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RECENT MARINE STUDIES AT ENEWETAK ATOLL, MARSHALL ISLANDS

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This volume presents contributions of participants at the symposium on recent marine research at Enewetak Atoll, sponsored by the Mid-Pacific Research Laboratory (MPRL) and held at the December 1982 meeting of the Western Society of Naturalists in Long Beach, California. The papers fall into two categories: general research contributions, and specific results of the Enewetak Submersible Program.

As a consequence of their geographic isolation, atolls comprise effective microcosms for the study of processes less approachable in a high island or continental margin ecosystem. Enewetak is the most thoroughly studied atoll in the world. As a former atomic weapons proving ground, Enewetak has provided insight into both short- and long-term environmental responses to radiological contamination. Since the founding of the Enewetak Marine Biological Laboratory (the predecessor of MPRL) in 1954, over a thousand scientists have conducted investigations at Enewetak. Four volumes of collected reprints spanning the period between 1954 and 1979 contain 223 papers which form the foundation of our understanding of atoll ecosystems. The work described in this volume both profits from and augments research conducted at Enewetak over the past four decades.

The contents of the general research papers reflect the diversity which characterizes work performed at Enewetak. Allen et al. discuss the pharmacology of extracts from a wide range of Enewetak marine invertebrates, noting promising anti-cancer potential in 14 natural product concentrates. Boucher and Miller each focus on aspects of dynamic interactions between marine communities. Boucher's nighttime observations of coral predation by muricid gastropod swarms document an alternative mechanism to *Acanthaster*-mediated episodes of reef damage. Using data collected over a 10-year interval, Miller suggests that fluctuations in algal turf density affect physical and biological mortality factors for intertidal invertebrate populations.

Three papers address lagoon sediment environments and the redistribution of properties by bioturbation. Characteristics of bioturbating communities are discussed by Colin et al. and by Suchanek and Colin, while specific influences of *Callianassa* spp. burrowing on radionuclide distribution are presented by McMurtry et al. Additional studies carried out as described in the submersible section underscore the importance of these previously overlooked components of the lagoon ecosystem, particularly in the context of understanding long-term environmental responses to radiological contamination.

Ebert and Ford present results of a 2-year study of spiny lobster populations, concluding that the windward atoll reefs could support a modest fishery producing roughly 1 metric ton (wet weight) per year. These findings are of immediate practical significance to the recently returned native populace of Enewetak which faces the problem of subsistence in a climate of dwindling U.S. foreign aid to Micronesia. The final two papers of this section describe aspects of the behavior of gray reef sharks. Using a wet-submersible, Nelson et al. provoked a series of attacks which were recorded on film and later analyzed for behavioral components in an attempt to better understand the motivation behind attacks on humans by

these animals. In a related study, McKibben and Nelson used innovative techniques of ultrasonic telemetry to track gray reef sharks, establishing distinctive patterns of movement and grouping.

The second group of reports presents results of the Enewetak Sumersible Program. During the summer of 1981, 14 scientists from a wide variety of disciplines and home institutions participated in studies of the Enewetak lagoon floor and outer reef slope. The research submersible, MAKALI'I, operated by the Hawaii Undersea Research Laboratory and supported by the National Undersea Research Program of the National Oceanic and Atmospheric Administration, made 52 dives evenly divided between lagoon and outer reef areas. MAKALI'I is a two-man, battery-powered, one-atmosphere submersible with a maximum operating depth of 366 m. During the Enewetak program (which was the submersible's inaugural mission as a research vessel), the equipment inventory included a hydraulic manipulator and cutter; sample storage basket; low-light black and white video camera with internal monitor and VHS recorder; 35-mm still camera and strobe; environmental monitoring package for continuous recording of depth, temperature, salinity, conductivity, oxygen, and incident light; and a directional antenna and pingers. Additional equipment was designed as needed for specific work objectives.

The paper by Colin et al. summarizes the results of the outer reef slope dives and provides the first detailed information on atoll slope geological and biological zonation. Colin also reports on benthic community distribution in the lagoon, using data gathered from submersible and diver observations as well as an extensive benthic remote camera survey. Suchanek et al. draw on both observational and experimental data to point out the environmental significance of callianassid bioturbation in the lagoon floor. The contribution of algae of the genus, *Halimeda*, to the carbonate budget of the atoll is discussed in detail by Hillis-Colinvaux. Although only a fraction of the 106 species of fishes recorded by Randall in his comprehensive survey were observed from the submersible, they comprise important new records for the Marshall Islands. In the final paper, Thresher and Colin describe the Enewetak deep-reef ichthyofauna as observed on numerous submersible dives.

The list of people who have contributed to this effort is too long to allow inclusion of all their names here. Many of them are acknowledged in the individual papers of this volume, but to those whose names are omitted, I extend my apologies and my gratitude. I would particularly like to thank D. Montgomery, P. Helfrich, R. Ray, and K. Grohs for their extra assistance at crucial phases of the project. Support for the Mid-Pacific Research Laboratory was provided by the United States Department of Energy, and additional funding for the Enewetak Submersible Program was provided by the National Oceanic and Atmospheric Administration of the United States Department of Commerce, and by the Defense Nuclear Agency of the United States Department of Defense.

Regrettably, I must end with two somber notes. On 22 September 1983, research operations at the Mid-Pacific Research Laboratory ceased. High level policy decisions resulted in curtailment of funding for the laboratory, and alternative funding could not be secured. Although such events are not uncommon, the uniqueness of the facility and the progress on in-house research efforts as reported in this volume convey special significance to this loss. Fortunately, the laboratory's extensive reference collection was preserved and is presently deposited with the Bernice P. Bishop Museum in Honolulu.

Shortly before the laboratory closed its doors, Dr. D. M. Devaney was lost in

a diving accident off Hawaii. As curator of the MPRL reference collection, Dennis was a frequent and welcome visitor to Enewetak. His comprehensive professionalism is reflected in his contributions to this volume, both as a co-author and as a reviewer of preliminary manuscripts. The MPRL family is diminished by his loss, and we dedicate this volume to his abiding memory.

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