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Source: *Ecological Monographs*, Vol. 30, No. 1 (Jan., 1960), pp. 65-127.

Published by: Ecological Society of America

# ECOLOGICAL RELATIONSHIPS OF THE FISH FAUNA ON CORAL REEFS OF THE MARSHALL ISLANDS[1]

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## INTRODUCTION

The greatly increased attention paid to scientific aspects of the central Pacific by American scientists following the close of World War II brought sharply into focus our exceedingly meager knowledge of this region. Problems faced by administrators of the newly created Trust Territory of the Pacific, and by those responsible for maximum safety during and after atomic weapons testing operations stimulated many studies of this vast portion of the globe, of which the study reported here was a part. Significant marine problems such as the nature and distribution of the poisonous fishes of the tropical Pacific islands, the effect of nuclear explosions and radioactive con-

[1] Contribution No. 128, Hawaii Marine Laboratory, University of Hawaii.

tamination from weapons testing, and the possibility of commercial sources of marine food products required a thorough knowledge of the nature, extent, and community relationships of the marine fauna and flora. More significant, perhaps, in the long run will be the opportunity for learning more about the optima for utilizing sunlight and raw materials in this relatively isolated, but complex, ecosystem which apparently fluctuates in composition very little, if at all, from year to year, and has over a long period of time acquired a biota successfully adjusted competitively in the relatively constant environment of the tropical west-central Pacific Ocean. It has already been realized by Odum & Odum (1955) that important information might be secured on the relationship between organic productivity, energetic efficiency, and the standing crop structure of such coral reef communities. Moreover, the answers as to how steady state equilibria, such as the reef ecosystem, are self adjusted may be more easily revealed by more critical, comprehensive examination.

To reach reasonable interpretations of the energetics of production and utilization it is necessary, among other things, to determine the relationship between the standing crop, defined as the biomass of existing organisms per unit area, and productivity, defined as the rate of manufacture of this biomass per unit area (Odum 1953). Odum & Pinkerton (1955) indicate that, on a theoretical basis, systems of many types when in open steady state tend to adjust to maximum output of energy consistent with available input energy and a correspondingly low but optimum efficiency. Therefore, if the apparently steady state coral reef ecosystems tend to be similarly self adjusted regarding efficiency of energy utilization between trophic levels, and if the biota remains rather constant in composition as it certainly seems to do, then the pyramids of biomass should be roughly proportional to the standing crop for a particular coral reef area. It becomes paramount in importance, therefore, not only to know the taxonomic composition of the biota of reef areas under intensive study, but to have a rather clear concept of the biotic interaction of the species present to categorize them in proper trophic levels, and to know the community relationships in the various physiographic environments characteristic of the coral reef biotope. The importance of the type of information embodied in this paper may best be illustrated by the following statement made by Odum & Odum (1955), "Although the trophic relationships of most of the higher organisms on the reef are very imperfectly known, an attempt has nevertheless been made to make rough groupings by trophic level as to herbivores, carnivores, and decomposers."

## Previous Research

Although numerous workers have reported on the feeding habits of Pacific fishes, only two authors report in any comprehensive manner and neither makes any attempt to express his results as meaningful ecological aspects. In a very painstaking study of the digestive system and feeding habits of fishes of Japan, Suyehiro (1942) provided far more information on these subjects than had theretofore been available. Moreover, he included an extensive review of the literature which now makes it unnecessary to discuss this matter for the period preceding his publication. Suyehiro based his study on 88 families, 132 genera, and 150 species, providing a firm basis for many of the central Pacific families and genera. Only a few species reported by Suyehiro reach the central Pacific area. Al=Hussaini (1947) reported on a similar study of some 60 species in the vicinity of the Marine Biological Station at Ghardaqa, Red Sea, and included many of the widespread Indo-Pacific types. Randall (1955) reported on the fishes of the Gilbert Islands and included notes on food habits for a few of the specimens collected. Only two papers dealing with the Indo-Pacific fish fauna (Hiatt 1947a, 1947b), and these dealing with a special type of ecosystem, have approached the problem of food and feeding habits of fishes from the point of view of biotic interaction. Scattered accounts of feeding habits of Pacific fishes occur incidentally in other papers, and these will be mentioned in the species accounts where pertinent.

## Scope of the Present Study

Reported herein are accounts of the food and feeding habits and ecological relationships of 56 families of Marshallese fishes, covering 127 genera and 233 species. Some idea of the completeness of coverage of the study may be gained from the fact that in the Marshall Islands there are about 225 genera and about 600 species of fish. We have examined therefore somewhat more than half of the genera and slightly less than half of the species known to be present. Because the Marshallese fauna is part of the widespread Indo-Pacific faunal complex, the significance and applicability of this study extends a great deal further than the west-central Pacific Ocean islands.

The study was initiated at Bikini Atoll in the summer of 1947, as part of the Bikini Scientific Resurvey to determine what changes had resulted, if any, from Operations Crossroads, continued at Arno Atoll during the summer of 1950 as part of the Coral Atoll Project of the Pacific Science Board, and completed at Eniwetok Atoll during the summer of 1955 as part of the regular studies being carried out at the U. S. Atomic Energy Commission's Eniwetok Marine Biological Laboratory. The total number of individual fish stomachs examined was 2,051, of which 209 were examined at Bikini, 1,185 at Arno, and 657 at Eniwetok.

A systematic list of the families, genera, and species covered by this food study follows, and a few species, not examined for food, are cited elsewhere in the text.