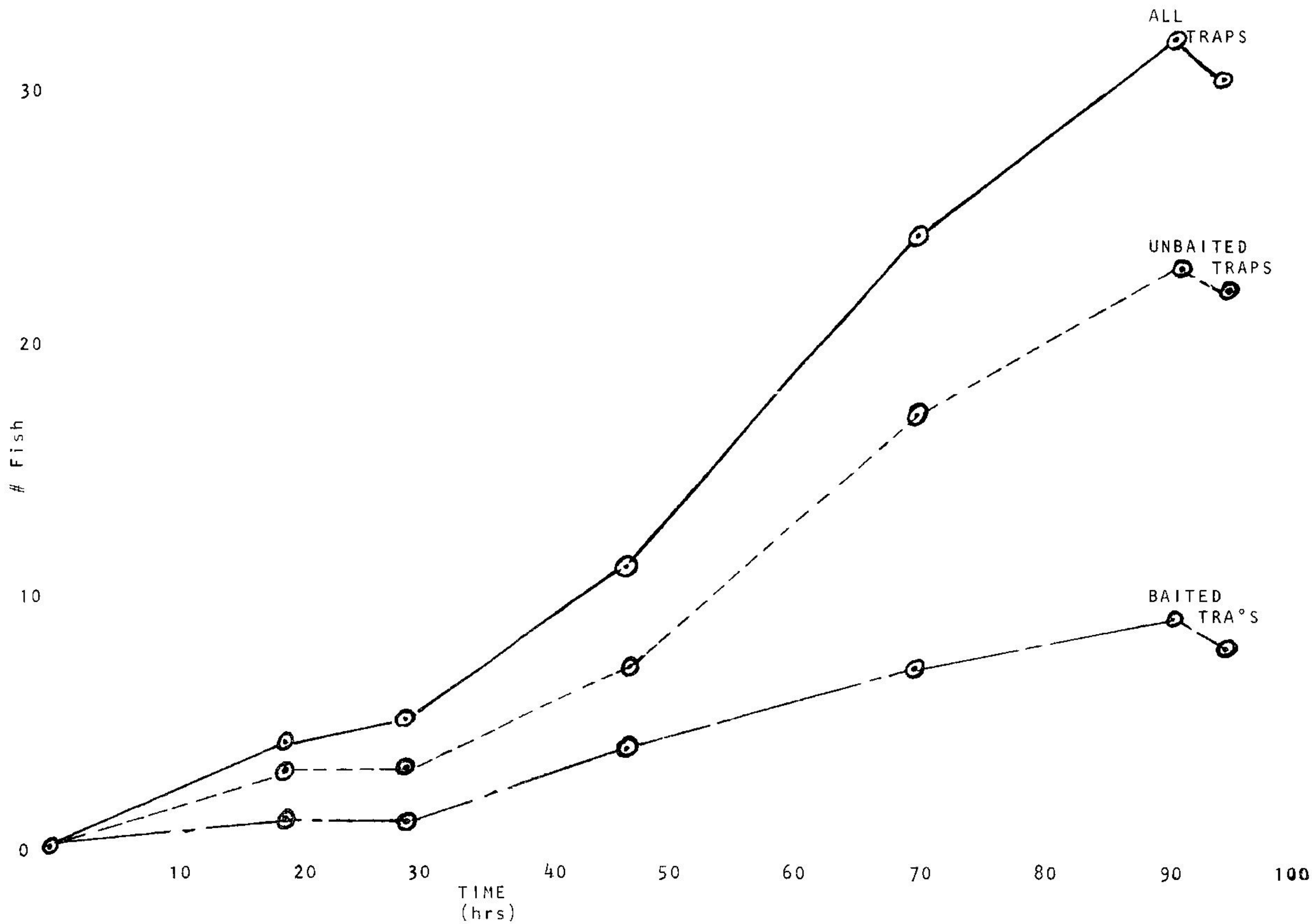


Fig. 9 The relationships between cumulative catch, unbaited and baited, and duration of soak of chevron fish traps located near the west transect on the algal mat at Islote, Puerto Rico.



III. PHYTOPLANKTON SAMPLING

Methods and Materials

One sampling site was established in each of three different habitats: algal flat, sand flat, and rock outcropping (Figure 6). Phytoplankton and chlorophyll samples were taken once a day at these sites 1 meter above the bottom. In addition, during two 24 hour studies (28 May and 2 June), chlorophyll samples were obtained from each of the three stations, and a phytoplankton sample was taken at Station 2. These samples were taken once every four hours. Dark-light bottle measurements were taken at each of the three stations on 27 May and 30 May.

Samples taken for phytoplankton enumeration were collected in 500 ml plastic bottles and preserved in 3% buffered formalin. Samples were examined with a Nikon Inverted Microscope (Table 9). Counts were made of an aliquot of the concentrate at 250X, and major species noted. Counts are in cells/liter of diatoms, dinoflagellates, coccolithophores, and blue-green algae (Table 10).

The chlorophyll samples were taken in 1 liter bottles and were filtered through a .47 micron AA Millipore filter. The filters were frozen immediately and stored. These samples were to be extracted and chlorophyll determined by the fluorimetry method described by Strickland and Parsons (1972), but the samples proved insufficient for analysis.

Three standard BOD bottles were filled with water at each station for dark-light sampling. Errors in measurement which might have resulted from air bubbling out as the bottle was filled were avoided by filling each bottle with nitrogen before the sampling was taken. One of the three bottles was fixed upon return to La Chalupa, and the other two (one dark, one clear) were secured <u>in situ</u> 1 meter above the bottom from 1200 to 1800 hours. The bottles were collected, fixed upon return to the habitat, and sent to the surface the following day. There the O_2 determinations were obtained by using the Winkler titration method as outlined by Strickland and Parsons (1972). Results are given in Table 11.

DISCUSSION

Data from the dark-light studies (Table 11) indicate minimal activity at the depths (18 to 24 meters) where observations were made. This may have been the result of low light conditions at the bottom due to generally increasing turbidity of the water in the afternoons. The generally low productivity levels noted by Steeman Nielsen and Jensen (1957) off the north coast of Puerto Rico were thus further reduced by low light to levels unmeasurable by dark-light bottle methods.

CONCLUSIONS AND RECOMMENDATIONS

Major problems inherent in sublittoral ecology are related to the limitations of exposure. By using La Chalupa and saturation diving techniques, the PRNC biologists were able to overcome these obstacles for fifteen days. The advantage of unlimited bottom time at 22 meters provided a closer look at even the most inconspicuous members of the bottom community. Unusual behaviors, feeding habits, and nocturnal activities were observed and selective sampling was accomplished.

The benthic phase of the program was aided greatly by the time factor. Biomass samples were collected in a fraction of the normal time. Saturation diving enabled us to know the area in more intimate detail than had been possible on previous sampling trips.

The advantage of witnessing the efficiency of standard fishing methods was invaluable to the ichthyology program. Daily observations of the fish not previously trapped or netted provided a more complete picture of the true fish community, knowledge that could not have been obtained without La Chalupa.

However, because we were unfamiliar with the capacity of the habitat, La Chalupa, we did not take full advantage of its capabilities. A more sophisticated sampling program should have been employed, and more long-term studies with post-mission follow up should have been initiated.

Constructive criticism can increase productivity of future survey missions. Two salient criticisms deal with the timing of the mission itself and the limitations of each excursion from the habitat. All PRNC members of the mission agreed that more could have been learned if the habitat had been used shortly after the preliminary survey work at Islote was completed. This would provide the advantage of being able to gather good quantitative baseline data rather than trying to fit the habitat into existing programs.

A series of minor problems contributed to the limitations of each excursion from the habitat. The hooka gear for the mission proved to be time consuming, unreliable, and bulky; therefore, it was avoided. The only alternative to this system was the double SCUBA tank (standard size) assembly, which limited both the range and duration of each dive. A proven "closed-circuit" system, with emergency air supply and good diver-to-habitat communication, would have allowed the divers to remain in the water for several hours at a time. This system is strongly recommended.

Moving the entire habitat to a different location half-way through the mission is feasible and would provide for the gathering of comparative data.

Future missions should be planned so that they are as self-sufficient as possible. Problems with habitat-to-surface communication and rough sea conditions caused delays in surface support operations and, consequently, in the sampling programs. Other problems with training, equipment, food, and communications during decompression should be overcome to insure the success of future missions.

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LIST OF TABLES

TABLE 1. Splitting fraction data

Sample #1 (North sandy area)

Screen Mesh	mm	ø	Weight g	Weight %	Cum. Wt. g	Cum. Wt. %
5	3.962	-2				
9	1.981	-1	negli.			
16	0.991	0	0.4	0.2	0.4	0.2
32	0.495	1	1.7	0.9	2.1	1.1
60	0.246	2	5.3	2.9	7.4	4.0
115	0.124	3	107.9	58.6	115.3	62.6
250	0.061	4	67.4	36.6	182.7	99.2
Pan			1.5	0.8	184.2	100.0

Initial sample weight 185.8 g
Cum. sample weight 184.2 g
Error 1.6 g (0.9%)

Sample #2 (North interphase)

5	3.962	-2				
9	1.981	-1	0.1	0.1	0.1	0.1
16	0.991	0	2.7	1.6	2.8	1.7
32	0.495	1	20.3	11.9	23.1	13.6
60	0.246	2	50.7	29.9	73.8	43.5
115	0.124	3	75.3	44.3	149.1	87.8
250	0.061	4	20.0	11.8	169.1	99.6
Pan		4	0.6	0.4	169.7	100.0

Initial sample weight 172.0 g
Cum. sample weight 169.7 g
Error 2.3 g (1.3%)

TABLE 1. (Continued)

Sample #3 (20 m from north sandy area)

Screen Mesh	mm	Ø	Weight g	Weight %	Cum. Wt. g	Cum. Wt. %
5	3.962	-2				
9	1.981	-1	2.1	1.2	2.1	1.2
16	0.991	0	4.7	2.7	6.8	3.9
32	0.495	1	11.2	6.6	18.0	10.5
60	0.246	2	42.5	24.5	60.5	35.0
115	0.124	3	79.0	45.6	139.5	80.6
250	0.061	4	31.6	18.3	171.1	98.9
Pan		4	1.9	1.1	173.0	100.0

Initial sample weight 175.0 g
Cum. sample weight 173.0 g
Error 2.0 g (1.1%)

Sample #4 (50 m from north sandy area)

Screen Mesh	mm	Ø	Weight g	Weight %	Cum. Wt. g	Cum. Wt. %
5	3.962	-2				
9	1.981	-1	4.5	2.5	4.5	2.5
16	0.991	0	11.0	6.1	15.5	8.6
32	0.495	1	24.4	13.6	39.9	22.2
60	0.246	2	48.2	26.9	88.1	49.1
115	0.124	3	67.0	37.3	155.1	86.4
250	0.061	4	23.1	12.9	178.2	99.3
Pan		4	1.3	0.7	179.5	100.0

Initial sample weight 180.4 g
Cum. sample weight 179.5 g
Error 0.9 g (0.5%)

TABLE 1. (Continued)

Sample #5 (100 m from north sandy area)

Screen Mesh	mm	Ø	Weight g	Weight %	Cum. Wt. g	Cum. Wt. %
5	3.962	-2				
9	1.981	-1	3.0	1.8	3.0	1.8
16	0.991	0	9.0	4.7	11.0	6.5
32	0.495	1	18.1	10.7	29.1	17.2
60	0.246	2	52.2	30.9	81.3	48.1
115	0.124	3	65.0	38.6	146.3	86.7
250	0.061	4	20.8	12.3	167.1	99.0
Pan		4	1.5	0.9	168.6	99.0

Initial sample weight 169.5 g
Cum. sample weight 168.6 g
Error 2.9 g (0.5%)

Sample #6 (South interphase)

5	3.962	-2				
9	1.981	-1	0.1	0.1	0.1	0.1
16	0.991	0	2.3	1.3	2.4	1.4
32	0.495	1	14.4	7.9	16.8	9.3
60	0.246	2	83.5	45.7	100.3	55.0
115	0.124	3	76.2	41.7	176.5	96.7
250	0.061	4	5.6	3.1	182.1	99.8
Pan		4	0.3	0.2	182.4	100.0

Initial sample weight 183.6 g
Cum. sample weight 182.4 g
Error 1.2 g (0.7%)

TABLE 1. (Continued)

Sample #7 (South sandy area)

Screen Mesh	mm	Ø	Weight g	Weight %	Cum. Wt. g	Cum. Wt. %
5	3.962	-2				
9	1.981	-1	negli.			
16	0.991	0	1.1	0.6	1.1	0.6
32	0.495	1	11.7	6.2	12.8	6.8
60	0.246	2	95.6	50.5	108.4	57.3
115	0.124	3	73.9	39.0	182.3	96.3
250	0.061	4	6.8	3.6	189.1	99.9
Pan		4	0.1	0.1	189.2	100.0

Initial sample weight 190.3 g
Cum. sample weight 189.2 g
Error 1.1 g (0.6%)

TABLE 2. Gorgonian branching with plane orientation

Pseudopterogorgia spp.*		*Pterogorgia* spp.*		*Eunicea* sp.	
280°	300°	280°	320°	300°	290°
280	280	280	320	300	310
310	310	300	330	300	300
320	300	300	310	290	310
330	320	310	300	320	310
300	320	310	320	290	330
290	330	300	310	310	
310	320	310	310	310	
290	310	300	310	300	
300	300	290		270	
320	310	300		280	
300	320	310		310	
300	310	300		290	
310	310	290		320	
300	300	290		300	
300	310	300		300	
$\bar{x}$ = 306°		$\bar{x}$ = 304°		$\bar{x}$ = 302°	

Average colony orientation - 304°- 124°

* Only two species found

TABLE 3. Gorgonian colony height in cm

Pseudopterogorgia spp.*			*Pterogorgia citrina*		*Eunicea laxispica*
25.0	27.5	15.0	25.0	15.0	32.5
42.5	20.0	25.0	25.0	17.5	45.0
32.5	40.0	20.0	20.0	15.0	30.0
15.0	30.0	25.0	17.5	20.0	32.5
30.0	25.0	25.0	17.5	22.5	42.5
17.5	17.5	22.5	20.0	27.5	45.0
20.0	25.0	40.0	22.5	25.0	20.0
27.5	32.5	37.5	25.0	25.0	40.0
30.0	35.0	35.0	17.5	30.0	35.0
30.0	20.0	25.0	17.5		22.5
25.0	25.0	25.0	22.5		
30.0	25.0		15.0		
$\bar{x}$ = 27.0			$\bar{x}$ = 21.0		$\bar{x}$ = 34.5

* Only two species found

TABLE 3A. Mean wet weights (gm) of algae collected in 1/4 m^2 samples

SPECIES	STATIONS*			
Rhodophyta	west	east	south	north
Amansia multifida	87.30	----	0.50	56.08
Bryothamnion triquetum	0.85	----	33.80	5.30
Chondria sp.	-----	----	-----	6.60
Coralline algae	30.55	2.05	90.70	62.40
Cryptonemia crenulata	-----	----	-----	6.00
Dictyurus occidentalis	0.25	----	-----	1.10
Enantocladia duperreyi	92.80	----	-----	14.70
Gelidiella acerosa	-----	----	-----	17.30
Gracilaria spp.	3.95	----	0.20	2.40
Laurencia sp.	2.30	----	-----	-----
Vidalia obtusiloba	79.35	----	-----	59.60
Miscellaneous red algae	4.05	----	-----	4.65
Phaeophyta				
Dictyopteris plagiogramma	2.50	----	1.00	-----
Dictyopteris spp.	-----	0.75	0.50	4.20
Dictyota jamaicensis	3.00	----	-----	-----
Dictyota spp.	-----	----	2.80	0.60
Pocockiella variegata	-----	5.75	-----	-----
Sargassum sp.	-----	218.50	-----	-----
Miscellaneous brown algae	-----	----	0.10	0.50
Chlorophyta				
Anadyomene stellata	-----	3.80	3.35	0.05
Aurainvillea nigricans	-----	----	0.15	0.85
Caulerpa microphysa	10.05	----	-----	0.05
Caulerpa prolifera	0.25	1.15	-----	-----
Chamaedoris peniculum	0.25	----	0.50	-----
Halimeda discoidea	-----	----	0.25	6.00
Miscellaneous Algae	14.25	----	-----	29.40

*Refer to Figure 3 for station locations

TABLE 4. Species list of benthic organisms from La Chalupa Mission #12, May - June 1974

Spermatophyta

Hydrocharitaceae

Halophila baillonis
Thalassia testudinum

Chlorophyta

Anadyomene stellata
Aurainvillea nigricans
Caulerpa cupressoides
C. microphysa
C. prolifera
Chamaedoris peniculum
Halimeda discoidea
H. opuntia
Penicillus capitatus
Udotea sp.
Valonia ventricosa

Phaeophyta

Dictyopteris justeii
D. plagiogramma
D. delicatula
Dictyota dentata
D. jamaicensis
Dictyurus occidentalis
Dilophus quineensis
Padina sp.
Pocockiella variegata
Sargassum sp.
Sporachnus sp.

Rhadophyta

Amansia multifida
Amphiroa fragilissima
Bryothamnion seaforthii
B. triquetum
Champia parvula
Chondria sp.
Coelartrum albertisii
Corallina subulata
C. cubensis
Cryptonemia crenulata
C. luxurians
Dasya sp.

TABLE 4. (Continued)

Rhadophyta (Cont.)

- Digenia simplex
- Galaxaura sp.
- Gelidiella acerosa
- Gelidium sp.
- Gracilaria ferox
- G. spp.
- Enantocladia duperreyi
- Jania sp.
- Laurencia poitei
- L. sp.
- unidentified encrusting (fam. Corallinaceae)

Porifera

- Adocia sp.
- Agelas sp.
- Anthosigmella varians
- Callyspongia sp.
- Cinachyra cavernosa
- Chondrilla nucula
- Cliona sp.
- Geadia papyraceae
- Haliclona sp.
- Ircinia fasciculata
- I. sp.
- Pseudosinella rosacea
- Trachygellus cinachyra
- Xestospongia muta

Coelenterata

Hydrozoa

- Millepara alcicornis
- Plumularia sp.
- Stylaster roseus
- unidentified - on algae
- unidentified - on Sargassum

Anthozoa

Octocorallia

- Eunicea laxispica
- E. tournefortii
- Muricea sp.
- Plexaura flexuosa
- Pseudapterogorgia acerosa

TABLE 4. (Continued)

Anthozoa - Octocorallia (Cont.)

Pterogorgia citrina
P. guadalupensis
Telesto riisei
unidentified Pennatulacean (fam. Virgulariidae)

Zooantharia

Agaricia agaricites
Colpophyllia natas
Condylactis gigantea
Dichocoenia stokesii
Diploria strigosa
Isophyllia sinuosa
Isophyllastrea rigida
Madracis dedactis
M. pharensis
Manicina areolata
Meandrina meandrites
Montastrea annularis
M. cavernosa
Muricea sp.
Mussa angulosa
Porites astrearides
Siderastrea siderea
Staichaetis sp.
Tubastrea aurea

Sipunculida

unidentified sipunculids

Annelida

Polychaeta

Sabellastarte magnifica
Spirobranchus giganteus
unidentified Aphaoditidae
Serpulid sp.
Hermenia verruculosa
unidentified Nereidae
Unidentified Syllid
Vermiliopsis sp.
Lysidice sp.
Marphysa sp.
Eunice sp.
unidentified Terebellid
unidentified Spionidae

TABLE 4. (Continued)

Arthropoda

Crustacea

Pygnogonidae

unidentified pygnogonids

Stomatopoda

unidentified juvenile stomatopods

Cirripedia

unidentified barnacle

Amphipoda

unidentified gammarid amphipods
unidentified caprellid amphipods

Tanaidacea

unidentified tanaidacean A
unidentified tanaidacean B

Isopoda

Paracereis caudata
P. sp.

Nebaliacea

unidentified Nebaliacean (Barnes)

Decapoda

Stenopodidae

Stenopus sp.

Macrura

Panulirus argus
Synalpheus sp.
unidentified Alpheidae

Brachyura

Carpilius corallinus
Dromidia sp.

TABLE 4. (Continued)

Arthropoda - Crustacea (Cont.)

Brachyura

Epialtus dilatatus
Lupella forceps
Menaethiops portoricensis
Mithrax sp.
Portunus floridanus
Stenorynchus seticornis
unidentified majid A
unidentified majid B
unidentified majid C

Anomura

unidentified pagurid

Mollusca

Gastropoda

Alaba incerta
Arca imbricata
Barbatia tenera
Barbya intricata
Colubraria lanceolata
Columbella mercatoria (dead)
Conus daucus (dead)
Conus mus
Crassispina leucocyma
Cydia drillia
Cypraea cinerea (dead)
Cypraecassis testiculus (dead)
Drithia sp.
Engoniophus unicinctus
Heliacus bisulcatus
Hyalina tenuilabra
Marginella dentialata
Mitra barbadensis
Mitrella lunata
Modulus modulus
Murex sp.
Nassarius sp.
Oliva reticularis
Olivella setiolita
Pussia pulchella
Rissoina cancellata
Rissoina sp.
Strombus gigas

TABLE 4. (Continued)

Mollusca - Gastropoda (Cont.)

Tricolia adamsi
Tricolia affinis
Vermicularia knorri
Williamia krebsi
unidentified nudibranch

Pelecypoda

Arca imbricata
Chama sp.
Pinctata radiata
Spondylus americanus
unidentified pelecypod

Cephalopoda

unidentified octopus

Scaphopoda

Dentalium sp.

Bryozoa

unidentified encrusting bryozoan
unidentified arborescent bryozoan

Echinodermata

Crinoidea

unidentified crinoids

Asteroidea

Astropecten sp.
Luidia sp.

Echinoidea

Diadema antillarum
Eucidaris tribularoides
Mellita sexiesperforata

Ophiuroidea

Ophiocoma sp.
Ophionereis reticulata

TABLE 4. (Continued)

Echinodermata - Ophiuroidea (Cont.)

Ophiostigma isacanthum
Ophiothrix sp.

Amphiuridae

Amphiodia sp.
Amphipolis sp.

Halothuroidea

unidentified Halothuroids

Chordata

Ascidiacea

Didemnum sp.
Eudistoma sp.
Eudistoma carolinense
Molgula sp.
Polycarpa sp.
Pyura sp.

Didemnidae

unidentified didemnids

TABLE 5. Species list of fish captured by trap at Islote, May - June 1974

Species	Baited	Unbaited
Acanthurus bahianus	2	2
Acanthurus coeruleus	1	3
Anisostremus virginicus	1	
Cantherhines pullus	6	
Cephalopholis fulva	8	4
Chaetodon striatus		2
Epinephelus guttatus	1	1
Epinephelus striatus		1
Gymnothorax funebris		1
Haemulon aurolineatum	44	128
Haemulon carbonarium		22
Haemulon chrysargyreum		3
Haemulon flavolineatum	1	4
Haemulon sciurus		2
Holocentrus ascensionis	15	16
Holocentrus rufus		2
Lactophrys triqueter		1
Lutjanus mahogoni		4
Lutjanus synagris	6	11
Mulloidichthys martinicus	9	6
Myripristes jacobus	7	9
Pseudupineus maculatus		2
Rhomboplites aurorubens	87	39
Total	188	263

TABLE 6. Species list of fish captured or observed during La Chalupa Mission May - June 1974

SPECIES

DASYATIDAE
Dasyatis americanus

CLUPEIDAE
Jenkinsia lamprotaenia

SYNODONTIDAE
Synodus foetens

MORINGUIDAE
Moringa edwardsii

MURAENIDAE
Gymnothorax funebris
Gymnothorax moringa
Gymnothorax vicinus

OPHICHTHIDAE
Morophus punctatus
Myrichthys oculatus

HOLOCENTRIDAE
Holocentrus ascensionis
Holocentrus rufus
Myripristes jacobus
Holocentris vexillarius

OPHIDIIDAE
Ogilbia sp.
Paraphidion schmisti

AULOSTOMIDAE
Aulostomus maculatus

FISTULARIIDAE
Fistularia tabacaria

SYNGNATHIDAE
Micrognathus crinitus

SPHYRAENIDAE
Sphyraena barracuda

BOTHIDAE
Bothus lunatus
Syacium micrurum

SPECIES

SERRANIDAE
Alphestes afer
Cephalopholis fulva
Epinephelus adscensionis
Epinephelus guttatus
Epinephelus striatus
Serranus baldwini
Serranus flaviventris
Serranus tigrinus

GRAMMISTIDAE
Rypticus bistrispinus
Rypticus subbifrenatus

GRAMMIDAE
Gramma loreto

PRIACANTHIDAE
Priacanthus arenatus
Priacanthus cruentatus

PEMPHERIDAE
Pempheris schomburgji

BRANCHIOSTEGIDAE
Malacanthus plumieri

CARANGIDAE
Caranx bartholomaei
Caranx fusus
Caranx ruber
Decapterus sp.
Elagatis bipinnulatus
Seriola dumerili
Trachinotus sp.

LUTJANIDAE
Lutjanus analis
Lutjanus apodus
Lutjanus cyanopterus
Lutjanus jocu
Lutjanus mahogoni
Lutjanus synagris
Ocyurus chrysurus
Rhomboplites aurorubens

TABLE 6. (Continued)

SPECIES	SPECIES
POMADASYIDAE	LABRIDAE (Cont.)
Anisostremus surinamensis	Thalassoma bifasciatum
Anisostremus virginicus	
Haemulon aurolineatum	SCARIDAE
Haemulon carbonarium	Scarus coeruleus
Haemulon chrysargyreum	Scarus croicensis
Haemulon flavolineatum	Sparisoma aurofrenatum
Haemulon melanurum	Sparisoma chrysopterum
Haemulon sciurus	
	OPISTOGNATHIDAE
SPARIDAE	Opistognathus aurifrons
Calamus bajonado	
	CLINIDAE
SCIAENIDAE	Malacoctenus triangulatus
Equetus acuminatus	Paraclinus fasciatus
Odontoscion dentex	Paraclinus grandicomis
MULLIDAE	SCOMBRIDAE
Pseudupineus maculatus	Scomberomorus regalis
Mulloidichthys martinicus	
	GOBIIDAE
CHAETODONTIDAE	Gobiosoma evelynae
Chaetodon sedentarius	
Chaetodon striatus	CALLIONYMIDAE
Holocanthus ciliaris	Callionymus bairdi
Holocanthus tricolor	
Pomacanthus arcuatus	SCORPAENIDAE
Pomacanthus paru	Scorpaena grandicornis
	Scorpaena bergi
POMACENTRIDAE	
Abudefduf saxatilis	ACANTHURIDAE
Chromis multilineatus	Acanthurus bahianus
Eupomacentrus fuscus	Acanthurus chirurgus
Eupomacentrus partitus	Acanthurus coeruleus
Eupomacentrus planifrons	
Microspathodon chrysurus	BALISTIDAE
	Alutera schoepfi
CIRRHITIDAE	Balistes vetula
Amblycirrhitus pinos	Cantherhines pullus
	Melichthys niger
LABRIDAE	
Bodianus rufus	OSTRACIIDAE
Clepticus parrai	Lactophrys polygonia
Doratonotus megalepis	Lactophrys triqueter
Halichoeres bivittatus	
Halichoeres garnoti	TETRAODONTIDAE
Halichoeres maculipinna	Canthigaster rostrata
Halichoeres pictus	Sphoeroides spengleri
Halichoeres radiatus	
Halichoeres poeyi	DIODONTIDAE
Hemipteronotus martinicensis	Diodon holocanthus

TABLE 9. Species list for phytoplankton 24 hour station, 0900 28 May - 0900 29 May 1974

Bacillariophyceae (Diatoms)

Actinoptychus sp.
Amphiprora sp.
Asterionella notata
Asterolampera marylandia
Basteriastrum elongatum
B. sp.
Chaetoceros atlanticus
C. diversus
C. laevis
C. peruvianus
C. sp.
Cocconeis sp.
Coscinodiscus sp.
Diploneis bombus (?)
Eunotia sp.
Fragilaria sp.
Grammatophora marina
G. undulata
Hemiaulus hauckii
H. membranaceus
Isthmia enervis
Leptocylindricus danicus
Licmophora sp.
Melosira sulcata
Navicula c.f. warwicki
N. sp. (lg)
N. sp. (sm)
Nitzschia closterium
N. delicatissima
N. longissima
N. paradoxica
Pleurosigma sp.
Rhabdonema arcuatum
Rhizosolenia alata
R. calcar aris
R. cylindricus
R. fragilissima
R. hebetata semispina
Striatella interrupta
S. unipunctata
Synedra closteroides
Thalassionema nitzschoides
Triceratium sp.
Pennate diatom

Dinophyceae (Dinoflagellates)

Amphidinium acutissimum
A. crassum
A. schroederi (?)
A. turbo
Amphisolenia quadrispina
Ceratium kofoidi
C. teres
C. sp.
Exuviaella sp.
Goniaulax minuta
G. scrippsae
G. sp.
Gymnodinium punctatum
G. sp.
Oxytoxum gracile
O. sp.
Peridinium conicum
P. divergens
P. globutus (?)
P. grani
P. hirobis
P. steini
P. trochoideum
P. sp.
Prorocentrum micans
Pyrocystis robusta (?)
Unidentified dinoflagellates

Coccolithophridae

Calyptrosphaera oblonga
Discosphaera tubifer
Holopappus adriaticus
Heyneckia barkowi
Pontosphaera sp.
Rhabdosphaera stylifer
R. tubulosa
Syracosphaera pulchra
Unidentified coccolithophores

Other

Merismopedium sp.
Stigonema sp.
Trichodesmium theibauti
Dictyocha fibula
Solenica setigera
Unidentified phytoflagellate
Eutreptia marina

TABLE 10. Important phytoplankton species (those appearing at least once in numbers greater than 50 cells/liter) and numbers (cells/liter) for Chalupa 24 hour station 28-29 May 1974

	Cells/liter				
	28 May			29 May	
	0900	1300	2100	0500	0900
Diatoms					
Asterionella notata	210	0	0	0	0
Chaetoceros laevis	0	20	50	0	0
Cocconeis sp.	90	40	70	30	0
Fragilaria sp.	0	0	10	60	20
Licmophora sp.	510	420	70	40	40
Navicula sp. (lg)	40	50	40	110	70
Navicula sp. (sm)	80	120	40	110	230
Navicula c.f. *warwicki*	0	10	40	0	100
Nitzschia closterium	110	180	110	340	670
N. delicatissima	250	590	360	280	700
N. paradoxica	0	0	80	0	0
Pleurosigma sp.	80	60	80	60	60
Rhizosolenia fragilissima	0	0	0	10	60
Striatella unipunctata	50	20	20	50	0
Thalassionema nitzschiodes	20	50	120	140	[illegible]
Pennate diatoms	470	430	380	580	420
Dinoflagellates					
Exuviaella sp.	50	10	10	30	[illegible]
Goniaulax minuta	10	10	20	90	5
Gymnodinium sp. (lg)	90	50	130	60	110
Gymnodinium sp. (sm)	150	200	160	250	250
Peridinium trochoidenum	60	0	20	30	0
P. sp.	50	20	90	60	30
Unidentified dinoflagellate	1910	160	660	300	200
Coccolithophores					
Discosphaera tubifer	40	10	40	0	80
Heyneckia barkowii	0	10	0	0	50
Pontosphaera sp.	0	40	10	10	90
Unidentified coccolithophore	30	40	20	20	80
Other					
Trichodesmium theibauti	90	10	10	20	220
Solenicola setigera	0	0	20	0	80
Unidentified phytoflagellate	250	500	160	290	510
Unidentified cell	50	140	60	90	80
Totals (cells/liter)	5040	3490	3190	3800	4630

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