A STUDY OF THE ECOLOGY OF HAWAIIAN REEF CORALS

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN OCEANOGRAPHY

December 1972

by

James Evans Maragos

Thesis Committee

K. E. Chave, Chairman
J. Bailey-Brock
J. Caperon
R. W. Grigg
E. D. Stroup
S. J. Townsley

ABSTRACT

A field study of the ecology of Hawaiian reef corals was carried out in a large embayment, Kaneohe Bay, off the windward coast of Oahu, Hawaii. The main purpose of the study was to assess the importance of physical factors in regulating the growth, survival, and other responses of reef corals. Surveys of reefs were conducted to determine the abundance and distribution of corals. Coral specimens of six species were transplanted to twenty-five localities within Kaneohe Bay. Information on growth rate, survival, growth form modification, and pigments were gathered during a year-long period following transplantation. Comprehensive information on water properties, substrate composition, and weather conditions were also acquired at each of the locations.

Corals are most abundant on protected reef margins in the northern lagoon of the Bay. A branching coral, Porites compressa, is much more abundant than all other corals combined. Reef flat and lagoon floor habitats are usually devoid of corals. Coral coverage attenuates on reefs nearer the sewer outfalls located in the south lagoon. On wave exposed reefs coral abundance is lower, diversity higher, and species composition different from those of non-polluted regions of the lagoon. Sediment cover is usually high on reef substrates where corals are rare or absent.

Results of growth studies suggested that moderate sized corals accelerate their weight growth rate with time, but increase their linear dimensions at a rate independent of size. Transplanted corals

also grew more slowly during winter months.

Regression analysis revealed a variety of physical factors to be highly correlated to coral growth. Pocillopora appears to be strongly light dependent. Montipora showed higher growth rates at moderately lower salinities. Growth responses of Porites were related to water circulation factors. Fungia grew fastest on reef areas removed from the sewer outfalls.

Correlation of physical factors to coral survival data showed similar trends. In addition, variables related to sewage discharge showed high inverse correlation to survival rates for all of the transplant species except Montipora.

Competition for substrate by benthic algae severely restrict coral survival and abundance in certain areas of the lagoon.

The transplant studies revealed that growth form variation within a species is in part controlled by environmental conditions. Some species, especially Montipora verrucosa, displayed a remarkable capacity to modify their growth form after transplantation to new habitats.

Analysis of zooxanthella pigment samples from transplanted corals at the end of the study showed photosynthetic pigment concentrations were reduced in specimens from shallow water habitats, and this effect was confirmed in other pigment studies on corals from the Marshall Islands. An unidentified ultra-violet light-absorbing pigment was more concentrated in corals taken from shallow water. These observations suggest photosynthetic pigment development is

inhibited by higher light intensities in shallow water.

A scheme describing the ecological succession of Hawaiian corals was devised, based upon results of the transplant studies and other past information on the corals.

Comparison of the growth rates of individual species revealed that branching corals occupy more space per unit time than massive corals. The more common species also grew much faster than the rarer species.

The Hawaiian Islands have a reduced coral fauna and a poorly developed reef compared to those of more tropical areas. Corals grow slower in Hawaii compared to similar ones studied at Samoa. Sub-optimum environmental conditions appear to explain the impoverished nature of Hawaiian coral development.

Some of the physical factors controlling abundance, growth, and survival of corals in Kaneohe Bay are the result of recent urbanization in the surrounding watershed. Dredging activities, sedimentation, and sewage discharge have destroyed 80% of the reef coral communities in the lagoon.