

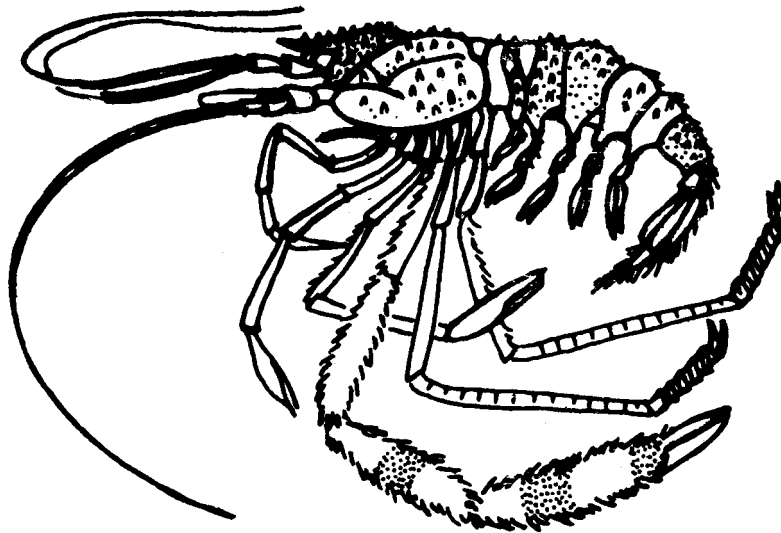
Ray Waldner

ASSOCIATION OF ISLAND MARINE LABORATORIES

OF

THE CARIBBEAN

Tenth Meeting



Department of Marine Sciences, University of Puerto Rico

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INTRODUCTION

Board of Directors (elected at the 10th Meeting):

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The tenth meeting of the Association of Island Marine Laboratories of the Caribbean was held September 4 to 7, 1973 at the Mayaguez Hilton Hotel, Mayaguez, Puerto Rico and hosted by the Department of Marine Sciences, University of Puerto Rico at Mayaguez. The meeting was organized by Dr. Máximo J. Cerame-Vivas, First Vice President of the Association.

The meeting began the morning of September 4 with an opening statement by Dr. Fred V. Soltero-Harrington, Chancellor, University of Puerto Rico, Mayaguez, and Dr. Francisco Pagán-Font, Acting Director, Department of Marine Sciences, University of Puerto Rico, Mayaguez. The opening address was given by the President of the Association, Dr. Bernd Werding, Director, Instituto Colombo-Aleman de Investigaciones Científicas, Santa Marta, Colombia.

It was the second time an AIMLC meeting was hosted by the University of Puerto Rico at Mayaguez, the first, organizational meeting having been held there in 1957. The 120+ registrants attested to the growth of the Association during the intervening years. Abstracts of the 62 papers presented are published herein.

A well attended banquet, hosted by Chancellor Soltero-Harrington the evening of September 6, featured an address by the Honorable Cruz A. Matos, Secretary, Department of Natural Resources, Commonwealth of Puerto Rico, San Juan, P. R.

Memorable diversions included an evening cocktail party at the home of Dr. M. J. Cerame-Vivas and an afternoon excursion to the Department of Marine Sciences laboratory at La Parguera. Activities at the laboratory consisted of swimming and snorkeling on an adjacent reef followed by a barbeque and evening boat trips for all to nearby Phosphorescent Bay.

ACTUAL AND POTENTIAL FISH PRODUCTION FROM CORALLINE SHELVES OF THE CARIBBEAN

A compilation of production statistics (1968) and of shelf areas shows that the total Caribbean and Bahamian production of demersal and neritic pelagic species (i.e. excluding oceanic pelagic species) averages less than 4 kg/ha. The greatest production rates are attained on the oceanic banks of the south-western and west-central Caribbean (10.4 - 15.1 kg/ha), and from the Jamaica Shelf (17.2 kg/ha), and these catches are almost entirely of reef fishes with only a small component of neritic pelagic species. Guadeloupe, Martinique, St. Lucia and Barbados also have high rates of production (9.7 - 14.5 kg/ha) but it appears that a large proportion of the catches is of neritic pelagic species (mostly carangids). Unsubstantiated reports indicate that the rate of production from the narrow northern shelf of Jamaica is around 37 kg/ha/yr, despite severe overfishing.

Gulland (1971) estimated the potential demersal fish production of the Bahamas region and of the Caribbean to amount to 2-4 kg/ha and 2-8 kg/ha yr respectively. These estimates appear to be conservative, and it appears possible that yields of demersal fishes exceeding 15 kg/ha/yr could be attained in many coralline areas. It is pointed out that the trophic structures of coral reef and coralline shelf communities are still not well understood, but that estimates of fish production rates of the order said to be attained on the northern shelf of Jamaica are by no means in-

compatible with available estimates of primary productivity or of the standing crops of fishes on shallow reefs.

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ESTUDIO SOBRE MADUREZ Y DESOVE DE PENAEUS BRASILIENSIS

Hemos realizado estudios sobre algunos aspectos de la madurez y desove del camarón Penaeus brasiliensis.

En esta especie como en la mayoría de los Penaeus comerciales, el ovario maduro está constituido por los lóbulos: anterior, medio y posterior. Se describen cuatro fases de madurez, cada una de las cuales presenta un rango de talla determinado; igualmente se determinó la talla mínima de primera madurez.

Se observa que Penaeus brasiliensis desova durante todo el año pero con períodos intensivos en los meses de marzo, agosto y octubre.

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LIFE HISTORIES OF TWO NAUSITHOE
(SCYPHOZOA: CORONATE) FROM
PUERTO RICO, ONE A NEW SPECIES

Life histories of two Puerto Rican species of Nausithoe have been followed through most stages. One species is new. The other is N. (= Stephanocyphus komaii Leloup, 1937, the medusa of which was heretofore unknown. Polyps of both species occur commonly on coral rubble at depths of 40 to 70 feet in the Parguera area, and in other places around the island. Both species strobilated in the laboratory, and the resulting ephyrae were raised, in about three months, to mature medusae.

The scyphistoma of Nausithoe n. sp. averages 6 mm in length and 0.6 mm in diameter at the aperture. It is solitary, conical, slightly curved, and the chitinous tube is annulated and yellowish to brown in color. Four whorls of large peridermal processes alternate with four whorls of small ones. The polyp extends slightly beyond the tube has up to 38 filiform tentacles and is colorless except for a ring of opaque white spots at the margin. From onset to termination, strobilation takes about four days. The distal two thirds of the polyp is converted to 11 to 37 ephyrae. The ephyrae are 0.5 mm in diameter; have a distinct coronal groove, 16 lappets, and eight statocysts; and lack tentacles. The adult medusa is 3 mm in diameter, the central disc is slightly flattened, gastric cirri are unbranched, and gonads are small and spherical. Ephyrae and medusae collected in the field agree in detail with those raised in the laboratory.

The scyphistoma of N. komaii (Leloup, 1937) is colonial. A single spoon-shaped internal peridermal process is present. The polyp extends well beyond the end of the tube, has up to 48 filiform tentacles, and is heavily laden with zooxanthellae. Strobilation is similar to that of the previous species. Ephyrae also are similar except they are ocher in color because of numerous zooxanthellae. Adult medusae are 1.1 mm high by 1.2 mm in diameter; the coronal groove is almost obliterated; gonads are small and spherical. The thick, clear mesogloea appears as a halo around the zooxanthellae-laden endoderm. The medusa is non-planktonic and has not been found in the field.

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THE GENUS GRACILARIA (RHODOPHYTA) IN PUERTO RICO

Gracilaria is a genus of the Rhodophyta commonly found in Puerto Rico and the West Indies in general. Taylor (1960) reports occurring in Puerto Rico: G. verrucosa, G. debilis, G. crassisima, G. ferox, G. cervicornis, and G. mamillaris as verified records. G. dura and G. kruggiana which Taylor included as uncertain records turned out to be G. debilis and G. domingensis respectively. Díaz-Piñer (1958) adds to the known species G. damaecornis, G. foliifera and G. curtissiae. Almodovar (1961) reports G. sjoestedtii, G. cylindrica and G. blodgetti. In the present work three new species will be added to the known species of Gracilaria from Puerto Rico.

Most of the earlier reports have been reviewed with observations of the original collections and compared with type specimens when available. In many cases the specimens have turned out to belong to totally different species.

Species of Gracilaria change greatly in size, and overall aspect with changes in depth, and wave action in their habitat. It is the purpose of this study to limit clearly the extent of these changes for each one of the species found in Puerto Rico and to gather more anatomical, cytological, morphological and ecological information which can be used in the classification of the species of Gracilaria for Puerto Rico.

Nearly 2,000 specimens belonging to the species of Gracilaria already known and to the new ones have been collected mainly in shallow water around Puerto Rico, Mona Island, Vieques and Culebra. Deep-water collections will be undertaken

late this fall and undoubtedly new species will be added to the list. Historical collections from Puerto Rico, such as Hauck's, M. A. Howe, and H. L. Blomquist have already been studied. Type specimens for most species have been obtained on loans from European and North American Herbaria.

In order to make a more complete study of the genus Gracilaria in Puerto Rico it seems necessary to secure specimens from other locations around the West Indies and in that way determine more closely the number of species involved.

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A STUDY ON GROWTH OF CORALS IN CURACAO

The growth of Madracis mirabilis, Acropora palmata, Agaricia agaricites, Montastrea annularis and Meandrina meandrites (Scleractinia) was studied in situ. These species are among the most abundant corals on the south coast of Curacao. Each species was kept in its particular habitat, ranging in depth from 3 to 30 m and weighed once a month with an underwater weighing apparatus. Some of the growth curves were shown.

The quantitative influence of encrusting calcareous red algae and boring sponges on the skeleton of stony corals is under investigation.

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PRELIMINARY NOTES ON THE ELECTRO-
PHYSIOLOGY OF HALOCORDYLE DIS-
TICHA (HYDROZOA, COELENTERATA).

Halocordyle disticha is a gymno-
blastic hydroid with capitate and filiform
tentacles. Activity of the individuals
(size: 1-2mm) consists of bending of the
hypostome accompanied sometimes by up
and down movements of some or all capi-
tate tentacles; sudden movements of one
or a few capitate tentacles; slow or fast
movements of one or more filiform tenta-
cles; movements of the whole animal. All
movements show various grades of strength.

The electrical events are picked up
with a suction electrode which can be
placed on various parts of the animal, mul-
tiplied by a function module, displayed
on an oscilloscope and recorded on an old
ECG-apparatus. The potentials as re-
corded are mostly between 5 mV and 50 μ V
(0.05 mV) and can be positive or negative.
All movements are preceded or accompa-
nied by potentials. The size of the poten-
tials depends strongly on the recording
place on the animal with respect to the
place of the movement.

The first objective of this study is to
determine which potential belongs to which
movement irrespective of the place of re-
cording. This is done by taking photographs
of the potentials displayed on the oscillo-
scope while observing the animal. The
second objective is to define character-
istics of the potentials belonging to certain

movements. This is done by longterm re-
cording on the animal and measuring all
potentials and the intervals between them.
Then the data are processed by a computer
(IBM 2780 by courtesy of SHELL CURAÇAO
N.V.) for autocorrelograms and histograms
of various orders. Because all kinds of po-
tentials occur in such a set of data, groups
of potentials are separated based on sign
and size. Once the basic electrophysiolo-
gical patterns are established experiments
will be carried out to follow changes in
these patterns induced by chemical and
other pollutants.

It should be mentioned that many
attempts were made to record electrical
events in stony corals. All efforts were
unsuccessful so far. The cause for the
"electrical silence" of these animals re-
mains to be searched.

Addendum: Just a few days before
the meeting I succeeded in recording po-
tentials of a stony coral, Madracis mira-
bilis. A piece of living tissue was cut off
from the animal. Potentials were recorded
mainly from mesenteries; some examples
were shown and discussed.

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ASPECTS OF THE REPRODUCTIVE BIO-
LOGY OF THE GRAPSID CRAB PERCNON
GIBBESSI

The grapsid crab Percnon gibbessi, commonly found living symbiotically with the urchin Diadema antillarum in the West Indies, exhibits a number of interesting features in its reproductive biology. Sexual dimorphism is pronounced with males having much larger chelae than females and narrow, triangular abdomens, whereas those of the female are broad and rounded. In addition, mature males have a dense patch of pubescence on the merus of the cheliped that is totally lacking in the females. The appearance of secondary sex characteristics in juveniles of both sexes corresponds with the attainment of sexual maturity which occurs at a carapace length of from 11.5 to 13 mm. Egg laying completely empties the ovaries of ripe ova, but by the time hatching occurs 12 to 13 days later, the ovaries are again distended with mature ova ready to be laid. The eggs hatch at night, releasing zoea 2 mm in size, and 6-10 hours later a new egg mass has already been laid unless molting is imminent, in which case laying is delayed until molting has occurred. Molting never takes place while a female is gravid. Usually two batches of eggs are brooded during each intermolt. Female reproductive cycles show no synchronization for the population as a whole. Copulation occurs while the female is hard and may be preceded by a period of court-

ship. Copulation itself lasts less than 5 minutes and takes place with the female uppermost. Sperm are stored in the seminal receptacle of the female and are present in quantities such that the female is capable of producing at least 6 successive batches of viable eggs without additional copulation. The sperm of Percnon are about 3 μ in diameter, including the capsule, and appear to consist of a mushroom-shaped cap attached to a short thick stem or collar through the center of which runs a single, non-motile flagella that projects slightly from the base of the stem. Each spermatozoan is surrounded by a capsule and spermatophores are absent. Field collections made at intervals of one month or less over a two-year period show that at any given time 85% or more of all mature females are gravid, thus proving that Percnon gibbessi breeds throughout the year. Egg masses contain an average of 4,000 eggs/female and this, combined with the large number of egg batches produced by each female, gives a very high fecundity rate and an extraordinary reproductive potential for the species.

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CORAL SKELETONS AS SUBSTRATES FOR ENDOLITHIC ALGAE

Endolithic (boring) algae are present within the skeletons of all live corals collected in water depths of 0-60 meters. In many hemispherical corals they are present in quantities large enough to produce bands and/or patches of green and red color within the skeletons. The siphonaceous green alga, Ostreobium, is responsible for the green coloration, while the cyanophyte, Plectonema, is responsible for the red coloration.

Endolithic algae apparently cannot penetrate through the layer of living animal tissue which covers most live coral surfaces, and so they must initially infiltrate into corals at sites not so covered. Ostreobium and Plectonema, alone among endolithic algae, are then capable of growing in the direction of coral growth at a rate at least equal to that of the coral. All other endolithic algae (e.g. Hyella, Hormathonema, Mastigocoleus) are restricted to narrow zones at the bases of living corals and to dead corals.

The green bands produced by Ostreobium form initially at or near the coral growth. Successive periods of slow and rapid coral growth may produce a series of concentric green bands if pigment is retained within the algal filaments. The incidence of multiple banding is directly correlated with coral size and shape. The maximum depth below the coral surface at which the outermost band occurs varies inversely with water depth, reflecting variations in the rate and direction of coral growth at those depths. Red bands and

patches produced by Plectonema are restricted to the bases of corals from shallow water, but are mixed with Ostreobium bands in corals from water deeper than about 45 meters.

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REEF MODELS: THE QUANTITATIVE DISTRIBUTION OF REEF CORALS ON A SUBMERGED BARRIER REEF

A submerged barrier reef exists on the west coast of Barbados which sustains prolific coral growths. The reef is about one half mile offshore and reaches to within 40 to 80 feet of the surface. Distribution of coral species is, with few exceptions, apparently patternless, and therefore the classical qualitative approach is likely to fail to describe this ecosystem adequately. A study is underway to collect biological, physical and chemical data of the environment and to use this data to build a model of the reef employing multivariate statistical analysis, i.e., a computer model.

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THE LIFE HISTORY OF BRYOPSIS HYPNOIDES LAMOUROUX

Heteromorphic life histories are now known for a number of species of Bryopsis. Rietema (1969-1971) showed that B. hypnoides life history changes with latitude. For plants collected from 51° 42' N in Zeeland (Netherlands) to 59° 55' N in Drobak (Norway) only direct development from germlings into new plants similar to the parents was obtained, none produced stephanospores and dormancy of germlings was easy to break. Plants from 40° 51' N in Naples and Banyulus in the Mediterranean Sea to 48° 43' N in Brittany; the filamentous germlings developed stephanospores, few germlings developed directly into new plants and dormancy of germlings was difficult to break. Material for the present study was collected in Anglesey, Great Britain, and in Puerto Rico. The life history of B. hypnoides from Anglesey at 53° 18' N, a little north of Zeeland, is of a Mediterranean type in which stephanospore formation occurred, 3% of the germlings directly developed into new plants similar to the parents, and dormancy of germlings was difficult to break. Plants from Puerto Rico; only vegetative reproduction was achieved in culture despite different approaches to the problem for three years.

SEXUAL REPRODUCTION: Plants in culture experiments formed gametangia within 24 - 72 hours after collecting. All plants were bisexual with both male and female gametes in a single gametangium; male sector toward the distal end, female toward the proximal. Both gametes were very different in morphology, color, size and movements. Gametes moved actively inside the gametangium, and when released until two paired and zygotes were formed. The majority developed into filaments of

about 5mm within 3 months, then went for 2-5 months. However, 3% of the germlings began to develop, producing plants similar to the parents within 5 months. Breaking of dormancy was achieved by experimenting with different alternating periods of darkness and light. Stephanospores moved inside the germling and were released by rupture of the filament wall, then settled in a few seconds and remained static for 24-72 hours when they began to grow into filaments which developed into plants similar to the parents within 5-7 weeks.

VEGETATIVE REPRODUCTION: In laboratory cultures plants of all species of Bryopsis tested reproduced vegetatively by 1) abscission of branches 2) by formation of aplanospores, 3) by the growth of small pieces of protoplast. Vegetative reproduction may play a larger part in the propagation of Bryopsis than suspected, although for some species there is evidently a sexual process at some period of the year. The difficulty of completing the life history from one gametophyte to the next in culture compared with the ease with which generation can be repeated vegetatively, suggest that this is the usual means of propagation in the field. How frequently the sexual cycle is completed in the field it is not known. This conclusion is supported by the fact that hundreds of plants collected in Puerto Rico and cultured for 3 years were able to reproduce only vegetatively.

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DISTRIBUCION Y ECOLOGIA DE LAS FACIES AMMONIA Y CRIBROELPHIDIUM EN LA LAGUNA DE LAS MARITAS (VENEZUELA)

La distribución de los foraminíferos bentónicos se estudió bioestadísticamente en 18 estaciones. El estudio fue basado en 1729 ejemplares incluyendo las variaciones correlativas de parámetros geoquímicos e hidrográficos en la Laguna de la Maritas, (Venezuela), para determinar las características ecológicas. Los sedimentos predominantemente limosos de esta albufera se caracterizan por sus altos contenidos de materia orgánica y de azufre, y elevados valores de consumo de oxígeno y de $KMnO_4$. Las variaciones de estos parámetros geoquímicos, así como las de temperatura y salinidad del agua, parecen limitantes para la gran mayoría de los géneros y especies. Existe una reducción drástica de la diversificación genérica y específica en la albufera, comparada con la del ambiente marino sublitoral. Sólo 7 géneros se hallan representados con más del 1% del total de ejemplares: Ammonia, Criboelphidium, Quinqueloculina, Triloculina, Textularia, Florilus y Ammobaculites. Ammonia y Criboelphidium. Por sus altas frecuencias son los indicadores ecológicos más característicos. Sus distribuciones están controladas por la naturaleza del sedimento, la proporción de la materia orgánica descompuesta y no descompuesta y las variaciones del contenido de oxígeno disuelto en el agua. Altos porcentajes de Criboelphidium indican una elevada proporción, y descomposición de la materia orgánica y un mayor contenido de azufre que los altos porcentajes de Ammonia. Por otra parte, Ammonia parece desarrollarse mejor que Criboelphidium en aguas con mayor concentración de oxígeno. Se observó que la asociación que vive en los

fondos arenosos no domina Criboelphidium sinó Ammonia y que la dominación del primer género corresponde típicamente al biotopo del sedimento limoso.

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y

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GONAD MATURATION OF THE MANGROVE OYSTER, CRASSOSTREA RHIZOPHORAE AND TEMPERATURE IN A HYPERSALINE LAGOON OF EASTERN VENEZUELA

Biweekly samples of oysters were collected from January 1972 to December 1972. Histological preparations of gonads were prepared and their maturity graded on a 5 point scale.

Highest percentages of mature gonads occurred during months of below average temperature. The correlation coefficient between temperature and percent mature gonads was $-.96$ which was significant at the 1% level. It appeared that surface water temperature near $30^{\circ}C$ had an inhibiting effect on gonad maturation.

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DISSOLVED OXYGEN REGIME OF THE
SALT WATER WEDGE OF SOME PUERTO
RICAN RIVERS

Many rivers in Puerto Rico have salt water wedges which intrude several miles inland. In Puerto Rico active longshore sand movements favors the formation of sand bars, which may completely stop or severely restrict the flushing of the intrusive sea water creating favorable conditions for stagnation.

Oxygen depleted conditions were found throughout the salt water wedge of most of the rivers studied, although relatively high dissolved oxygen concentrations were found at the surface. The accumulation of solids with a high oxygen demand in the river bed, the high ambient tropical temperatures and the almost stagnant intrusive sea water are responsible for this condition and may cause the periodic fish kills observed in some streams.

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ON THE OCCURRENCE OF THREE NEW
DITERPENES IN AN UNIDENTIFIED
GORGONIAN

Three unreported diterpenes have been isolated from an as yet unidentified gorgonian taken from the waters of western Puerto Rico. Two of these have been purified by column adsorption chromatography. Elemental analysis and/or low resolution mass spectrometry indicate these compounds have the compositions $C_{20}H_{32}O_3$, $C_{20}H_{34}O_3$, and $C_{20}H_{36}O_3$. Infrared, nuclear magnetic resonance, and mass spectral data will be discussed.

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FACTORES FISICO-QUIMICO EN EL CICLO DEL FITOPLANCTON Y LA PRODUCCION ORGANICA PRIMARIA DE UNA ENSENADA TROPICAL

El ciclo de la producción orgánica primaria en la ensenada de Turpialito, Golfo de Cariaco, fue estudiada durante 1972-1973. La determinación de los parámetros físico-químicos y biológicos para una columna de agua de 10 metros de profundidad se efectuó en forma bimensual.

La producción orgánica primaria fluctuó entre 0.1 y 2.34 g C/m²/día, con una producción anual estimada en 235.5g C/m²/año. La concentración de clorofila a en el fitoplancton de la columna de agua varió entre 8 y 43 mg/m². Los productos de degradación de la clorofila a alcanzaron un porcentaje promedio de 30.2%. Dos períodos, una de alta y otra de baja producción primaria fueron claramente identificados. El primero de ellos entre los meses de enero y agosto y el segundo entre septiembre y diciembre. Durante el primer período, época de afloramiento en el Golfo de Cariaco, el fitoplancton estuvo alternativamente dominado por diatomeas, *Nitzschia seriata*, *Rhizosolenia stolterforthii*, *R. styliformis*, *Leptocylindrus danicus* y por micro-flagelados. El período de baja productividad se caracterizó por la gran estabilidad de la columna de agua y la baja concentración de las sustancias nutrientes. La biomasa primaria fue consistentemente baja y compuesta por dinoflagelados, *Peridinium* sp., *Gonyaulax polygramma*, *Gymnodinium* sp., y por micro-flagelados.

La relación entre la biomasa primaria, la abundancia de las especies del fi-

toplancton y la concentración de las sustancias nutrientes fue también analizada.

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CORAL - BIOTOPES IN THE REGION OF SANTA MARTA, NORTH COLOMBIA

Coral communities at three sites in Santa Marta Bay, Colombia, S.A. were studied, Morrito Island, Punta de Betin Peninsula and Morro Grande Island. Reef structures are not present, but corals colonize rocky slopes to depths of 25-35 m. Clear zonation of coral species is observed at each site with a single dominant species in each zone, but the bathymetric distributions of the dominant corals differ between sites. These differences are attributed to variations in the currents and the underlying substrates.

Preliminary observations of coral communities at other sites along the Colombian coast showed that the region of Santa Marta possesses the most abundant coral development. A species list of corals is included.

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THE GRAZING OF THALASSIA TESTUDINUM (KONIG) IN KINGSTON HARBOUR, JAMAICA

An attempt has been made to assess the importance of Thalassia testudinum (Konig) as a macrobenthic primary producer in Kingston Harbour. There are approximately 2,000 acres of T. testudinum in the harbour and the most extensive and luxuriant meadows are concentrated in the shallow waters (0.5 - 4.0m depth) at the western end. The mean range of blade standing crop is 224g - 320g/m² (oven dried weight).

A pure stand of T. testudinum grazed by the echinoid Lytechinus variegatus (Lamarck) was selected for a 2-year investigation into blade production and consumption. The mean blade standing crop was 272g dry weight/m². The L. variegatus population had a mean density of 24 urchins/m² and the mean test diameter of the urchins was 48mm.

Mean gross blade production was 53.8g dry weight/m²/week, of which 24.0g/m²/week was consumed by urchins feeding at a mean rate of 1.0g dry weight/urchin/week. A minute fraction 0.01g/m²/week (mean value) was consumed by fishes,

mainly the herbivore Sparisoma radians. The net blade yield of 29.79g/m²/week ultimately became available by senescence to organisms constituting the detrital food chain.

Over grazing would only occur if the density of urchins exceeded 59/m² feeding at the mean rate or 30/m² feeding at the maximum recorded rate of 1.75g dry weight/urchin/week. Experimental work, however, has shown that at densities of 32 - 64/m² urchins fed at a reduced rate of 0.5g/urchin/week whilst at densities of 128/m² the feeding rate was actually suppressed to 15% of the mean rate: Thalassia blade denudation, therefore, seems unlikely.

In the Kingston Harbour T. testudinum meadow it appears that an equilibrium exists between blade production and blade consumption; food is available to organisms of both grazing and detrital food chains in approximately equal amounts and the absence of over grazing prevents the denudation of this ecologically valuable marine angiosperm.

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A CONTRIBUTION TO THE BIOLOGY OF THE DEEP SEA OFF JAMAICA

Six cruises have been made to an area off the eastern end of Jamaica between 75° 50' & 76° 20' W and 17° 00' & 19° 00' N. The bathymetry of the area has been described by Robinson and Cambray (UNESCO Symposium on Investigations of the Caribbean Sea and Adjacent Regions, Curacao November 1968, pp. 285-289), and preliminary biological observations by Goodbody and Munro (UNESCO Symposium pp. 437-447).

The principal features of the area include a series of banks rising to within 30 metres of the surface and separated by depths up to 1500 metres. A variety of bottom types occur including soft oozes, ripple marked coarser sediments, hard limestones and manganese-coated slabs. Surface currents appear to be predominantly to the west and south-west past Morant Point. A single current meter placed on the bottom at 680 metres from October to December 1972 shows a diurnal oscillation between north-east and south-west with an overall drift to north-east of about 3 kilometers per day.

There is evidence for unusually high levels of primary production in the vicinity of Dingle and Norseman Banks immediately to the south of Morant Point. This area is also characterized by the presence of dense shoals of Flying-fish (Hirundichthys) at certain times of the year.

The benthic fauna below the photic zone varies considerably according to the sediment type and in most areas is predominantly infaunal. On the soft oozes epibionts are scarce but where firmer substrata exist

lithistid sponges are sometimes common and form the dominant component of the fauna. Limestones and manganese-coated slabs do not have heavy encrustations of organisms; small sponges, serpulid worms and bryozoans are the principal colonizers. In the passage between Morant Point and Norseman Bank a rich community of animals occurs at 250 metres; this may be associated with high levels of surface production or with increased water flow around Morant Point. The principal fauna elements are sponges (Lithistida, Verongia (?)) hydroids (Sertularella), gorgonians (Callogorgia, Chrasogorgia, Placogorgia, Acanthacis, Deltocyathus, Ellisella), Anthipatharia (Aphantipathes), Alcyonacea (Neospongodes), polychaetes, molluscs (Pleurotormaria, Murex), brachiopods (terebratulids), crinoids (Neocomatella, Neocrinus, Democrinus, Comactinia, Stylometra, Caryometra), ophiurans (Astroschema).

Acknowledgment is made to the Woods Hole Oceanographic Institution, the Oceanographic Program of Duke University and to the U.S. National Oceanic and Atmospheric Administration for the use of the research vessels 'Gosnold', 'Eastward' and 'Discoverer' respectively.

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DIADEMA ANTILLARUM AND PLANTS: A STUDY OF A SHALLOW WATER MARINE FOOD CHAIN

The echinoid Diadema antillarum Philippi is an abundant grazer of Caribbean coral reef environments. The relationship of Diadema to its benthic plant food sources was studied from April 1972 to January 1973 on two patch reefs (PR-2 and PR-3) arising out of a Thalassia bed on the northeastern coast of St. Croix. Diadema were conspicuously abundant on these reefs with densities averaging 5 to 10/m² and as high as 20/m² in some areas.

Diadema from the edge of PR-3 feed upon Thalassia during nocturnal migrations which commence between 1600 to 1800 hours. Urchins move out from the reef between 0300 and 0600 hours. This grazing is responsible for the formation of a conspicuous halo around the reef.

Up to 10% (about 1000 individuals) of the urchins present on PR-3 migrate. The remainder move about upon the reef surface which appears barren at first glance. However, PR-3 supported the growth of 48 species of benthic algae. Of these, at least 30 were taken by Diadema, with very small algal mat species predominating. In general, the urchins ate the plants that predominated in the area in which they were collected.

Certain algae attain conspicuous growth on PR-3, especially the red, Laurencia obtusa. Preliminary work (P. Dotinger and P. Ehrlich, pers. comm.) has indicated the presence of alkaloids in this species. Alkaloids are toxic compounds which may function as defensive substances in benthic algae.

One patch reef (PR-2) was completely cleared of Diadema in April, 1972 and the successional events on the reef were followed for over one year. Periodic reclearing was necessary to eliminate immigrants. The algal biomass of the reef increased within 6 months from approximately 15 gm dry wt/m² to over 250 gm dry wt/m². Total numbers of species on the cleared reef compared with a control reef (PR-3) did not change dramatically, but species diversity (as measured by H') dropped sharply. The cleared reef was dominated by one species, the brown alga Padina sanctae-crucis.

Fish populations, especially juveniles, increased on the cleared reef compared with the coral reef.

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OXYGEN BALANCE OF TROPICAL BENTHIC COMMUNITIES

Rates of oxygen production and utilization by several types of tropical benthic communities and invertebrate-algal symbiotic associations from Puerto Rico, Australia, Eniwetok, and the Virgin Islands are presented. Apparatus for the in situ determination of diurnal cycles of photosynthesis and respiration is described. Data on the respective communities and associations include: net and gross photosynthesis to respiration ratios, maximum photosynthesis to respiration ratios, compensation times of day, compensation light intensities, and light dependence curves of photosynthesis.

Productivity and species diversity of algae and sponge dominated benthic communities were studied 10 km. off the south-west corner of Puerto Rico in August 1973. One of these series involved a gradient of species diversity from 0.170 to 2.351 nits extending perpendicularly from a coral reef. Oxygen consumption rates ranged from 0.08 to 0.3 grams $O_2/M^2/hr$, and production rates at midday varied from 0.11 to 0.22 grams $O_2/M^2/hr$. The photoperiod during which the communities were above compensation was approximately 8 hrs, and compensation light energies were from 180 to 200 $\mu W/cm^2$.

Maximum photosynthesis to respiration rate ratios ranged from 0.8 to 3.6 and net photosynthesis to net respiration ratios from 0.45 to 1.8.

Rates of respiration were dependent on oxygen concentration below 53% saturation. At an O_2 concentration of 1 Mg/L, O_2 consumption was 40% of the value obtained at O_2 saturation. Oxygen consumption was greatest immediately after the end of the photoperiod and then assumed a constant value until sunrise.

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TRENDS IN CARIBBEAN SEDIMENTATION

Integrated sedimentological data gathered from Caribbean Deep Sea Drilling legs 4 and 15, and L-DGO piston cores show that two major facies trends prevailed from Cretaceous to recent in Caribbean open deep-sea environment. In the younger facies, from Middle Miocene to present, biogenic components are essentially calcareous, whereas the preceding facies is characteristically rich in biogenic silica. Biogenic siliceous facies, mainly Radiolaria, were particularly important during Paleocene, with maximum development between Middle and latest Eocene. In contrast to the younger facies, which is of present Caribbean and Mid-latitude Atlantic type of sediments, the older trend is very similar to sediments of the present Equatorial Pacific belt of high silica productivity. The two contrasting facies trends are designated Caribbean-Pacific facies respectively.

Superimposed on the two major facies are minor cyclic fluctuations in total carbonate and preservation of biogenic calcareous components which reflect minor intermittent changes in conditions of sedimentation. Similarities between these fluctuations and Pleistocene climatic cycles suggest changes in oceanic water mass properties also related to climatic fluctuations, whereas the two major facies trends are related to overall oceanographic conditions that existed prior and after the emergence of the isthmus of Panama.

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COMMUNITY DYNAMICS ON THE CARIBBEAN AND EASTERN PACIFIC COASTS OF PANAMA

The utilization of space by sessile animals follows very different patterns on the two coasts of Panama. The dominant space-holders in the Caribbean tend to be long-lived, slow-growing, often slow to reach sexual maturity, large in body or colony size, and competition for space is clearly important. In the eastern tropical Pacific, the predominant sessile animals are short-lived, very fast-growing, reach sexual maturity rapidly, small in size, and competition for space is not so clearly observed. About 85% of the substratum is occupied after a period of one year by the same individuals in permanent quadrants in the Caribbean, while artificial reefs may take years to resemble the surrounding natural reefs. Usually, less than 1% of the substratum in eastern Pacific quadrants are occupied by the same individuals after one year intervals, but virgin substrata come to resemble the surrounding natural substrata in 4 to 6 months. Recruitment to Caribbean communities is more seasonal in organization or quality while recruitment to eastern Pacific communities is more seasonal in production or quality. Evidence is presented that these differences are due to heavier pressure from fish grazing on benthic animals in the eastern Pacific and this, in turn, is due to the absence of certain categories of piscivorous fish.

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W. atlantic = K species
E. Pacific = r species

NEW OBSERVATIONS ON CORAL DESTRUCTION IN REEFS

A considerable number of invertebrates has been discovered over the last decade, which feed directly on living stony corals. One of those is the amphinomid polychaete Hermodice carunculata (Pallas), first observed in 1962 to feed on Porites porites and Acropora palmata. The list of known prey species has increased to roughly a dozen since. Surprisingly this list does not contain Acropora cervicornis. So far, the white, tissue-stripped branch tips of A. cervicornis, have not been shown to be caused by H. carunculata predation. On the contrary: in 1972 a theory of natural pruning in A. cervicornis was published.

According to observations in the field and preference experiments in aquaria, H. carunculata, offered a choice, will feed almost exclusively on A. cervicornis. Depending upon the size of the worms, the eaten tips measure up to 15 cm. The tissue-stripped tips never recover. They are overgrown by a succession of algae and are subsequently completely removed by browsing parrot fish. Living tissue later overgrows the stump and heals the injury. However, by removing a noticeable number of tips of living branches, H. carunculata may well amount to a controlling factor in A. cervicornis populations.

Relatively little is known about bio-destruction of corals than by predation. Coral killing by the blue-green alga Oscillatoria submembranacea shows the following characteristics. The alga on coral heads appears first as a dark patch, later in the form of a band or belt, 1-3 cm wide, encircling an area of tissue-stripped coral skeleton. This algal band kills the living coral tissue, moving about 2-5 cm per week, thus constantly enlarging the diameter of the dead area. In its immediate wake usually remains a narrow space of brilliant white coral skeleton, while the rest of the dead patch is covered by other species of algae. This process continues until O. submembranacea reaches the lowest part of the coral head, where light intensity becomes insufficient and the alga ceases to grow. Thus, under overhangs of coral heads sometimes a small portion of living coral tissue may survive. Investigations are presently being aimed at the nature of the biochemical reactions between alga and coral and evaluation of the ecological importance of O. submembranacea in coral reefs.

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THE PUERTO RICO'S COASTAL FISHERIES, 1972

During 1972, a minimum total of 5 millions pounds of fish and shellfish were landed from the coastal waters of the Island of which 85% was fish of various species and 15% shellfish. The average ex-vessel price per pound was 36 cents for fish and 84 cents for shellfish.

At least 2,000 fishermen participated and 800 boats were used in the fishery. The fishing gear consisted of 13,000 units of which 66% were fish and lobster pots and 34% other gear, mainly hand lines and nets.

The minimum total value of the fish and shellfish production in 1972 reached 2 million dollars, based on the ex-vessel price. This value was distributed as follow: north coast 11%; south coast 13%; east coast 36% and west coast 40%. The highest price per pound was paid on the north coast, which also reported the lowest production. The lowest price was paid on the West coast where fish and shellfish production was highest.

The percentage composition of 1972 landings in Puerto Rico were 20% snapper (mainly different species of the genus *Lutjanus* and *Ocyurus chrysurus*); 10% grunt (*Haemulon* spp.); 10% grouper (mainly several species of the genus *Epinephelus*, *Mycteroperca venenosa* and *Cephalopholis fulva*); 5% parrotfish (*Sparisoma* spp.); 5% mackerel (*Scomberomorus cavalla* and *S. regalis*); 5% triggerfish (*Balistes vetula*); 4% tuna (mainly *Euthynnus pelamis*, *Thunnus atlanticus* and *T. albacares*); 26% other fishes; 6% spiny lobster (*Panulirus argus*); 5% conch (*Strombus gigas*); and 4% other shellfish.

During 1972 the landings by coast were: 9% north, 12% south, 35% east and 44% west. The same year a total of 309,200 and 75,300 pounds (80% actual production) of fish and shellfish were landed in Vieques and Culebra Islands, respectively.

The areas of highest production of fish and shellfish in 1972 were Luquillo (north coast), Guánica (south coast) Fajardo (east coast) and Cabo Rojo (west coast).

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ASPECTOS BIOLOGICOS Y ECOLOGICOS DE *CONGERIA SALLEI* RECLUZ, *LAMELLIBRANCHIA* (*EULAMELLIBRANCHIA*) EN LA REGION DEL RIO UNARE VENEZUELA

Estudios anteriores sobre lamelibranquios de la familia Dreissenidae, se han efectuado principalmente en *Dreissena polymorpha* PALL, con el objeto de conocer su bioecología. Sin embargo, *Congeria sallei* RECLUZ (Familia Dreissenidae) también es bastante desconocida en sus aspectos biológicos fundamentales. En lo que se refiere a Venezuela, su biología y ecología está ignorada casi totalmente.

Debido a la importancia que este bivalvo pueda tener como colonizador de áreas no ocupadas por otros bivalvos y a su vez productor de incrustaciones (Fouling), se presenta la siguiente información morfológica y biológica del adulto de la lar-

va. En general *Congeria sallei* (conocida como Caliche localmente es bastante variable en forma y tamaño (máximo 2.2 cms.) manifestando características primitivas como posesión de larva veliger plantotrófica, glándula del byssus funcional en los adultos y fusiones simples del manto. La concha del adulto se asemeja a la de un mitilido, con la diferencia notoria de presentar un septo vertical en la región del umbo con undiente triangular pequeño que se proyecta hacia abajo. Los sifones son cortos, lobulados, y separados. La larva veliconcha presenta valvas equivalvas e inequilaterales, con el gozne sin provínculo.

Hasta donde se sabe, este animal no sólo está confinado a corrientes relativamente lentas de los ríos antes mencionados, sino también en los cuerpos de agua estáticos (salinidad de 39.7‰) que se forman a partir de los ríos Unare y Uchire durante el verano. En general se encuentra regular y abundantemente en la desembocadura de los ríos Unare y Uchire (salinidad máxima del 25‰ en verano), fuertemente adheridos a objetos sumergidos y semisumergidos, aunque también puede encontrarse adaptado a condiciones de baja salinidad en el mismo río Unare (salinidad promedio de 0.9‰). Así mismo también puede adaptarse a condiciones dulceacuícolas extremas; como lo demuestran experimentos en el laboratorio usando agua potable.

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MISIDACEOS DE ALGUNAS REGIONES DE MANGLARES DEL ORIENTE DE VENEZUELA

Se estudia la sistemática y algunos aspectos ecológicos de los misidáceos que habitan las regiones de manglares de diferentes zonas del litoral del oriente de Venezuela, Bahía de Mochima (Estado Sucre) y Laguna La Restinga, (Isla de Margarita). Se tomaron varias muestras en diferentes sitios dentro de las zonas antes mencionadas. Se observó que los misidáceos son habitantes permanentes de dichas regiones, encontrándose una sola especie para cada región. La población de misidáceos está representada por la especie *Mysidium gracile* (Dana), representante nuevo en la fauna de Venezuela, la cual es típica y única en estas zonas de manglares.

Se establece una comparación de la especie encontrada junto con las condiciones ecológicas de esas regiones orientales con otra zona de manglar situada en Laguna Grande, (Carenero, Edo. Miranda) del litoral central y distante aproximadamente en más de un centenar de kilómetros, donde se encontró otra especie diferente, *Metamysidopsis insularis* Brattegard.

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EL CPOM Y SU SIGNIFICADO

El Centro de Preclasificación Oceánica de México, ha sido creado como una colaboración de México a los programas biológicos de CICAR, con ayuda de UNESCO.

Las muestras recibidas en el centro son registradas y archivadas con los datos abióticos. El procesamiento de las muestras se lleva a cabo desde la obtención de biomasa por volumen sedimentado, desplazado, peso húmedo y peso seco, su fraccionamiento en alicuotas de 3 a 5cc, una de las cuales es preclasificada separando los componentes en 50 grupos. Las fracciones son supervisadas, etiquetadas y almacenadas listas para ser enviadas a los especialistas. Se efectúan trabajos para probar la efectividad de algunas técnicas. El CPOM ofrece facilidades para estudiantes que realizan estudios de maestría y cursos al mismo nivel. Colabora con equipo y personal en cruceros de CICAR y contribuye con la comunidad científica mundial ofreciendo para su estudio el material preclasificado. Se planea una preclasificación en otros sub-grupos, tratamiento de los datos por computadora y la creación de una colección de referencia del material del Caribe.

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APENDICULARIA DE LAS AGUAS QUE CIRCUNDAN EL ARRECIFE "LA BLANQUILLA," VERACRUZ, MEXICO

Se estudian las apendicularias de las aguas que circundan el arrecife "La Blanquilla", Veracruz, como una contribución al levantamiento faunístico de la zona. Los especímenes fueron obtenidos de muestras de plancton colectadas en mayo de 1965, en doce estaciones establecidas alrededor del arrecife. Los muestreos fueron verticales del fondo a la superficie, con red de malla de 0.10 mm. Se separaron todas las apendicularias de cada una de las muestras. Se identificaron 20 especies y se escriben notas sobresalientes de la morfología de algunas de ellas, que discrepan con lo consignado por autores anteriores y en forma de tablas se presentan las tallas obtenidas de los especímenes más grandes de cada una de las especies. Se hace el análisis de su distribución y abundancia, donde se nota una predominancia de especies consideradas por otros autores como marcadamente oceánicas, siendo muy escasas las formas costeras. Por último se describe una nueva especie del género Tectillaria.

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SURFACE SALINITIES IN THE NORTHERN VENEZUELAN BASIN OF THE CARIBBEAN SEA

It has been suggested in recent years that the variation in surface salinities south of Puerto Rico are due primarily to the advection of river waters from northern South America. The purpose of this study is to show that the surface waters can be affected by local precipitation and runoff from Puerto Rico.

Oceanographic data have been accumulated by personnel of the Department of Marine Sciences over the past four years. Surface salinity measurements are available for the upper 100m at a single station 38 km off the southwestern coast of Puerto Rico. There is an average annual variation of surface salinity of 2.01‰ usually affecting a change of 1.5‰ to a depth of 25m. Although variations to depths of more than 50 m have been measured, those lowest salinity values appear two or three months after the minimum surface salinity and probably reflect the diffusion of salt through the surface layers.

A close relationship exists between periods of low surface salinity with high concentrations of reactive silicate and periods of high rainfall. More than 60% of the precipitation over Puerto Rico occurs during July to November and most of this is confined to intense rainstorms. These

storms result in flooding and maximum runoff. One of these storms is used as an example to show the great extent of surface dilution that may occur to northern Caribbean waters.

During a storm of early October, 1970, runoff from just 53 km of coastline between Ensenada and Santa Isabel, P. R., was $3.42 \times 10^8 \text{ m}^3$ for an eight day period. This fresh water is enough to cause the salinity to drop over 0.29‰ in an oceanic area 53 km by 38 km and to a depth of 20 m. This change is equal to 20% of the decrease in surface salinity actually measured for that year. This does not include the additional effect of oceanic rainfall.

Water quality data were available for the rivers, and concentrations of silica even during flood stages had values ranging between 12 and 27 milligrams/liter. In light of the volumes of fresh water from land drainage during this storm, such high quantities of silica must affect the water chemistry south of Puerto Rico.

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SALINITY AND SILICATE STRUCTURE OF UPPER 400M OF VENEZUELA BASIN

Preliminary results from three hydrographic transects between Puerto Rico and Venezuela during June, 1972, October, 1972, and March, 1973 are presented. A strong correlation between silicate and salinity exists in the near-surface water of the southern 2/3 of the basin ($Si = -2.15‰ + 76.4$, $r = -0.98$, $n = 41$). The seasonality of low-salinity, high-silicate surface water and its apparent origin is discussed, particularly with reference to the Amazon discharge. The core of the Subtropical Underwater (salinity maximum) is shown to display a silicate minimum north of the upwelling zone. Fluctuations in the lateral position and strength of the core are discussed.

Additional data are presented from serial hydrographic stations occupied monthly south of Puerto Rico. A strong correlation exists between silicate and salinity in the near-surface water which differs from the above equation ($Si = -1.35‰ + 48.8$, $r = -0.87$, $n = 94$). The significance of this difference with respect to origin of seasonal low-salinity surface water is discussed. Time series of salinity and silicate are presented which display the fluctuations in both surface water and the core of the SUW.

These results are compared with previous similar investigations.

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EVIDENCE FOR 18°C SARGASSO SEA WATER IN THE EASTERN CARIBBEAN

Salinity, temperature and dissolved oxygen measurements have been made at a serial hydrographic station at 17°38'N and 67°00'W as well as on a transect of eight stations along 67°00'W between La Parguera, Puerto Rico and La Guaira, Venezuela, over a period of three years. A core of "18°C Sargasso Sea Water" has been identified and apparently exists throughout the Eastern Caribbean. It is characterized by a temperature of 17.5°C $\pm 0.6^\circ$ C, a salinity of 36.4% $\pm 0.1\%$ and a maximum in the dissolved oxygen profile. This water core was previously described in the mid latitudes of the Western Atlantic and the Western Caribbean by Worthington in 1959 and Schroeder, Stommel, Menzel and Sutcliffe, also in 1959. However, this is the first evidence of it in the Eastern Caribbean.

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SURFACE ACTIVE ORGANICS IN THE CARIBBEAN SEA

High molecular weight materials found in sea water have been shown to affect the adhesion of planktonic algal cells to glass surfaces. The nature and distribution of this activity in the northern Venezuelan Basin of the Caribbean Sea has been studied.

A total of 133.77 liters of sea water have been analyzed in this study. The water samples were collected during the periods of November - December, 1972, February and April, 1973. The amount of high molecular weight substances (HMW) found in the sea water samples analyzed varied from approximately 400 to 2 mg/liter. Coastal water in the area of the Marine Station at La Parguera was high in this material (400 mg/liter). Water samples taken from a variety of depths at a permanent hydrographic station off the south coast of Puerto Rico (17°40'N, 67°00'W) were analyzed. The water samples taken from depths of 50 M and 140 - 272 M both contained substantial amounts of HMW substances.

Water samples were collected from a depth of approximately 150 M at five stations on a longitudinal transect from 64°50'W to 68°00'W. This transect was taken at latitudes between 17°36'N and 17°59'N. Analysis of these samples revealed a fairly even distribution of HMW substances in the sea water samples taken from the station south of St. Croix to the station south of Mona Island.

The HMW materials found in the various sea water samples were assayed for their effects on the adhesion of microalgal cells to glass. The materials isolated from coastal sea water significantly enhanced the adhesion of the algal cells. Significant activities were found in the water samples taken at the hydrographic station 20 miles south of Puerto Rico. These activities were found in the samples taken from depths of 40 - 50 M and 138 - 177 M. Significant activities were found in the water samples taken at the longitudinal transect stations south of the Jungfern Passage (65°34'W) and south of the Marine Station at La Parguera (67°00'W). Little or no activity was found in the water taken at 66°15'W and 68°00'W.

The surface activity found in these preparations represents between 13 - 23% of the material by weight. The HMW material appears to be composed of sulfonated polysaccharides with small amounts of glyco-proteins. The significance of the distribution of this activity with respect to its origin and biological function is discussed.

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THE AGGREGATION OF PLANKTONIC ALGAL CELLS

Planktonic algal cells secrete material into sea water. This material gathers on the outside of these cells and promotes their adhesion to other suspended cells, resulting in the formation of discrete clumps of cells.

A quantitative system has been developed to study this phenomenon. This system utilizes the fact that a suspension of particles scatters light in proportion to the size and number of the objects in suspension. In a suspension of small particles (2-5 microns in diameter) at high concentration (10^7 /ml), this effect is more dependent on the concentration of particles than on their size.

The planktonic algal cell used in this study is the marine *Chlorella vulgaris* (Beij). When washed and suspended in a supplemented sea water medium at a concentration of 10^7 cells/ml, in the light at 27°C, these cells multiply, with a mean generation time of 16.1 ± 3.3 hours.

The light scattered at 90° to the incident beam in suspensions of washed cells at concentration of from 10^6 to 2×10^7 cells/ml, was determined using the Brice-Phoenix Light Scattering Photometer. The light scattered from these suspensions is a linear function of the concentration of suspended cells.

On the basis of the generation time and the light scattered from suspension of varying concentrations, a relationship has been developed between the scattered light and time, in a growing suspension of *Chlorella* cells. This relationship can be expressed as:

$$\log_2 S = \frac{1}{T} t + \log_2 S_0$$

where S is the light scattered at time t (hours), T is the generation time (hr) and S_0 is the light scattered by the cell suspension at time $t=0$. The cell suspensions used in this study were incubated at 27°C in the light for periods of five hours. The linearity of the relationship between $\log_2 S$ and t is demonstrable between 1.5 and 5 hours after the initiation of growth. The initial period of growth is characterized by a nonlinear relationship between these parameters. The early period of growth (0-1.5 hr) has been interpreted as an adaptive phase in the newly initiated culture, followed by a 'steady state' phase (1.5-5hr) in which the generation time is constant.

Exudate material isolated from the media of suspensions of *Chlorella* cells after 24 hours of growth has been tested in this system. The relationship between scattered light and time, in a growing suspension of washed cells, is altered by the addition of the exudate material to these suspensions. The data suggest that this material causes the cells to adhere to one another, reducing the effective concentration of particles in suspension, and thus the scattered light.

The importance of this aggregatory behavior in terms of the growth and productivity of planktonic algal cells is discussed.

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THE EFFECT OF OUABAIN ON THE DISTRIBUTION OF Na IN THE ROOTS OF THE MANGROVE SEEDLING

The distribution of Na in the isolated roots of the Rhizophora mangle seedling has been examined. Seedlings were grown in running sea water 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 Na contents were determined.

The seedlings used in this study were approximately 4 to 5 months old. They generally had from six to eight leaves and the root structure was composed of 14 roots. The length and total water content of these roots are linear functions of the total dry weight of the tissue. The Na contents (micro-mol) however increase exponentially with the dry weight of the roots. Over the weight and length ranges of the roots examined in this study, the water content of the whole roots was constant, $4.0870 \pm .3410$ gm H₂O/gm dry wt.

The Na contents of sequential segments of roots taken directly from the aquaria grown trees were examined. The micro-mol. Na/gm dry wt. of 1" segments systematically varied from the distal end of the root to the proximal end. This gradient can either be positive, that is with the distal end of the root containing less Na than the segment from the proximal end of the same root, or negative, in cases where the distal end of the root contains more Na than the proximal segment. Roots taken from the same tree vary with respect to the sign and magnitude of this

gradient. No root tends to be the same within a tree or among trees, of the age used in this study.

The Na content of the proximal segments of the roots selected was constant (1744 ± 139 micro-mol. Na/gm dry wt.). The Na content of the distal segments varied from 7258 to 150 micro-mol. Na/gm dry wt. In approximately 67% of the roots examined in this study the distal segment of the root in question had a Na content greater than that found in the proximal segment of the same root.

Selected roots were incubated in the laboratory for periods of 2 hours, in the dark, at 28°C. The relationship between the Na contents of the distal and proximal segments of these roots was the same as that found in roots that were not incubated. The effects of light, ouabain (10^{-3} M) and copper (10^{-6} M) on the Na contents of the proximal and distal portions of incubated roots have been examined. The results of this study suggest the presence of an internal regulatory mechanism that controls the Na content of the roots of the Rhizophora seedling. The relationship of this mechanisms to the movement of water through the root structure in this plant is discussed.

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THE PIGMENTARY ADAPTATION OF BRYOTHANNIUM TRIQUETRUM

The red alga Bryothannium triquetrum is widely distributed in the tropical and subtropical marine environment. Specimens have been dredged from depths of 100 ft., but B. triquetrum is also found in shallow zones, such as tide pools and rocky shorelines. The nature and intensity of the illumination reaching this alga are strongly affected by the depth at which the alga is found, thus B. triquetrum is able to exist in a wide range of light regimens. In the work reported here the pigmentary adaptations of this alga to these conditions have been studied.

The absorption spectra of the pigments extracted with methanol from both shallow and deep water plants were determined. The shallow water plants were collected at Bahia Ballena on the southwest coast of Puerto Rico. These plants were taken from a depth of 1 foot. The deep water plants were dredged from 80 ft. of water off the southwest coast in the area of La Parguera. The absorption spectra of the pigment extracts of both the shallow and deep water plants showed maxima at 666 and 435 nm. The extracts of the shallow water plants also showed distinct absorption maxima at 335 nm. The spectra of the extracts made from the deep water samples did not show this peak.

Shallow water plants were collected and placed in deep water (75') for a period of two months. Samples of the transferred algae were examined every two weeks. Methanol extracts of these samples were prepared and their absorption spectra determined. The absorption maxima found to characterize the shallow water plant (335 nm) diminished throughout the time during which the transferred algae were studied. Coupled with this decrease in the pigment absorbing at 335nm, there was an increase in the absorption at 666 and 435 nm. The total quantity of pigment in the shallow water plant decreased when it was transferred to the deep water. The pigmentary component responsible for the absorption maxima at 335 nm found in the shallow water plant appears to be related to the flexibility of this algal species in its adaptation to different illumination conditions.

The relationship of these findings to chromic adaptation in red algae is discussed.

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THE CONTROL OF BACTERIAL LUMINES- CENCE IN THE MARINE ENVIRONMENT

Marine bacteria have been reported to secrete organic materials into the media in which they grow. These materials accumulate both on the surface of the bacteria as well as in the media surrounding the cells. The physiological significance of these materials, and their role in the regulation of microbial populations are not well understood.

Two strains of heterotrophic luminescent bacteria have been isolated from coastal sea water in the area of the Marine Station at La Parguera, Puerto Rico. Stock cultures of these micro-organisms are maintained in the laboratory. The media employed to maintain these bacteria is composed of a sea water solution supplemented with peptone, yeast extract and glycerol.

These bacteria multiply and produce light when grown in a minimal media, a salt solution osmotically equivalent to sea water, containing glycerol (0.3% by volume). In the experiments reported here the cell suspensions were grown in a lighted incubator at 28 °C. The growth of these populations is determined by following the change in the optical density (660nm) of the suspension with time. Light production is assessed using the Mitchell-Hastings Photometer.

Cells inoculated at a low initial concentration in minimal media show a transient diminution in light production during the first five hours of growth. This phenomenon is not seen in cultures inoculated at higher concentrations. In both

these cases the growth of the cell population is in its logarithmic phase. In the bacteria suspensions initiated at low concentration, the observed dip in light emission is followed by the production of increasing amounts of light.

Cultures were allowed to grow in minimal media for 18-24 hours. Following this the bacteria were removed from the used media (UM) by centrifugation. Cultures initiated at low concentration in this used media, did not undergo a diminution in light production during the first five hours of their growth.

These data suggest that the bacteria used in this study 'condition' the media in which they are grown. Used media, UM, contains substances produced by the bacteria that had grown in these media. Cultures initiated at low concentrations in the presence of these factors do not show a diminution in light production during their growth. The factors responsible for this 'conditioning effect' have been characterized.

The activity of exudates obtained from marine micro-algal cells has been examined in this system. The significance and inter-specific nature of the activity of cellular exudates from marine bacteria and micro-algal cells is discussed.

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THE OSMOTIC EQUILIBRATION OF ACANTHOPHORA SPICIFERA

Acanthophora spicifera (Rhodophyceae) is a red alga found associated with mangroves along the coast near La Parguera, Puerto Rico. It is commonly found attached to the roots of Rhizophora mangle in shallow water. The mangrove habitat of this alga is exposed to sharp changes in tonicity due to rainfall, run off and evaporation. In the work reported here the osmotic properties of this alga have been studied.

Samples of this alga were equilibrated in sea water solutions ranging in tonicity from 700 to 1300 mOsmols/kgH₂O. These solutions were from 2/3 to 1 1/3 the tonicity of sea water (1050 mOsmols/kg H₂O). In the experiments reported here, incubation times varied from 15 minutes to 18 hours. These experiments were all conducted at 28° C.

The isotonic water content of the algae used in this study was constant over 18 hours of incubation, 11.4749 ± 1 gm H₂O/gm dry wt. The osmotically responsive water was 37% of the total isotonic water content. This fraction remained constant over 18 hours of equilibration. The equilibration of Acanthophora spicifera over the range of tonicities employed in this study did not affect its subsequent survival. The osmotic equilibration of this

alga was not altered by the presence or absence of light and was not affected by ouabain (10^{-3} M).

The Na contents of the incubated samples were determined by flame photometry. The average total Na content of Acanthophora spicifera was 488 ± 25 micromol./gm dry wt. (N=103). The Na contents of the alga did not significantly change with changes in the tonicity of the media with which it was equilibrated. Incubation for as long as 18 hours, both in the presence and absence of light, did not alter the Na content of this alga.

These data are consistent with the interpretation that the alga gains or loses water in response to altered tonicity. Acanthophora spicifera is capable of maintaining this state for 18 hours without damage to itself. The relationship between the osmotic capabilities of Acanthophora and the conditions found in its natural habitat is discussed.

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CARBONATE SEDIMENTS OF THE PUERTO RICAN SHELF

The sediment distribution on the insular shelf of Puerto Rico is directly affected by the river discharge. A large sediment load of the rivers flowing into the northern and northwestern shelf caused predominance of terrigenous sediments. The calcareous and fraction of those sediments is composed primarily of molluscan fragments and benthic foraminifera, with lesser amounts of bryozoan and echinoderm fragments and sponge spicules. The outer shelf sediments contain abundant planktonic foraminifera and pteropods. Widespread relict and residual sediments contain in addition coral and coralline algae fragments, as well as gastropods and calcareous lithoclasts.

The remaining shelf areas contain skeletal carbonates. Several major sediment facies are recognized: 1) Reefal facies with abundant *Halimeda*, corals and coralline algae, 2) shallow inshore facies with *Halimeda*, mollusca and benthic foraminifera, 3) fine grain backreef lagoon facies with mollusca, benthic foraminifera and reef derived components, 4) outer reef pelagic facies with planktonic foraminifera, pteropods, benthic foraminifera, gorgonian and sponge spicules.

Relict and residual sediments dominate the inner shelf but are also found on the outer shelf. They contain pyritized and glauconitized shallow water skeletal particles. Highly rounded and polished, often neomorphically replaced coarser particles are also abundant. The inner shelf areas appear to be sites of recent carbonate sedimentation.

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RELIC SPUR AND GROOVE, LA PARGUERA SHELF

The general level of the shelf south of La Parguera is 21 meters below present sea level. The bathymetry and sedimentation suggest that this was a general level developed during a stand-still of the Wisconsin transgression. On the outer edge of this shelf there is a buttressed relict reef. The upper surface of this feature is at 21 meters, and the grooves, normal to the edge of the shelf, all terminate at approximately 30 meters. The general morphology suggests that this was at the outer edge of the shelf, and that the channels are tidal surge channels. The slope beyond this feature dips 43° .

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THE AÑASCO SUBMARINE CANYON

During the month of August 1973 the University of Puerto Rico, Department of Marine Sciences in association with Texas A & M University conducted a geophysical survey of the insular shelf of western Puerto Rico.

Preliminary results suggest the presence of a submarine canyon off the Añasco River north of Mayaguez. Seismic profiling suggests a graduation from a present day river delta to an ancient submarine canyon. Extensive sampling of bottom conditions remains to be conducted before the geological nature of the canyon can be more exactly determined.

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CAYO ENRIQUE SEDIMENTS AND ECOLOGY

Four transects were made across Enrique reef which lies a few kilometers off the south west coast of Puerto Rico. Each transect was described in terms of morphological features. Sediment samples were taken at intervals along the transects, and were analyzed for the proportion of sand silt, and clay in each sample. The percentages of the major constituents (Halimeda, coral, coralline algae, Foraminifera, and mollusks) in the sand fraction were determined by point counts on thin section slides and by gross estimates. Results show that the percentage of sand in a sample may be indicative of the location of the sample on the reef. The distribution of major constituents is discussed as well as the role of relic sediments.

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SOME TERTIARY BRACHIPODS FROM PUERTO RICO

Brachiopods of late Oligocene or early Miocene age occur at two localities in the middle Tertiary belt in southwestern Puerto Rico. The most abundant forms are the genera Argyrotheca and Lacazella and rhyconellids. Also present are terebratulid but these are extremely rare. This is the first record of fossil brachiopods in Puerto Rico.

The brachiopods are associated with the coral Porites, and the orbitoid foraminifer Lepidocyclina undosa, both occur in great abundance. In addition the thanatocoenosis includes several species of foraminifers, ostracods, shell fragments of mollusks and echinoids, abundant spines of several species of echinoids, bryozoa and other shallow-water forms. The foraminiferal assemblages consist of species generally characteristic of the reef or back-reef environment. The presence of many planktonic foraminifers, however, indicates a fore-reef environment and that the back-reef fauna are probably displaced. The brachiopods indicate a protected cryptic habitat on coral undersurfaces and in caves and crevices probably in the fore-reef slope.

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PRELIMINARY RESULTS OF THE GEOLOGY OF SOME SEAMOUNTS OFF PUERTO RICO

In the neighborhood of Puerto Rico is a number of seamounts many of which have distinctive magnetic anomalies. According to Griscorn and Geddes (1966) these seamounts may represent a chain of submarine volcanoes analogous to the inner arc of young volcanoes of the Lesser Antilles. A preliminary survey of three of these seamounts has shown the following features. The most northerly, on the west-ernside of the Mona Canyon, is composed of marble. The Grappler Seamount is composed mainly of pyroclastic rocks, some of which are definitely of subaerial origin. A dredge haul from the Whiting Seamount indicates the existence of a surficial conglomerate composed of a large number of rock types cemented in part by a Pliocene foraminiferal limestone. Pebbles of Miocene shallow water limestone in this conglomerate are especially interesting in that they show a feature previously reported from Aves Island of infilling of cavities in the Miocene limestone by the younger Pliocene material.

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FORAMINIFERS OF GUAYANILLA BAY AND THEIR USE AS ENVIRONMENTAL INDICATORS

Samples from thirty-two stations were taken in Guayanilla Bay to study the living and dead microfauna. The ratios of the number of nematodes to living foraminifers of Guayanilla Bay were compared with the ratios at Mayaguez and Jobos Bays. The lowest ratios are the ones of Guayanilla.

Foraminiferal populations of Guayanilla Bay were compared with populations of Mayaguez, Jobos, San Juan and Phosphorescent Bays, the bay east of Ponce Bay, and Mar Negro, La Torrecilla Piñones and Cabeza de San Juan Lagoons.

Fursenkoina punctata is dominant in the deepest part of the bay. Compared with populations from other areas of Puerto Rico, three different forms were described, one of them related to pollution. The mean dimensions of individuals of this species were plotted in a graph. A part of the graph includes all populations of polluted areas while the other part includes populations of unpolluted areas.

Ammonia catesbyana forma tepida is the most abundant foraminifer of the bay. Three forms were determined in Puerto Rican waters: forma typica, forma tepida and high-spire form. Some populations of forma tepida are related to chemical and thermal pollution. A small percentage (5%) of populations under thermal pollution conditions are deformed. High-

spire form occurs in environments under stress conditions with abundant organic matter. All or most specimen of this form are megalospheric and under extreme conditions of organic pollution they have a giant protruding proloculus. A. catesbyana is the species most resistant to pollution.

Quinqueloculina rhodiensis develop to abnormal forms, one under thermal pollution and another one under organic pollution. Ammobaculites salsus has deformed chambers under thermal pollution.

Florilus grateloupii and Criboelphidium poeyanum have low resistances to pollution. A core taken at Warm Water Lagoon (Guayanilla Bay) show a population previous to thermal pollution where C. poeyanum is the dominant form. It has practically disappeared at present on account of thermal pollution.

Through the study of a core the previous environmental history of a bay or a lagoon may be reconstructed and under some circumstances the future development may be predicted.

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MICROSTRUCTURES IN FISH SAGITTAE

Of the three otoliths occurring in the labyrinth of teleost fishes the one in the sacculus, called sagitta or sacculith, is generally the largest and is well known in its outer morphology. Very little attention, however, has been paid to the inner sagitta microstructures. Because of the suspected multifunctions of otoliths, the study of these internal structures from a functional point of view is of interest.

Many sagittae, even those morphologically different, have similar internal structures, indicating that they fulfill similar functions. Sagittae are made of argonitic needles, elongated toward the external surface and with their optical c-axes perpendicular to the growth surfaces. All the needles converge and originate in the central part of the sagitta and develop in a trumpet-like fashion. The central part consists of several elliptical nuclei, rich in organic matrix and connected by straight bundles of argonitic needles to the outer sulcus acusticus in which the neurons are inserted.

In some groups the anterior part, and in particular the rostrum, has digitate extensions with convex growth layers and fan-shape bundles of needles converging toward the center.

All these structural features recall the wave reception system of some sophisticated antennae where all the peripheral units converge to the focal point where wave signals are concentrated and magnified.

The observations of the internal structures, coupled to the recent discov-

ery of the piezoelectric properties of sagittae, strongly support the contention that the major function of fish sagittae is the underwater detection of sounds. Sagittae is a perfect system that transforms mechanical impulses into electric stimuli which are then carried, through the neurons, to the brain.

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THE ENDOLITHIC MICROFLORA OF LIVING REEF CORALS

The microscopic examination of endolithic plants from corals collected at depths from 0-61 meters, showed that two algae, Ostreobium quekettii Bornet & Flahault (Chlorophyta) and Plectonema terebrans Bornet & Flahault (Cyanophyta) and two fungi belonging to the Deuteromycetes are present in Atlantic and Pacific corals. Ostreobium brabantium Weber van Bosse and Ostreobium constrictum sp. n. are restricted to Pacific and Atlantic reefs respectively. A study of filament morphologies showed that Ostreobium reineckeii Bornet is a synonym of O. quekettii.

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A FEASIBILITY STUDY OF TILAPIA RACEWAY CULTURE IN THE UPLAND WATERS OF PUERTO RICO

A study of the performance of Tilapia rendalli and T. aurea in concrete raceways was conducted from May 22 to December 19, 1972, at the Fish Hatchery in Maricao, Puerto Rico. The study was undertaken to determine the feasibility of growing Tilapia in raceways and to test the potential of the cool, upland waters of Puerto Rico for culture of these fish.

The experimental design called for two sections or growth periods per species, a "summer period" from May 22 to September 29 and a "winter period" from September 29 to December 19. The summer section with T. aurea had to be delayed until July 12 and July 13 due to the lack of a sufficient number of fish. The T. rendalli were raised in rectangular raceways 42 X 5 X 1.5 ft. while the T. aurea were raised in circular raceways, 12 ft in diameter and 1.5 ft deep at the center diam. The water flow averaged 5.0 gal/min (18.9 liters/min) per raceway.

Using net production per raceway, food conversion efficiency, and rate of survival as the evaluation criteria, it appears that the upland waters could be used for warmwater fish culture during the summer months. But to obtain a harvestable sized fish, larger than 0.15 lb., initial stockings should be in March or April. It would also appear that T. rendalli and T. aurea are suitable fish for raceway culture; however, since this is the first study

of Tilapia in raceways, much more work must be done.

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OBSERVATIONS ON SEA CAGE CULTURES OF TILAPIA AUREA IN WATERS OFF LA PARGUERA, PUERTO RICO

The feasibility of culturing Tilapia aurea in waters off La Parguera, Puerto Rico, was tested in three locations near Magueyes Island. Tilapia used in the study were acclimatized to full sea water in fiberglass tanks over a period of eight days, allowing two days for each increment of twenty-five per cent. At each test site forty fish were stocked in each of two one-cubic meter cages. Control fish were held in fiberglass tanks both with and without running sea water. All fish received floating feed of 36 per cent protein five days per week.

Tilapia held in cages at each of the three test sites exhibited symptoms of open body lesions, fin rot and exophthalmia, and high rates of mortality. A few control fish exhibited the same symptoms, but no mortalities occurred during day to day feeding among fish held in the fiberglass tanks.

Tilapia proved difficult to handle in sea water as mortalities occurred among both control and caged fish after sampling.

Examination for parasites was negative. However, a bacteriological examination of the diseased fish indicated causative organisms to be systemic Aeromonas and Vibrio. It is possible these organisms exist in high numbers due to heavy pollution from raw sewage in the La Parguera area.

Results from these studies shed unfavorable light on Tilapia sea culture near La Parguera. However, current studies indicate bacterial diseases among Tilapia can be controlled by feeding terramycin at the rate of one gram antibiotic per pound of fish.

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PEN CULTURE OF CHANNEL CATFISH, ICTALURUS PUNCTATUS, AND TILAPIA AUREA

Channel catfish and Tilapia aurea were reared in separate and contiguous pens during two growing seasons (175 and 217 days, respectively) at the International Center for Aquacultures of Auburn University, Auburn, Alabama. Thirty-eight, 0.025 acre (0.01 ha.) pens were constructed along shallow, marginal areas of a fertilized 25.5 acre (10.3 ha.) fresh water pond. Pens were constructed of 1-inch mesh nylon netting during the first growing

season and of 1/2-inch mesh Vexar (DuPont) plastic netting during the second season. The netting was attached to wooden frames supported by metal fence posts. Water volume inside the pens averaged 91 cubic meters. Pens were built singly and in groups of three and five to determine how contiguity versus separateness of pens influenced production of fish.

Both fed and non-fed treatments were evaluated. In fed trials a sinking pelleted ration of 45% protein was fed 6 days per week. Channel catfish were stocked in multi-species combinations and as mono-species at rates ranging from 37 to 1500 fish per pen. Tilapia aurea were stocked with and without catfish at 200 fish per pen. Maximum production among fed fish during the two growing periods was 538.8 pounds of catfish and Tilapia per 0.025 acre pen (21,552 lb/acre or 24,138 kg/ha). Unfed Tilapia yielded a net production of 86.6 lb/pen (3,464 lb/acre or 3,879 kg/ha).

Problems encountered in pen culture of fish included 1) the occurrence of holes in nylon netting during the first growing period, 2) outbreaks of parasites and diseases of fish, and 3) the occurrence of vitamin C deficiency in channel catfish. Major advantages of pen culture of fish included 1) greater yields per surface area of pond or reservoir, 2) application of intensive rates of feeding to fish in pens because waste products are dispersed over a much larger area than the actual pen, and 3) use of bodies of water normally unavailable for conventional aquaculture methods.

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DEVELOPMENTS IN CAGE CULTURE OF TILAPIA AUREA IN A ROCK QUARRY POND IN PUERTO RICO

On May 16, 1973, eight cubic meter cages of 1/4-inch mesh were stocked with Tilapia aurea, 2-3 inch fingerlings and placed in a 0.23 acre (0.09 ha) rock quarry pond in San Germán, Puerto Rico. This study is the first of its type in Puerto Rico and, possibly, for the entire Caribbean area. The experimental design consisted of four treatments: 300 fish per cage not receiving a feed ration and 300, 400, and 500 fish per cage receiving a complete (36% crude protein), floating feed ration at a rate of five per cent of the total weight of fish per cage. There were two replications of each treatment.

The unfed trial was discontinued after the first sampling date, June 21, 1973 as the results revealed that the natural food organisms in the pond's system could not support growth at that stocking density. These fish were in poor condition, having lost 0.78 lbs (0.35 kg) of the total stocking weight of 5.12 lbs. (2.33 kg).

The treatments with feeding are still in progress and the results to date are promising. Through July 24, 1973 the 70th day of the 150 day experimental period, the cages with 300 fish had gained an average of 31.4 lbs. (14.2 kg) with a food conversion of 0.95 and a daily growth of 0.024 oz. (0.68 grams) per fish. The cages with 400 fish had gained an average of 33.8 lbs. (15.3 kg.) with a food conversion of 0.90 and a daily increase of 0.017 oz (0.05 /grams) per fish. The cages with 500 fish had gained an average of 39.9 lbs. (18.1 kg) with a food conversion of 0.91 and a

daily increase of 0.018 oz. (0.52 grams) per fish.

Frequent monitoring of the pond's water chemistry has not revealed any significant changes that could be attributed to the intensive culture. However, heavy rainfall experienced in the area at this time of the year makes it impossible to draw any definite conclusions as to the carrying capacity of the pond.

During sampling, fish are visually examined for parasites or diseases. The feeding activity is also observed daily as low activity would be indicative of parasites or disease. To date, no ill effects have become apparent.

The entrance of wild fish, mainly Tilapia mossambica, into the cages and their subsequent residence therein, has been a constant problem during this study. This problem will probably occur in any other cage culture operations taking place in bodies of water in which wild fish population are present. The wild fish affect stocking densities, food conversions and weight gains of the caged fish and they can be vectors of parasites and disease. They do, however, add to the total weight of the cages at harvest.

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POTENTIAL FOR CAGE CULTURE OF THE CICHLID FISH, TILAPIA AUREA

A two-year study to determine the feasibility of raising the cichlid Tilapia aurea (Steindachner) with feeding in cages suspended in the water column, was conducted in ponds at the research facilities of Auburn University International Center for Aquaculture, Auburn, Alabama. Earthen pond and cage culture investigations were carried out for comparative evaluations. Cages used had the following characteristics: 1) Size - 1.0 cubic meter; 2) Shape - Square; 3) Construction material - Polyvinyl-Chloride Pipe (PVC), nylon netting, wire, and wood.

The criteria used to evaluate this type of culture included standing crop, net production, efficiency in feed conversion, rate of survival, the A_f value or percentage by weight of harvestable fish, effects of such type culture on the water quality and the relationship between these effects and the health of the fish. The trials consisted primarily of stocking fish in cages and ponds at four different densities in the former units and a single one in the latter. These rates were 286, 429, 571 and 857 fish per cage and 14,814 fish per hectare of pond.

The highest standing crop obtained in cages was 149 kg, at a stock density of 857 fish per cage. Net production was 138 kg during a 156-day growing period with a feed conversion of 1.8:1.0. Results from this trial were significantly different from those of the remaining trials in cages, at the one percent probability level, 11 d.f. The highest production attained in the study produced 198 kg per 0.04-ha pond or 4,950 kg per hectare. It was obtained by a combined pond-cage culture system. Fish from that system had

a feed conversion of 1.3, with an average survival of 98.2 per cent.

The most efficient food conversion by caged fish was 1.2. It resulted with fish stocked at a density of 286 per cage. The rate of survival for all caged fish ranged from 73.8 to 99.5 per cent. Heavy fish mortalities occurred in four cages due to two main factors: 1) oxygen depletion and 2) a bacterial disease.

Cage culture was introduced as a mechanical method to control the production of young Tilapias.

The following advantages of cage culture of Tilapia aurea were observed:

- 1) It allows for Tilapia cultures in bodies of water in which otherwise cultures would be impossible to conduct;
- 2) harvesting operations were greatly reduced in time and labor compared with pond fish harvesting;
- 3) production results from the cage system compared favorably with results from pond culture;
- 4) prevention of offspring production in cages insured A_f values of 100 per cent;
- 5) it allows for better control of the fish crops.

The most serious disadvantages encountered were: 1) occurrence of high rates of mortalities as a result of oxygen depletion and disease outbreaks; 2) need for a costly nutritionally complete feed; 3) danger of poaching of crops.

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AIMLC MEMBER LABORATORIES
(with lists of resident scientists and specialities)

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St. James, Barbados, W.I.

Sander, Finn, Director. Marine productivity: primary and secondary.

BERMUDA BIOLOGICAL STATION*
St. George's West, Bermuda

Sterrerr, W. E., Director. Marine meiofauna: systematics, zoogeography.

CARAIBISCH MARIEN BIOLOGISCH INSTITUT
Piscadera Bay
Curacao, Netherlands Antilles

Kristensen, Ingvar, Director. Marine ecology.
de Boer, Bart A. Reef fish, ethology.
Kruijf, Hans A. M. Corals, ecology, neuro physiology.
Nagelkerken, Wil. Fish populations.

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Almodóvar, Luis R. Marine botany.
Atwood, Donald K. Chemical oceanography.
Cerame-Vivas, Máximo J. Marine ecology.
Colin, Patrick L. Ichthyology, reef ecology.
Cutress, Charles E. Marine invertebrates.
Díaz-Piferrer, Manuel R. Marine botany
Engstrom, Norman A. Marine invertebrates.
Hendrick, Walter. Director of Underwater Activities.
Hernández-Avila, Manuel L. Physical oceanography.
Morelock, Jack. Geological oceanography.
Pagán-Font, Francisco A. Fisheries-aquaculture. (on leave)
Tosteson, Thomas R. Marine physiology.
Williams, Ernest H. Parasitology.

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Woodley, Jeremy D., Acting Head. Echinoderms: biology.
Graham, Eileen A. Marine algae, corals: systematics, ecology.

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Culture Departments. (on leave)
Cáceres, Rigoberto. Fisheries technology; biology oyster cultures.
Carreño, Albino. Chemistry technician.
Gómez, Jesús. Geology technician.
Guevara, Pedro. Foraminifera technician.
Guaiquirian, José. Ichthyology-fisheries biology technician.
Lozano, Alfonso. Fisheries biology.
Momente, José A. Chemical oceanography.
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INSTITUTO DE INVESTIGACIONES MARINAS DE PUNTA DE BETIN

Apartado Aéreo No. 1016
Santa Marta, Magdalena, Colombia

Sánchez, Hernando, Co-Director. Hermit crabs.
Werding, Bernd, Co-Director. Corals, porcellanid crabs and trematodes.
Duque, Fernando. Molluscs, annelids.
Koster, Friedemann. Fish.
Manjarrés, Gustavo. Invertebrates, especially actinians.
Wedler, Ebeihard. Hydroids.

INSTITUTO OCEANOGRAFICO

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Okuda, Taizo, Director. Chemical oceanography.
Acuña, Amado. Cultivation of mollusca.
Bashirullah, Abul. Fish parasitology.
Benitez, José. Hydrochemistry.
Bonilla, Jaime. Chemical aspects of sediments.
Caraballo, Luis F. Marine Geology.
Carpíos Castillo, Luis. Technology of foods.
Carvajal R., José. Cultivation of fishes.
Cedeño, Gilberto. Biochemistry.
Fernández, Esther. Marine bacteriology.
Ferraz de Reyes, Elvira. Phytoplankton.
Flores, Celestino. Mollusca.
Gamboa, Benito. Trace elements.
Ganesan, E. Kandaswamy. Algae.
García, Angel José. Pigments.
González, Domingo. Hematology of fishes.
Gregorio, Reyes. Phytoplankton.
Herrera, Luis. Physical oceanography.
Krog de Baha al Deen Biserka. Marine radiochemistry.
Lares, Luis B. Crustacea.
Lemus Castro, Andrés. Algae.
Lin, Alan L. Physiology of the invertebrates.
Martínez, Aida. Equinodermos.
Sellier de Civrieux, Jean. Foraminifera.
Urosa, Luis J. Zooplankton.
Vélez, Aníbal. Mollusca.

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Goreau, Nora. Coral biology.
Greenfield, Madge. Marine biology; physiology.
Itzkowitz, Murray. Fish behaviour.
Steele, Dunbar. Algal symbionts in coelenterates.
Wade, Barry. Benthic ecology; coastal management.
Young, Ronald. Physiology.

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Rubinoff, Ira, Director. Evolutionary biology of marine shore fishes and sea snakes.
Glynn, Peter W. Marine invertebrate ecology.
Graham, Jeffrey B. Fish physiology.
Hendler, Gordon L. Marine environmental monitoring.
Robertson, David R. Ecology and behavior of coral reef fishes.
Rodaniche, Arcadio. Biology of cephalopods.
Rubinoff, Roberta. Evolutionary biology, behavior of intertidal organisms.

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Dill, John, Director. Marine geology.
Gladfelter, William. Invertebrate zoology, coelenterates.
Ogden, John. Marine ecology, plant-herbivore relations.

The following papers were inadvertently omitted and are placed here with the editors' apologies.

GEOGRAPHICAL DISTRIBUTION OF THE GENUS
Spirocamallanus Olsen, 1952

Olsen introduced the genus Spirocamallanus in 1952 on the basis of the presence of spiral thickenings in the buccal capsule, and he transferred 16 species of Procamallanus to the new genus and designated as the type species Spirocamallanus spiralis Baylis 1923. At present there are 30 species in the genus, all described from fishes, predominantly tropical, of the five continents with the exception of one species. Of the 30 species, 12 have been reported from the Indian sub-continent and 10 others from South America. Spirocamallanus n. sp. from a marine fish, is a third record from marine fish.

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A CONTRIBUTION TO THE BIOLOGY OF THE GRAYSBY,
Petrometopon cruentatum, FROM CURACAO

Petrometopon cruentatum, one of the dominant groupers in the Caribbean, is very abundant on the reefs along the south coast of Curacao. Several aspects of the biology of the Graysby were studied there.

The fieldwork started in January 1973 and continued until February 1974. Every week about 10 specimens were collected with a speargun. Otoliths were used for the determination of age and growth.

Distribution on the reefs was studied by repeated census in various places. The Graysby occurs at depths between 10 and 120 feet with maximum numbers around 30 feet.

Vertical profiles of the reefs with respect to the bottom and mainly determined by corals were measured. The numbers of P. cruentatum were related to the profiles.

The stomach contents were studied quantitatively as well as qualitatively. P. cruentatum feeds mainly on fish but Crustacea are consumed also.

Until July, 203 specimens were collected; 153 females, 38 males and 12 transitionals. The size of the females (total length) varies between 12 and 30 cm with a mean of about 19 cm, the size of the males varies between 19 and 29 cm with a mean of about 25 cm, and the transitionals have a length between 20 and 25 cm with a mean of 22.5 cm. Because most females change into males, females are generally smaller than males.

Munro found the peak of the spawning season in Jamaica to be in March. In Curacao, the spawning season starts in April with the highest number of ripe females found in July. During our study, transitionals were found just before the spawning season, but none was found during the spawning season.

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COORDINATED STANDARD OCEANIC OBSERVATIONS AS PART OF CICAR

The field phase of CICAR (Cooperative Investigation of the Caribbean and Adjacent Regions), an internationally coordinated oceanographic research programme under the auspices of the IOC of UNESCO, started in 1970. Since then CICAR has proved to be a highly effective mechanism to promote cooperation amongst marine scientists in the Caribbean area.

An "Operations Centre" for CICAR was established at the Caribbean Marine Biological Institute, Curacao, with its main objectives to promote coordination of ship's activities, to act as clearing-house for information, to assist and facilitate exchange of services between CICAR-participants and to keep in close contact with research vessels, CICAR-coordinators and scientists in the participating countries.

Special attention of the Operations Centre is given to coordination of the activities on standard sections during the so-called CICAR Survey Months (CSM's). A number of carefully chosen lines in the Caribbean Sea, its passages, and the Gulf of Mexico serve as standard sections. During a CSM as many ships as possible are requested to occupy stations on the standard sections simultaneously. The standardized programme to be carried out on the stations of standard sections consists of meteorological observations, a Nansen cast for measuring temperature, oxygen and salinity, a Standard Biological Station (SBS), including plankton sampling and determination of primary productivity and a recently drawn up Standard Chemical Station (SCS).

It is hoped that the overall data collection will result in atlas-type publications.

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ON THE STRUCTURE AND REPRODUCTION
OF THE MARINE RED ALGA Pseudogloio-phloea
halliae (Setchell) JOLY AND CORDEIRO-
MARINO (CHAETANGIACEAE, NEMALIALES)

The genus Pseudogloio-phloea (Nemaliales, Rhodophyta) is known so far only from three species in the tropical and sub-tropical region of the American Atlantic Ocean. These are P. halliae and P. caribaea from the Caribbean Sea (Taylor, 1960) and P. braziliensis from Brazil (Joly, et al., 1965). Details of reproduction, particularly the pre- and post-fertilization developments leading to carposporophyte formation are not known in any of these species. These are given here for the first time in the Venezuelan plants of P. halliae. Microtechnique procedures followed in the present study were the same as outlined by Chiang (1969) and Ramus (1969).

Carpogonial branches of P. halliae are three-celled and characteristically before fertilization the hypogynous cell divides into a group of four densely staining and cruciately arranged cells. The first cell of the carpogonial branch cuts off sterile cells which after fertilization give rise to branched filaments forming a pericarp. A comparison with details of pre- and post-fertilization developments known in other species of Pseudogloio-phloea is also made and differences and similarities with the present study pointed out. Based on the present work, some remarks on the identity of the three species of the tropical and sub-tropical American Atlantic are also included.

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