ATOLL RESEARCH BULLETIN

Published by

PACIFIC SCIENCE BOARD

National Research Council

Washington, D.C.

October 15, 1951

MARINE ZOOLOGY STUDY OF ARNO ATOLL, MARSHALL ISLANDS

SCIENTIFIC INVESTIGATIONS IN MICRONESIA

Pacific Science Board

National Research Council

Robert W. Hiatt, assisted by
Conald Strasburg
University of Hawaii
Honolulu, Hawaii
December 1950.

ACKNOWLEDGMENTS

The author of this report was a participant in the 1950 SIM (Scientific Investigations in Micronesia) Project of the Pacific Science Board of the National Research Council, and this report covers field work for the period 13 June - 12 September, 1950. This project is supported by funds granted to the National Academy of Sciences by the Office of Naval Research, and the field work was carried out with the active assistance of the Navy Department, the Military Air Transport Service, and the officials of the Civil Administrative Staff of the Trust Territory (Navy).

Especially helpful in numerous ways were Commander Kenney, Ensign Dodds and Mr. Ben Kessler on Majuro, and Commander Avila on Kwajalein. The many ways in which Miss Ernestine Akers, Honolulu secretary of the Pacific Science Board, assisted in arranging for this project were greatly appreciated by the entire personnel.

The University of Hawaii through its Pacific Islands Research Fund provided generously for all the equipment and supplies for several members of the group, and is now providing technical help in working up the mass of data accumulated at Arno.

To all of the above who contributed to making the research described in this report possible I wish to express my gratitude and appreciation.

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS	i
NATIVE USES OF MARINE PRODUCTS	1
Subsistence or Food Resources	1
Species Used	1
Catch Statistics	2
Methods of collecting and fishing	2
Methods of preparation of marine products	6
Use of marine products as fertilizers for agricultural crops	6
Use of marine products as food for domestic animals	6
Tuna baitfish resources	6
Poisonous species	7
Use of uninhabited islets as a source of marine products	7
Importance of marine products from the reefs and lagoon as compared with the oceanic realm	8
Implement and Ornamental Resources	8
Sponges	8
Shell Jewelry	8
Other uses of shells	8
SURVEY OF ECONOMICALLY IMPORTANT MARINE RESOURCES	9
Fish	10
Turtles	11
Invertebrates	12
Plant Resources	13
GENERAL IMPRESSIONS	13

NATIVE USES OF MARINE PRODUCTS

Subsistence or Food Resources

Species Used

Approximately 175 species of fish and invertebrates are used for food by the Arnoese. The exact total may reach 200, but the most important species involved are included in the 175 which were seen and identified both by their scientific name and by the local Marshallese name. Frequently, differences between Radak and Ralik names were noted, so to avoid confusion a policy was established to adhere only to the Radak name. Lists of these species will be presented in the technical reports.

Very few of the species used are of seasonal occurence. This results, in part, from the nearly total lack of fishing for pelagic fish with migratory habits such as the tunas and spearfishes. The fish and invertebrates usually taken are present in the lagoon throughout the year, although lunar phases, tides and spawning season do influence fishing activity for certain species.

There is a surprising lack of conservation measures and tabus relating to the marine species. In times past certain fishes, e.g., the mole (Siganus rostratus) were reserved for the iroij, but such practices have been largely discontinued, except for certain choice parts of some fish. No seasonal restrictions or minimum size limits are invoked. The absence of such restrictions most certainly stems from the abundance of food fishes available.

No species are reserved for special occasions, although the fishing methods involved preparatory to a large community celebration largely determine the species which will be caught and consumed. In general, it

appears that "occasions" arise following a very successful fishing operation, rather than before the fishing activity.

Catch statistics

As was noted in the initial Field Progress Report, catch statistics as such are impossible to secure because fishing is a family enterprise and is not entered into commercially on Arno Atoll. The only opportunity for determining the catch was to keep several typical families under observation to ascertain the amount of sea food consumed per person. Data of this sort are extremely difficult to secure because of the variable fishing activity between families and with time, coupled with the fact that interviews on such subjects are far from satisfactory. Some data are available from the Anthropologists of this Project who lived for periods with native families. The data available will be set forth in the technical report. It suffices here to mention that fish is, in general, a staple food item, and, if available, is eaten at every meal. The consumption of sea food probably averages one pound per day for each person.

Methods of collecting and fishing

The fin fishery on the lagoon reef is by far the most important to the Arnoese. A rather complete description of all the gear and its use has been compiled for inclusion in the technical reports.

Stone traps erected on the lagoon reef or on reef passes between islands are frequently met. The position and construction of each trap is designed for certain fish species. Their production varies from place to place, but in general the traps are very successful. The village of

Lōnar, for example, maintains a series of five traps which supply the population of 50 to 60 persons with all the fish needed.

Wooden stick traps of the type used generally throughout Micronesia are set out on the reefs by individual families.

Aside from its use in throw nets, flying fish nets, the square ukonjabuk net and bonbon net, regular cord netting is seldom used. Most of the seining methods are accomplished with coconut fronds built into leaf sweeps of various kinds and dimensions. Seven different methods of using leaf sweeps were recorded in detail, and the chief fishes taken with each have been listed. Some trolling for tunas and carangid fishes is done with wooden plugs to which chicken feathers are tied so as to resemble the common feather jig used by sportfishermen. In times past trolling lures were fashioned from the shell of the pearl oyster, but this is virtually a lost art; only a few of the old Arnoese remember how to make these lures. One built on our request will be described in detail in the technical report.

Many Arnoese are excellent spear fishermen and this method is one of the chief ones employed to provide fish for individual families. Spearing is done on both the seaward and lagoon reefs. Unlike American spears which are barbed and shot from an air gun or a rubber sling, the Arnoese spears are barbless and have firmly attached, slim wooden handles with a short rubber sling fastened to the handle. A long spear about 12 feet in length, a shorter spear about 6 feet in length, and a long gaff about 4 feet in length are carried by each spear fisherman.

Fishing poles made of wood from the Premna corymbosa tree are used without reels. The short line is attached to the tip of the pole. These

are used at the edges of channels and at the outer edge of the reef where the line can be let down into deeper water. Most hook and line fishing is done from small paddling outrigger canoes, usually at the outer edge of the lagoon reef or over coral mounds rising near the surface from the lagoon floor.

Other fishing methods to be described in the technical reports include the ikaidrik (for Elegatis bipinnulatus), the jibke (for porpoise), the jaibo (for huge sipunculid worms), the erdroe (hand groping), the kaikikit (groping with a stick), the kawōr (treading), the kabwil (treading at night with a torch) and fish poisoning in muddy swamps by hydrogen sulphide and by the crushed fruit of the Barringtonia tree.

Except for fish hooks and some twine all the gear used in fishing is hand made by the Arnoese. A real lack in present fishing supplies is twine for fishing lines and for weaving nets. No special fishing vessels are used at Arno. The small paddle canoes are essentially just hand line boats, whereas, the larger sailing canoes are chiefly for transportation, with fishing operations secondary in importance. While many canoes are in operation on Arno, they are in short supply. Lumber from breadfruit trees and skilled canoe builders are not plentiful.

It was not possible to ascertain the catch per unit of effort because the time spent in fishing and the fishing trips were very erratic.

The fin fishery in the ocean is relatively unimportant to the Arnoese. Some trolling for tunas and some fishing for flying fish is done, but the total catch is insignificant.

There is no sea turtle fishery on Arno. The Green Sea Turtle is not common and the catch at infrequent intervals occurs by chance. A few

turtles have been seen to deposit eggs on the sandy beaches, but the observations are rare.

Among the invertebrate fisheries the molluscan species are the most important to the Arnoese. Certain gastropods of the families Strombidae, Turbinidae, and Neritidae are sought for food while cowries (Cypraeidae) are collected for the making of jewelry and for other ornamental purposes. Among the pelecypods the most important is Asaphis deflorata which is esteemed as food, and the shell makes a most useful scraper for various activities in the preparation of food. The giant clams (Tridacnidae) are not used extensively for food, but the small attached species Tridacna crocea and T. elongata are frequently gathered to fertilize the breadfruit trees. Native opinion on the use of the giant clams indicates that they are less desirable than fish for the table, and that the abundance of agricultural crops (breadfruit, etc.) at Arno makes it unnecessary to exploit all available subsistence resources on the reefs.

Land crabs, both brachyuran and the anomuran, Birgus latro, are caught and eaten frequently. An intensive study of the ecology of land crabs was made and will be presented in the technical report.

Holothurians are not used at Arno for any purpose although the reefs, typical of the tropics, abound with many species. The tremendous population density of Holothuria cinarescens on the lagoon reefs was investigated in detail and will form the subject of a special technical report.

No use whatever is made of the algae on the reefs. Unlike Polynesians, the Micronesians do not consume sea weeds, nor do they use it as fertilizer.

Methods of preparation of marine products

The methods of handling various food fishes for immediate consumption or for storage were recorded in detail. Large tunas and porpoises are butchered according to a stereotyped plan, the various cuts are given names, and the iroij portions are designated. A ll these observations will be described in considerable detail. Of note is the fact that the porpoise caught at Arno may well be a new species according to preliminary reports from Dr. David Johnson of the U. S. National Museum. The author has furnished photographs and ecological notes to Dr. Johnson. No marine species are prepared for export.

Use of marine products as fertilizers for agricultural crops

The only marine organisms used for fertilizer are the two small species of giant clams, T. crocea and T. elongata. These are used to fertilize breadfruit trees; the methods will be detailed in the technical report.

Use of marine products as food for domestic animals

The sole uses of marine products to feed domestic animals are fish for dog food and ghost crabs (Ocypode) which are fed to sows to increase lactation.

Tuna baitfish resources

Since baitfish resources may become the most significant marine income item to natives on atolls, a thorough survey was made of the baitfish available. Data were gathered on species present, population density, distribution about the atoll, ecology, and length frequencies. Several large

schools of dusumierids and clupeids were poisoned so that an examination of the reproductive condition, food habits and length frequencies could be ascertained. It may be stated here that baitfish resources are relatively great at Arno Atoll. Schools were frequently encountered which would supply up to 200 scoops of bait.

Poisonous species

Through interviews with natives approximately 15 species of fish were found to be poisonous. These included many of the fishes known to be poisonous in tropical waters such as Ctenochaetus strigosus, several species of Tetraodon, Canthigaster and Diodon, some scorpaeonids, Synancea verrucosa, Pterois, certain muraenid eels, and certain balistids. No seasonal differences in poisonous properties was apparent, but certain species poison on one side of the atoll were not poison on the other.

Use of uninhabited islets as a source of marine products

General observations showed that natives did not venture far away from their home island to fish, and the fish populations, as seen during long periods of skin diving with face plates, along the shores of uninhabited islets were definitely greater. It was apparent that the fish populations around inhabited islets, although sparser than around uninhabited islets, were still adequate to provide the necessary food fish in the time available for fishing. Thus, it is not necessary for the natives to go to uninhabited islets to fish. The fish resources around these uninhabited islets are definitely under-exploited.

Importance of marine products from the reefs and lagoon as compared with the oceanic realm

As stated previously, the reefs and lagoon produce virtually all the marine products utilized. The paucity of passes through the reefs, the location of all dwellings along the quiet lagoon shore and the distribution of canoes on the lagoon beaches preclude any extensive use of oceanic waters.

Implement and Ornamental Resources

Sponges

Sponges of commercial types are scarce at Arno, and, except for limited household use by the natives, are not harvested.

Shell jewelry

The Arnoese have never made shell jewelry for export. Some cowries were collected by parties of Japanese during the Mandate for use in jewelry, but no commercial exploitation occurred.

Other uses of shells

The use of pearl oyster shells for fishing lures has been mentioned previously. The shell of the pelecypod, Asaphis deflorata, is used as a scraper for many household uses, viz., scraping charcoal from baked breadfruit, scraping soft coconut meat from drinking nuts, and scraping bark off mangrove sprouts for the preparation of dye. The shell of the helmet conch, Cassis cornuta, is used as a scraper for cooked Pandanus fruit on a device termed the beka.

No shells have ever been exported from Arno for commercial purposes.

SURVEY OF ECONOMICALLY IMPORTANT MARINE RESOURCES

Rather than make a very general survey of the resources over the entire atoll, our study was concentrated in a small area typical of much of the atoll so that a thorough ecological account of life on an atoll might be obtained. Coincident with the detailed observations, a few field trips were taken to other important areas to view the resources and to discuss them with the inhabitants. Thus, a fundamental basis for comparison of other areas visited with our intensively studied area was afforded. For this purpose three transects were laid out, one across the sea reef, another across the lagoon reef and a third across Ine Island from the sea beach to the lagoon beach. Plots were marked off at 50 foot intervals on the sea reef and 100 foot intervals on the lagoon reef and across the land. Thorough collections of the animals present in each plot were made. Temperature and salinity were determined for each section under varied conditions, and the contours of the reef and coral tops were measured. The fish present in each section were collected by poisoning with rotenone so that a quantitative study of their abundance and distribution in relation to environmental factors could be made.

Species of corals present were collected and estimates of their abundance were made for each section. Drawings of these transects have been made showing the type and distribution of dominant corals present in each section. The vegetative cover and surface contours have been drawn for the land transect to show the ecological features significant in the ecology of land crabs.

Fish

As this report is written 310 species of fish have been identified and several additional species will result from more detailed examination of a few of the more difficult families. One or more specimens of each species collected has been returned to Honolulu for subsequent check on identifications and for use as a named collection to aid subsequent studies in the Trust Territory. This collection combined with the duplicates of fish species taken during Operation Crossroads at Bikini which were sent to the University by the United States National Museum and the collections made throughout the Hawaiian and Line Islands by staff members of the University and of the Pacific Oceanic Fishery Investigations provide what is probably the best fish collections for the Central Pacific. These collections will be made available to any qualified scientist working in the area. The 310 species now listed represent 60 families (following the classification of Berg). A total of 1197 fish representing 146 species were examined for their food and feeding habits. These data will provide the most comprehensive account of biotic interaction on a coral reef yet made. The gonadal development was noted on all fish opened for stomach examination. Thus, for approximately 1200 fish we have records on their standard length, sex, and gonadal development. Such data will be of great importance in estimating reproductive seasons and the age and size at maturity for fish in this latitude.

Considerable information on larval and juvenile development of reef fishes was obtained. Several series showing growth and pattern metamorphosis were taken, preserved and returned for study. For each species ecological notes were recorded to indicate its niche in the biocoenosis,

its preferred habitat, and its behavior patterns. Careful notes were taken on aggregating habits of many species.

Except for certain species of clupeids and atherinids suitable for tuna baitfish, no other food fishes were taken in sufficient abundance to afford analyses by length frequencies. Consequently, the effects of fishing on the size and age structure and abundance of most species was not obtained. However, all species commonly utilized for food were present in abundance and in all size ranges known for the species. It is apparent from these observations that fishing intensity at Arno is not affecting the structure of fish populations in any way. Generally speaking all food fishes are being underfished rather than overfished and the reef and lagoon fisheries could be increased several fold without decreasing the yield per unit of fishing effort.

For the baitfish, Stolephorus delicatulus, Harengula ovalis and Atherina ovalaua, several large collections were made with rotenone so that length frequencies could be studied. From these data we are able to indicate the age groups in the population, the size range available in a baitfishery so that mesh sizes may be computed, and the abundance and location of the bait. These data are of great importance to any contemplated tuna exploration in the Central Pacific.

Turtles

The green sea turtle (Chelonia mydas L.) was the only species observed at Arno and this species is too scarce to be of any importance commercially or otherwise. The hawkshill turtle, Eretmochelys imbricata L., undoubtedly occurs at Arno but it is rarer than the green turtle.

There is no fishery for turtles, although the natives frequently catch them in the stone fish traps.

Invertebrates

Invertebrates of importance to the natives have been listed previously in this report. Plans had been laid to analyze species of the giant clams for size and age for the purpose of evaluating the effects of fishing on them. However, it was discovered that the most abundant species in the Northern Marshalls, Hippopus hippopus, was not common at Arno, while the larger species Tridacna squamosus and T. gigas were rare or, as in the latter case, not present at all. Such anomalies in the distribution of such common species which occur so abundantly both north and south of Arno Atoll are inexplicable at present. Thus, one of the significant differences between natives of the Northern and Southern Marshalls is the great dependence upon these clams in the north and the almost total disregard of them in the south.

Spiny lobsters (Panulirus penicillatus and P. japonicus) are present in considerable quantity on both the seaward and lagoon reefs. Frequent fishing trips are made, usually at night with a torch, to secure these lobsters. Many young lobsters were observed in small holes in coral heads.

Perhaps the most frequently sought marine invertebrate is the "leked" (Canarum luhuanum luhuanum) a gastropod belonging to the family Strombidae. These occur on the lagoon reefs by the thousands, and at each low neap tide the women and children flock onto the reef to collect them. In spite of what appears to be one of the most intensive of all the native fisheries, these gastropods seem to withstand the fishing mortality.

Plant resources

Like most coral reefs, the algae is sparse except for the Lithothamnium at the windward reef edges. Toward shore on the wide windward lagoon reefs algae grows more abundantly than elsewhere. The Arnoese make absolutely no use of the algae as either food or fertilizer.

General Impressions

The reefs and lagoon of Arno Atoll are exceedingly productive of organisms. In general the fauna and flora resembles other coral atolls of the Central Pacific, but certain differences are striking. While the author believes that studies on one atoll may serve as a sound basis for regulations on and interpretations of others, it is certainly obvious that real and important differences do exist. Causes of such differences are not readily apparent, but detailed studies on ocean currents, upwelling, and life histories of organisms will shed much light on variations in species and population densities and overall productivity. In selecting sites for future programs of investigation it would be well to choose areas in different oceanic environments so that they may be compared with previous studies in regions of different environmental conditions. Such comparisons may enable one to associate variations with known environmental differences. Once these differences were related to environmental changes, generalizations for all atolls within certain defined environmental conditions could be made.

The marine environment at Arno is of great importance to the people but it is underutilized by the present population. This is a significant fact because Arno is considered to be a heavily populated atoll. Should the present level of population be the result of natural forces rather than that imposed by unnatural phenomena, viz., birth control, disease, emigration, etc., it is not the supply of marine resources which exerts the regulatory effect.