

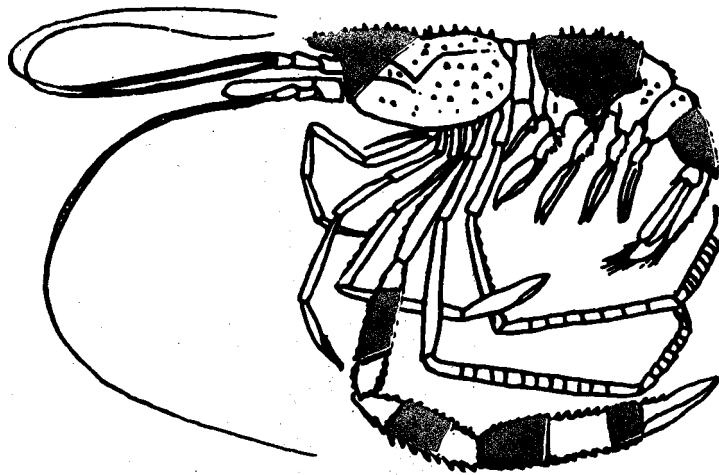
Ray Waldner

ASSOCIATION OF ISLAND MARINE LABORATORIES

OF

THE CARIBBEAN

Seventh Meeting



Bellairs Research Institute of McGill University

Barbados W. J.

Aug. 24-26, 1966

Date of publication: March, 1967

ASSOCIATION OF ISLAND MARINE LABORATORIES
OF THE CARIBBEAN

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The Seventh Meeting of the Association of Island Marine Laboratories of the Caribbean was held on August 24-26, 1966 at the Marine Hotel in Barbados, W. I. Host station was the Bellairs Research Institute of McGill University. Dr. John B. Lewis, director of the Institute and past president of the Association, organized the meeting with the help of the secretary treasurer, Juan G. González from Puerto Rico.

During the three-day program papers were presented on widely different topics such as fish behavior, primary productivity, ecology of algae and marine invertebrates and oceanography. The evening of August 25 was devoted to a business meeting during which the new board of directors was elected. After the election of officers and nomination of new individual and institutional members, there was a lively discussion on two subjects of interest to marine biologists and oceanographers in the Caribbean region, the proposed sea-level canal in Central America and the proposed establishment of a tropical marine biological laboratory in Puerto Rico by a consortium of mainland universities.

The afternoon of August 26 was devoted to an excursion around the island of Barbados followed in the evening by an informal dinner at the Bellairs Research Institute in St. James.

The thoughtful planning and arrangements of Dr. John B. Lewis and his associates at the Barbados marine station contributed much to the success of the meeting and enjoyment of the delegates.

The member institutions that participated, as well as, the representative members who attended the meetings are listed below.

BELLAIRS RESEARCH INSTITUTE OF MCGILL UNIVERSITY, St. James, Barbados, W.I.,
John B. Lewis, Director.

BERMUDA BIOLOGICAL STATION, St. George's West, Bermuda, B. W. I., Albert L. Brooks, Assistant to the Director.

CARAIBISCH MARIEN BIOLOGISCH INSTITUUT, Piscadera Baiia, Curaçao, Netherland Antilles, Fred Kreutzberg, Director and P. A. W. J. de Wilde.

INSTITUTO DE BIOLOGIA MARINA, Universidad Autónoma de Santo Domingo, Santo Domingo, República Dominicana, Sophie Jakowska represented Idelisa Bonnelly de Calventi who is the director of this station.

INSTITUTE OF MARINE BIOLOGY, University of Puerto Rico, Mayagüez, Puerto Rico, Manuel Díaz Piferrer, Juan G. González, Luis R. Almodóvar, Francisco Pagán, Charles E. Cutress and Bertha M. Cutress.

INSTITUTO OCEANOGRAFICO, Universidad de Oriente, Cumaná, Edo. Sucre, Venezuela, Neil Maloney and Taizo Okuda.

UNIVERSITY OF THE WEST INDIES, Mona Kigston 7, Jamaica, W.I., Thomas F. Goreau, Ivan Goodbody, Director of the Zoology Department, Cynthia Page, George Warner, and John Grahame.

The Association was honored by the visit of Mrs. Helen Hayes from the U. S. Office of Naval Research.

Other people present were Drs. Patricia Farnsworth and Antoinette M. Anastasia from Fairleigh Dickinson University in New Jersey. Dr. Walton Smith from the Institute of Marine Science in Miami. Mrs. Juanita Spires from the same institution and Dr. Barry A. Wade from the Marine Biological Laboratory at Woods Hole, Massachusetts. Dr. Frank J. Schwartz from the Chesapeake Biological Laboratory in Solomons, Maryland and Dr. W. F. Rathjen who is at Bridgetown, Barbados working with the U. N. S. F. / FAO Caribbean Development Project. Dr. David M. Steven, former director of the Zoology Department at the University of the West Indies and the Marine Laboratory in Jamaica, now with McGill University at Montreal, Canada and Dr. Donald Phelps of the Puerto Rico Nuclear Center in Mayagüez, Puerto Rico. Dr. John H. Wickstead from the Department of Technical Cooperation and Marine Biological Association at Plymouth, England, Dr. Merton C. Ingham of the Bureau of Commercial Fisheries, Miami, and Dr. Joan Marsden, Associate Professor of the Zoology Department, McGill University, Montreal, Canada.

Below are the abstracts of the papers that were presented at the meeting.

RELATION BETWEEN THE HYDROGRAPHIC CONDITIONS AND THE
SEASONAL VARIATION OF INORGANIC AND ORGANIC
NITROGEN IN THE BAHIA DE MOCHIMA AND
LAGUNA GRANDE (VENEZUELA)

by

A. García, E. Fernández, J. Benítez
and T. Okuda

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Universidad de Oriente
Cumaná, Venezuela

The present study was designed to explore the environmental conditions in important fisheries regions of eastern Venezuela. Monthly hydrographic and chemical observations during 1964 and 1965 are used to relate the hydrographic conditions with the seasonal variation in organic and inorganic nitrogen in Bahía de Mochima and Laguna Grande.

There was a seasonal variation in the hydrographic data and in organic and inorganic nitrogen between Bahía de Mochima and Laguna Grande. In general, the low temperature, low oxygen and high density in both areas were encountered in August and during February and April, while, the high temperature, high oxygen and low density were observed during June and July and during October and November. On the other hand, the former months showed high content of inorganic nitrogen (NO_3^- and NH_3) and the latter months were the reverse.

Although there were no great differences in the annual average of the various forms of nitrogen between Bahía de Mochima and Laguna Grande, it was noted that the former showed an increase of organic nitrogen and a decrease of inorganic nitrogen from the outside to the inside of the bay, while the latter was the opposite.

It may be concluded from the discussion that the seasonal variation of inorganic nitrogen in both areas depends not only on the metabolic circulation in the bay but also the interchange of water between the outside and the inside of the bay.

(authors' abstract)

THE LIFE HISTORY OF THE TREE CRAB ARATUS PISONII
(MILNE EDWARD'S)

by
George Warner
University of the West Indies
Mona Kingston 7
Jamaica, W.I.

The majority of this work was carried out in the mangrove swamps at Port Royal, Jamaica. Situated on the inside of the Palisadoes peninsula which forms the southern border of Kingston Harbour, these swamps support a large population of Aratus pisonii, the tree crab. The breeding of these crabs was studied by means of biweekly samples of the female half of the population during the year 1965-66.

Breeding was continuous throughout the year and synchronized to the lunar cycle such that the eggs hatched at or near the full and new moons. The eggs are considered to hatch in the abdomen of the female while she is out of the water. This hatching is thought to stimulate the female to descend into the water to release the prezoaea which is effected by rapidly vibrating the abdomen.

Lunar and semilunar hatching migrations were worked in which females bearing eggs that were about to hatch accumulated at the seaward fringes of the swamps at times of full and new moon.

The eggs pass through four colour phases during development beneath the abdomen of the female. These phases are: khaki, dark brown, light brown and grey and last for 5, 6, 4, and 1 days respectively. The total duration of the development, therefore, is 16 days.

The larval life consists of a single, prezoal stage and a single megalops. These stages were raised in the laboratory being fed on the fertilized eggs of the sea urchin, Lytechinus variegatus (Leske).

A measurement of growth rate was obtained for the female and it is considered that the life span of the animal is about three years. Mature females moult, on the average, once every 53 days. As they grow larger the percentage increment at each moult becomes smaller.

Mature females ovulate, on the average, once every 66 days and thus usually once in every intermoult period. However, ovulation twice in a single intermoult period has also been recorded. The number of eggs laid was found to be proportional to the volume of the crab and the average breeding female (just under 16 mm carapace width) was found to lay 4900 eggs in a single batch. From these figures the average output of Aratus prezoaea from the fringe zones of the swamp could be calculated; this figure was found to be 207 prezoaea per square metre per day.

Mortality during the life history is greatest during the larval life and is caused almost entirely by predation.

(author's abstract)

SOME ASPECTS OF THE BIOLOGY OF THE GENUS
ASCIDIA IN JAMAICA

by
Ivan Goodbody
University of the West Indies
Kingston 7, Jamaica

There are five species of the genus Ascidia found in Jamaican waters. A. sydneyensis Stimpson is chiefly confined to depths beyond 10 metres in open ocean habitats. A. correloides (Van Name) and A. curvata (Traustedt) are shallow water forms found under stones on reef flats. A. interrupta Heller and A. nigra (Savigny) are primarily inshore species characteristic of harbour waters, although both species occur in small numbers on certain coral reefs. In mangrove lagoons A. interrupta and A. nigra exhibit definite habitat preferences. A. nigra is usually found on Rhizophora roots or other structures which keep the ascidian clear of the bottom sediments. A. interrupta is characteristically found embedded in the bottom sediments and is especially common at the base of the peat bank between mangrove swamp and lagoon. Filtration rates of the two species are very

similar but differences in the organisation of branchial tentacles apparently result in different types of food being collected. The morphology of the gut is also different in the two species and suggests that the food is utilised in a different manner. In external form the larvae are very similar but their behaviour patterns are not the same. Larvae of A. nigra will settle and metamorphose on almost any clean surface within three to six hours of hatching, while the larvae of A. interrupta will seldom settle on clean surfaces. Larvae of the latter species will swim for four days and die without metamorphosing: precise conditions for settlement have not yet been elucidated.

(author's abstract)

EFFECTOS ANTIMICROBIANOS DEL EXTRACTO DE ASCIDIA NIGRA DEL LITORAL DOMINICANO

by
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Universidad Autónoma de Santo Domingo
República Dominicana

agua que en cualquier otro solvente, prefiriéndose, por este motivo, las soluciones acuosas en las pruebas de actividad antimicrobiana. Estas fueron realizadas en placas de Petri con agar nutritivo y agar sangre solidificados, inoculados ambos con cultivos de 24 horas de Micrococcus aureus, Escherichia coli, Pseudomonas aeruginosa y Eberthella typhosa. Discos de papel absorbente de 12 mm. de diámetro fueron impregnados con extractos que representaban, aproximadamente, 100 gramos de material homogenizado y colocados sobre la superficie del agar inoculado con el organismo. La actividad contra todos los microorganismos empleados se manifestó después de 24 horas de incubación a 37°C. en forma de una zona de inhibición de 2-7 mm. alrededor de los discos. Esta actividad pareció disminuida o suprimida en extractos purificados hasta el punto de eliminar el pigmento. Las características del pigmento de la túnica y su papel en la antibiosis ecológica de la Ascidia nigra quedan por determinarse.

(author's abstract)

Numerosas colonias del tunicado Ascidia nigra fueron observadas en el muelle de Andrés, ciudad a 26 kilómetros de distancia de Santo Domingo, a una profundidad de 0.6 - 3 metros. Los individuos se encontraron adheridos a los pilotillos y tenían tamaños que oscilaban entre 45-80 mm. Fue de notarse que las colonias estaban aisladas unas de otras y que las túnicas aparecían libres de los organismos que habitualmente están asociados con los tunicados. Al hacerse cortes, in situ, de 2 cm. de largo y de 1 mm. de profundidad las heridas cicatrizaron en los primeros 8 días sin aparente infección y sin afluencia de otros organismos. Estos hechos hicieron sospechar la existencia en Ascidia nigra, de un agente antimicrobiano soluble en agua de mar. Se prepararon entonces extractos de la túnica con material fresco ó congelado que fue homogenizado con agua y secado a 90°C. durante 18-48 horas. También se utilizó el sobrenadante pigmentado del homogenizado después de una centrifugación de 1/2 hora. Los extractos exhibían un color morado oscuro. Agua destilada, alcohol etílico y acetona fueron utilizados para la extracción, observándose sin embargo, que el pigmento era más soluble en

SOME ASPECTS OF THE OSMOREGULATION IN LAND HERMIT
CRABS, COENOBITA CLYPEATUS (HERBST)

by

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Curaçao, Netherlands Antilles

The soldier crab Coenobita clypeatus, a common species of the Caribbean goes into the sea only to breed. Among the many Crustacea, which can stay out of the water for some time, it is the one with the most terrestrial habits. It can live without water supply for a couple of weeks. Adaptations for economical water management seem to be very important.

Also valuable is the storage of water under the shell (shellwater). This water is taken up in an active way. After the smaller pincer, with the help of the maxillipeds, has brought water into the mouth the water flows backward through the gill chambers and the pumping movements of the abdomen press it under the shell.

If water of both high and low salt concentration is available the animal mixes out of these a milieu exterieur of a fixed salinity (about 32‰). By drinking small amounts of water of low salinity the crab can maintain the salinity of its shellwater at a more or less distinct level. Osmoreceptors play a prominent part in both events.

In the laboratory C. clypeatus which drank fresh water only used about 50 to 60 times less water than did crabs which drank 100% sea water or hypersaline water.

This implies that animals which use fresh-water are by far the least dependant on drinking water and so they have a more terrestrial life than animals which have to drink salt water.

The shell proves to be a rather good barrier to prevent (a) dilution of the shellwater during rainfall and (b) increase of the salt concentration when the animals remain in such places where sea water or brine occurs.

It is apparent that the ability of C. clypeatus to adjust the salinity of its shellwater is an important factor in the osmoregulation of these animals.

THE BIOLOGY OF BERTHELINIA CARIBBEA

by

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Mona, Kingston 7
Jamaica, W.I.

A programme of work on the biology of the bivalve sacoglossan gastropod Berthelina caribbea Edmunds has been carried out. In its feeding and general behaviour the animal resembles other Sacoglossa. B. caribbea appears to feed only on the green alga Caulerpa verticillata Agardh.

The life span of the animal is about 3 - 3 1/2 months, the animal spawns for the latter 9 - 10 weeks of this. Fecundity is high. Isolated B. caribbea self-fertilize and spawn, as does the related Japanese Berthelina limax Kawaguti & Baba. A penial stylet has been described for the first time in Berthelina. It resembles a hollow harpoon with two barbs, and is probably used to secure the penis within the partner during copulation.

Eggs are laid in clusters or masses of about 40 eggs each, the size of the masses is very variable. Eggs hatch 15 days after spawning, the larval stage is suppressed and the newly hatched larva has a radula capable of piercing Caulerpa shoots. Larvae

settle readily on the nearest piece of Caulerpa and begin to feed. The bivalve shell develops as two flanges below the protoconch, the left flange is fused with the protoconch and the right flange is hinged onto it. Growth is rapid and uniform until the animals reach a size of about 2.8 mm long, when the curve falls off, the largest animal found measured 3.77 mm from anterior to posterior margins of the shell.

Experiments have shown that B. caribbea populations should be able to survive the reductions in salinity which occur in the mangroves from time to time as a result of heavy rains.

When irritated the animal discharges a viscous white secretion which is defensive in nature. The secretion causes distress in other small animals, it has a pH of 3.5 and also appears to be toxic.

(author's abstract)

THE CONTINENTAL BORDERLAND OF VENEZUELA

by
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Universidad de Oriente
Cumaná, Venezuela

The continental margin north of Venezuela, between Aruba and Margarita, is complex, with basins and island chains separating the continental shelf and slope. Shephard and Emery (1941), named a similar region, off southern California, the continental borderland.

The borderland north of Venezuela is 485 klms. long and as much as 190 klms. wide; it contains two large basins and nine island groups. The continental shelf is narrow having a maximum width of 42 klms. north of Río Unare and a minimum width of less than one-half klm. east of Puerto Cabello.

The basins are 45 to 155 klms. wide. Their slopes are gentle in most areas; steep scarps occur south of the island of Tortuga (30°), north of Cumaná (14° - 17°), and west of Puerto Cabello (20°). The western

basin (Bonaire) has a maximum depth of more than 2000 meters and a sill depth of about 1650 meters, and the eastern basin (Cariaco) has a maximum depth of about 1400 meters and a sill depth of 130 to 140 meters. The northern boundary of the Cariaco Basin is a submarine bank extending from Cabo Codera to Isla Margarita. Tortuga is the highest elevation on the bank. A more northerly series of islands stretching from Aruba east to La Blanquilla forms the northern boundary of the Bonaire Basin. Igneous and metamorphic rocks exposed on some of the eight island groups are similar to the rocks exposed in the Coast Range of Venezuela. The island groups are separated by submarine canyons which are directed south into the basin and north onto the continental slope.

(author's abstract)

COELOMOCYTE INVASION OF THE INTESTINE DURING
DIGESTION OF FOOD BY HERMODICE
CARUNCULATA

by
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Following the intake of food by the amphinomid polychaete, Hermodice carunculata, there are histological changes in the wall of the intestine. The changes involve apparent secretion by cells of the intestinal epithelium as well as an invasion of this tissue by masses of coelomocytes which appear to move from the coelomic cavity toward the intestinal lumen. There is, in addition, some evidence suggesting a subsequent outward movement of replete amoebocytic cells from the intestinal lumen to the body cavity.

(author's abstract)

A COMPARATIVE STUDY OF GROWTH RATES OF SOME TROPICAL
AND SUBTROPICAL CARIBBEAN MARINE INVERTEBRATES

by
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The purpose of the investigation was to determine the rates of growth in a number of common Caribbean littoral animals on a latitudinal basis. The methods of study of growth rates of a number of intertidal and littoral animals were described.

Three techniques were used for six species of intertidal gastropods:

- 1) Monthly determinations of size frequency distributions of a population using samples of approximately 500 animals.
- 2) Monthly measurements of color coded animals from their normal environment using a samples population of animal of similar size.

- 3) Monthly measurements of individually marked and numbered animals of the whole species size spectrum from a normal environment.

Growth rates of four species of corals were determined by monthly measurements in selected colonies in situ. Branches of colonies were inserted in sections of rubber tubing set in concrete blocks in the sea.

The investigation was begun in Barbados in June 1965 at the Bellairs Research Institute and in Jamaica in October 1965 at the University of the West Indies.

(author's abstract)

SOUND PRODUCTION, SCHOOLING, AND FEEDING HABITS
OF THE MARGATE, HAEMULON ALBUM CUVIER
OFF NORTH BIMINI, BAHAMAS

by

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University of Miami

The behavior of a school of margates, Haemulon album Cuvier, was studied using hydrophones and an underwater television system. Margates entered the acoustic-video underwater observation area about sunrise. They schooled during the day and dispersed in late afternoon. Feeding and activity increased considerably at night. Common food organisms included crustaceans, small fishes, and bivalves. Night and daytime food organisms were of similar composition. The sounds of feeding and other activities were recorded on magnetic tapes, while the fish were within acoustic range. Using underwater television, observations were made of margates schooling, feeding, and being preyed upon by amberjacks and barracuda. The use of identifiable natural characters and Petersen disc tags indicated that after nocturnal foraging, margates returned to school in the same place each morning. Large margates were not observed to school.

(authors' abstract)

GROWTH AND REPRODUCTION OF THE FORAMINIFERA,
AMMONIA BECCARII

by
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Bermuda, B. W. I.

The growth, reproduction and longevity of a naturally occurring population of Ammonia beccarii (Linné) was determined from the analysis of a chronological series of percentage frequency distribution curves. These curves were based on measurements from over five thousand living specimens retrieved from two hundred eighty three core samples collected from Narragansett Bay, Rhode Island over a period of twelve consecutive months.

Four bursts of asexual reproductive activity, resulting in as many distinct generations, occurred between April and October. The life span of the individual specimens required from five to ten months depending upon the date of generation. Rate of growth of individuals, shown to be nearly negligible in the colder months, attained a maximum in July and August and was well correlated with seasonal changes in bottom water temperatures.

Fluctuations in the temperature influenced benthic microflora probably played a major role in the nutrition of Ammonia beccarii.

(author's abstract)

UPWELLING EFFECTS ON THE MARINE FLORA OF VENEZUELA

by
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University of Puerto Rico
Mayagüez, Puerto Rico

This is an initial report on the results of a survey of the marine flora of Venezuela made from January to July 1966 under the auspices of the Oceanographic Institute, University of Oriente, Cumaná, Venezuela. A more complete version of this paper will be published in the Caribbean Journal of Science, University of Puerto Rico. The present investigation is a continuation of a project begun several years ago on the biogeography of the marine flora of the Caribbean.

The upwelling reported as occurring along the north coast of Venezuela is more intense over the continental shelf off the north coast of Margarita Island and toward Los Testigos Islands. In this area surface temperatures of 19 to 23° C give rise to a temperate zone enclave within which the benthonic marine flora is markedly affected. The most obvious aspect of this flora is the luxuriant growth of some eurythermic, tropical and subtropical species and the presence of some temperate zone species of algae during the greater part of or entire year.

The most significant genera and species associated with this upwelling are Porphyra umbilicalis (Linnaeus) J. Agardh, Placodium coccineum Harvey, Arthrocardia stephensonii Manza and Acrosorium uncinatum (Turner) Kylin, among the Rhodophyta; Levringia brasiliensis (Montagne) Joly and Dictyopteris hoytii Taylor, among the Phaeophyta. The absence of genera and species typical and representative of the tropical seas and particularly of the Caribbean marine flora; most noticeable absentees are Neomeris, Cymopolia, Penicillus and some other calcareous among the Chlorophyta, and Turbinaria turbinata (Linnaeus) Kuntze and Sargassum polyceratium Montagne, among the Phaeophyta. It is also significant the ecological pattern of distribution in the intertidal zone of Sargassum cymosum C. Agardh and Sargassum filipendula C. Agardh which are common species to the Temperate and the Tropical Zones in the Western Atlantic. S. cymosum is predominantly a southern species, and S. filipendula a northern one. Both species live submerged in the warm waters of the Caribbean but they also populate, in great abun-

dance, the rocky intertidal zone, S. filipendula toward the northern part of its range from the Carolinas to Massachusetts; S. cymosum toward the southern part of its geographical distribution in southern Brazil. These two species are found populating abundantly the intertidal zone in the area affected by the Venezuelan upwelling, thus behaving in the same fashion found in the Temperate Zone.

The foregoing observations on the algae in the area of the Venezuelan upwelling suggest that:— 1. certain species of marine algae, by their presence or absence, are indicators of oceanographic conditions occurring in the area; 2. the adaptation of some tropical and subtropical algae to temperate conditions is possible only in such circumstances; 3. there is a correlation between the occurrence of these algae and the chemical-physical characteristics of the area that have been revealed by oceanographic studies.

(author's abstract)

EXPLORATORY FISHING PLANS - U.N. CARIBBEAN FISHERIES DEVELOPMENT PROJECT

by
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Formally activated in August 1965, the U.N. Fisheries Development Project includes 16 governments* in the West Indian area. Activities include fisheries development under three sub-headings - Marketing, Training and Exploratory Fishing.

Exploratory Fishing field studies start in the fall of 1966 and will include investigations on pelagic fishes, trawlfish resources and other species which appear to offer potential for development. Research will be conducted in the Caribbean waters bounded by the Antillian chain of islands and adjacent waters of the North Atlantic, south of 20°N. latitude and extending eastward to the Brazillian border. Two sub-bases have been established, one at Bridgetown, Barbados and the other at Kingston, Jamaica. There will be three or more combination exploratory fishing - training vessels assigned to the project. Two of these have been completed in Japan for the Project, and a third is nearing completion in England.

Nine specialists recruited internationally form the nucleus of the exploratory

fishing staff, and this number is supplemented by vessel crews and others supplied as "counterpart" staff by the participating countries.

Field operations are scheduled to continue through most of 1969 and project personnel are anxious to cooperate with other research organizations either located in the Caribbean area or investigating problems related to it.

(author's abstract)

* The countries participating in the Project are France (in respect of French Guiana, Martinique, Guadeloupe and their dependencies); Guyana; Surinam; Trinidad & Tobago; the Netherlands Antilles; Dominica; St. Vincent; Grenada; Jamaica; the Dominican Republic; St. Kitts; Montserrat; Antigua; St. Lucia; the United States (in respect of Puerto Rico); and Barbados.

EMBRYOLOGY AND FEEDING BEHAVIOR OF THE
ATLANTIC COWNOSE RAY
RHINOPTERA BONASUS

by
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Cownose rays, Rhinoptera bonasus, arrive en masse in the upper Chesapeake Bay each year about June 5. Young are born tail first by being discharged as the female swims or jumps. Remating occurs within ten days by a ventral to ventral union. Immature young-of-year specimens exhibit a dorsal back-riding unsuccessful copulatory behavior in late August or early September. Early development, once fertilization has occurred, is rapid and by 15 August embryos are about 51.0 mm wide and resembling miniature adults, possess a yolk sac and elongated exterior branchial filaments. Embryos by 10 October average 133.0 mm in disc width and often are devoid of yolk sac and umbilicus but retain an umbilical scar. Term individuals are born with wings folded on themselves and average 305.0 mm disc width. Interim embryonic nourishment is via papillar villi of the left uterus, which is filled with a yellowish-mucoid material.

The heavily endowed sensory fleshy flaps on the ventral-anterior portion of the head are used in a probing, creeping, and directing fashion when feeding. A peculiar arching of the body dorsally occurs once a food item has been hydraulically mined from a sandy or muddy area. Mining occurs once the flaps sense an edible object. A specific glide pattern is exhibited as an indicating to feeding.

(author's abstract)

THE SYMPATRIC OCCURRENCE OF DONAX SPECIES IN THE CARIBBEAN, AND ITS POSSIBLE IMPLICATIONS

by

Barry A. Wade

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Systematics-Ecology Program, Marine Biological Laboratory
Woods Hole, Massachusetts

The beach clams, Donax denticulatus Linné and Donax striatus Linné, occur sympatrically on exposed sandy beaches throughout the Caribbean. Of the two species, D. denticulatus is the more common and occurs frequently in high densities, while D. striatus is more sporadic and is usually found in lower densities. D. striatus is always found with D. denticulatus although the latter frequently occurs by itself.

The sympatry of D. denticulatus and D. striatus is discussed in relation to Gause's Law which states that two species with similar ecology cannot occupy the same niche. Three possible explanations are considered for this apparent exception to the law.

(a) The two species, though closely related, do not make the same demands of their environment, and so are not in active competition. This explanation is thought to be unlikely as all the available data indicate that the species are ecologically very similar.

(b) The species, though coexisting, do not cohabit the same niche. It is pointed out that there are distinct "microhabitats" within the intertidal zone of sand-beaches and that the occupancy of these microhabitats varies between the species in time and space. Thus whereas D. denticulatus is normally confined to the saturated wash zone of the beach, D. striatus may occur in this zone as well as on both sides of it

in (1) the surf zone, and (2) the unsaturated wash zone. Consequently populations of both species do not always overlap within the broad spectrum of the habitat, and therefore are not in constant competition.

(c) Populations of the species are not in equilibrium and at least one of the species is undergoing diversification. Comparison of the ecology of both species shows that whereas there are well established populations of D. denticulatus throughout the entire range, populations of D. striatus are both temporally and spatially unstable. Furthermore, ecological, zoogeographical, and morphological evidence suggests that D. striatus is a more recent species than D. denticulatus and that it is still in the process of becoming adapted to the sand-beach environment.

The sympatry of Donax is considered in the context of the Caribbean fauna. It is thought that sympatry in Caribbean waters is indicative of the active speciation and diversification that is taking place, and of the recentness of the fauna.

(author's abstract)

Supported in part by Grants GB-561 and GB-4509 from the National Science Foundation to the Systematics-Ecology Program.

TURBULENCE AND PRODUCTIVITY NEAR ST. VINCENT ISLAND, B.W.I.
A Preliminary Report

by
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Physical Oceanography Program
Bureau of Commercial Fisheries

Tuna schools and bird flocks in the vicinity of the Lesser Antilles, as found during fishery-oceanography investigations during February-April, 1966, were concentrated in an area west of St. Vincent Island. Plankton density in the upper mixed layer of this area was high and bathythermograph data revealed the presence of turbulent eddies. The increased productivity of this area possibly is a consequence of the downstream turbulence from St. Vincent Island. Future investigations are planned to further resolve the size and time scales of the turbulence and the enrichment mechanisms.

(author's abstract)

THE TROPICAL ATLANTIC BIOLOGICAL LABORATORY
AND OCEANOGRAPHIC RESEARCH
IN THE CARIBBEAN SEA

by
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The Tropical Atlantic Biological Laboratory was recently established to study the biology and ecology of the tunas and other pelagic predators in the tropical Atlantic Ocean, Caribbean Sea and Gulf of Mexico.

Prior to 1965, most of the laboratory's cruises were conducted in the tropical Atlantic near Africa; three cruises since 1965 have involved regions of the Caribbean Sea. Further investigations are planned to complete seasonal surveys and to investigate more thoroughly areas of specific interest in the Caribbean Sea. Sampling operations conducted during the laboratory's fishery-oceanography cruises are described.

It is proposed that a system of near-shore stations be established in the Lesser Antilles to monitor surface salinity and temperature. Data from these stations would be used to describe the variation of characteristics of flow into the Caribbean, in order to mutually benefit the research programs of the various laboratories interested in this area.

(author's abstract)

PRIMARY PRODUCTIVITY IN THE CARIBBEAN SEA OFF
JAMAICA AND THE TROPICAL NORTH ATLANTIC
OFF BARBADOS

by
John R. Beers¹
John B. Lewis²
David M. Steven³

The principal findings of the cooperative study carried out from 1961 to 1964 are presented in summary form. Observations of the primary productivity and related hydrographic and nutrient characteristics were made at approximately monthly intervals at offshore stations near Barbados from November 1961 to November 1964 and Jamaica from March 1962 to March 1964. Productivity was measured from the surface to 100 m and other data to 250 or 300 m. The rate of production was relatively low at Jamaica. The average gross production was $0.18 \text{ gC/m}^2/\text{day}$ (range .08 - .52) and the average net production $0.11 \text{ gC/m}^2/\text{day}$ (range .03 - .28). The estimated gross annual production was $66 \text{ g C/m}^2/\text{year}$ and net annual production $40 \text{ g C/m}^2/\text{year}$. At Barbados average gross primary production was $0.38 \text{ gC/m}^2/\text{day}$ (range .19 - .62), or an estimated $139 \text{ gC/m}^2/\text{year}$. The annual level of production at Barbados is comparable with that found for the Sargasso Sea off Bermuda and roughly twice that off Jamaica.

At both stations there was some evidence of regularly recurring variations of production which may be of a seasonal nature. Off Jamaica production peaks of brief duration occurred in the late spring and fall, alternating with periods of lower production in the summer and winter. The fall production peak may be associated with the main wet season. Off Barbados production increased during the spring, was relatively high during the summers of 1962 and 1963 and low during the fall and win-

ter. The high summer values may be associated with low salinity surface water, believed to be of South Equatorial origin, that occurs in the area during this season.

Nutrient values at both stations were generally low in the euphotic zone throughout most of the year and the temperature and salinity structure of these waters is such that there is little possibility of nutrient-rich deeper water mixing well with the surface water. Since plant production is believed to be controlled primarily by the availability of nutrients, we should expect to account for the seasonal variations of production in terms of changes restricted to the surface waters and possibly of a highly local nature.

(author's abstract)

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PROGRESS REPORT ON THE PRIMARY PRODUCTIVITY OF THE NERITIC
AND OCEANIC WATERS OFF THE WEST COAST
OF PUERTO RICO

by
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A study of the primary productivity of the neritic and oceanic waters off the west coast of Puerto Rico was undertaken from December 1964 through November 1965. Samples were obtained for the determination of phosphate, nitrate, nitrite and silicate at nine depths (0, 15, 25, 50, 75, 100, 150, 200, and 250 meters) using PVC van Dorn samplers. In addition, a transparent and an opaque bottle were filled from each of the depths at which 100%, 50%, 25%, 10%, and 1% of the surface light penetrated. A measured volume $C^{14}O_3^-$ of known activity was added to each of these bottles which were, then, placed in a tray, cooled with running sea water, and exposed to the sunlight. The bottles were covered with filters which transmitted the same a-

mount of light as had been present at the depth where the samples were taken. Chlorophyll, as well as salinity and oxygen were determined for all depths.

The data analyzed indicate that there is a high production in the inshore waters and this decreases considerably in the oceanic waters. The same holds true for the concentration of nutrients. The concentration of chlorophyll also appears to follow the same trend, indicating that the standing crop is much higher in the bays than offshore.

Bathythermograph records show that there is a fairly permanent thermocline in the oceanic waters.

(author's abstract)

OBSERVATIONS ON A RED-WATER BLOOM IN
KINGSTON HARBOUR, JAMAICA

by
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A red-water bloom caused by Exuviella sp. was observed in the eastern basin of Kingston Harbour in October 1962 close to a station (3J) at which data on carbon fixation, chlorophyll, phytoplankton and nutrient concentrations were obtained from July 1962 to July 1964. Samples of red water were collected from the surface and 5 m and compared with the harbour water. Carbon fixation, chlorophyll a and phytoplankton concentrations were five to seven times greater in the red water than in nearby harbour water and two to three orders of magnitude greater than in Caribbean surface water.

Exuviella numbers in the red water reached 29×10^6 cells/l and 95% of all cells. Nitrate, phosphate and silicate concentrations in Kingston Harbour were two to four times higher than normal at the time

of the bloom and some nitrate values were very much higher. The N: P ratio was unusually high (20 to 50:1) before the bloom and low after it (1:1). The bloom appeared at the peak of a growth and decay cycle of Exuviella when the harbour water was diluted with fresh water during the rainy season, and was preceded by at least two diatom blooms with comparable cell concentrations. It is suggested that nitrogen enrichment of the harbour water was a precondition for the bloom and nitrogen exhaustion a factor in its decline, but that dilution of the water provided conditions specifically favouring the growth of the dinoflagellate.

(author's abstract)

COASTAL UPWELLING NEAR VENEZUELA (1)
--Year to year change of upwelling--

by
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Universidad de Oriente
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Upwelling is seen along the eastern parts of the Venezuelan coast. Hydrographic data indicate year to year variations between these variations and the regional wind systems are being studied. Analyses of sparse data taken during the springs of 1963 and 1964 indicate that upwelling rates correlate with wind speeds.

(author's abstract)

STUDIES OF THE PUERTO RICO NUCLEAR CENTER IN PROGRESS AND PLANS FOR FUTURE INVESTIGATIONS

by
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The Marine Biology Program of the Puerto Rico Nuclear Center was started January 1, 1962 by Frank G. Lowman and has continued until the present under his direction. The program's purpose is to study distributions and movements of selected stable elements through bio-geochemical systems in a tropical marine environment. Particular attention is placed on food web relationships leading to man since pathways indicated through distributions of stable elements may be used to predict movements of radionuclides of the same chemicals through similar systems.

A 65-foot research vessel, the Shimada, is equipped for standard oceanographic collections, and is used as a base for sampling operations. Research facilities at the laboratory include in addition to basic laboratory equipment a one megawatt research reactor, an atomic absorption-flame photometry unit, a multichannel gamma spectrometer, an arc spectograph and a Carbon-Hydrogen-Nitrogen analyzer.

Some of the studies completed to date include: "Differences in trace element composition in the sea urchins Tripneustes esculentus (Leske) and Echinometra lucunter" (L.) by Robert A. Stevenson and Sara Lugo Ufret, 1966., *Limnol. and Oceanogr.* 11: 11-17. This work considered differences in stable element concentrations between closely related taxonomic groups, and utilized atomic absorption analyses. "Partitioning of the stable elements, Fe, Zn, Sc, and Sm within a benthic community, Añasco Bay, Puerto Rico", D. K. Phelps,

1966, in *Proceeds. Intern. Symp. Radioecol. Conc. Processes*, Stockholm, Sweden, reports differences in elemental composition between and within closely related ecological groups. Activation analyses were used for this study. "The Biogeochemistry of Scandium", Ms., 1966, By Frank G. Lowman et al., reports on the relative abundance of a single element within the non-living and living terrestrial, fluvial, and marine environments. Activation analyses were used in this study also.

The geographic location of the Puerto Rico Nuclear Center allows easy sampling of discrete limestone, volcanic, and serpentine watershed.

The current senior staff includes:

Dr. Frank G. Lowman, Director
Dr. Donald K. Phelps, Benthic Studies
Dr. Robert Y. Ting, Fisheries and Benthic Groups
Dr. John H. Martin, Zooplankton and primary productivity
Dr. Donald J. P. Swift, Marine Geology

There is an excellent 25-member supporting staff. The program of studies at the Nuclear Center is currently being expanded to include feasibility studies in areas of the proposed new isthmian canal.

(author's abstract)

VERTICAL DISTRIBUTION OF INORGANIC AND ORGANIC NITROGEN
IN THE CARIACO TRENCH

by
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Some characteristics of the vertical distribution of organic and inorganic nitrogen in the Cariaco Trench are discussed on the basis of the observations made by the R/V "Guaikeri" during September 1965 and July 1966.

The deeper water (more than 300 or 400 meters) is anaerobic and has some irregular values in the ammonia and nitrate content. There is a great difference in the ammonia and nitrate content between the western and eastern basins. From the present data, it seems that there is a possibility of the sinking of the upper water mass.

A comparison was also made on the forms of nitrogen (particulate and dissolved organic nitrogen, ammonia, nitrite and nitrate) between the Cariaco Trench and the area north of the Trench.

(authors' abstract)

COMPARISON BETWEEN THE CONTENT OF ORGANIC
MATTER IN SEA WATER AND THE CHEMICAL
COMPOSITION OF THE MUSSEL
(PERNA PERNA)

by
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A comparison between the content of organic nitrogen in sea water and the chemical composition of the mussel was carried out in order to confirm the importance of particulate organic nitrogen as a food source of this mussel.

The maximum values of particulate organic nitrogen were observed in the front of an experimental raft and in the surface water, then, decreasing from the front to the hind part of the raft and with the depth. A similar phenomenon was observed in the chemical composition of the mussels.

It may be concluded from the observations that there is a positive relation between the content of particulate organic nitrogen and the fatness of mussels.

(authors' abstract)

GIGANTISM AND ABUNDANCE IN THE MACROBENTHOS OF JAMAICAN CORAL REEFS

by

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Soft bodied macro-benthonic forms are believed to be relatively uncommon in tropical shallow water coral reefs because of heavy predation by browsing fishes. However, recent underwater explorations of coral reefs on the north coast of Jamaica revealed enormous populations of fleshy macro-benthonic forms, and relatively few scarid fishes. In these reefs the Scleractinian corals are the predominant biotic element only above 40 m, whereas the sponges, algae, Gorgonacea and Antipatharia become more important at depths greater than 45 m on the fore-reef slope. In this environment, the benthos achieves very large standing crops, and many species are present in great profusion but few become absolutely dominant. Moreover in such diverse groups as algae, sponges, corals, and others, gigantism is a common attribute of some of the abundant forms.

The coral associations inhabiting the fore-reef slope have a very different species composition from those of the shallow reefs. In the deep reef coral communities, the genera Agaricia, Helioseris and Madracis predominate, and are represented by species which do not occur above 30 m. Several of these corals achieve not only very great local abundance but their colonies may also grow to very large sizes, having a surface area comparable to or exceeding that of the largest corals found in shallow water. Such species as Agaricia undata often grow in the form of "megacolonies" with dimensions of about 20 m on a

side. In such communities, usually about 40 to 50 m deep, the coral fronds are imbricated so that they cover all of the available bottom area with several layers of living coral. The leaf-like coralla of these Agaricias are thin and tough and cover a remarkably large surface area in proportion to their weight. This characteristic is common among deep water reef corals, and is inferred to be of survival value in an environment where the destructive activities of boring sponges limit both size and life-span of heavy massive corals. At the same time the flattened frondose colony form gives the corals a maximum feeding surface with a minimum of structural weight.

The algal communities of the fore-reef slope are characterized by several indicator species restricted to this habitat. Among these, Halimeda copiosa n. sp. (Chlorophyta, Caulerpales) is notable for its great abundance at certain times of the year, and the large size to which individual plants will grow in the absence of browsing fish. H. copiosa is a giant among its kind, plants of about 0.5 m long are common and individuals up to 1 m long have been observed. Although this species occurs mostly in reefs below 25 m in relatively shaded localities, it grows rapidly and has a high annual population turnover rate. H. copiosa is also one of the most important contributors to the coarse sand fraction of the reef sediments of the fore-reef slope, and well preserved segments have been found in fossil reef facies of upper mid-Pleistocene age.

In view of its abundance and importance in the formation of reef sediments in Jamaica, it is paradoxical that this Halimeda has not yet been reported from any other part of the West Indies.

Preliminary estimates indicate that the aggregate biomass of the sponges probably exceeds that of other groups of the fore-reef slope combined. At depths of 50 m and below, the sponges as a whole are the dominant members of the macrobenthos, absolute dominance being combined with great species diversity and large size of individual sponges. Species in the genera Agelas, Verongia, Spaaciospongia and Xestonpongia, among others, often achieve gigantic size, sponges measuring two to three meters in all dimensions have been observed. The growth rates of these large sponges may be very slow: measurements of the regeneration rate in a 2 m wide Agelas muta growing at a depth of 70 m suggest that the age of this individual may be about 200 years.

The observations of abundance and large sizes in fore-reefs slope macrobenthos of Jamaica cited above constitute a few examples of a general and unexplained phenomenon where high population density,

great species diversity and large individual size all occur together in a very heterogeneous biota. It is difficult to understand why such rich communities have not been reported before in more intensely studied coral reef localities elsewhere. Indeed, other workers have described the fore-reef slope habitat of Indo-Pacific and some Western Atlantic coral reefs as being relatively devoid of macrobenthos other than corals. More comparative information is necessary before it can be concluded that the fore-reefs slope communities of Jamaica are an exception. If the answer is in the affirmative, it remains to be decided whether the lack of browsing reef fishes may have been a factor in the development of the Jamaican fore-reef slope communities, or whether other causes such as local upwelling and increased productivity may be in part responsible.

(author's abstract)

This work was done with support of the National Science Foundation and the U.S. Navy Office of Naval Research.



View of some of the participants of the Seventh Meeting of the Association of Island Marine Laboratories of the Caribbean at Barbados, W. I.

1. Thomas F. Goreau
2. Neil J. Maloney
3. Warren F. Rathjen
4. Peter Bacon
5. Walton Smith
6. Merton C. Ingham
7. Donald Phelps
8. Frank J. Schwarz
9. Fred Creutzberg
10. Taizo Okuda
11. Meredith Jones
12. Sophie Jakowska
13. Albert Brooks
14. Barry Wade
15. Helen Hayes
16. John H. Wickstead
17. George Warner
18. John B. Lewis
19. John Grahame
20. Joan Marsden
21. David Steven
22. Juanita Y. Spires
23. Ivan M. Goodbody
24. Cynthia Page
25. Manuel Díaz-Piferrer
26. Juan G. González.

