PRNC ~ 178! PUERTO RICO NUCLEAR CENTER LA CHALUPA MISSION #12 FINAL REPORT (March 1975) OPERATED BY UNIVERSITY OF PUERTO RICO UNDER CONTRACT NO. AT (40:1)-1899 FOR US ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION ---Page Break--- LA CHALUPA Mission #12 FINAL REPORT by R. Castro, P. H. Davis, J. J. Kimmel, T. W. Purcell, and J. A. Rivera Report Coordinator: P. H. Davis Technical Editors: M. L. Kimmel and Ferne Galantai ---Page Break--- The Rico Water Resources Authority completed a research mission utilizing underwater habitat, La Chalupa, of Puerto Rico in the Barrio Islote area. The habitat was located 20.2 kilometers 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 Thomas W. Purcell, Research Associate II Phytoplanktology Roberto Castro, Scientific Associate II Benthic Ecology José A. Rivera, Scientific Associate II Benthic Ecology Eric Klos, Research Associate I Benthic and Plankton Support Noé Rivera, Research Assistant III Ichthyology Support *aquanauts ---Page Break--- TABLE OF CONTENTS ---Page Break--- 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

Gaviroment 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 Conse Nuclear). The underwater habitat, La Chalupa, was operational in June 1974. This facility allowed PRNC to study the ecology of the area from a different perspective. A team of two invertebrate zoologists, one ichthyologist, and one phytoplanktologist entered La Chalupa, which was positioned approximately 300 yards offshore in 22 meters of water (Figure 2). The team had access to 4 x 10% of bottom for the duration of the mission. Within this area, different habitats were determined, observations were made, and samples were collected. The other team members provided support for the aquanauts, supporting committees. The invertebrate zoologists were primarily interested in the 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 cubicles designated for sample collection. Several physical parameters (sedimentation, sediment transport, and currents) were considered in relation to animal distribution.

FESR Sampling The PRC-PRWRA ichthyology program began in June 1973. Fish traps, surface and bottom silt sort, spear guns, and rotenone fish poison had been used for sampling from the R/V Sultana. With the aid of La Chalupa, many 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.

Plankton Sampling. The phytoplanktologist gathered data during the mission to supplement information to the phytoplankton survey of the area in the form of: identification of populations and major species near the bays, determination of changes which might occur in the populations as a result of environmental influences.

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, marking 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. ---Page Break--- ---Page Break--- ---Page Break--- 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 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 quadrats. A fifth station was established southeast of La Chalupa, and one 1/4 m 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 with non-palty branches in one plane, and the height of these gorgonians was measured to obtain an average colony size (Table 3). The area surveyed can be divided generally into three major communities: algal flat, sand flat, and rock outcroppings (Figure 5). Of these community types, each 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 50 meters wide at the north-south transect. The substrate is composed of calcareous red algae and shell fragments cemented together. There are a few large crevices and holes. The other portion of the substrate is covered by sand pockets.

The dominant species in this area are the red algae Bryothamnion triquetrum, the brown algae Dictyota spp. and Dictyopteris spp., the common eastern sponge Yestospongia spp., and an octocoral Pseudopterogorgia. The reef is covered mostly by red and brown algae, with some green algae present (Chaetomorpha peniculum, Halimeda discoidea, and Valonia ventricosa). The sponges and gorgonians were conspicuous but rather scarce. Observed on the algal flat were Montastrea cavernosa, Dichocoenia stokesii, and some encrusting Yaniacina colonies. Two common epifaunal invertebrates were the arrow crab Stenorynctus seticornis and Condylactis gigantea, an anemone.

The lack of epifaunal invertebrates is likely due to the absence of hard substrate. 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 spp. 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 5 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 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. Among the conspicuous species in the north sand flat is a seagrass, Halophila baillonis, which forms large scattered patches along the transect line. A sizable worm was observed during both day and night. Sault sea dollar (Melita sexiesperforata) skeletons were noted and live snail specimens collected: a Fortunid crab (Gonias floridanus), two unidentified nudibranchs, one Aphroditidae worm, and shells (all Olivella petiolata) were collected. During four

Night dives to the north area, the starfish Astropecten sp. was observed, and two individuals were noted eating a small fish Sepiella perforata. ---Page Break --- Figure 3, 7 General community map showing placement of sediment traps and areas of benthic sampling. Legend: Terepping & F k 8 sand Flat Halophytic algal tape sediment traps biomass samples care PRO sediment samples ---Page Break --- During these night dives Pennatulaceans, tentatively classified as Stylatula sp., were observed and collected. They were observed only at night. Findings 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 outer 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 Eudendrium laxispica. The taxa of the species were now assessed as the other outcrops. The north outcrop is surrounded by sand about 100 meters from the algal flat, approximately 8.

meters high, meters wide, and 10 meters long. Hake svaii algae" than corals were observed, but most of the species of coral found on the other outcrops were present. The gorgonian Telesto riisel, the corals Stylaster roseus and Tubastrea sursa were also common. TADAEERER aurea and TOGTTSET EE Sosomad only on the Whee outcrop. Other organisms were the coral crab Carpilius coralimus, the lobster Panulirus, serpulid worms among the corals, Sabelid worms, and a feather-like bryozoan 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 8) 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. ---Page Break--- Figure 5, Cumulative percentages of sediment grain sizes (Md 8) of sediments from seven stations. 0% 005: 0% 40% 30% 70% 90% 35% 99% ---Page Break--- Figure 6, Median grain size (Md 6) of sediments from seven stations. Isr sta ste — sta ote st? sre La cHaLuPa, sandy ALGAL_FLAT- ROCK SAN = 700 Ey 200 250 300 NORTH o———— METERS ——» SOUTH ---Page Break--- 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 were seen 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 300° = 176° direction. The genus Pseudogorgia (Citeine being the novel name of one species found) was oriented in a 50° = 124° direction. The genus Eunicea (E. laurensia and E. tourneforti, neither common) was oriented in a 302° = 123° 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. Any 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. In the Islote, this is especially noticeable in the living tables at Hien Lanriers, and corals and gorgonians. Populations of fish congregated around the sanctuary pings for shelter and food. Lobsters were found only in protective areas 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 and from the outcrops and ridges. Scleractinian corals were consistently found growing on hard substrate. Of the 45 species of

Scleractinian corals reported for Puerto Rico by Ainy-Carrién (1963), 17" (391) were collected at Islote. Of the 17 species of corals found in the general area, only two species (Montastraea cavernosa and Dichocoenia stokesii) were observed on the algal flat. “The habit 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. ---Page Break--- 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 (193), 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. ---Page Break--- IL, FISH SAMPLING Methods and Materials - Four chevron fish traps, 36" x 18", two baited and two unbaited, were dropped from the R/V Susans and placed for six 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 involved swimming along a transect line and noting all the fishes.

within 2 meters of the Tine’ “Eorensiteect 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 Mayeguct. Laboratory Analysis. All specimens captured were identified and the standard length, weight, and sex recorded. RESULTS AND DISCUSSION Table S 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), damselfishes (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 (Pomadasyidae), 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 (Ranchiostegidae), and flounders (Bothidae). ---Page Break--- Figure 6. 1" General community map showing

Placement of fish traps, transect times, and phytoplankton stations. Legend: outer cropping © sons $BF votonite ‘OA algal flat © fish trap (unbaited) | fish trap (baited) | transect lines | phytoplankton stations. The pelagic fishes consist primarily of three or four species of the family Carangidae, but also include the Scombridae. The carangids do not seem to require the protection of the bottom; they apparently depend on the bottom for food, as they were often observed close to it in search of feeding opportunities. The general distribution of fishes over the Islote area is patchy, with individual fish dispersed around the outcrops. According to census data, the wrasse, especially represented by the garibaldi (Hypsypops rubicundus), and the damselfishes (Pomacentridae), and coney (Serranidae), fulva were the most abundant species in this habitat. The razorfish (Dactylopteridae), the sand tilefish (Malacanthidae), and the flounders (Bothidae) were also present. The grunts (Haemulidae), squirrelfishes (Holocentridae), snappers (Lutjanidae), and groupers (Serranidae) were the most frequently trapped fish. 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 to the traps. The frequent extreme weather conditions at slow prostration provide protective shelter necessary for many species, and this need might factor into the fish traps being more efficient than gill nets for regular sampling. The number of fish captured by trap averaged 28 but ranged up to 98. Water clarity seems to aid the fish in detecting gill nets, such that the number of fish captured by this method significantly decreased.

does not adamustely refisct wearin, Set of species' compost ign, 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 baited ones (Fig 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. Muro 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 within 7 to 10 days. Preliminary observations made at Islote indicate that optimum soak time is less than 10 days, ---Page Break--- ---Page Break--- sae ois oF aos a wise ---Page Break--- ---Page Break--- 19 TIT, 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 34 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 0.47 micron AA Millipore filter. The filters were frozen immediately and stored. These samples were to be extracted and chlorophyll determined by the fluorometry 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 in situ 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 oxygen determinations were obtained by using the A. titration method as outlined by Strickland and Parsons (1962). 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. ---Page Break--- 20 CONCLUSIONS AND RECOMMENDATIONS Major problems inherent in sublittoral ecology are related to the limitations of exposure. 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.

Bionass 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, I did not take full advantage of its capabilities. A more sophisticated sampling program should have been employed, and for long-term studies, with post-mission follow-up should have been initiated. Constructive criticism can increase the 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 hookah 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 halfway 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 ensure the success of future missions. ---Page Break---
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---Page Break--- 10. u. LST OF TAME Splitting fraction data Gorgonian branching with plane orientation Gorgonian colony height in cm Mean wet weights (gn) of algae collected in 1/4 m samples, Species list of benthic organisms from La Chalupa Mission #12, May - June 1974 Species list of fish captured by trap at Tslote, May - June 1974 Species list of fish captured or observed during La Chalupa Mission May - June 1974 Relative abundance of fishes on the algal mat (Based on three 100 meter transects during La Chalupa Mission) Summary of trapped fishes indicating location, habitat, and percent composition of catch Species list for phytoplankton 24 hour station, 0900 28 May - 0900 29 May 1974 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 Average 0» values (ppm), dark-light bottles 23 2 28 2» 7 38 as 44 ---Page Break--- ---Page Break--- 23 TABLE 1, Splitting fraction data Sample 1 (North sandy

area) re ata one ss eo ma gousmingie ts Error 1.6 g (0.91) scunemngie ate ---Page Break--- TABLE 1, (Continued) Sample #5 (20 m from north sandy area) Screen m s Weight Weight Gm. Wt. Gum, We, Nesh f s i 5 3.9622 9 ager 2a 12 24 12 6 a) 47 27 6.8 3.9 3 0.4951 naz 6.6 18.0 10.5 60 0.26 2 ans 24.5 60.5 35.0 115 orm 8 79.0 45.6 139.5 250 ee) 31.6 18.5 ma 98.9 Pan ‘ 19 nT 173.0 100.0 Initial sample weight 175.0 8 Gm. sample weight YS08 Sample #4 (50 m from north sandy are 5 3.9622 9 vost 4s 2s 4s 25 16 a) 11.0 6A 18.5 8.6 3 ons 1 2.4 13.6 3.9 22.2 60 0.26 2 48.2 26.9 8.1 ao us ons 07.0 3.8 155.1 86.4 250 0.0614 2.1 12.9 178.2 99.3 Pan 4 13 0.7 179.5 100.0 Initial sample weight 180.4 g Gun, sample weight 179.5 g Error Or ---Page Break--- TABLE 1, (Continued) Sample #5 (100 m from north sandy area) Screen ™ ‘ Weight Weight Mesh ni i k 5 3.962 2 9 1.981 1 3.0 18 3.0 18 16 0.991 o 9.0 47 no 6s 3 0,495, 1 18.1 10.7 20.1 172 60 0,246 2

82.2 30.9 81.3 48.1 Ns o.124 3 65.0 38.6 146.3 86.7 250 0,061 40, 28 12.3 167.1 99.0 Pan 4 1S 0.9 168.6 99.0 Initial sample weight 169.5 9 Gun, sample weight 168.6 & Error 2:9 g (0.58) 5 3.962 -2 9 1,981 on on on on 16 0.991 ° 23 13 24 14 2 0.495, 1 144 19 16.8 9.3 60 0,246, 2 83.5 45,7 100.3 55.0 us 0.124 3 76.2 a7 176.5 96.7 250 0.061 4 5.6 3a 182.1 99.8 Pan 4 0.3 0.2 182.4 100.0, Initial sample weight 183.6 g Gm, sample weight 182.4 g Error 1.2 g (0.79) ---Page Break--- 6 TABLE 1. (Continued) Sample #7 (South sandy area) 3 0,495 1 Ws 6.2 12.8 0 0,286 2 95.6 50.5 108.4 57.3 ns 0.128 3 73.9 39.0 182.3 96.3 250 0,061 4 68 3.6 199.1 99.9 Pan 4 on ot 189.2 100.0 Initial sample weight 190.3 g Gum. sample weight 189.2 g Error 11 g (0.68) ---Page Break--- TABLE 2. Gorgonian branching with plane orientation Pseudopterogorgia spp.* Peerogorgia spp.* Bunicea sp. 280° 300" 280° 320° 300° 290° 280 280 280 320 300310 310310 300330 300300 320 300 300310 290 510 330320 30300 320510 300320 310320 200330 290330 300510 310 310320 so sto 310 20 310 300310 300 300300 290 270 320 Mo 300 280 300320 310 310

300310 300 290 310 sto 290 320 300300 290 300 300310 300 300 K = 306° i = 308° % = 302% Average colony orientation - 304°- 124° * Only two species found ---Page Break--- ‘TABLE 3, Gorgonian colony height in cm Pseulopterogorgia spp. Terogorgia citrina Eumices lacispica 35.0780 SSO 325 as 0 80 ITS 15.0 25 40.0 2.0 SO 30.0 15005017, 20.0 3.5 30.0 35.0 50S BRS as 5S SS 45.0 2.0 5.00 SSD 20.0 ms RS 95 0 0 20.0 woo 35.0 50. 30.0 38.0 soo 20, 35.078 2s 3.0 5.0 50S 300 25.0 15.0 & = 27.0 221.0 k= M45 * only two species found ---Page Break--- 2 TABLE 3A, Mean wet weights (g) of algae collected in 1/4 m² samples — SPECIES STATIONS* Rhodophyta fransia multifida ator eriguetum op Coraline tigue tonenta renutate Dietyuras eceldeneatts EnantocTauts deere dies sceioer racilaria Sop reacia sr tusiloba scot Tanooas Tee algae Phacophyta 2.50 0.75 Pistemterte plagograms Bieqapteris Sop - Distt mle amaicensis 5.00 Fospehe i variegaca Sargassum 5p Wiseettancots brow algae Guiorophyta 5.75 218.50 3.80 10.05 0.25 115 see fsconden = a Miscellaneous Algae 14.25 dnadyonene stettata KuratnvTfea sigricans “Refer to Figure 3 for station locations ---Page Break--- TABLE 4, list of benthic organisms from La Jupa Mission #12, May - June 1974 Spermatophyta Hydrocharitaceae Halophila baillonis Chlorophyta Phacophyta iassia testudinum stellata Canferpa cipiessoiges a mi PenicttTus capitatus rea Sp. Valonfa ventricosa Dictyopteris justeii 1B, delicatuta os a fineensts Pocockielia variegata Soe aaa feansin multifide uaa att Sapte ates Coelartrim albertisii Corallina subulata gubensis Choptonents crenstace Daya =p. ---Page Break--- TABLE 4, (Continued) Rhadophyra (Cont) oigeta sieuex a Taurencia poitei Esp. unidentified encrus ag (Zam, Coratli Porifera Adocia sp, SAthorighotia varians Ghathgra aver nose Sianarta greta ends papyraceae iatictons ope Treinis faseicutata Ficufosinetta rosacea TrachygeTlus cinaclyra Kestospongia muta Coelenterata Hydrozoa Millepara alcicomis lumlarta sp. ‘Stylaster roseus SHOEI tn aigae identified - on Sargassum

Anthozoa Octocorallia Eunicea laxispica Tournefortii ricea sp, Plexaura flexuosa lapterogorgia acerosa ---Page Break --- TABLE 4, (Continued) Anthozoa - Gctocora} Lia (Cont.) Prorogorgia cizrina Papste Teresto ritset anidentified Pennatulacean (fa, Jooantharia Spntastres anelar rises sp. ‘Sige angulosa Torites astrearides Silerastrea siderea Stalchaetts sp. ‘Tubastren aurea, Sipuncudida unidentified sipurcan ias Annelida Polychaeta Saheliastarte magni fica Spirobranchus gigantens unidentt Fed AphodT eae Serpulid sp. llermenia verrucilosa nti fied Nereidae Unidentified Syitid Vermitionsis sp. lysifice sp. ftarphysa sp Enlce sp. siti ied Terebel Lid unidentified Spionidae ---Page Break --- 3B TABLE 4. (Continued) Arthropoda Crustacea Pygnogonidae imidenti fied pygnogonids ‘Stomatopoda umidentified juvenile stonatopods Cirripedia \midentified barnacle Anphipoda imidenti fied gamarid amphipods ‘unidentified caprellid amphipods Tanaidacea unidentified tanaidacean A unidentified tanaidacean B Tsopoda Paracereis caudata re Nehatiacea unidentified Nebaliacean (Barnes) Decapoda Stenopodidae Stenopus. sp. Macrura Panulirus angus alphegs se unidentified Alpheidae Prachyura gettus coratinus ---Page Break --- M4 TABLE 4, (Continued) Arthropoda - Crustacea (Cont.) Mollusca Gastropoda Brachyura jaltus dilatatus a, forceps 3S portoricensis, ihrer sp Fortimus floridanus Stenarynchus seticomis inidentifled nayi imidentified na}id B tnidenti fied majid C Anomra unidentified pagurid ‘aba incerta ieee wabionta ‘Sphatie tenets Columbella nercatoria (dead) Conus: daucus Conus, mis Trassispins Jeueooma a pee cates (dead) raecassis testiculus (dead) iter Tagenfophue unicinctus fettacus bisufcaras alin temilabra ginevie dontiaTote ieee Sarbanes tSurels Tages aa >. oie Suse weet Fee tore Rissoina sp. Stronbus gigas ---Page Break --- 35 TABLE 4. (Continued) Mollusca - Gastropoda (Cont.) Tricolia adansi faelis Sie SRR ST aS hranch Pelecata fog ice Sees cephatopoua unidentified octopus Scephopna ‘un =p. brazen chidentified smooweeiag, ozo,

Echinodermata unidentified echinoid Stiropecten sp, Mesostoma Fehinoidea fetter se ‘Sexiesperforata Cucuroden Wocena sp. Wlonereis reticulata ---Page Break--- TABLE 4, (Continued) Echinodermata - Ophiuroidea (Cont.) eee Ophiuridae Ophiura sp. Epiphytic Hiatothuroides unidentified Halothuroids Chordata Ascidiacea idem sp. Stoma sp. Endostoma carolinense ‘Solgula sp. Tolgaarpa sp. ira Spe Didemnidae unidentified didemnids ---Page Break--- TABLE 5, Species list of at istote, Nay Species Belted Acanthuras bahianus 2 Acanthinus coeruleus 1 Anisostrems virginicus 1 Ganeherhines puttus é Gephatophotis! fala 5 Chaetodon striatus Bottelils putats Pinephelus striatus Gymnothorax fimbriatus Haemulon aurolinestam Haemulon carbonarium Tenon chrysangyrean tacmiton Flevel nests Haemilon sells Holocentrids ascensionis Holocentrus rufus Lactophrys triqueter [ejamus nahopent Lutjanus synapris Malotrichthys martinicus Myripristes jacobus Ines macilatus Rhomboplites aurorides Total ad 188 fish captured by trap June 1974 4 2 i 1 1 28 0 ---Page Break--- 38 TABLE 6. Species list of fish captured or observed during La Chalupa Mission May - June 1974 SPECIES DASYATIDAE. Dasyatis americana CLUPEIDAE Jenkinsia Lamprotaenia ‘SYNODONTIDAE Synodus foetens MORINGIIDAE Moringa edwardsii MORAENIDAE Gymnothorax funebris Gymnothorax moringa Gymnothorax vicinus OpatarmnAE Morophus punctatus Nyrichthys oculatus HOLOCENTRIMAE, Holocentrus ascensionis Holocentrus rufus Myripristes jacobus Holocentris Vexillarius OmardrIMAE Ogilbia sp. Paraphidion schnisti AULOSTOMIDAE ‘Aulostomus maculatus FISTULARIIDAE Fistularia tabacaria SmiquTHIDE Micrognathus crinitus ‘SPHYRAENIDAE Sphyraena barracuda BOTHIDAE Bothus lunatus Syacium micrum SPECIES SERRANIDAE Alphestes afer Cephalopholis fulva Epinephelus adscensionis Epinephelus guttatus Epinephelus striatus Serranus baldwini Serranus flaviventris Serranus tigrinus GRAMMIDAE Rypticus bistrispinus Rypticus subbifrenatus GRAMIDAE Grama loreto PRIACANTHIDAE, Priacanthus arenatus Priacanthus cruentatus PENPHERIDAE

Penpheris schonburgii ‘BRANCHIOSTEGIDAE Malacanthus plusieri ‘CARANGIDAE Caranx bartholonaei 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 ---Page Break--- TABLE 6. (Continued) SPECIES POMADASYIDAE Anisotremus surinamensis Anisotremus virginicus Haemulon aurolineatum Haemulon carbonarium Haemulon chrysargyreum Haemulon flavolineatum Haemulon melanurum Haemulon seiurus ‘SCIAENIDAE, Calamus bajonado SCIAENIDAE Equetus acuminatus Odontoscion dentex SULIDAE Pseudupeneus maculatus Mulloidichthys martinicus AETODONTIDAE Chaetodon sedentarius Chaetodon striatus Holocanthus ciliaris Holocanthus tricolor Pomacanthus arcuatus Pomacanthus paru POMACENTRIDAE Abudefduf saxatilis Chromis multilineatus Eupomacentrus fuscus

Eupomacentrus partitus Eupomacentrus planifrons Microspathodon chrysurus CURRUITIDAE ‘Amblycirrhitus pinos LABRIDAE Bodianus rufus Clepticus parrai Doratonotus negralepis Halichoeres bivittatus Halichoeres garnoti Halichoeres maculipinna Halichoeres pictus Halichoeres radiatus Halichoeres poeyi Henipteronotus martinicensis 39 SPECIES LABRIDAE (Cont..) Thalassoma bifasciatum ‘SCARIDAE Scarus coeruleus Scarus croicensis Sparisoma aurofrenatum Sparisoma chrysopterum OPISTOGNATHIDAE Opistognathus aurifrons CLINIDAE, Malacoctenus triangulatus Paraclinus fasciatus Paraclinus grandicomis GOBIIDAE Scomberomorus regalis Cosine Gobiosoma evelynae CALLIONIDAE, Callionymus bairdi SCORPAENIDAE Scorpaena grandicornis Scorpaena bergi ACANTHURIDAE Acanthurus bahianus ‘Acanthurus chirurgus Acanthurus coeruleus BALISTIDAE Alutera schoepfii Balistes vetula Canthigaster pullus Nelichthys niger (OSTRACIDAE Lactophrys polygonia Lactophrys triqueter ‘TETRAODONTIDAE Canthigaster rostrata ‘Sphoeroides spengleri DIODONTIDAE Diodon holocanthus ---Page Break--- a TABLE 9. Species List for phytoplankton 24 hour station, 0900 28 May

- 0900 29 May 1974 Bacillariophyceae (Diatoms) Actinoptychus sp. fragilarioides Ehrenberg, Fistulifera saprophila (G. M. Smith) Hasle, Hemiaulus hauckii (G. M. Smith) K. M. H. Schiller, Thalassiosira atlanticus (H. Peragallo) W. M. M. H. S. D. and T. peruvianus (Grunow) G. C. M. Bourelly, Tocconeis sp. Fragilaria sp. Biddulphia fobs >) Fragilaria sp. Crematium foraminosum (Ehrenberg) Hasle, Franchia rauchii (Ehrenberg) Hasle, Cylindrotheca danica (Grunow) Grunow, Nitzschia sp., Richelia intracellularis (L. L. H. M. E. M. M. S. M.) N. Tongissina & paratetraselmis Hablonema sp. and Rhizosolenia setigera (Meunier) M. A. M. H. H. calcar (Ehrenberg) & Gigas (Ehrenberg) R. faberi (Ehrenberg) Striatella intermedia ~ unipunctata Stes, Counteroties in Closterium fassionena Nitzschia delicatissima Teleration iceratiun sp. Pennate diatoms Dinophyceae (Dinoflagellates) Gyrodinium acutispina * Schroeder. (7) x on “Solenia quadrispina C. teres, Spe Buvisetta sp. ataminice, Scrippsae & Sp. nium pectinatum Sosa, Sam azacile Poridinium conicum, Peridinium divergens globatus (2) F. Grant Hires P: seein P. Prochloron micans is robusta (2) identified dinoflagellates Coccolithophoridae Catenaria longa Foliose aivtations aspera Rhizobium styliter or other Nitzschia sp. THOpsezaity chethoutt fhetbaurt a Tubularis ae Unidentified phytoflagellate Eutreptia marina ---Page Break--- TABLE 10, Important phytoplankton species (those appearing at numbers greater than 50 cells/liter) and timbers (Chalupa 24 hour station 28-29 May 1974) Diatoms Asterionella notata 210, Thalassiosira laevis 0, Tocconeis sp. 90, Fragilaria sp. 0, Heterococcolithus 0, 510, Savonia sp. (1g) 20, Navicula sp. (sm) 80, Navicula c.f. warwicki 9, Mitzschia closterium 40, delicatissima 250, R. paradoxica 0, Pseudodictyocha sp. 80, Wilzonia solentis Trichodesmium —“ Striatella wipes sb Thalassionema nitzschiae 2) ee, istas 0, Dinoflagellates Exuviaetta sp. 50, Fonaiulax minuta 10, Gymnodinium sp. (n) 90, Gephyrocapsa hiatus sp. (=m) 150, Gymnodinium trochoides 60, Fp. 50. SP. Unidentified dinoflagellate 1910, Coccolithophores Discosphaera tubifer 40, Barkowit 0, Eitosphaera sp. 4, unidentified coccolithophore 30, Other Trichodesmium thiebautii 30, Solenococcum setaceum 0, identified phytoplankton 250 Unidentified cet 30, Totals (cells/liter) 5040

1300 ° 20 0 420 50 120 10 180 590 60 ° 20 50 430 10 50 200 2 160 10 40 0 0 500 140 3490 2100. 180 20 on 40 10 20 10 20 160 60 3190 Colis/Liter 28 May 215/liter) 29 May 0300 3600 ---Page Break--- ‘This paper was prepared in connection with work under Contract No. E~(40-1)-1832 with the U.S. Energy Research Development Administration. ERDA retains a non-exclusive royalty-free license in and to any copyrights covering this paper, with the right to authorize others to reproduce all or any part of the copyrighted paper.” ---Page Break--- ---Page Break---