

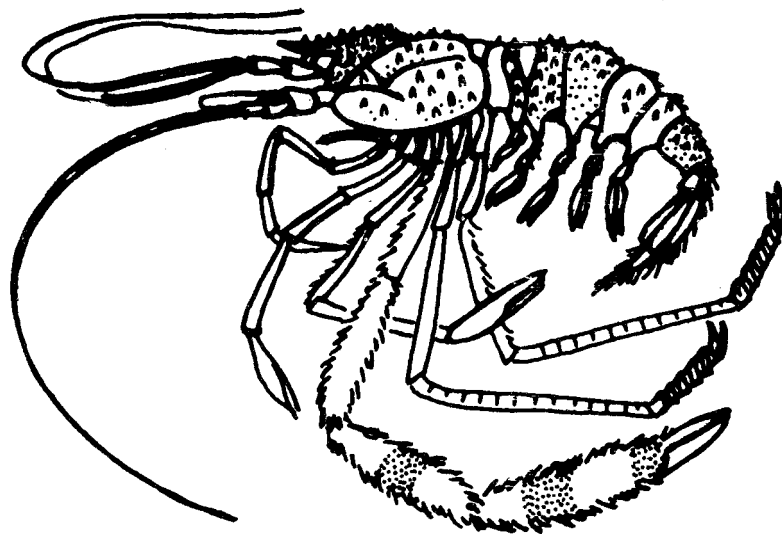
Ray Waldner

ASSOCIATION OF ISLAND MARINE LABORATORIES

OF

THE CARIBBEAN

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INTRODUCTION

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The 11th meeting of the AIMLC was hosted at the Estate Carlton Hotel on St. Croix, U.S. Virgin Islands, by the West Indies Laboratory from May 2 through May 5, 1975. 1st Vice President John Ogden organized the meeting magnificently and all the members of the West Indies Laboratory made the event most pleasant. Betsy Gladfelter's cordiality and indefatigable behind-the-scenes work, in particular, helped make the meeting run smoothly.

There were 95 registrants from seven countries and 48 papers were presented by 61 authors, making this one of the Association's largest meetings. Diversions included nightly dancing and entertainment at the poolside bar and patio of the Estate Carlton and a trip to Buck Island Reef following the conference, as well as numerous impromptu informal trips to the West Indies Laboratory and other points of interest on the island of St. Croix.

FACTORS INFLUENCING THE DISTRIBUTION OF Chromis cyanea
(Poey) ON THE REEFS OF CURACAO

by

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Chromis cyanea is one of the territorial Pomacentridae and is quite abundant on the reefs of Curacao. The distribution of this species on the reef was ascertained by weekly counts in the depth range from 6 to 45 m. The highest population density is reached between 18 and 34 m, while in the shallower and deeper areas the density decreases. In trying to establish which factors affect this distribution, different measurements of the reef-habitat were taken: percentage of coral cover, diversity of coral species, number of hiding places, number of other territorial Pomacentridae, availability of food and the extent of the field of vision which is actually a measure of the vertical relief in the area. A strong positive correlation was found only between the number of C. cyanea and the number of hiding places, and between this and the number of territories. Hiding places play an important role in the establishment of a territory. Nests are always made within a short distance of a hiding place. Evidence was found which suggests that there is a relative shortage of hiding places in the shallow area and this presumably makes this area less attractive than the deeper parts of the reef where there are many hiding places available to C. cyanea. A strong negative correlation was found between the number of territories and the field of vision, and between this and the total number of C. cyanea. Experiments showed that a decrease in the field of vision would make an area more attractive for maintaining territories.

Food may also play a role in the distribution of C. cyanea. Under certain circumstances, food is more abundant on and below the blue edge than above it.

From the behavior of C. cyanea, it may be concluded that in spite of the increased aggression in the high-population-density area, non-territorial males are more attracted to this area than to the area with a low population density. The numbers of the adults remain fairly constant throughout the year. The numbers of juveniles, however, vary widely. Though juveniles are present the whole year round, there seems to exist a certain seasonality in the recruitment of C. cyanea.

A STUDY OF THE RELATIONSHIP BETWEEN SUBSTRATE
COMPLEXITY AND REEF FISH DIVERSITY

by

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A simple field method to obtain an estimate of the gross complexity of the substrate in a quadrat is described. The method employs a series of chain measurements to establish a substrate complexity index (SCI) value for a quadrat. The SCI is the ratio of the actual surface distance (following the contours of the substrate) to the linear distance. Individual SCI values from all quadrats ranged from 1.1 to 4.0. A series of vertical relief measurements were taken in conjunction with the chain measurements.

The mean SCI and mean vertical relief are given for 12 quadrats (each 9m^2) from the southwest coast of Curacao. The quadrats occur at 10 m depth intervals along three transects. These transects start at the drop-off (10 m) and end at 40 m on the deep reef slope. The mean SCI and mean vertical relief for all quadrats are shown to be highly correlated ($p < .001$). The mean SCI values for the 10 m quadrats are highly variable (1.28 - 2.07). Maximum values for each transect (1.93 - 2.39) occur at the 20 m quadrats and values then show a consistent decrease with depth. The range of values for the 30 m and 40 m quadrats are 1.73 - 1.76 and 1.43 - 1.65 respectively.

The concept of an observability index is introduced in an attempt to take into account the difficulty encountered in detecting some species in the field. The assessment of the resident fish diversity of each quadrat is based on one year of data (1974) obtained from biweekly visual censuses and the observability index values for each species. Linear regression analysis showed that resident species diversity was strongly correlated ($p < .01$) with the mean SCI of a quadrat. An example (from Bonaire) of the usefulness of the SCI for comparative work is briefly discussed.

AGING OF THE GROUPER Petrometopon cruentatum
(Graysby) IN CURACAO

by

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Otoliths were collected weekly from January 1973 till now. The conditions to use the otoliths for aging Petrometopon cruentatum were satisfied, namely:

1. The relationship of otolith length to standard length is linear, $r = 0.994$.
2. The relationship of age group and standard length is almost linear.
3. The annuli are formed always at the same time of the year, namely one in the beginning of January, one in May and in the beginning of June, one at the end of August and in the beginning of September; P. cruentatum also forms three annuli a year.
4. The growth curve developed from empirical data agrees closely with the growth curve developed from the back-calculation of body length.

Temperature is probably the cause or one of the causes of annulus formation. The oldest Graysby found is 9 years old. Sexual maturity as a female occurs between ages 2 and 4. The change from female into male (sexual transition) occurs between ages 3 and 6 immediately before and after the spawning season.

OBSERVATIONS ON THE BEHAVIOR AND ECOLOGY OF THE
LONGTAIL JAWFISH, Lonchopisthus micrognathus

by

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The burrow-dwelling longtail jawfish, Lonchopisthus micrognathus, was studied near La Parguera, Puerto Rico. Groups of individuals were observed at 18 m depth on fine mud bottoms. Burrows were cast and found to have multiple entrances and side tunnels, unsuitable for habitation by the fish, dug by commensal organisms.

This jawfish hovers above its burrow and engages in particulate plankton feeding. Its behavior and ecology are remarkably similar to the yellowhead jawfish, Opistognathus aurifrons, but the two species inhabit very different sediment types.

THERMAL ACCLIMATION, TOLERANCE, AND PREFERENCE
IN THE YELLOWTAIL SNAPPER, Ocyurus chrysurus

by

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Yellowtail snappers, Ocyurus chrysurus, were tested for rate of acclimation and tolerance to elevated temperatures. Acclimation, defined as the increase in lethal temperature for a 24 hour period, took place in one day and did not yield results significantly different from acclimations of up to 10 days. Lethal temperatures, defined as the temperatures that 50% of the population could survive for 7 days, ranged from 32.6°C at a 20°C acclimation to 33.5°C at a 32°C acclimation. The ultimate lethal temperature was found to lie between 33.5 and 34.0°C.

Temperature preference was tested against acclimation. Fish selected significantly different temperatures when acclimated at temperatures of 20, 24, 26, 28, 30 and 32°C. The mean selected temperature ranged from 24.7 (20°C acclimation) to 30.6°C (32°C acclimation).

COMMERCIAL FISHERIES AND MARINE RESEARCH IN
THE LOS ROQUES ARCHIPELAGO NATIONAL PARK

by

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The Los Roques National Park is a uniquely rich marine archipelago of 366 islands which the Venezuelan government is attempting to conserve through fishery management programs, limited development of tourism and research in tropical marine ecology and aquaculture. The area is host to roughly 1000 resident and seasonal commercial fishermen who are the backbone of a productive lobster and conch fishery, which is supplemented by regularly good catches of Spanish mackerel, snappers, groupers, octopus, jacks, tunas and bait fishes. This paper describes the fishery: its people, methods, boats, markets and management efforts. The ecology of the system is discussed in terms of primary productivity, commercial species, habitats and seasonality. Activities of the Los Roques Research Station and the National Fisheries Office (ONP) regarding stock assessment, protection of nursery areas, control of catch, and mariculture are outlined, with comments about the future of such programs. The high quality of the waters (absence of pollution, nearly constant physical conditions, and high productivity) affords a superb natural environment for research into the culture of locally successful species, with the ultimate objective being to establish small culture efforts operated by the families of fishermen.

COASTAL UPWELLING ECOSYSTEMS ANALYSIS PROJECT
AND ITS JOINT II EXPERIMENT OFF PERU IN 1976-1977:
IMPLICATIONS FOR FISHERIES

by

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The Coastal Upwelling Ecosystem Analysis Program (CUEA), sponsored in the United States by the office of the International Decade of Ocean Exploration of the National Science Foundation and in other (Latin) countries by similar designation, has as its major research objective to develop a generalized and comprehensive model of the ecosystems found in coastal upwelling zones through specific research conducted by biological, physical and chemical oceanographers. Coastal upwelling is found along the margins of the world's oceans, particularly along the eastern boundaries of ocean basins. Biological productivity is greatly enhanced in these regions by the physical processes that cause water at depth to vertically ascend on the continental shelves and slopes. As the nutrient rich water comes into the euphotic zone it permits vigorous productivity by phytoplankton which in turn may support major coastal fisheries such as the anchovies fishery off Peru.

The research plan for several initial CUEA field studies has been to proceed in two phases. Phase I was to select several different coastal upwelling zones, e.g., coastal zones of Oregon, Baja California and N.W. Africa where physical and biological conditions differed, in an effort to collect sufficient information on the important physical driving forces and the subsequent biological changes in the respective locations. Work was also started on the development and evaluation of numerical and analytical models to be used as sub-models in the overall ecosystems model. Based on what CUEA oceanographers have learned from the four previous field studies, CUEA scientists are planning to conduct their most comprehensive field effort in the coastal upwelling zone off Peru in 1976-77. This new and important interdisciplinary research (start of Phase II) is expected to shed light on several major questions yet to be answered by the earlier studies. These questions bear on the seasonal character of coastal upwelling off Peru and the alongshore scale associated with the upwelling process, the temporal and spatial variability of fronts and/or plumes both from the standpoint of the physics and how these small scale features affect the different trophic levels found in the coastal water off Peru. To deal with the larger time scales the field experiments will take place over an 18 month period. JOINT II research is expected to provide the needed environmental information in order to understand how fluctuations in the great anchoveta fishery are related to the rest of the coastal upwelling ecosystems off Peru, and more indirectly to ecosystem models for other coastal upwelling zones of the world's oceans.

A SURVEY OF FISHES FROM BARRIO ISLOTE
ON THE NORTH COAST OF PUERTO RICO

by

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Fish populations in the nearshore waters ($\leq 30\text{m}$) off Barrio Islote, Puerto Rico were sampled to identify the species common to the area where a nuclear power plant is to be installed. Visual censuses indicate that the most abundant fishes are labrids, serranids, pomacentrids, and acanthurids. The distribution of fishes is dependent on the existing habitats (sand, algal mat, and rock outcrops) with the greatest concentrations associated with rock outcrop. Seasonality in fish population is not evident from the data, but fishes tend to wander further from their respective habitats during the summer (calmer) season than during the winter (rougher) season.

According to the data obtained in this and other studies, some of the fishes spawn year round, or at least have prolonged spawning seasons.

A SURVEY OF PHYTOPLANKTON FROM THE ISLOTE
VICINITY OFF THE NORTH COAST OF PUERTO RICO

of

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Under Contract for
Puerto Rico Water Resources Authority

Water bottle samples were taken at five stations off Islote, Puerto Rico from February, 1974 through January, 1975. Three of the stations were in 20 m and two in 100 m of water. Total sampling area was less than 5 km^2 . The waters appear to be well mixed and should closely approximate a homogeneous system. The five sets of data may be combined to yield a valid picture of the population off the north coast of Puerto Rico during the one year period. Apparently extraordinary weather conditions led to a very low standing crop in February, March and April of 1974. Numbers increased after the onset of the rains and averaged approximately 5,000 cells/liter during the remainder of the year. Two pulses of 10,000 cells/liter were noted in August and September. Both pulses were diatomaceous in nature, and in both cases the most prominent organism was the pennate, Nitzschia sp. Differences between the population of the north coast and those of the south and west coasts are noted.

ARTIFICIAL UPWELLING MARICULTURE PROJECT
ON ST. CROIX, U.S. VIRGIN ISLANDS

by

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The technical feasibility of mariculture in a combined sea thermal power/fresh water/mariculture plant, using artificially upwelled deep water, has been investigated on St. Croix over the past six years. Nutrient-rich water from 870 m depth is pumped into concrete 45,000 liter ponds onshore, where planktonic centric diatoms are grown in continuous cultures and then fed to filter-feeding bivalve shellfish (oysters, clams and scallops). Cultures of the temperate diatom Thalassiosira pseudonana (3H) and two high temperature-tolerant diatoms, Bellerochea polymorpha (STX 114) and Chaetoceros simplex (STX-105), can be maintained nearly unialgal for 1-2 weeks in continuous culture; deep water cultures supplemented with chelated metals and vitamins last longer than unsupplemented cultures. Chaetoceros curvisetus (STX-167) can be maintained in unsupplemented deep water for more than four weeks, apparently because over 90% of the nitrate and silicate in deep water are removed by this diatom, thereby effectively inhibiting invasion by competing weed species.

Six species of bivalves grown on various mixtures of the above diatoms reached market size in 6.5-16 months. These were evaluated on the basis of growth rate, survival, stocking density at market size, and per cent meat, and were ranked in order of decreasing economic value per unit area of shellfish tank as follows: Tapes semidecussata (Japanese little-neck clam), F₁ clams (cross of Mercenaria campechiensis and M. mercenaria), M. campechiensis (Southern clam or quahog), Crassostrea gigas (Pacific oyster), Ostrea edulis (European oyster), and Argopecten irradians (Bay scallop). Populations of Crassostrea virginica (North American oyster) showed poor survival rates, and M. mercenaria (Northern clam or quahog) grew too slowly to be of practical interest. Studies underway indicate a great potential also for the Kumamoto strain of C. gigas, and for Pinctada mertensii (Japanese pearl oyster).

Two successive generations of Tapes semidecussata have been spawned in our St. Croix hatchery.

The effluent from the bivalve shellfish tanks is used to rear Strombus gigas (Queen conch) on algae that grow on the bottom of the pond, and to

grow carrageenan-producing seaweeds. The seaweed Hypnea musciformis grew about three times faster in the effluent from a clam tank than in reef water, and about five times faster than in deep water.

Spiny lobster (Panulirus argus) are reared on slow-growing bivalves culled from the system.

The advantages of mariculture in artificially upwelled deep water in the tropics include fast growth rates, low mortalities, and the high quality of shellfish meat produced. The achievements to date undoubtedly are related in part to the absence, in deep water, of man-made pollutants and diseases and predators harmful to shellfish.

CARIBBEAN SCYPHOMEDUSAE, FOOD AND FOOD CAPTURE

by

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Food capture was observed both in situ and in the lab. Field preserved specimens were examined for food. Where coelenteron contents were unobtainable medusae were offered prey in the lab.

The common cubomedusa Carybdea marsupialis feeds on copepods, planktonic polychaets and small fish, the dwarf herring Jenkensia being the most important. Prey is captured on the tentacles which then contract. The food is transferred to the mouth by the inward bending of the pedalia. The sennaeostomes Chrysaora sp. and Drymonema gorgo feed mostly on other coelenterates; Chrysaora feeding on the ctenophore, Mnemiopsis and D. gorgo on Aurelia. Prey is captured on the tentacles, transferred to the oral arms where digestion takes place. Aurelia aurita feeds on microcrustacea which are captured on the tentacles and umbrella surfaces. The rhizotomes Phyllorhiza punctata and Cassiopea frondosa also feed on microcrustacea. P. punctata captures copepods and other crustacea on the frilled mouths which cover the distal surface of the oral arms. Food is captured as water passes through the arms during swimming. The bottom dwelling medusa C. frondosa captures harpacticoid copepods, tanaids, ostracods and other benthic crustaceans which are stirred up from the bottom as the medusa swims in place. Food capture is similar to P. punctata.

ECOLOGICAL ASPECTS OF THE SEAGRASS COMMUNITIES OF JOBOS BAY

by

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A descriptive ecological study of the seagrass communities of Jobos Bay, located on the southeast coast of Puerto Rico, has been conducted over a year period. The study was supported by the Puerto Rico Water Resources Authority.

The principal marine phanerogams of the bay are Thalassia testudinum (Konig) and Halophila baillonis (Ascherson) of the family hydrocharitaceae; Syringodium filiforme (Kutzing) and Diplanthera wrightii (Ascherson) of the family potamogetonaceae.

The distribution of the seagrasses depended on geographic location and depth. Their general zonation pattern was the following: (a) Diplanthera was observed in the very shallowest part of the profile close to the shoreline; (b) Thalassia or Syringodium intermixed with Thalassia inhabit the mid-shallow portion of the beds; (c) Thalassia by itself occurs in the deeper section of the beds, while Halophila inhabits the substrate in the very deepest parts of the bed where no other marine angiosperm occurred.

Reproductive structures and young seedlings of Thalassia were observed and photographed during the late spring and early summer period from May 1974 through July 1974.

Biomass values of Thalassia were related to physical parameters such as geographic location, substrate stability and light penetration; and to biological factors such as grazing activity and competition for substrate. Very low biomass values of Thalassia (2 g 1.2/.02m² dry weight) were obtained in very unstable substrate in locations where mangroves shade off much of the light while higher biomass values (95 17.2/.02m² dry weight) were obtained from shallower, unshaded beds where the substrate was of a more consolidated nature. A peak of highest biomass values was obtained during the month of March 1974.

The photosynthetic pigment diversity of green leaves of Thalassia using the Margalef ratio (D430/D665) ranged from 1.722 ± .125 to 1.965 ± .150.

Erythropodium carribboeorum covered large portions of some Thalassia beds by encrusting the substrate, other organisms, and the Thalassia plants themselves. Other luxuriant epiphytes of Thalassia in the bay were the bryozoan Schizoporella, the rhodophyte Hypnea spinella, the phaeophyte, Dictyota linearis, and the sponge Chondrilla nucula.

The larger macroinvertebrate fauna of the Thalassia beds varied with location and depth. The corals Siderastrea and Erythropodium, the sponges Haliclona and Oligoceros show a zonal distribution and are very common in the better illuminated beds located outside the bay, while the urchin Lytechinus and solitary ascidians such as Polycarpa were most abundant in siltier beds inside the bay.

FEASIBILITY OF REPLANTING SEAGRASSES IN CARIBBEAN SHALLOW, NEARSHORE WATERS

by

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A new technique for large scale transplantation of the dominant marine seagrass Thalassia testudinum has been investigated in a series of energy regimes, sediment types and locations in southeast Florida. The major portions of this research include gathering fruit, germinating seeds, seedling nurseries and field planting. This latter phase is critical for an economic analysis of cost. Production functions and corresponding costs will be derived to determine the least cost methods for propagating grass under various conditions. Results have indicated that regrowth of the Thalassia beds occurs in a fraction of the time required by natural processes. Two years' efforts in a series of locations have enabled us to assess regrowth under the various conditions. Present efforts at replanting several other species of major seagrasses and macroalgae would allow natural successional stages to occur while the dominant plant Thalassia is recolonizing. Seagrass replantation is an alternative, in the Caribbean nearshore waters where dredging, thermal additions and oil spills have altered existing seagrass communities. The authors gratefully acknowledge the support of N.O.A.A., Sea Grant, U.S. ERDA and Florida Power and Light Co.

ASPECTS OF THE ECOLOGY AND ETHOLOGY OF Lytechinus
variegatus IN JOBOS BAY, PUERTO RICO

by

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Jobos Bay, on the south coast of Puerto Rico, is one of the largest mangrove communities on the island. The Puerto Rico Nuclear Center is carrying out contract work for the Puerto Rico Water Resources Authority to establish baseline data and do environmental monitoring for power generating plants under construction there. This paper presents data and observations from the environmental baseline studies of the echinoid fauna of the bay.

Echinoid composition and distribution throughout the bay is outlined. During the month of February 1975 a population density census was made, in order to compare the population densities of L. variegatus in different Thalassia beds throughout the bay. The average population density of three Thalassia inner bay stations was $13.37 \pm 9.66/m^2$ while the average population density of three Thalassia outer bay stations was $1 \pm 1.13/m^2$. The only echinoid in the inner bay stations was L. variegatus. The outer bay stations were characterized by the presence of Diadema antillarum, Eucidaris tribuloides, Tripneustes esculentus and L. variegatus. Competition for food substrate by other echinoids, clear water conditions, predator pressure, low Thalassia biomass values and water current patterns may account for low population densities of L. variegatus in the outer bay stations.

Test diameter of L. variegatus was measured in different Thalassia beds throughout the bay at three month intervals for a nine month period. Average test diameter for inner bay stations is 33.36 ± 4.73 mm while the average test diameter for outer bay stations is 42.73 ± 2.94 mm. The average test diameter increases from inner bay stations to outer bay stations; population density may account for this trend.

Observations on the day-night migration and feeding behavior of L. variegatus in the Thalassia community during four hour intervals for a twenty-four hour period were accomplished. They do not seem to migrate diurnally from the deeper portions of the bed to the shallower portions of the bed. Rather they seem to migrate vertically from the substrate, rhizome-sheath level of the Thalassia plant to the Thalassia blades. Grazing by L. variegatus on Thalassia occurred in the upper section of the leaves and on the sheath tissue and remnants of decaying leaves on the lower portion of the Thalassia plants. Other types of feeding by L. variegatus are discussed.

PREDATION BY THE HELMET SHELL Cassis tuberosa
UPON SEA URCHINS IN Thalassia BEDS

by

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Urchins are abundant consumers of Thalassia testudinum and therefore play important roles in determining the structure of the seagrass community. The rate of consumption of seagrasses depends upon the population density of urchins, their sizes and the species present. By its selective predation upon certain species and sizes of urchins within seagrass beds, Cassis tuberosa (the helmet shell) may have a major impact upon the seagrasses themselves.

Two sites near La Parguera, Puerto Rico have been chosen for comparative studies of the effects of Cassis predation. One of the sites has relatively high populations of Cassis (\approx one per 500/m²) while Cassis has been eliminated from the other by over-fishing. The differences in the urchin faunas of the areas are striking. At the area of high Cassis density the small Lytechinus variegata is the principal species present along with some Echinometra lucunter. Roughly 70% of all intact empty urchin tests at this site have a characteristic hole drilled by Cassis. By contrast, at the site where Cassis is absent, the urchin fauna is composed of Diadema antillarum and Tripneustes esculentes, as well as Lytechinus and Echinometra. Of 100 intact urchin tests collected at the latter locale, all were of Tripneustes and none had been drilled by Cassis, hence death is apparently due to senescence.

The foraging and attack behavior and prey preferences of Cassis and the variety of escape responses and daily activity patterns of the urchins suggest that the members of this food sub web have evolved in close association.

LONG-TERM MONITORING OF POLLUTION IN KINGSTON HARBOR

by

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An average of 3,000,000 gallons of primary treated sewage enters Kingston Harbor daily, in addition to brewing wastes and other water-borne pollutants. Together, these sources supply 40 times the natural nutrient level of the water in the harbor.

Phytoplankton blooms are commonplace and in the inner harbor the O₂ level is normally only 50% of saturation.

Changes in the benthic fauna have been studied since 1968. In that year there were 15 spp. in samples collected in the inner bay, and 96% of the specimens were the polychaete Spiochaetopterus. In the outer bay in 1968 150 spp. were collected and the most abundant was Venereis (8%). By 1974 only 78 spp. were found in the outer bay and a single species accounted for 19% of the total. Bivalves were conspicuously lost, while nematodes were among invading taxa. Each year from 1968 to 1974 an "abiotic zone" advanced further from the inner reaches of the harbor toward the mouth.

Capitella capitata is useful as an indicator of high organic sediments. In 1968 it was found only in (inner) Hunt's Bay, but in October 1973 it had spread to the outer harbor where it was collected along with Spiochaetopterus.

A YEAR-LONG STUDY OF ZOOPLANKTON FROM
THE NORTH COAST OF PUERTO RICO

by

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A year-long study of zooplankton from the north coast of Puerto Rico reveals a plankton dominated by copepods, fish eggs, chaetognaths, and larvaceans. Other animals such as ostracods, pteropods, gastropod veligers, and salps were occasionally numerous but did not appear in every sample. Sampling was bi-monthly and the abundances of many zooplankton species changed significantly between each sampling period. It is not yet known whether the observed fluctuations are truly seasonal; several hypotheses are offered to explain their cause.

DETRITIVOROUS AMPHIPODS FROM Thalassia
BEDS NEAR LA PARGUERA, PUERTO RICO

by

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Preliminary work on detritus selection by gammaridean amphipods taken from an intertidal turtle grass bed (Thalassia testudinum) indicates that the major amphipod species of this system are detritivores. A compartmented flow-through, seawater system containing detrital material from three marine plants (Thalassia testudinum, Rhizophora mangle and Pocockiella varigata) was inoculated with gammaridean amphipods from inter-tidal Thalassia. These were a natural assemblage of 6 species and 705 individuals. The species, in rank order of abundance, were: Cymadusa filosa, Elasmopus rapax, Gammaridae (new genus), Melita sp., Lemboides sp. and Maera sp. After one month, the experimental detritus system was disassembled and the surviving amphipods removed. Of the original, 5 species remained in the same order of abundance as the original. Individual numbers had increased to 930. During the test period, the amphipods were observed to be reproducing, as evidenced by brooding females and more juveniles, and to be actively feeding on the detritus presented, as supported through gut and feces examinations. Additionally, greater numbers of amphipods were found in the Thalassia compartment, thus apparent selection occurred for Thalassia over Rhizophora and Pocockiella.

THE INVERTEBRATE FAUNA OF THE LOCKS OF THE PANAMA CANAL

by

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Collections of invertebrate animals were made in the east Upper, Middle, and Lower Gatún Lock chambers, at the Atlantic end of the Panama Canal in March, 1974. Further collections were made at the Pacific end of the Canal in the east Upper and Lower Miraflores Lock chambers (August 1974) and in the east Pedro Miguel Lock chamber (February 1975). On all occasions paired samples were taken at five equally-spaced sites along the length of each chamber, one from the chamber floor and one from the wall, about two meters above the floor.

A total of 165 different species of invertebrates was found in the lock chambers; 126 species in the Pacific series; and 57 species in the Atlantic series.

Both the Upper Gatún and the Pedro Miguel chambers supported a freshwater (F)/brackish (B) fauna; the same species of Trochospongiella (sponge, F), Cordylophora (hydroid, BF), Tanais (tanaid, BF), Mytilopsis (bivalve, BF), Munna (isopod, BF), and Gitanopsis (amphipod, BF) were found in both; different species of Neritina (gastropod, BF) were found in each chamber.

The Middle Gatún and the Upper Miraflores chambers had the same species of Tanais, Mytilopsis, Gitanopsis, Boccardia (polychaete, BF), Cassinidea (isopod, BF), Exosphaeroma (isopod, BF), Cirolana (isopod, B), Balanus (barnacle, B), Granderiella (amphipod, BF) and Cerapus (amphipod, BF) in common, as well as the previous pair of Neritina. Apart from these, there is little faunal similarity between these two chambers. Generally, the fauna of both chambers has a brackish/marine aspect.

The Lower Gatún and the Lower Miraflores chambers have the same species of Garveia (hydroid, B), among others, in common; different species of 18 genera, notably Isognomon (bivalve, B), Brachidontes (bivalve, B), Thais (gastropod, B), Hexapanopeus (decapod, B) and Callinectes (decapod, B) occurred in each. The remainder of the fauna of both chambers, especially at the lower ends, is fully marine.

Of the 19 species common to both sides of the lock system, 11 can live in fresh water and may well live in Gatún Lake; populations of the remain-

ing eight species are separated by the lake and from two to four lock chambers, suggesting a fortuitous transit of the canal sometime in the past. All of the 19 species are fouling organisms or associated with such, which suggests how the fortuitous transit might have occurred.

The presence of 19 species in common, more than half of which are freshwater species, of a total of 165 species encountered, does not substantially alter the effectiveness of Gatún Lake as a barrier to the transisthmian migration of the vast majority of marine invertebrates. It is felt that any salinization of Gatún Lake will break this barrier and allow indiscriminate interoceanic migrations of marine animals.

THE ECOLOGICAL EFFECTS OF PHYSICAL DAMAGE FROM MOTOR BOATS ON TURTLE GRASS BEDS IN SOUTHERN FLORIDA

by

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Observation has shown that beds of turtle grass, Thalassia testudinum, although highly productive, do not recover rapidly following physical disturbance of the rhizome system. In shallow waters the most common form of rhizome disturbance is from the propellers of motor boats.

In turtle grass beds that are otherwise thriving, tracks resulting from propellers have been observed to persist from two to five years. The proportion of fine sediment components is reduced in the sediments from the boat tracks, and the pH and EH are reduced in comparison to the surrounding grass bed.

Damage of this type is most likely to occur in the shallow passes between islands and keys. These areas are also the slowest to recover due to the rapid tidal currents present in the shallow passes.

GRAZING BY Diadema antillarum PHILIPPI (ECHINODERMATA:
ECHINOIDEA): DENSITY-DEPENDENT EFFECTS ON CORAL
AND ALGAL COMMUNITY STRUCTURE

by

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The study in progress is designed to determine and quantitatively define the effects of grazing by Diadema antillarum at different intensities on the composition, diversity, distribution, and abundance of both coral and algal species in the shallow patch-reef community of Discovery Bay, Jamaica, West Indies and to demonstrate control of interspecific competitive interactions between them.

The first experiment involves elimination of a high density Diadema population (approx. $34/m^2$) from a patch-reef; the second, elimination of the entire regular echinoid community (approx. $54/m^2$ remaining) on one-half of the same reef six months later both treatments to be compared with a nearby non-treatment reef. After six months, the first treatment showed higher coral recruitment, particularly in Agaricia and Porites spp., a higher degree of settlement exposure in Agaricia fragilis and Porites spp., and a higher mortality of adult colonies through overgrowth by algae, particularly in Agaricia agaricites, A. fragilis, and Porites astreoides. The second treatment resulted in a much higher degree of adult coral mortality. Algal biomass and species numbers were higher in both treatments.

The third experiment involves implantation of benthic inclusion/exclusion cages with an increasing gradient of Diadema densities ($0-64/m^2$) to demonstrate density-dependent effects on initial colonization of corals and algae on virgin Acropora palmata substrate. An increase in grazing pressure resulted in a sharp decrease in both number of coral individuals and species recruiting. Spat $\geq 500\mu$ in diameter were tentatively assigned at least to genus and, in some cases, species. Algal biomass and dominant species numbers decreased with increased Diadema density.

It may be concluded that both the coral and algal communities are drastically affected by intensity of Diadema grazing. Intense grazing activities result in a high degree of direct biological disturbance to newly settled coral planulae. Low grazing pressure, while increasing coral recruitment, may indirectly cause high species-specific coral mortality through competition for space with algae.

GRAZING AND PRODUCTIVITY AS CONFOUNDING FACTORS IN THE DEVELOPMENT OF BENTHIC MARINE COMMUNITIES

by

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Although r and K species are present in the early stages of succession in both oceans, " r -selected species" with rapid reproduction and high turnover dominate the later stages of succession in the eastern Pacific, while " K -selected species," which are longer-lived and put more energy into maintenance, defense, and large body size dominate the later stages of community succession in the Caribbean. The high productivity of the eastern Pacific allows weedy fast-growing forms associated elsewhere with the early stages of succession to outcompete K -selected species, such as hermatypic corals.

Species with r -selected characteristics are not just "opportunists." Under conditions of high nutrient input such as upwelling, they can be superior competitors for space. Evidence is reported from four years of experiments with settling plates, fish exclusion cages and artificial substrata at various depths. In highly productive areas of nutrient upwelling in the eastern Pacific, newly settled hermatypic corals are rapidly pushed off settling plates by barnacles, overgrown by bryozoans, smothered by filamentous algae, or scraped off by grazing fish. Hermatypic corals can survive in these areas where a crevice or shade under a rock permit them to grow large enough not to be eaten or smothered. Those corals which "escape in size" persist in regions of upwelling. In the Caribbean, corals settling on the plates are not smothered and eventually take over much of the space. Herbivorous fish which remove surrounding algae avoid scraping corals as small as 3 mm in diameter.

Within coral communities in either ocean, the dominance of K -selected species increases with depth as the energy input of light decreases. In shallow water, coral planulae metamorphose most often on undersides or shaded sides of settling plates or blocks, growing onto the upper surface as they reach a refuge in size. In deeper water where algae grow slower, they settle on upper surfaces and survive. Even among coral species, the superior competitors by extra-coelenteric digestion can be overgrown by r species corals in shallow water but can maintain their space in deeper water where r species grow slower.

BEHAVIORAL AND ECOLOGICAL STUDIES ON THE ECHINOID
Echinometra lucunter (L) AT ST. CROIX

by

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and

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Studies on the activity pattern, behavior, and diet of Echinometra lucunter were carried out on selected areas of beach rock and nearshore algal ridges at Boiler Bay, St. Croix, U.S. Virgin Islands, in January 1974.

In general, the highest urchin population densities, and the largest urchins, occurred in the lowest part of the intertidal zone and in the immediately adjacent subtidal zone to a depth of about 0.5 m. The highest populations and the largest urchins occurred on the algal ridges, where the porous reef structure provides a more three-dimensional habitat than beach rock. No urchins less than 10 mm in test diameter were found in the study area.

All E. lucunter occupied protected pits, crevices, or holes in hard substrata, though none appeared trapped in their burrows. Movement began about 1700 hrs; the animals were farthest from their burrows between 2200 and 0400 hrs, and most animals returned to their home site by 0700 hrs. Maximum distances from the burrow achieved for any urchins under study were 6 cm on beachrock and 11 cm on the algal ridges. Dispersion in populations of settled adults is virtually absent. A densely populated area of beachrock 1 x 3 m² was cleared of urchins in October 1973; in September 1974, nearly a year later, the area was still almost completely bare of urchins, and its boundaries were clearly marked by dense urchin populations on all sides.

Of the total diet, 45% consisted of plant species grazed from rock surfaces within and immediately adjacent to the burrows. Plants taken by grazing were eaten more or less in the order of their local abundance. The remainder of the diet (55%) consisted of drifting plant materials, not growing near the burrows but brought to the urchins by waves and currents, and captured by actions of the spines and tube feet.

E. lucunter displayed territoriality and agnostic behavior. Individuals defended their home sites against trespassing urchins of the same and other species. Aggressive behavior displayed by host urchins on their home sites and also sometimes by intruding urchins, included pushing and biting. Injuries incurred during fights were not severe but included numerous spines bitten off and some damage to peristomial tissues in mouth-to-mouth battles. The frequent occurrence of fresh pieces of urchin spines in urchin gut contents suggests agonistic behavior is common in natural populations. The habit of rock-boring and crevice-dwelling permits E. lucunter to inhabit regions of severe wave action. Territoriality and aggressive behavior permits individuals to defend their protective shelters, and to retain their access to both attached and drifting plant foods.

STRUCTURE, FUNCTION AND BEHAVIOR OF THE TENTACLES AND
PSEUDOTENTACLES OF THE ANEMONE Lebrunea coralligens

by

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The aliciid anemone Lebrunea coralligens is a denizen of small cavities in carbonate substrates in shallow (to 7 m) marine waters of the Caribbean (St. Croix, Puerto Rico, Jamaica).

Just below the ring of tentacles are six large lobelike extensions of the uppermost part of the column called pseudotentacles. The latter are packed with zooxanthellae with very localized nematocysts. The tentacles have lower zooxanthellar concentrations and higher nematocyst densities. In darkness the tentacles are moderately extended and the pseudotentacles are retracted. The tentacles extend with increasing light intensity up to about 4 ft. can. then contract; whereas the pseudotentacles extend with increasing light up to about 500 ft. can. Lebrunea breeds its larvae up till a stage immediately preceding tentacle formation. The young are released simultaneously at night and many do not leave the cavity occupied by the parent. Light seems to play an important role in the biology of this animal at all stages of the life cycle.

COMMENTS ON THE LIFE HISTORY AND BIOLOGY OF
Carybdea alata REYNAUD 1830 (CUBOMEDUSAE)

by

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The scyphozoan order of Cubomedusae, on the basis of the distinctiveness of the polyp generation of Tripedalia cystophora, elucidated by Werner, Cutress, and Studebaker (1971), has been elevated to a class, Cubozoa, by Werner (1973).

In a subsequent life history, Studebaker (thesis, 1972) showed that the polyps of Carybdea marsupialis differ from those of Tripedalia in a number of important features. Believing that investigations of life histories of other Cubozoa might, therefore, reveal phylogenetic relationships with the class, an effort was made to rear polyps of other species, particularly those in other genera and the one other family. Carybdea alata has now been successfully reared, leading to a better understanding of the biology and relationships of this species.

Early growth stages of C. alata medusae, both reared and taken in plankton samples, compare in all respects with descriptions of C. aurifera Mayer (1900) and C. verrucosa Hargitt (1904) with which C. alata is considered to be conspecific.

Populations of C. alata are frequently predominantly of one sex and possibly result from clones of asexually produced secondary polyps.

Aggregations of large, sexually mature C. alata have been observed for two successive years (23 July 1973 and 12 August 1974) at Aguadilla, Puerto Rico and off Sardinera Beach at Mona Island, 50 miles west of Puerto Rico. Spawning was initiated and completed within 36 hours, peaking on a single night. This is the first observed instance of synchronous spawning of a cnidarian.

C. alata approximately one-tenth full size have been found on several occasions to bear ripe gonads, indicating that individuals may reach sexual maturity early in their development and spawn several times.

Fertilization in C. alata occurs on the surface of the ovary. The development of the planula, settlement, maturation time of the polyp, and polyp morphology are essentially the same as for C. marsupialis. The polyps differ with respect to size, pigmentation, number of polyp tentacles, and distribution of nematocysts.

SEASONALITY OF SEXUAL REPRODUCTION AND GROWTH
RATES OF SELECTED COLONIAL ASCIDIANS
IN LA PARGUERA, PUERTO RICO

by

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Reported here are two aspects of an investigation seeking factors which influence the distribution of some common species of tropical colonial ascidians. Under consideration are seasonality of sexual reproduction, larval taxis, duration of larval life, growth rate, age at sexual maturity, longevity, competitive interactions, and predation.

It has been repeatedly reported that temperate ascidians spawn during the warmer parts of the year, suggesting that spawning is controlled by temperature. Goodbody (1961) has shown that in Jamaica spawning is continuous throughout the year in three species of tropical ascidian: Ascidia nigra, Diplosoma macdonaldi, and Symplegma viride. In a mangrove lagoon at La Parguera, Puerto Rico, six additional species have been spawning continuously from November through March, bridging a temperature range of 25°C to 30°C. The following species, listed in order of their abundance, have appeared regularly on 672 cm² and 348 cm² frosted black formica collectors with a sanded surface: Ecteinascidia turbinata, Botrylloides nigrum, Botryllus planus, and Perophora viridis. A minimum of two collectors is being submerged semi-monthly among the prop roots of Rhizophora mangle and examined after 14-16 days. Two additional species, Aplidium lobatum and Eudistoma olivaceum, do not appear on collectors, but zygotes have been found inside colonies collected monthly over the same period of time.

Colonial ascidians are characterized by colonial growth through asexual budding. In the absence of competition, growth rates for B. nigrum, E. turbinata, and Didemnum sp. have been determined to be exponential, with the colony size doubling every 5-10 days.

Van Name (1945) was used for identifications.

BIOLOGICAL BASIS FOR POLYCHAETE COLONIZATION PATTERNS IN A BIMINI LAGOON

by

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Nearly 7000 polychaetes (Annelida, Polychaeta) representing 18 families were extracted from small plastic mesh islands placed in a Bimini lagoon. In general, the composition and relative percentage of various polychaete families stabilized at the end of the first month and the pattern was maintained through a one-year period. When the number of individuals per family was compared, three families formed one large, dominant group of nearly 6000 individuals. The dominance of the families in this group and the lack of success of other families is explained on the basis of feeding and reproductive behaviors, juvenile and adult body size, and locomotive abilities. Pelagic larvae, thought to be characteristic of most polychaete populations, are not characteristic of the worms taken from these islands.

ZOOGEOGRAPHY AND SYSTEMATICS IN INTERSTITIAL MARINE FAUNA

by

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Interstitial marine fauna, although sedentary in its habits, is globally distributed. Reports of "cosmopolitan species" are common in most taxa, and although many of them may not stand up to close scrutiny, the high similarity of species over a vast geographic range is a fact. Since means of contemporary dispersal, due to ecological peculiarities of interstitial fauna, seem restricted to short range, a possible explanation for cosmopolitanism and high global similarity is slow speciation, coupled with geological dispersal by continental drift. It is suggested that careful evaluation of geological and biological evidence, and especially the comparison of the taxonomic difference between species, and their present geographic distance, will reveal new insight into the interplay between biological and geological mechanisms of speciation and dispersal.

ASPECTS OF BARBADOS INSHORE PLANKTON

by

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The report is a time-series study of the inland mass effect of Barbados particularly concerned with the offshore-to-inshore rise in numbers of diatoms as principle primary producers, and copepods as chief beneficiaries of the phytoplankton increase.

Cell counts during a two-year period averaged 22,536 of which 93.99% were diatoms, and showed no evidence of regularly recurring variations of seasonal nature. Chaetoceros and Nitzschia species were the major numerical contributors to the diatoms. A high ratio (17:3) of neritic to oceanic species of the most common diatoms was considered indicative of an island mass effect. Species composition of the total phytoplankton community was also considered. A total of 144 taxa was found as follows: Diatoms, 104; blue-greens, 1; dinoflagellates, 35; silicoflagellates, 1; coccolithophores, 2. The latter three were present in consistently low concentrations.

A total of 52 species of copepods was identified during the two-year period with no evidence of seasonal variation in the estimates of copepod numbers, which varied between $4/m^3$ and $1326/m^3$ with a mean count of $292/m^3$. An inverse relationship between absolute and species numbers of copepods inshore and offshore supports the concept of higher diversity in oceanic than in neritic zooplankton. A low equitability for both inshore and offshore copepod populations was observed, and the composition of the respective groups compared. An intrusion of oceanic water near shore was apparent in the high numerical percentage contribution of oceanic species inshore.

SOME OBSERVATIONS ON THE ECOLOGY OF
Oscillatoria (TRICHODESMIUM)

by

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Investigations are in progress of the ecology of the planktonic, filamentous cyanophyte Oscillatoria. This alga appears in great numbers in the seas around Barbados at approximately three month intervals. At these times the large population is concentrated above 50 m, during the rest of the year the numbers are uniformly low to below 175 m. Some preliminary data on this distribution, photosynthesis and nitrogen fixation by the alga will be given.

Oscillatoria has two colonial forms, one with filaments aligned in parallel, the other with filaments crossing a common centre. These 'radial' colonies serve as a floating substrate, developing definite communities in which several species of pennate diatoms, dinoflagellate cysts, hydroid polyps, ciliates, flagellates and bacteria coexist. This community will be described and the possible relationships of associated organisms will be discussed.

AN INVESTIGATION OF SOME EPIPHYTIC ALGAL COMMUNITIES
ON MANGROVE PROP ROOTS NEAR LA PARGUERA, PUERTO RICO

by

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Algal epiphytic communities on prop roots of Rhizophora mangle L. were examined at sheltered and exposed locations at Guayacan Island near La Parguera, Puerto Rico. Algal development was greater at the shaded (leeward) station with 35 species and an average biomass of 47.6 g/root than at the exposed station with 19 species and an average biomass of 11.6 g/root. Light intensity varied greatly between stations. Peak intensities of 4,000 to 5,000 ft-c. in the water column at the exposed station versus 330 to 360 ft-c. at the sheltered station may be responsible for the observed differences between the epiphytic communities.

A BENTHIC SURVEY OF AN ALGAL REEF ON THE NORTH COAST OF PUERTO RICO

by

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The study of epibenthic communities in the Islote area was designed to acquire knowledge of population relationships through such parameters as standing stock, composition, seasonal variation, and species interactions. Three months of preliminary data and nine months of survey data have been collected to date, and the present phase of this study is scheduled to end on June 30, 1975.

It is estimated that about 70 per cent of the study area is covered by a hard conglomerate substrate that supports a moderately diverse community. The dominant organisms in this system, in both numbers and biomass, are the algae. The majority of the effort has been placed on them for this reason. Their abundance, distribution, and seasonal fluctuations are being estimated at three stations using random quadrats, photographs and settling blocks. Also, estimates of gorgonian, sponge, lobster (Panulirus argus), and conch (Strombus gigus) densities are being made. The smaller invertebrates that are directly associated with the bottom have also been collected, but quantification of their distributions is difficult and is not entirely complete. In addition, the soft bottom areas have been sampled using a coring device. Results of these samples show extremely low population levels with low diversity.

Sedimentation has strong influence on the study area, and special traps have been used to monitor this parameter. Sedimentation patterns indicate trends that are believed to be affecting definite "seasonal" variations in the algae and the invertebrates. Sedimentation is also believed to be responsible for some of the spatial changes that have been noted.

SUBMARINE FEATURES AND BENTHIC COMMUNITIES
OF THE MONA ISLAND SHELF

by

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and

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Mona Island, a limestone plateau, lies 72 kilometers west of Puerto Rico. The northern coast of the island is composed of sheer cliffs 60-70 meters high plunging into 30 meters of water. The east, southeast, and west coasts are characterized by a shallower shelf and a fringing reef. Well developed spur and groove structures are typical of the reef slopes. A deeper set of grooves and spurs is found extending to the shelf edge. A map of these features has been prepared on a 1:20,000 scale from available aerial photography. Underwater observations of these structures suggest that coral development is mainly a thin veneer on an older structure of indeterminate origin.

The southwest coast is characterized by a sharp drop-off. Here an essentially vertical limestone wall extends from 10 meters to 43 meters below the surface. Evidence of ancient sea level standstills is found at 15 meters and 42 meters. At 42 meters the vertical wall ends in a narrow terrace (2-10 m wide). An indentation into the wall similar to the wave-cut nip now found at sea level is observable here. At 15 meters a similar but less eroded nip is found.

The vertical surfaces of the wall are encrusted with sponges and octo-corals. Antipatharians increase in importance below 25 meters. Stony corals are found throughout the wall but generally form only small encrusting colonies. Most common are *Agaricia agaricites*, *Montastrea cavernosa*, *Eusmilia fastigiata*, and *Musa angulosa*.

OBSERVATIONS ON THE ECOLOGY OF THE HAWKSBILL TURTLE,
Eretmochelys imbricata, ON MONA ISLAND, PUERTO RICO

by

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The hawksbill, Eretmochelys imbricata, is the dominant nesting species of sea turtle at Mona Island, Puerto Rico (18°05'N, 67°54'W). During the 1974 nesting season, surveys were conducted on the island's six kilometers of beaches. A nesting population of at least sixty females is estimated for this season. The nesting season extended from May to January 1975. Peak nesting month was September. Peak nesting times for individual beaches varied. Nest site selection and nesting behavior are related to beach configuration and stability and disturbance by human and animal predators. Five hawksbills were tagged and measured. of the four other species of sea turtle found in Puerto Rican waters only the green turtle, Chelonia mydas, was also observed to nest on Mona. Observations of hawksbills in the water were made by telescope from a station located approximately fifty meters above sea level in a vertical cliff-face. A total of 39 adult males and 23 females was identified by distinctive carapace marks. Repeated sightings of some animals suggest residency. Juvenile green turtles are abundant in this cliffside area. Behavior of hawksbills and greens on the surface does not suggest an interrelationship between the two species. Although protected by federal law under the Endangered Species Act of 1973, hawksbill turtles are threatened by local fishing pressures.

THE ROLE OF ESTUARINE AND MARINE SANCTUARIES IN RELATION TO ISLAND MARINE LABORATORIES

by

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It is now widely recognized among practicing ecologists that preservation of environmental options of future generations rests, in no small measure upon preservation or remnants of our native ecosystems. Natural area reserves not only provide for the permanent protection of the native ecosystem types and genetic pools, but they also provide areas for in-depth analysis of ecosystem structure and function, areas for long-term monitoring of environmental quality, and sites for education and training of advanced students of environmental science.

In regions of high technological development it is already virtually impossible to locate undisturbed examples of all the native ecosystem types for preservation, and the trend of technological disturbance will undoubtedly move outward, like a cancer, into those regions which are presently less developed. Estuaries and marine environments represent a special challenge. Preservation of such areas does not simple represent the setting aside of submerged property. Rather, attention must focus upon those dynamic processes which constitute ecosystem function and upon upstream activities which determine the quality of the water bathing a given sanctuary area. Operationally, management must focus upon regulation rather than ownership.

Estuarine and marine sanctuaries are of special importance in connection with island marine laboratories in that they provide undisturbed sites for long-term study somewhat remote from mainland sources of pollution. Thus, they will undoubtedly prove of inestimable national and international value in monitoring the subtle effects of chronic marine pollution. One looks forward to the eventual establishment of a worldwide system of estuarine and marine sanctuaries which may, at the same time, protect the genetic and ecological diversity and serve as living environmental quality monitoring sites. Since we are not yet knowledgeable enough to know just exactly how estuarine and marine areas should be managed to achieve ecological preservation, efforts should be made immediately to develop this knowledge.

DISTRIBUTION OF CHLORIDE IN THE ROOTS OF THE MANGROVE SEEDLING

by

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The distribution of chloride in the isolated roots of the Rhizophora mangle seedling has been examined. Seedlings were grown in running seawater aquaria filled with gravel, maintained outside the laboratory at the Marine Station at La Parguera, Puerto Rico. Roots, 6-11" in length, were removed from these trees and their Cl contents were determined.

The Cl contents of sequential segments of roots taken directly from the aquaria-grown trees were examined. The micro-mol Cl/gm dry wt. of 1" segments systematically varied from the distal end of the root to the proximal portion. The proximal portion of the root contained 4630 ± 958 micro-mol Cl/gm dry wt. whereas the distal segment contained significantly less Cl (1334 ± 1011 micro-mol Cl/gm dry wt.).

Selected roots were incubated in the laboratory for periods of 2 hours, in the dark at 28 °C. The relationship between the Cl contents of the distal and proximal segments was the same as that found in roots that were not incubated. The effects of ouabain ($10^{-3}M$) and copper ($10^{-8}M$) on the Cl contents of these segments of the incubated roots have been examined. The effects of the Cl transport inhibitor furosemide ($4 \times 10^{-5}M$) on the Cl contents of the roots and portions of the seedling itself have also been determined. The results of this study suggest the presence of an internal regulatory mechanism that controls the Cl contents of the roots of the Rhizophora seedling. The relationship between this mechanism and the movement of water through the root structure in this plant is discussed.

INTERACTION OF MARINE MICROBIAL POPULATIONS

by

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Marine bacteria and micro-algae secrete organic materials into the media in which they grow. These materials accumulate on the surfaces of these cells as well as in the media surrounding them. The microbial populations employed in this study consisted of one strain of marine luminescent bacteria and the marine Chlorella vulgaris. These microbes were isolated from coastal seawater in the area of the Marine Station at La Parguera, Puerto Rico. They are kept in constant batch culture in the laboratory.

Media in which cultures of the bacteria were grown, as well as the media in which cultures of Chlorella were grown, contain high molecular weight components produced by these micro-organisms. These substances mutually affect the growth and physiological behavior of these microbial populations. The effects of these high molecular weight materials isolated from cultures of the bacteria and the micro-alga on (1) the light output and growth of the bacterial populations, (2) the growth of the Chlorella populations, and (3) the adhesion of the Chlorella to glass surfaces have been examined. Similarly the effects of these microbial populations on each other has been examined in a 'mixed growth' system in which they are directly combined.

The results of this study suggest that each of these microbial populations 'condition' the media in which they are grown. The role of the high molecular weight components produced by these cells during their growth in this phenomenon was examined. These materials mutually affect the growth and physiological behavior of both of these microbial populations. The relationship between these effects and the regulatory interactions of these microbial populations in the sea is discussed.

ADHESION ENHANCING ORGANICS IN THE EASTERN CARIBBEAN SEA

by

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The distribution of adhesion enhancing organics in the eastern Caribbean Sea, between the southern coast of Puerto Rico and the northern coast of Venezuela has been examined. A transect consisting of seven hydrographic stations along 67 °W between Puerto Rico and Venezuela was sampled in October, 1974. Seawater samples were obtained from the mixed surface layer (approximate depth of 50 meters) and the high salinity water which characterizes the Subtropical Underwater (approximate depth of from 100 to 160 meters). Water samples were taken in 30 liter Niskin Bottles and subsequently transferred to the laboratory at the Marine Station at La Parguera, Puerto Rico. The samples were reduced in volume and the high molecular weight materials isolated.

The biological activity of the materials recovered from the samples taken in this study was assessed in terms of their effect on the adhesion of the marine Chlorella vulgaris to glass surfaces. The results of this study indicate that the materials recovered from the high salinity core of the Subtropical Underwater enhance the adhesion of the Chlorella to these surfaces. This activity was present in this water mass at all locations examined between Puerto Rico and Venezuela. The materials recovered from the mixed surface layer samples showed the presence of adhesion enhancing activity in the northern part of the transect and in the extreme southern part, on the Venezuela shelf. However, the activity was not present in this water mass immediately to the north of the Venezuela shelf, 100 to 150 nautical miles north of the coast of Venezuela. The relationship between the absence of this activity in the surface waters of the southeastern Caribbean and the westward flowing current in this area is discussed.

CHARACTERIZATION OF WATER MASSES OF
THE EASTERN CARIBBEAN SEA
BY LIGHT SCATTERING

by

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Three water masses of the eastern Caribbean Sea between the southern coast of Puerto Rico and the northern coast of Venezuela have been characterized by light scattering. The water masses examined were (1) Caribbean surface water (10 meter depth), (2) the mixed surface layer (50 meter depth) and (3) the high salinity water that characterizes the Subtropical Underwater (100-160 meter depth). A transect consisting of eight hydrographic stations along 67°W between Puerto Rico and Venezuela was sampled in February of 1975. Water samples were taken in 30 liter Niskin Bottles and subsequently transferred to the laboratory at the Marine Station at La Parguera, Puerto Rico.

The light scattering properties of the samples were determined with the Brice-Phoenix Light Scattering Photometer. The relative turbidity of each sample was determined. The sample was then filtered (millipore, 0.22 micron pore size) and the relative turbidity of the filtered sample determined. The results of this study indicate that the change in the turbidity with filtration is a linear function of the turbidity of the unfiltered samples. The filtered turbidity was the same for all the water masses examined. The vertical distribution of the turbidity of the water masses examined reverses as one goes from the northern end of the transect to the southern portion, on the Venezuela shelf. The significance of this shift with respect to the transport of materials in the Subtropical Underwater is discussed.

STUDY OF ORGANIC-CALCIUM INTERACTIONS:
GYPSUM PRECIPITATION IN TROPICAL SURFACE WATERS

by

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This paper demonstrates the involvement of dissolved organic compounds in the precipitation of gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) from near-surface seawater. A rapid CaCl_2 titration procedure is described by which seawater samples are calcium saturated and the precipitation of gypsum is followed turbidimetrically. Quantitative differences have been observed between the titration curves of filtered samples and those subsequently liquid-liquid extracted with cyclohexane, ethyl acetate and chloroform, or treated with hydrogen peroxide. Further differences have been noted between samples from remote isolated areas and those collected in localities of human activity indicating more inhibiting material is present in the latter.

Results demonstrate the following:

- (1) The rate of precipitation does not affect the identity of the mineral precipitated;
- (2) The organic compounds involved are somewhat polar and susceptible to mild oxidizing conditions.

Implications of the above mentioned phenomena on the activity of calcium ion in seawater and the metal's availability to living organisms are discussed.

SALT RIVER ESTUARY: MIXED CLASTIC AND CARBONATE SEDIMENTATION

by

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Salt River Estuary (Sugar Bay, Triton Bay, and Salt River Bay, north-central St. Croix) is the site of mixed carbonate and clastic sedimentation in transgressive marine and brackish environments. High amounts of turbidity in the southern portion of the estuary control in situ carbonate production, causing formation of near-strandline algal-mollusc banks. A transported sedimentary regime is clearly distinguishable from the in situ regime. More northerly sediment assemblages are derived from in situ grass bed and reef biotas, with minor admixtures of clastics.

Core analysis suggests that the original bay-barrier reef was an off-shore bar, now covered by an actively growing coralgal reef. Carbonate sand lenses and banks are completely surrounded by fine-grained, highly clastic, sediments, suggesting a model for interpretation of Cretaceous limestone lenses (Tepee Zone, Pierre Shale) in Colorado. Production of algal mounds with reef-complex geometry is possible in strandline environments, additionally raising the question of origin of phylloid algal bank complexes in Upper Paleozoic rocks of the United States mid-continent and southwest.

TEMPORAL VARIATIONS IN CURRENT TRANSPORT IN THE EASTERN CARIBBEAN SEA

by

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As part of the PESCA (Programa Estudios Caribe) at the University of Puerto Rico in Mayaguez, a transect of eight hydrographic stations along 67°W between Puerto Rico and Venezuela has been occupied three times yearly since June 1972. Using data from these transects, the dynamic method has been applied to calculate the geostrophic current flow perpendicular (east-west) to the transect. The results of this work show significant temporal variations in the mass transport in the Eastern Caribbean. The largest flow is the westward flowing Caribbean current which consists of two branches in the southern half of the area. However, an eastward flowing current exists in the northern half of the Eastern Caribbean, and varies significantly in space and time. During summer months, this eastward flowing current can extend from Puerto Rico to about 230 kilometers south and have velocities of 25 cm/sec.

SUBMERGED REEFS ON THE WESTERN ISLA CAJA DE MUERTOS INSULAR SHELF, PUERTO RICO

by

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Submerged reefs are common over the middle and outer shelf southeast of Isla Caja de Muertos. These reefs have been divided into three groups based primarily on physiographic position on the shelf and general morphology.

The first includes fossil barrier reefs which occur in single or double lines within 500 meters of the shelf edge. Reef crests trend east-west with depths of about 22 meters and are less than 50 meters wide. Double reef lines characteristically have gradual back-reef rises from depths of around 36 meters to the inner crest. The reef front plunges more than 16 meters into a middle valley which averages about 250 meters in width. There is another steep rise to the outer crest. The outer reef front is on the shelf edge and plunges with slopes commonly greater than 40° into the Muertos Trough. When one row is present it borders on the shelf edge with generally a gentle back-reef slope.

The second group includes a line of relict fringing reefs trending northeast-southwest across the central shelf. Crest depths range from 6 meters in the northeast to between 12 and 14 meters further south. Reef front relief averages between 6 and 10 meters. Back-reef areas show a gradual drop of about 3 meters onto an adjacent platform. Relict surge channels are present.

The third group is comprised of fossil patch reefs located across the outer shelf. Their crests are generally crescent shaped with depths of about 20 meters. They commonly have steep sides which may be partially buried by recent sediments.

No large colonies of framework corals were observed living on these reefs although small encrusting colonies were common. Rapid Holocene rises in sea level and changed circulation patterns are probable causes for the death of these reefs.

FORM-PROCESS RELATIONSHIPS ON ISLAND COASTS

by

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Variations in geometric properties and spatial arrangement of major coastal morphologic landforms (beaches, cliffs, rocky shores, and swamps) of the islands of Barbados, Dominica, Grenada, St. Lucia, and St. Vincent were compared to coastal process sectors established by variations in mean wave power levels.

Multivariate analysis of variance results indicate that the spatial arrangement of coastal morphologic landforms cannot be predicted from wave power distribution alone. Coastal landform classes do not exhibit distinguishing wave power levels. The main process-response parameter interaction is shown to be between breaker-point wave power and offshore slope, which are inversely correlated, especially on cliffy and rocky coasts. Correlation analysis revealed that coastal geometric properties other than offshore slope steepness and morphologic landform width relate more to geomorphic and structural inheritance than to physical dynamic processes alone.

The results of statistical and probabilistic analyses demonstrate the collective and individual contributions of geometric and process variables within the general context of two process-response conceptual models. Testing models were designated as Model CN (dependent variable: wave power clusters) and Model MT (dependent variable: morphologic landform class). A significant amount of the variability in geometric properties of the coastal morphologic landform units is attributed to wave power distribution patterns.

A NEW OVER-THE-HORIZON DIRECTION-FINDING SYSTEM
FOR TRACKING COASTAL AND SHELF CURRENTS

by

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A new direction-finding system has been tested along the east coast of the United States, in Barbados, and at the University of Puerto Rico Marine Laboratory (La Parguera) which is capable of tracking, from shore-based stations, the drift of drogues more than 100 km from the shoreline. One of the most attractive features of this system is that as many as 15-20 frequency separated drogues may be tracked quasi-simultaneously, enabling the researcher to obtain mesoscale synoptic data at a reasonable cost for the first time. Current traps for the drogues may be deployed at various depths, allowing current profiles as well as simple synoptic surface drift to be obtained.

The system was developed by personnel in the Electrophysics Laboratory of ITT. A surface wave which travels over the saline water surface is propagated by the active buoy transmitters and picked up by the completely passive, portable direction-finding (DF) system on shore. Two DF units are used to triangulate each drogue position, as with optical techniques. The approximate cost for shore-based receiver and DF unit is approximately \$1,000 for each station and nearly \$100 for each drogue. During the Puerto Rico test sea-surface temperature (accuracy within 0.2 °C) was successfully transmitted along with the direction-finding signal. Other models are currently under research which will have ranges in excess of 3,000 km and will transmit data concerning wave state, sea-surface temperature, and other important environmental parameters.

SEDIMENT REWORKING RATES OF THREE BURROWING ORGANISMS

by

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Sediment collection and time lapse photography were used to compute the amount of sediment reworked per day by Balanoglossus, Holothuria and Callianassa on Enrique Reef, La Parguera, Puerto Rico. The population of the same three animals on the Enrique Reef apron also was determined. The combination of these results allowed a computation of time required to rework completely a layer of sediment one meter deep. This time varies between different zones on the reef due to varying population densities. Callianassa appeared to be the most prominent sediment reworker. Balanoglossus was not present in great enough numbers to affect the total reworking time.

Ten sediment samples each were taken from mounds of Callianassa, Balanoglossus, Holothuria, and the intermound area. These samples were compared by grain size, per cent organic matter, per cent carbonate, per cent fines, and optical density of pigments. It was determined that Holothuria mounds contained sediment of a significantly smaller grain size than the other three types. Further experiments carried out to determine the cause of this difference indicated that it was due to the animal reducing the grain size as it passed through its intestinal tract.

How these organisms disrupt the sediment was also observed. Holothuria were placed in an artificially stratified sediment in an aquarium. Their disruption of the stratigraphy was observed and recorded. Daily underwater photographs of an area leveled of mounds demonstrated the rate at which the bottom topography is returned to its original state by the three organisms.

AÑASCO BAY SEDIMENTS

by

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Añasco Bay is on the west coast of Puerto Rico, north of the town of Mayaguez. The insular shelf is very narrow, and is marked by a line of submerged coral reefs about one mile offshore.

Sediments are derived from the areas of coral reef, erosion of the alluvial plain of the Añasco River, and from the discharge of the Añasco River. These modern sediments are mixed with relict sediments deposited during the lower Wisconsin sea level. As a result of the diverse sediment sources and fairly irregular bathymetry, there are markedly different sediment facies.

The two major facies of sediment deposition are carbonate reef deposits and terrigenous sediments. The carbonate reef sediments may be divided into two sub-facies; areas of bare rock and thin patches of shell sand gravel, and near reef sediments with a gravelly sand texture and relatively high carbonate content that are mixed with terrigenous sands.

The terrigenous facies is composed of quartz, serpentine, feldspar, and volcanic rock fragments and clay minerals derived from the Añasco River and alluvial plain. The carbonate content is less than 15 percent. There are four distinct sub-facies based on textural characteristics. The beach system facies lies between the shore and the 10 foot contour line. This is an active zone of longshore transport and cyclic movement of fine to medium grained sand.

Terrigenous sands and silty sand dominate the open shelf south of the Añasco River. North of the river there is a mud facies of silts and clay, with less than 20 per cent sand. The fourth facies are sandy muds that are found on the outer shelf and slope.

The distribution of these sediments reflects the pattern of wave refraction and current circulation in the Añasco Bay. Each of the facies can be correlated with the topography, current and wave patterns, and general physical characteristics of the shelf area.

PRELIMINARY RESULTS OF A GEOLOGICAL STUDY OF THE
VENEZUELAN CONTINENTAL MARGIN BETWEEN 65° AND
70°W LONGITUDE AND BETWEEN THE MAINLAND AND THE
VENEZUELAN AND NETHERLANDS ANTILLES

by

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A total of 232 sediment samples has been taken on the Venezuelan continental margin between 66° and 70°W longitude and between the mainland and the Venezuelan and Netherland's Antilles in connection with a general descriptive study in the fields of geology, oceanography, and fisheries biology currently being carried out by the Fundación La Salle de Ciencias Naturales. The area described above represents the Zone Central of the project, called the Carta Pesquera.

To date, approximately one-half of the samples have been processed and a study of the geomorphology of the area has been completed. The geomorphology of the area is dominated by the Bonaire Basin (Fosa de Bonaire), which is some 74 km wide and approximately 390 km long and has a maximum depth of at least 1120 fathoms. To the southeast of the Bonaire Basin lies the La Guaira Plateau, a platform some 110 km long and between 35 and 45 km wide. Depths over the plateau range from 110 to 190 fathoms and the platform contains a submarine bank called the Macuto Bank, where the depths reach 52 fathoms. This bank is apparently made up of a drowned coral reef built during lower stands of sea level. The plateau is also undergoing down-warping, as indicated by foraminiferal studies and seismic reflection profiles. The northern boundary of the Bonaire Basin is made up of the volcanic and metamorphic island chain of Aruba, Curacao, Bonaire, Aves Islands, Los Roques Islands, and Orchila Island.

The majority of the sedimentation occurring at present is of clay-sized particles with the sand-sized particles present being made up predominantly of foraminifera, except in close proximity to the mainland and the islands, where terrigenous sediments are found. The calcium carbonate content is also higher in proximity to the land areas.