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MARINE STUDIES ON THE NORTH COAST OF JAMAICA

edited by Gerald J. Bakus

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## INTRODUCTION

During July and August of 1970 a group of 12 students and several instructors participated in research and teaching in the second Organization for Tropical Studies (OTS) course in Tropical Marine Biology. The primary site was the Discovery Bay Marine Laboratory and immediate environs on the north coast of Jamaica. The laboratory provided facilities for maintaining live marine organisms, under the direction of Mr. Norman Copland, Manager.

Discovery Bay consists of a variety of marine communities, particularly sandy bottoms, *Thalassia* beds, and coral patch reefs. Among the most striking communities is an exceptional sponge bed located at a depth of 50-75 feet (15-23 m) just off Columbus Park, with certain specimens approaching the size of a washtub. The bay is contained by a reef crest of zoanthids, scleractinian corals, sea urchins, and numerous associated organisms. Beyond the reef crest, scleractinian corals slope gently seaward before the island shelf plunges into the depths. Underwater visibility on the outside of the reef crest often approaches 150 feet (46 m). Scleractinian corals are magnificently developed along this narrow shelf. Sclerosponges occur as cavernicolous cryptofauna in waters 8 to 92 meters deep (Hartman and Goreau, 1970). Goreau (1959) presented a detailed report on the ecology of coral reefs on the north coast of Jamaica. The low incidence of exposed soft-bodied invertebrates and the low standing crops of exposed fleshy algae on the reef slope are in part interpreted as the evolutionary product of tropical predator-prey and grazer-plant interactions (Bakus, 1969).

The abstracts presented below summarize studies conducted during the OTS program. A complete report of our research activities is on file in the OTS North American Office.

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<sup>1</sup>Allan Hancock Foundation, University of Southern California, Los Angeles, California  
(Manuscript received Nov. 1970--Eds.)

## ABSTRACTS

*Distributional patterns of rocky intertidal gastropods in Discovery Bay, Jamaica*

By Lenora H. Atsatt, Dept. of Environmental and Population Biology, Univ. of California, Irvine

Distributional patterns of rocky intertidal gastropods in Discovery Bay, Jamaica, were examined in an attempt to develop a quantitative method of describing habitat differentiation. The relationship of common species of gastropods of the families Neritidae and Littorinidae to a series of physical variables, including texture, moisture content, slope angle, exposure, and zonation was analyzed using chi-square tests. Each species was found to differ in habitat preference from the other species for at least one of these variables. *Tectarius muricatus*, a littorine, was distinct from all other species in habit preference, while the three *Nerita* spp. were less clearly segregated. *Littorina ziczac* and *Echinimus nodulosus*, two littorines which were relatively unsegregated with regard to the physical variables, were found to be positively associated.

Activity patterns in *Tectarius muricatus* were examined in an attempt to relate behavioral response to distributional patterns. Results indicated that moisture level is the most critical factor involved for the initiation and termination of activity, and that combinations of other environmental stimuli are responsible for direction of motion.

*Model experiments on the releasing mechanism of cleaning behavior in the shrimp Periclimenes pedersoni*

By Patrick L. Colin, School of Marine and Atmospheric Sciences, Univ. of Miami, Miami, Florida

*Periclimenes pedersoni* exhibits cleaning behavior towards anesthetized fish, paper fish models, paper fish shapes, and paper rectangles. When satiated with food the shrimp did not exhibit any cleaning behavior towards any of the models. Food deprivation for periods greater than 24 hours lowered the selectivity of the cleaning response to models. A white paper model with inked features produced cleaning responses most often; more often than an anesthetized cardinal fish, *Apogon maculatus*. Contrast between ground color and markings was most important in releasing cleaning behavior. Movement of the model inhibited release of cleaning, and olfactory clues were not important.

*Some observations on the metabolism and growth of Thalassia testudinum König and its epibiota*

By David D. Dow, Dept. of Zoology, Univ. of Georgia, Athens

On the basis of bottom area, *Thalassia* plants were found to have a metabolic rate of 3.47 g O<sub>2</sub>/m<sup>2</sup> per day. On the basis of leaf area the *Thalassia* blades with epibiota had a metabolic rate of 2.27 g O<sub>2</sub>/m<sup>2</sup> per day, while the epibiota alone accounted for 0.18 g O<sub>2</sub>/m<sup>2</sup> per day. Enclosure experiments suggested that grazing by reef fishes and invertebrates does significantly affect the standing crop of *Thalassia* but not the blade length distribution.

*The distribution and abundance of anemones and their commensal shrimp in Discovery Bay, Jamaica*

By Catherine P. Engel, Dept. of Biological Sciences, Univ. of California, Santa Barbara

A two-week study of the distribution and abundance of the anemones and their associated shrimps was done in Discovery Bay, Jamaica. Transect surveys were made in mixed *Thalassia* (10 ft. depth), a shallow inshore shelf (1-2 ft. depth), the reef crest (1-2 ft. depth), and the back reef (2-3 ft. depth), with twenty-four 2 m<sup>2</sup> samples in each area. The anemones that were surveyed included *Bartholomea annulata*, *Stoichactis helianthis*, *Condylactis gigantea*, *Heteractis lucida*, *Lebrunia coralligena*, and a burrowing anemone (unidentified). The anemone species were most evenly ranked in the mixed *Thalassia* and the mean number of anemones per 2 m<sup>2</sup> was greatest in the reef crest sample. No shrimps were associated with *Heteractis*, *Lebrunia*, or the burrowing anemone. *Periclimenes yucatanicus* and *Periclimenes pedersoni* were found on *Bartholomea* and *Condylactis*. *Periclimenes* sp. was found only on *Stoichactis*. *Alpheus armatus* was associated with *Bartholomea*. *Thor* sp. was found with *Stoichactis* and *Bartholomea*. *Thor amboinensis* was associated with *Bartholomea*, *Condylactis*, and *Stoichactis*. *Heteromysis actiniae* was found with *Bartholomea*. The greatest number of shrimp species present was in the mixed *Thalassia* area.

The distribution and abundance of both the anemones and their shrimps were variable from one area to another. This was primarily attributed to substrate and water movement.

*Patterns of distribution of Foraminifera on Thalassia testudinum*

By Malcolm G. Erskian, Institute of Ecology & Bodega Marine Laboratory, Univ. of California, Davis

In Discovery Bay, Jamaica, the spatial distribution and density of epiphytic Foraminifera was studied. Two species of polythalamous Foraminifera, *Planorbulina* sp. (Family Planorbulinidae) and *Sorites* sp. (Family Soritidae) were found epiphytically on turtle grass, *Thalassia testudinum*. Samples were collected by removing all of the *Thalassia* in an area of 0.1 square meter. Three replicate 0.1 square meter samples were taken at a depth of 3 meters. From each 0.1 m<sup>2</sup> plots, ten whole *Thalassia* plants were chosen and each blade divided into quadrats. The number of each species of Foraminifera was recorded. A coefficient of dispersion (r) was calculated by the variance: mean ratio method. *Planorbulina* sp. and *Sorites* sp. were found to have an aggregated spatial distribution. Variance: mean ratios were found to be significantly greater than unity, except one station. Aggregation seems more pronounced in *Planorbulina* sp., r ranging from 1.4 to 2.4, than *Sorites* sp., with r ranging from 0.9 to 1.4. There seems to be a niche partitioning between species. *Planorbulina* sp. is found along the margins of the *Thalassia* blade in a higher proportion than toward the median, whereas *Sorites* sp. is found in a higher proportion in the median. The epiphytic niche increases the area of available substrate when compared to the sediment surface. *Thalassia* was found to increase the available substrate to Foraminifera by a factor of 6, producing a very high population density when compared to a unit area of sediment surface. *Planorbulina* sp. averaged over 60,000 individuals per square meter sediment surface and *Sorites* sp. over 12,000.

*A preliminary study on the toxicity of the sponge Haliclona rubens (Pallas) de Laubenfels*

By Gerardo Green-Macial, Dept. of Biological Sciences, Univ. of Southern California, Los Angeles

A high degree of toxicity was found in the sponge *Haliclona rubens*. The toxin was extracted by homogenizing 4 g of live sponge in each of the following solvents: hexane, benzene, ether, chloroform, acetone, ethanol, methanol, and distilled water. After centrifugation and evaporation of the supernatant, the extracts were tested against squirrelfishes (*Holocentrus rufus*). The behavior of the fish was observed and timed. Control experiments were run each time.

A coefficient of toxicity ( $\alpha$ ) was calculated according to the following formula:  $\alpha = \frac{xt}{y} \times 100$  where: x = weight of the toxin, y = weight of the dead fish, t = time in which death of the fish occurs. The effectiveness of the toxin and its solubility are inversely proportional to the value. In the case of *H. rubens*, the most effective solvent (lowest  $\alpha$  value) is acetone (0.28 g of acetone-toxin extract in 2 liters of sea water, killed a 53.2 g fish in 5.5 min.).

*Aspects of the biology of the bluehead wrasse Thalassoma bifasciatum*

By John B. Heiser, Dept. of Anatomy, Cornell University, Ithaca, New York

Because of its shallow water diurnal habits and non-retiring nature, the labrid genus *Thalassoma* is an appropriate organism for investigation of the morphological and behavioral adaptations that have contributed to the success of the suborder Labroidei in tropical marine shore waters. Pectoral muscular modifications, as well as extensive development of the cephalic lateralis system, correlate with observed behavior patterns. The behavioral contexts of the varied color patterns were tentatively identified and found to be rather consistent. The depth distribution was examined and thought to correlate with the environmental diversity of coralline areas, especially below 10 meters. The species is not uniformly distributed on all reef zones nor is there a uniform decline with depth, though a large percentage of the population is in water less than 30 meters. The species is an opportunistic micro-carnivore, including its cleaning behavior. Despite this latter behavior, it does not enjoy complete immunity from predation. Aggregate spawning by yellow phase fishes was repeatedly observed and analyzed into successive components. Spawning by bluehead phases was not observed but it is felt that such polymorphism may be an important key to the success of the Labroidei, many of whose members show similar patterns.

*Observations on the associations and feeding of six species of prosobranch gastropods on Anthozoans*

By Alan C. Miller, Dept. of Biology, Univ. of Oregon, Eugene

The associations and predation of prosobranch gastropods on anthozoans was studied in Discovery Bay, Jamaica. *Coralliophila abbreviata* was associated with 12 scleractinian coral species, *Ricordea florida* (Actiniaria), and *Zoanthus sociatus* (Zoanthidea). *Coralliophila caribea* was associated with 6 stony corals, 3 gorgonians, *Zoanthus florida*, and the actinarians *Rhodactis sanctithomae* and *Ricordea florida*. Two methods of feeding were observed for *Coralliophila*: the proboscis is inserted through the epidermis of corals into the gastrodermis where it is moved around; the proboscis is extended over the colony and inserted into the oral opening of an individual polyp. It could not be discerned what the *Coralliophila* were digesting, but zooxanthellae were found in the digestive tract.

*Cyphoma gibbosum* is associated with erect gorgonians. The many undigested zooxanthellae in its fecal pellets suggest that it mainly digests animal tissues.

*Heliacus cylindricus* and *H. infundibuliformis* (one individual each) were found among *Zoanthus florida* polyps. Feeding was not observed.

One *Calliostoma javanicum* (Trochidae) was found, and it consumed part of an *Agaricia agaricites* colony (scleractinian coral) in the laboratory. Its fecal pellets contained many undigested zooxanthellae and undischarged nematocysts which suggests that it might be digesting the animal tissue. This has been observed before at the Discovery Bay Marine Laboratory and is of interest since trochids are considered to be herbivores.

#### *Relationships between type of locomotion, size, and speed in larger gastropod molluscs*

By Susanne E. Miller, Dept. of Zoology, Univ. of Washington, Seattle

The speed and methods of locomotion in a wide size range of large Caribbean gastropod species were studied in order to determine the effects of absolute size on different types of locomotion. *Cittarium pica* and *Fasciolaria tulipa* move by retrograde alternate ditaxic waves of muscular contraction of the sole of the foot, *Strombus gigas* by leaping movements, and *Cassis* species apparently by ciliary action. Leaping is the fastest method of locomotion and ciliary movement is slowest in these large gastropods. Absolute speed on suitable horizontal substrates seems to increase with size over the size range of the species tested, and absolute speed on vertical or inclined substrates also increases but at a lower rate. These effects of weight on speed are most apparent in the species with ciliary locomotion and in *Fasciolaria tulipa*, in which adhesion at higher speeds is poor. Speed is inversely proportional to size in *Cittarium pica* but directly proportional to size in *Strombus gigas*. The limitations of the types of locomotion with absolute size are discussed with respect to different types of habitats.

#### *Preliminary study of six Jamaican blue crabs, genus Callinectes (Decapods: Portunidae)*

By Elliott A. Norse, Dept. of Biological Sciences, Univ. of Southern California, Los Angeles

Results of a summer study of Jamaican blue crabs are presented. Ecological separation between the six Jamaican species is discussed. Collecting localities for *Callinectes sapidus*, *C. bocourti* and *C. exasperatus* indicate that these prefer mud bottoms to sand bottoms; *C. danae* is found on both bottom types, while *C. marginatus* and *C. ornatus* are members of sandy bottom communities. *Callinectes bocourti* and *C. sapidus* males are found in fresh water rivers; *C. danae*, *C. exasperatus* and *C. sapidus* females live in estuaries and brackish bays while *C. marginatus* and *C. ornatus* are recorded from marine situations. Further separation based on feeding is proposed, with *C. exasperatus* and *C. marginatus* being able to exploit hard-bodied food organisms, while other species are not anatomically equipped to do so. An albinistic population of *Callinectes ornatus* is described in conjunction with implications on the evolutionary role of geographical isolation in speciation. Cannibalism is an important population control in *Callinectes* species. Laboratory studies of interspecific competition found males of *C. exasperatus* occupying the dominant position in shelter hierarchy while males of *C. bocourti* are more active in asserting feeding dominance in a two-species experiment. *Callinectes* species are found to be the largest and most active carnivores resident in estuarine and brackish environments on Jamaica's northern shore. Using a "Number of Features of Difference" table, a tentative phylogeny of six Jamaican and a seventh species of swimming crabs from the Pacific (Panama) is proposed. *Callinectes marginatus* and *C. exasperatus* are found to compose a closely related "species group" while *C. ornatus*, *C. danae* and *C. arcuatus* represent a second species group.

*On the biology of Ophioblennius atlanticus*

By Janet Osburn, Dept. of Zoology, Univ. of Washington, Seattle

The blenniid *Ophioblennius atlanticus* is a common shallow water shorefish inhabiting regions of primarily dead coral and cobble rock. Like many other members of its family, this species maintains a stable home range, generally about two meters in diameter. Individual fish forage over this more or less defined area in short bursts of feeding activity, biting detritus and fine algal layers from the substratum. The territory typically includes a station such as a particular rock or crack to which the fish returns between forays. Initial tagging experiments showed that when individuals were transplanted several meters from their home range, there was a tendency for them to return from such transfers.

*A study of predation on tropical holothurians at Discovery Bay, Jamaica*

By James D. Parrish, Graduate School of Oceanography, Univ. of Rhode Island, Kingston

Evidence is presented for predation on littoral holothurians by large gastropods in the lagoon behind a fringing reef at Discovery Bay, Jamaica. An observation of consumption of an *Actinopyga agassizi* by the triton *Charonia variegata* in the field was followed by observations in the laboratory of attacks by 4 specimens of *C. variegata* on 5 specimens of *A. agassizi* and by 5 specimens of *C. variegata* on 2 specimens of *Ludwigothuria mexicana*. In all, 4 *A. agassizi* and 2 *L. mexicana* were killed and eaten. There is strong evidence that *Isostichopus badiotus* is also attacked in the laboratory and in the field. The full sequence of attack and defensive behavior was observed in the laboratory. *Actinopyga agassizi* appears to release a noxious substance locally from the body surface under rather specific forms of irritation, including attack by *C. variegata*. This defense appears to be rather effective under some circumstances. Advanced hunger and periods of exposure in close proximity to the holothurian appear to give *C. variegata* sufficient resistance to the "noxin" to permit successful predation. Observations and repeated census in the field study area suggest that, based on numbers of holothurians and predaceous snails and normal range of movements, this predatory interaction may be of ecological importance.

*Larval salinity acclimatization in the tropical shore crab, Sesarma ricordi*

By Jon D. Standing, Dept. of Zoology, Univ. of California, Berkeley

Zoea of the euryhaline shore crab, *Sesarma ricordi*, from Jamaica, were collected in environments with high (36.8 ‰) and low (4.2 ‰) salinities and were subjected to ten acutely administered salinity conditions from 0 to 175‰ sea water for three days. One hundred percent of the high acclimatized zoea survived 100% S.W.; survival percentages decreased to forty-five percent at 25% S.W. and fifty-five percent at 150% S.W. By contrast, one hundred percent of the low acclimatized zoea survived the range from 10 to 100% S.W., and seventy and forty percent of the animals survived 5‰ and 150‰ S.W., respectively. More animals survive a graded salinity stress than an acute stress of the same magnitude and over the same time period. Hyperosmotic stresses in the supralittoral pool habitat of the larvae are gradual but often extremely high. Hypo-osmotic stresses after rains may be extremely low because of the inability of larvae to swim into well developed freshwater lenses (rain water tends to float as a layer on top of the salt water of the pools).