ATOLL RESEARCH BULLETIN

No. 13

Preliminary Report on Marine Biology Study of Onotoa Atoll, Gilbert Islands

Part I

by A. H. Banner

Part II

by John E. Randall

Issued by

THE PACIFIC SCIENCE BOARD

National Academy of Sciences---National Research Council

Washington, D. C.

December 15, 1952

PRELIMINARY REPORT ON MARINE BIOLOGY STUDY OF ONOTOA ATOLL, GILBERT ISLANDS

SCIENTIFIC INVESTIGATIONS IN MICRONESIA

Pacific Science Board

National Research Council

Part I — Dr. A. H. Banner
University of Hawaii
Honolulu, Hawaii
February 20, 1952

Part II — Mr. John E. Randall
University of Hawaii
Honolulu, Hawaii
March 4, 1952

ACKNOWLEDGMENTS

This field work was carried on in connection with the Coral Atoll Project of the Pacific Science Board of the National Research Council and was supported by funds granted to the National Academy of Sciences from the Office of Naval Research.

Generous cooperation was received from the Military Air Transport Service and the United States Coast Guard in assisting with transportation, the University of Hawaii in supplying much needed equipment, the administrative officials of the Gilbert and Ellice Islands Colony. The author is particularly grateful for the assistance extended by Miss Ernestine Akers and Mr. Harold J. Coolidge of the Pacific Science Board.

Thanks are also due to Dr. Preston E. Cloud, Jr., the leader of the expedition, for the use of the map he made of the island, and to R. Tucker Abbott of the U. S. National Museum for the identification of some of the molluscs.

PREFACE

The marine biological work on Onotoa is divisible into five portions:

1. The investigation of shallow water ecological associations, reported herein:
   A. The ecology of the windward reef.
   B. The ecology of the lagoon reefs and shores.
2. The investigation of the deeper water ecological associations, to be reported by Dr. Preston E. Cloud, Jr.
3. The investigation of the marine algae, to be reported by Dr. Edwin Moul.
4. The investigation of the ichthyofauna, reported by Mr. John Randall and appended to this report.
5. The native use of the marine invertebrates for food, reported herein.

My portion of the study, the marine invertebrates, was severely limited by an attack of blood poisoning and a subsequent attack of influenza that resulted from attempting to do field work when not fully recovered from the first illness; as a result of these two illnesses, over five of the ten weeks spent on Onotoa were lost and the investigations made were neither as thorough nor as extensive as planned.

The following reports are preliminary, and should be taken to show merely the extent of the work done. The identifications are field identifications and must be confirmed by experts, with the exception of some of the molluscs which have already been identified by R. Tucker Abbott of the U. S. National Museum; and no conclusions are incorporated in the reports. When these reports are published the deficiencies will be corrected.

PART I

I

WINDWARD REEF TRANSECT

The windward reef on Onotoa is found along the northern, eastern and southern shores of the atoll, presenting an almost unbroken barricade against the force of the prevailing waves. It varies in width from three or four hundred feet to over a quarter of a mile and is more extensively developed around the southern island than around the northern. As it is of quite uniform height, structure and biotic zones, a single transect across its surface was deemed to be indicative of the general ecology of the reef.

Conditions of the Reef

The inshore border of the reef is composed either of consolidated and eroded coral rock or moderately fine sand with the upper edge extending to the maximum height of the storm waves and the lower edge varying but usually about the 2.0 to 2.5 foot tide level. Beyond this steep shoreward area the reef flat extends to a uniform area of slight slope, with frequent small to large shallow pools of water left at low tide. The reef flat in the transect studied was 650 feet broad. Seaward of the reef flat is a depression, the back-ridge trough, between 50 and 100 feet wide and ranging in depth from about the + 0.2 to the - 1.5 foot tidal level. The final edge of the reef is the coralline ridge (or Lithothamnion ridge by previous workers), a rampart between 1.0 and 2.0 feet above the zero tide and 50 - 100 feet broad. Its shoreward edge presents an almost continuous front of reddish coralline algae, but on its seaward side soon develop deep fissures or surge channels at right angles to the shore that reach six or more feet below the surface of the reef and that are of varying width, widening as they reach seaward. The seaward edge of the coralline ridge thus separates into a series of

separate and depressed fingers that finally slope rapidly down to the growing reef surface below. The outermost reef or the reef shelf is relatively narrow, about three hundred feet wide, and slopes rather rapidly from about ten feet deep on the shoreward side to over thirty or thirty five feet deep on the seaward side; it consists of living coral growing in irregular mounds with areas between the heads strewn with dead coral fragments. Beyond this reef shelf the bottom drops suddenly away, at a slope of perhaps more than 45° and soon disappears in the turbid waters; this last zone was not explored at all.

The windward reef facing the trade winds sustains the almost continuous beating of the waves. At low tide the waves are broken against the coralline ridge and only slight waves are felt in the backridge trough. However, when the tide is high, only a portion of the strong waves is expended against the coralline ridge and the adjacent trough and moderate sized waves sweep across the reef flat, carrying enough energy to move coral rocks a foot or two in diameter.

The reef flat from the coralline ridge back is the evident result of the consolidation of a living coral reef, chiefly of Heliopora, by coralline algae; in almost all areas the old Heliopora is completely dead and covered with the algae to make an almost table-like top. This top, however, is pitted with small to large depressions, and in many areas perforated by burrows leading down among the old coral fronds.

Animals living upon the flat are subjected to many biological vicissitudes in addition to the action of waves. In the inshore area especially the reef flat is exposed to the air for several hours at a time at the lower low waters, and those animals that cannot migrate to the shallow pools must be able to withstand this period of dessication. Those animals in the pools, as well as those exposed to the air must also be able to withstand great changes in

salinity of their environment, for the high tide has the normal ocean salinity, while the low tide may expose them to torrential rains which would lower the salinity of the topmost layers at least to almost zero. However, because of the difference in specific gravity and the absence of agitation in these small bodies of water it is likely that the bottoms of the pools and the burrows in the rock especially maintain their normal salinity.

Probably the most pronounced physical change the animals are subjected to is the change in temperature for the dark reef surface on low tides is exposed for long periods to the tropical sun. At these times the water in the inshore pools become hot to the touch (studies on temperature made by Strasburg will be reported by Cloud): yet with the flooding tide the temperature will drop perhaps 15° in a few minutes.

Previous studies have shown that the oxygen content of the water over the reef at high tide and in the pools at low tide is always near if not above its saturation value. But as the temperature rises this saturation value, in grams of oxygen per liter of sea water, decreases rapidly, so the reef inhabitants must be able to adjust to less than normal oxygen.

Two biological conditions of the reef flat should be mentioned as influencing its ecology. In the first place the reef surface not in the small tide pools is covered in most areas by a dense algal mat that affords both food and protection for the inhabitants; this was particularly true in the middle and outer portions of the reef flat. Secondly, while few larger predators and scavengers like larger fish, lobster and crabs were found while the survey was conducted at low tide, they moved onto the reef at high tide.

Methods and Limitations of the Study:

The objects of the investigation were to find the transition of dominant forms over the reef surface, and, if possible, to designate sharply delimited

zones on the reef through a quantitative study.

On the main reef flat the study was conducted by laying out a series of continuous stations, twenty feet wide and fifty feet long, and within them areas extending the length of the station one or two feet wide. Within the smaller area all animals were collected and counted; the larger area was then inspected for larger but less common animals like the larger snails, sea cucumbers, etc. Then areas in the same tidal zone adjacent to the studied area were superficially examined to see if the zone selected was typical; it was found so in all cases.

In the inshore beach area, in the backridge trough, and over the offshore shelf no quantitative study was attempted because of difficulty in obtaining either enough animals in a typical area or because of the difficulty in laying out an area for study and collecting it (as in twenty to thirty feet of water). Because of poor tides and poor weather conditions when it was possible for me to do field work, almost no study was made on the coralline ridge at all.

The limitations of the study are:

1. The study is limited to macroscopic invertebrates; no microscopic forms of life nor any fish are considered. Mr. Randall did a parallel study on fish and will report it separately.

2. Concerned as it is with the dominant animals, this study omits the more rare animals.

3. All identifications of animals are but field identifications, and will be corrected upon the identification by experts.

4. The study is limited by necessity to the more superficially occurring animals; it was impossible to explore the tubes reaching down from the consolidated surface of the reef.

5. No statistical checks have been applied to the quantitative results, and they should be accepted merely as rough indications rather than accurate statistics; in other words, a similar section two hundred feet away might give different figures, but would show the same trend.

Transect

Area A-0; Shoreward beach.

The well-demarked beach extends from about 2.5 feet to about 8-10 feet above the zero tide zone. It is divisible into two different habitats, the sand beach composed of loose and shifting sand, and the rock beach consisting of consolidated coral and beach rock, eroded and with some small tidal pools.

The sand beach is the habitat only for Ocypode ceratophthalma, the "ghost crab" that lives in deep burrows by day; also at night terrestrial hermit crabs migrate down to the upper zones of the beach.

The rock beach is inhabited by Grapsus grapsus in fair numbers, some identified hermit crabs, and large numbers of *Nerita plicata (species marked * indicates the identification has been confirmed by R. Tucker Abbott.)

Areas A-1 to A-14.

These stations covered the reef-flat and present roughly the same type of substrate. The surface is relatively smooth, being built up by the consolidation of the individual heads and fronds of coral by coralline algae. Its surface is pitted with small shallow depressions in which water stands at low tide; these are usually less than a square foot in area and not over about three inches deep. The exposed surface of the coral and in some areas the tidal pools, are usually covered with a more or less dense growth of algae (to be reported by Dr. Moul). The exceptions to these generalizations are in the back-ridge trough (areas A-13 and A-14) where the surface is below the level of the lowest tides. Areas A-7 and A-8 and A-9 were at least in part covered by a single extensive tide pool; in these areas a few living pieces of Heliopora were still growing uncovered by coralline algae.

TRANSECT, WINDWARD REEF FLAT

Stations A-1 to A-14

In the tabulations below those animals not quantitatively estimated and those animals that are rare, scattered or very irregular in their occurrence (as would be those found only in the occasional loose coral boulders) are indicated by P for present.

Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Distance from beach	0-50	50-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450	450-500	500-550	550-600	600-650	650-700
Height above 0.0 tide zone	2.4	2.2	2.0	1.8	1.6	1.4	1.2	1.0	1.0	0.8	0.6	0.4	0.4 to -0.2	-0.2 to -1.4
Approximate percentage covered by tidal pools.	70%	30%	30%	50%	30%	30%	80%	100%	90%	70%	80%	70%	20%	100%

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PORIFERA														
Black Sponge	-	-	-	-	1	80	20	40	60	-	1	120	-	-
Purple Sponge	6	11	3	1	40	100	40	-	-	-	-	-	-	P
Yellow Sponge	-	-	-	-	-	-	-	-	-	-	-	-	-	P
COELENTERATA														
Heliopora sp.	-	-	-	-	-	-	-	2P	5P	-	-	-	-	-
Zooanthids	-	P	-	-	-	-	-	-	-	-	-	-	-	-
Sea Anemone	6OP	-	-	-	-	-	-	-	-	-	-	-	-	-
Porites lobata	-	1	-	-	-	-	-	-	20	100	20	240	4P	-
Porites (papilliform)	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Pocillopora meandrina	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Acropora sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	10
Orbicella	-	-	-	-	-	-	-	-	-	-	-	-	P	P
Goniastraa	-	-	-	-	-	-	-	-	-	1	-	20	-	-
Platygyra rustica	-	-	-	-	-	-	-	-	-	-	-	-	-	P
PLATYHELMINTHES														
Polyclad	-	-	1	-	-	-	-	-	-	P	P	-	-	-

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
NEMERTEA														
Nemertine	-	-	-	-	-	-	-	-	-	-	-	-	-	P
ANNELIDA														
Eurythroe sp.	-	P	-	-	-	-	-	-	-	P	40P	1P	-	-
Other Errantia	-	P	P	11P	P	P	-	-	-	P	-	120P	-	P
Tubeworms with foraminiferal tubes	-	P	P	-	-	80P	4P	P	P	-	-	-	-	-
Sipunculus sp.	-	P	P	P	P	P	20P	-	-	P	-	-	-	-
CRUSTACEA														
Stomatopoda (Pseudosquilla ciliata)(?)	-	P	-	1P	1P	-	-	-	-	P	P	80P	-	-
Crangon sp.	-	P	17P	70P	120P	-	20P	20P	P	P	40P	140P	P	4P
Synalpheus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1P
Shrimps, other	-	-	-	-	3P	-	-	40P	-	-	-	-	-	P
Callianassa sp.	-	-	-	1P	-	-	-	-	-	-	-	-	-	-
Paribaccus sp.	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Hermit crabs	800	87	689	1500	3400	3900	1720	111	60	-	-	-	-	-
Drcmia sp.	-	-	-	-	P	-	-	-	-	-	-	-	-	-

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Thalmita edwardsii	-	-	-	3P	40P	-	-	-	-	-	-	-	-	-
Trapezia	-	-	-	-	-	-	-	-	-	-	-	-	-	19P
Grapsoid crabs	-	-	-	-	-	-	80P	-	-	-	-	-	-	-
Lybia tessalata	-	-	-	-	-	-	-	-	-	-	-	-	-	1P
Crabs, other	20P	P	P	P	P	P	P	120P	P	P	20P	-	-	P
GASTROPODA														
Patelloida sp.	-	-	-	20	-	-	-	-	-	-	-	-	-	-
Patella stellaeformis	-	-	1	-	-	-	-	-	-	-	-	-	-	-
*Nerita plicata	50,000	6000	4	-	-	-	-	-	-	-	-	-	-	-
*Cerithium concisum	1100	200	28	20	-	-	-	-	-	-	-	-	-	-
Cerithium obeliscus	-	-	-	20	20	-	-	20	-	1	-	-	-	-
*Cerithium columna	-	9000	1420	1000	20	20	-	20	-	-	-	-	-	-
*Nautica sp.	-	3	3	20	0	-	-	-	-	-	-	-	-	-
*Monetaria moneta	6	18	30	50	140	160	40	180	100	80	5	-	-	-
*Ranularia muricina	-	10	4	4	-	-	60	20	40	40	-	-	-	-
*Cymathium chlorostomum	-	-	1	1	20	-	-	-	-	-	4	-	-	-
Bursa bufonia	-	-	-	-	-	-	-	-	-	40	4	60	-	-

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Gyroscala perplexa	-	-	-	20	-	-	-	-	-	-	-	-	-	-
*Thais hippocastanum	4	7	16	20	3	2	-	-	-	-	-	-	-	-
Vasum ceramicum	-	-	-	-	-	-	-	-	-	-	20	2	2P	-
*Mitra litterata	250	85	49	500	160	40	50	20	20	40	80	100	-	2P
*Mitra virgata	5	-	-	-	-	-	80	-	-	40	-	-	-	-
*Engina mendicaraia	150	8	21	70	40	4	-	-	-	-	-	-	-	-
*Drupa grossularia	-	2	1	-	-	-	-	-	-	-	-	20	-	-
Drupa ricina	-	-	1	-	-	-	-	-	-	-	-	-	-	-
*Morula granulata	52	30	6	6	1	-	-	-	-	-	20	40	-	-
*Morula fiscella	150	-	-	20	-	-	-	-	-	-	-	-	-	-
*Conus hebraeus & C. spondylus	22	81	100	500	140	60	60	120	-	2	1	-	-	-
*Conus miliaris	-	2	8	70	1	-	1	20	20	-	1	-	-	-
Conus flavidus	-	-	-	-	-	20	-	20	-	-	1	-	1P	-
Conus sp.	1	-	-	-	-	-	-	60	-	-	-	-	-	-
Cythara sp.	-	-	-	200	20	280	-	-	-	-	-	-	-	-
*Torinia varigata	1	1	2	20	20	20	-	-	-	-	-	-	-	-
Vermitidae	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Nudibranch	-	-	1	-	1	-	-	-	-	P	-	-	-	-

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PELECYPODA														
*Barbatia tenella	1	-	5	P	20	40	360	390	1400	720	840	260	1P	-
Volsella auriculata	-	-	-	40	-	-	-	-	-	-	-	-	-	-
*Isognomon perna	3	2	3	-	20	40	-	-	20	60	-	-	-	-
*Gafrarium pectinata	-	-	2	-	-	-	-	-	-	-	-	-	-	-
ECHINODERMATA														
Tripneustes gratilla	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Echinometra mathaei	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Diadema paucispinus	-	-	-	-	-	-	-	P	-	-	-	-	-	-
Distichopis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Ophiocoma brevipes	-	-	-	-	-	-	-	-	-	-	1	-	-	P
Other brittle stars	125P	2	8	-	1P	-	2P	-	-	-	-	120P	P	-
Holothuria atra	-	P	1	1	-	-	-	1	-	1	1	-	-	-
Actinopyga mauritana	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Other Holothurians	-	-	-	-	-	-	-	-	-	20	-	-	-	-
CHORDATA														
Ptychodera sp.	1	P	P	-	20P	-	-	-	-	-	-	-	-	-

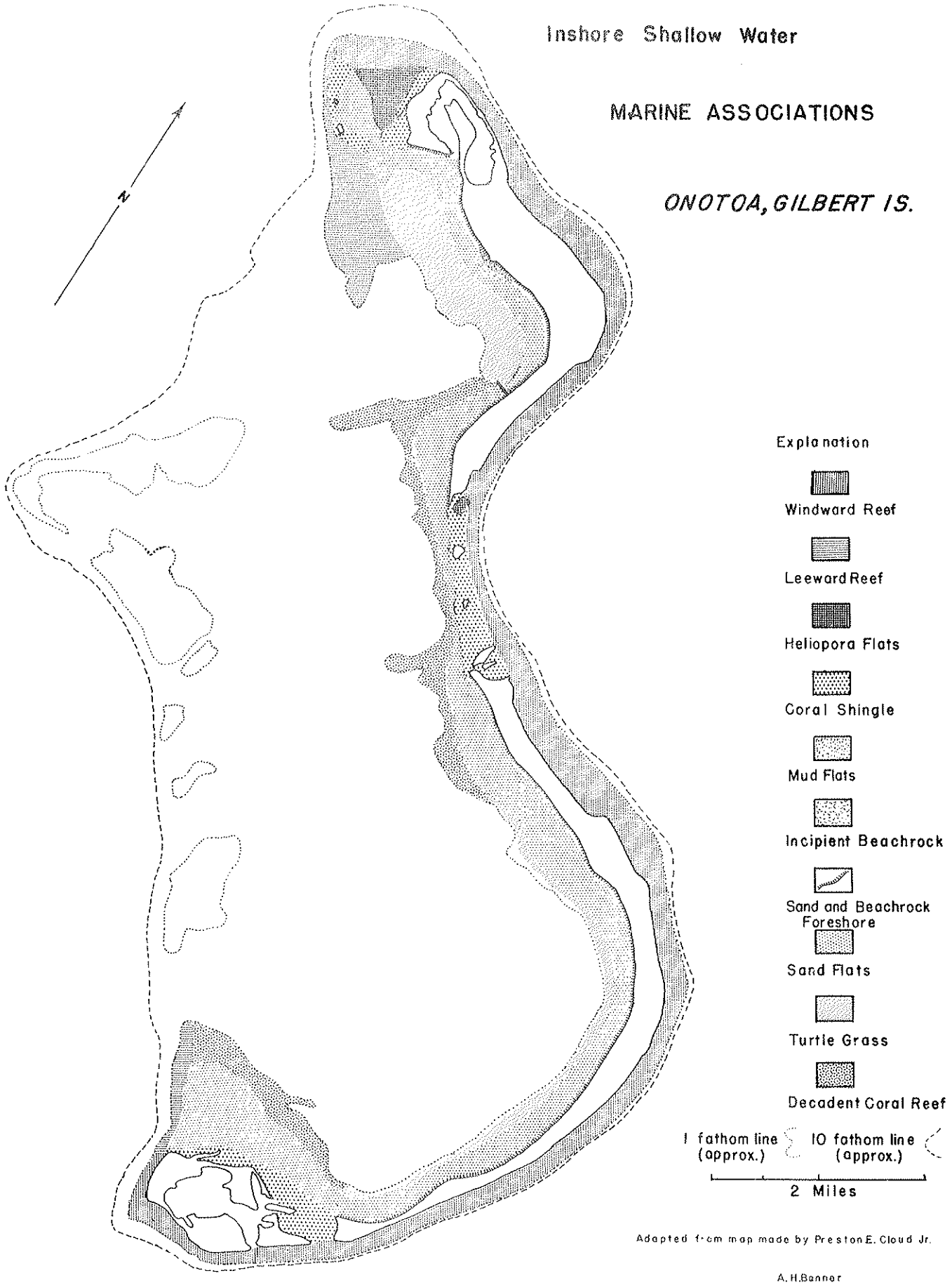
Coralline ridge.

The topographical features of this ridge are described above. Unfortunately tides and waves did not permit an examination, neither quantitative nor qualitative, of the fauna of this zone. The relatively smooth surface of the coralline algae did not offer any protection for animal life; the shifting rocks at the bottom of the surge channels offered less. However, reaching into the mass of the coralline algae were numerous openings, and within the heads were chambers in which many animals lived. In this habitat were found such animals as Echinometra mathei, Heterocentrosus sp., and several species of xanthid crabs.

Reef Shelf.

This area, lying beyond the outer edge of the coralline ridge, was estimated to be about 300 feet wide, from 8-10 feet deep at the coralline ridge to about 30 feet deep where the bottom begins to drop away abruptly. In this area no invertebrates other than corals were observed, and no facilities were available to transport heads of coral to shore for further examination; however, numerous holes were noted in the coral floor where crustaceans, worms and other forms could have lived.

The coral on the shelf was roughly zoned, with the dominant species in the shallower water near the coralline ridge being Pocillopora meandrina, and in the deeper water of the middle and outer shelf, species of Acropora. In the middle and outer portions of the shelf massive heads of Porites lobata were conspicuous. Among the other corals found in this area were all of those reported from the back-ridge trough and some small specimens of Stylaster growing on the undersides of coral heads in twenty feet or more of water. Large areas of the bottom were covered with dead, loose fronds of Acropora.


Inshore Shallow Water
MARINE ASSOCIATIONS
ONOTOA, GILBERT IS.
N
Explanation
Windward Reef
Leeward Reef
Heliopora Flats
Coral Shingle
Mud Flats
Incipient Beachrock
Sand and Beachrock Foreshore
Sand Flats
Turtle Grass
Decadent Coral Reef
1 fathom line (approx.)
10 fathom line (approx.)
2 Miles
Adapted from map made by Preston E. Cloud Jr.
A. H. Banner

II

SHALLOW WATER LAGOON REGIONS AND ADJACENT AREAS

AREAS NOT IN LAGOON.

I. Leeward Island Reef.

This area lies to the lee of the ends of the islands, west and northwest of Tabaurorae and its northern reef. The regions faunistically approach the windward reef but on them there is not a well-developed reef flat and no backridge trough or coralline ridge whatsoever, but instead changes at places quite abruptly into conditions similar to the reef shelf off the windward reef. In water of moderate depths -- two to five feet -- the major elements of the fauna are the same as the backridge trough on the windward reef.

The major exception to these generalities lies in the region northward of the Heliopora flats off Anteuma; here, the conditions are similar to the area within the reef to the west of Abenecnec Island (to be described by Dr. Cloud).

II. Heliopora Flats.

The areas designated as Heliopora Flats are found in a protected region behind the windward reef at the south end of the north island and northwest of the tip of the north island.

The southern Heliopora flat consists of an extensive tide pool about 800 feet in diameter, protected on the oceanside by a coarse coralline boulder ridge, and by elevated sand and boulder covered reefs on the other sides. The bottom of the pool is estimated to be about the 0.0 tidal level, and the water stands about twelve to eighteen inches deep. The bottom is sand. The dominant animal is Heliopora, with one head about every square yard; Porites sp. is perhaps a tenth as plentiful. Other corals, all infrequent, include

Orbicella, Pocillopora, Leptoria. On the exposed sand bottom no animals except Holothuria atra are conspicuous. Other invertebrates are found in two habitats.

A. Under coral heads. Here are found stomatopods (Pseudosquilla ciliata), Tethys, two species of tunicates, four species of holothuroids, *Thais hippocastanum, and several species of brachyuran crabs.

B. In coral heads. Here the dominant forms are crangonid shrimps and small xanthid crabs. Encrusting sponges of various types are common; black colonial tunicates are plentiful; one head only showed numerous small sea anemones. Annelid worms, both Errantia and Sedentaria, are moderately common. Several species of clams, including *Isognomon sp. and *Barbatia tenella, are found between the inner branches of the coral.

The northern Heliopora flat is faunistically similar to the southern, with the same population. However, it shows the transition, on its inner side, between a typical Heliopora flat as described above with infrequent heads of Heliopora reaching from the sand bottom, through a condition where the Heliopora is growing thickly and the top ends were being consolidated by coralline algae, to a consolidated condition like that described in section A-8 of the windward reef. In the labyrinthian passages below the surface consolidation are numerous small fish. On the outer edge these flats gradually change in a moderately deep water coral association with passages between the coral six or more feet deep.

III. Shingle Flats.

These areas of shingle -- flattened and waveworn coral rocks lie in regions where the waves and the currents are strong enough to sweep away the sand. These conditions are found in the passes between the islands, as in the three passes between North Island and South Island, and the two passes west of South Island. The size of the rocks varies with location, being large

where there is an unbroken sweep of the water, as between the windward side of the Abenecnec passes, and gradually changing into fine gravel on the more protected extensions of the current, as to the west end of the southern tip of North Island, which in turn is replaced by the fine sand characteristic of the lagoon. All shingle areas inspected were above the 0.0 tidal zone, and in places extended up to the edge of the terrestrial flora. In some portions of the passes there were developed broad shallow tidal pools, with a bottom of finer rocks or sand.

Without exception these actual pass areas were found to be devoid of larger animals; even the tidal pools appeared lifeless. However, where there was slight protection either from islands or from bars, there was a feeble fauna developed, with some xanthid crabs, a few sponges and heads of Porites in the tidal pools. In the fine gravel zones, transitional between the shingle and the lagoon sand, some life was found in the levels near the zero tide zone. Burrowing into the dead coral reef under these areas were found sipunculids and annelids; in the small shallow tidal pools were found occasional brittle stars, solitary zooanthids and small crabs under the scattered loose boulders.

LAGOON AREAS

IV. Sand Foreshore.

Along the lagoon side of the island the foreshore, from about the two foot tidal level up alternates between fine sand and consolidated beach rock with more areas of beachrock off the northern island and more sand off the southern. Only near the tips of the islands and around smaller islands like Anteuma and Abenecnec are these two characteristic beach formations replaced by coral shingle. The sand foreshore is devoid of life except for occasional ghost crabs Ocypode ceratophthalma the same species that is found much more

plentifully on the windward sand beach.

V. Beach-rock Foreshore.

Alternating with the sand foreshore are areas where the elevated beach-rock of the island's base is exposed by wave action. This slab is eroded on the top surface into the typical cupped pattern, and often is undercut along the lower edge by wave action and possibly solution by fresh water from the island lens. At places, especially in the lower tidal zones, the undercutting has proceeded far enough so that slabs up to several feet or more long have broken off from the base rock and lie free on the substrate of either beach-rock or of sand.

Animal communities in this habitat when the tide is out are subjected to dessication and heat, to rain and especially to the flowing fresh water, common all along the shore; when the tide is in, to moderate wave action (except, possibly during periods of storms from the west when the wave action would be vigorous).

The rocks can be subdivided into four associations:

A. The higher beach-rock area. This is above about the 2.5 foot tidal zone and is almost devoid of life except for Nerita plicata and Grapsus grapsus, neither as common as on the similar rocks on the windward side of the island.

B. Lower beach-rock area, rocks lying on solid substrate or undercut solid rock. These rocks lie between the 0.0 and 2.5 tidal zones. In them are found burrowing sipunculid worms; near the edges of the rocks are numerous Holothuria atra and less numerous Holothuria monocaria, some colonies of colonial tunicates and some sponges; under them are numerous crabs of at least four species, four or more species of crangonid shrimps, very few hermit crabs, and no worms.

C. Lower beach-rock, rocks lying on sand. These are in the same zone as B above, but lie with the base imbedded in the sand. About their edges is the common Holothuria atra and clusters of zooanthids; in burrows under them in the sand are numerous large worms of the genus Eurythoe and three species of crangonid shrimps.

D. Lower beach-rock, suspended rocks. These, lying with one end on other rocks, leave a large surface underneath open to free circulation of water or air, and protection from the sun and rain. On this surface, hanging down, are hydroid colonies in profusion, and some colonial tunicates, a few sponges.

VI Mud Flats.

In a short narrow area along the middle of the North Island, below the foreshore and behind the incipient beach-rock (VII) there is a mud flat. The height of the mud flat is slightly above the zero tide level. The mud is soft, so that a person walking over it would sink between ankle and knee-deep; slippery with little admixture of sand, and rich in organic matter whose decomposition gives it the characteristic odor of hydrogen sulfide.

In this mud flat proper is only one species visible, the brilliantly colored fiddler crab, living in burrows. In areas transitional between the mud flat and the sand are found some burrows of stomatopods. There were no traces of annelid burrows or of other macroscopic life.

VII Incipient Beach-rock

A small area off middle of the northern island, bounded inshore by the mudflats (VI) and off shore and at the ends by sand flats or turtle grass (VIII and IX), is composed of beach-rock in the process of formation, according to Dr. Cloud. The rock is as firm, or almost as firm as the typical elevated beach rock (V) but its surface, near the zero tide zone, was roughly eroded like the more exposed rock (IV-A).

In protected areas in the rock, as in deeper cusps, in fissures and under the occasional loose rocks are the following snails: *Thais hippocastanum; *Mitra virgata and *M. litterata; *Cymathium chlorostomum and *Conus hebraeus. Under the rocks are numerous hermit crabs. Burrowing into the rock were sipunculoid worms and sea anemones were found in protected locations where they were living in shallow pits that precisely fitted the basal portions of their columns. In shallow but rather long burrows that they have either excavated or taken are the large red-eyed crabs and fiddler crabs; at the entrance of these burrows were vast numbers of Collembola.

VIII Sand Flats.

The most extensive habitat in the lagoon is the sand flat. These flats run from the inshore beach along the three major islands extending as a broad, almost level, flat from the inshore beach outwards for several hundred feet wide to a half mile or more. On the outward edge they either continue as the sand bottom of the lagoon or are covered by turtle grass (IX), or are demarked by a decadent coral reef (X). The portions of this area described below run from about two feet above to several feet below the zero tidal zone. The sand varies from less than an inch thick, covering old coral reef, to at least several feet thick.

The fauna of this zone varies with the depth in the tidal zone, the fineness of sand particles, the amount of wave action, and with the depth of the sand. The differences in the fauna are not well demarked and most often are quantitative rather than qualitative -- the same species present in most areas, but varying in relative abundance. Of course, with the difference in depth the fauna changed markedly; for example, in the highest portion here considered (some tidal pools in the middle tidal zone off Anteuma), the only elements of

the fauna left were the Enteropneustan, Ptychodera, and on the other hand, below the -1.0 tide level solitary heads of coral would reach up above the surrounding sand.

These solitary heads of coral in this area, like those in the Turtle grass area, constituted microenvironments markedly different from the surrounding sand. For that reason they are considered as a separate subdivision below.

A. Sand area proper, fauna:

Porifera: Purple sponge, black sponge (two kinds), orange sponge.

Coelenterata: Zooanthids (corals considered below).

Annelida: Tubeworms with leathery tubes and with sand tubes; two species of Errantia; small and giant sipunculids.

Crustacea: Lysiosquilla maculata; Callianassids, Calappa sp.

Mollusca: (Note: remarkably few traces of living mollusca were found, although dead shells were seen in some areas; this may be attributed to the fact that most of the sand flat molluscs are esteemed as food by the Gilbertese.) Clams, various species including *Cafrarium pectinata, *Tellina crassiplicata, *Tellina sp., *Nautica sp., various species of Mitra, Terebra, Cymathium, Trochus.

Echinodermata:

Holothuria atra (extremely common in some areas, counted at 5-15 per square yard).

Chordata:

Ptychodera sp.

B. Isolated coral heads, fauna:

Porifera: same as above.

Coelenterata: Porites sp. (dominant); Pocillopora damicornis; Acropora servicornis; Orbicella; other corals in lesser numbers.

Pennaria.

Annelida: Tube worms in limy tubes; sipunculids

Crustacea: Crangonids, various species; brachyuran crabs.

Mollusca: Cyprea erosa, *Monetaria moneta, *Barbatia amygdalumtostum.

Chordata: Colonial tunicates.

IX. Turtle Grass

Large areas in the northern part of the lagoon and portions of the southern lagoon are dominated by Turtle Grass (Thallasia sp.) which extends over the sand bottom from water about at the zero tide line or a little above to six or ten feet below the surface. The Turtle Grass, which makes a dense stand like the northern eel-grass (Zostera), seldom grows over a foot or more high; its creeping rhizomes make a dense interwoven mat in the sand substrate. In the southern portion of the lagoon less area is adaptable to the growth of the plant, and in general it is limited to a relatively narrow zone near the shore of the island; in the middle of the lagoon, off the passes between North and South Island and the adjacent areas, and off Tabuarorae and the southwesternmost portion of the lagoon there is no Turtle Grass whatsoever.

The Turtle Grass proper is relatively devoid of invertebrate life. On the fronds of the grass are found black colonial tunicates and occasional sponges of several types; about the bases of the grass are more sponges of the same type and, most abundant in many areas, a papillose green-black holothurian. It was impossible, once digging was started, to dig out the

few burrowing animals detected because of the clouds of fine silt that rendered underwater vision impossible. The burrowing animals, however, are few in number and appeared to be limited to a small squillid (Lysiosquilla) and some burrowing worms.

In the deeper portions of the Turtle Grass beds, especially in the area off the northern island, there appear solitary and separated coral masses, like islands in a sea of grass. These isolated masses are rich in life, both fish and invertebrate. They evidently are made up primarily of Porites, but they are covered in a large extent by other corals like Acropora, Pocillopora, Orbicella, etc. The invertebrate fauna is in general similar to the fauna of coral heads in the sand beach area (VIII-B).

X. Decadent Coral Reef.

In many areas the sand flats grade gradually into a region of dead coral reefs that lie between + 1.0 and - 1.0 tidal level. These areas appear to be those where the wave action and current action is stronger, sweeping the veneer of sand from the harder substrate. They are found to the southeast of Anteuma; off the southern portion of the North Island and the northern portion of the South Island and the passages between; and they are extensively developed off Tabuarorae and in the southwestern portions of the lagoon.

The decadent to dead coral reefs present a variety of habitats for invertebrates: on the hard coral there are places of attachment, protected and unprotected, for sessile forms; in naturally occurring spaces and in burrows in the coral there are places for the smaller invertebrates to hide; in the areas between the heads of coral, either broken off as the reef was growing or subsequently eroded from the reef surface are pockets of sand and gravel to accommodate burrowing forms; these pockets, some of them many feet

long, retain water when the tide is out and provide a tidal pool for the protection of its inhabitants. For this reason the fauna of the area is more diverse than any other area of the lagoon; however, with few exceptions, no elements of the fauna are exceedingly common:

Porifera:	Yellow to red encrusting sponges, several species	Moderately common
	Black, rounded sponge	Uncommon
	Orange upstanding sponge	Uncommon
Coelenterata:		
	Pennaria	Common on undersides of coral overhangs.
	Porites, living	Uncommon
	Pocillopora damicornis	Uncommon
Annelida:		
	Worms in limy tubes, two species	Uncommon
	Burrowing Errantia, 1 specimen	Uncommon
	Sipunculus sp.	Common
Crustacea:		
	Crangon, and other genera	Uncommon
	Brachyuran crabs (other than Portunids)	Uncommon
	(Portunids)	(Moderately common)
	Hermit Crabs	Rare
Gastropoda:		
	*Conus hebraeus	Uncommon
	Conus flavidus	Rare
	*Monetaria moneta	Moderately common
	*Nautica sp.	Rare
	*Mitra virgata	Rare
	Nudibranch	Rare

Pelecypoda:	
*Barbatia amygdalumtostum	Uncommon
*Isognomon perna	Common
*Pinctada vulgaris	Common
*Tellina sp.	Rare
*Tellina crassiplicata	Rare
Echinodermata:	
Brittle Stars (as in A-2 windward reef)	Common
Linkia sp.	Rare
Holothuria atra	Abundant in tide-pools at inner edge of area (60 in one pool of about 60 square feet); otherwise rare.
Papillose sea cucumber (as in IX above)	Rare
Chordata:	
Ptychodera	Rare
Encrusting compound tunicate, three species	Rare to common, according to the species.

III

GILBERTESE UTILIZATION OF INVERTEBRATES

One of the important phases of a study of a native peoples is the study of the food resources available to the people, and of their utilization of these resources. This is especially true of the inhabitants of a coral atoll, where the food resources at best are somewhat limited, and where, on a small dry and overpopulated atoll like Onotoa, these resources may be the deciding factor in social structure and even of life and death.

On Onotoa the population had available three sources of food; the conventional land produce, plant and animal which obviously was inadequate to support the island's population, especially in times of drought; the marine fisheries, apparently the chief source of protein in the native diets and one of the main sources of calories; and finally, the marine invertebrates, which appeared to be at best merely a supplementary source of food, gathered primarily either when fortuitous occasions arose, like low tides at night for the collection of lobsters, or to serve as mere variations in the usual diet of coconut-pandanus-fish.

However, this study will give some indication of the extent that the Onotoans are utilizing most of the available resources as food.

Methods and Limitations of the Study:

This study was carried on to large part when I was immobilized by blood-poisoning. A native assistant was assigned to help me when he was not busy with other jobs; he was willing and cooperative, but the study was inhibited by his most imperfect English and my total lack of Gilbertese; at times an interpreter was used to bridge the gap.

The study, in its original phases, consisted of looking at pictures in illustrated books of marine life. Later, upon finding that that system was inaccurate because of the inability of natives to interpret correctly the illustrations, all information was gathered by showing the natives actual specimens, specimens that were either collected for us by our native assistants or by ourselves.

The study has three major limitations and sources of inaccuracies. First is the probability that we were unable to find all of the foods of the people because we had neither illustrations nor specimens of them, and our informants did not discuss them because of the language limitations. Second because of their "willingness to please" the natives included animals that possibly were not eaten, or that were eaten only under extreme famine conditions. To remove this possibility several natives were checked, one against another, in as many instances as possible. Third is that not all individuals or family groups utilize the invertebrate foods as much as others -- like in our own society some families eat crabs but others would not consider them. Perhaps my informants were not among those who knew and utilized all of the foods found on the reefs and shores of Onotoa. I did observe on some of the food species that there was no agreement as to the native name; for example, I received three native names for the snail Quimalea pomum. This would seem to indicate that it was not a common article of food.

Systematic Account

Scientific Name Native Name	Notes
1. Coelenterata-Scyphozoa (Carybdea alata Reynaud)	These large (10-12") scyphomedusae occurred at a moderate tide slightly
Te Baitari	before the full of the moon; reportedly

they occurred at similar phases of the moon throughout the year. They are gathered on the windward reef by wading women and children who either put them in baskets or string them on pandanus fibers. In preparation the outer layers of jelly are stripped off, the oral and aboral ends removed and only the remaining material -- the muscular coat of the gastro-vascular cavity is saved. The cleaned material is thus 6-8 inches long, 1½ inches broad and about 1/8 inch thick. It is reported that this is boiled to form a rather sticky "soup".

Annelida-Sipunculoidea

2. Sipunculus indicus Peters

Te Ibo

These are found burrowing in sand flats of the lagoon. They are one to two feet long and the diameter of a man's little finger. When the native, usually a man, finds a hole and casting made by the worm he probes the sand behind it with a flexible and sharpened young root of a pandanus; this, when hitting the vertical portion of the worm burrow follows down the tube. When the worm is touched

by the tip of the probe, it is thrust with vigour and penetrates with the introvert into the anterior body pocket, securely holding the worm. The worm is then dug from the tube. The probe is jerked out, rupturing the anterior body wall of the worm. Then the worm is seized by the back end and snapped like a whip, completely eviscerating it and leaving nothing but the thick muscular coat. This is washed and eaten raw, cooked by boiling or dried for future use.

Arthropoda, Crustacea-Stomatopoda

3. Lysiosquilla maculata

Te Waro

This large stomatopod (about 1 foot long) is found only burrowed in the sand in the lagoon. It is caught by both men and women by placing a spear in the sand so that it is in line with the hole; a piece of fish is placed at the entrance of the burrow as a lure, a noise is made to attract its attention, and as the stomatopod comes to the mouth of the burrow to strike the bait, the spear is thrust home. The animal is cooked and all except the viscera under

the carapace is eaten.

4. Pseudosquilla ciliata (and other species)

Te Maro (as above)

All smaller stomatopods when captured are eaten; they run from one to four inches long. The principal source of these stomatopods is under rocks on the windward reef flat, where they are gathered by hand or by small scoop nets together with shrimps, etc. They are gathered principally by women. Method of preparation as in 3 above.

Decapoda

5. Crangon strenuus (Dana)

Teniwarowaro

(Note: this Gilbertese name evidently includes other genera and species of chelate shrimp and lobster-like crustaceans but the only form observed was Crangon strenuus). These range in size from one inch to fourteen inches long and are caught by all members of the family near the back-ridge trough of the windward reef in small nets when torch-fishing. They are boiled and both the cephalothorax and abdomen are eaten.

6. Panulirus pencillatus (Oliver)

Te Ura

This lobster runs from six to eighteen inches long. It is caught along the windward reef by men and women either during the day when the tide is out or

over the reef surface at night, when torch fishing. Dip nets are used for its capture. It is boiled and the abdomen, portions of the cephalothorax, and legs are eaten.

7. Parabaccus antarcticus (Lund)
Te Mnawa

The sand lobster reaches the length of nine inches; it is caught, prepared and eaten in the same way as in 6.

8. Birgus latro
Te Aii

These coconut crabs are entirely terrestrial and are found by day in burrows. They are dug out only by men. When boiled the abdomen and legs are eaten.

9. Geocaroides sp.
Te Manai

These large land crabs are found only on the North ends of both major islands of Onotoa. They are caught by men and women at night by torch light in the middle of the island. They are boiled and eaten like other crabs (see below).

10. (Terrestrial Hermit Crabs)
Te Makauro

These are small terrestrial hermit crabs that live in the shells of Turbo, etc. They are caught either by day or by night, the latter time by torch light. Only children were observed gathering them. They are boiled and the abdomen alone is eaten.

11. Calappa hepatica (L.)
Tennonno

These sand crabs reach the breadth of about 3". They are captured in the sand of the lagoon when the tide is out by feeling for them under the sand with the hands or feet. Everyone helps in their capture. They are boiled and the legs alone are eaten.

12. Charybdis erythrodactyla (Lamark)
Tentabarereki

These crabs are six to eight inches broad across the carapace and found both on the windward reef and in the lagoon. They are gathered by anyone finding them and boiled; the legs and the ventral portion of the cephalothorax is eaten.

13. Carpilius maculatus (L.)
Te Iba Taburimai

These crabs are found only on the windward reef when the tide is out by day or at night by torchfishing; only adults catch them, either by nets or by hand. They are boiled and eaten as above.

14. (Unidentified crab)
Te Nikarewerewe

These crabs are about 6-7" across the carapace, and their habitat, mode of capture and preparation are the same as 13.

15. (Red-eyed crab)
Tentababa

These crabs are found high in the intertidal zone on both windward and leeward beaches, underneath beachrock;

they reach the carapace breadth of about 3 inches. Anyone may catch them, and they are gathered by hand and prepared in the same fashion as above.

16. Ocypode ceratophthalma (Pallas) — These "ghost crabs" are found high on the sand beaches on both shores of the islands where they live in burrows; they reach the breadth of 3". Anyone may capture them, either by digging by day or by torching at night with a net. They are boiled and portions attached to the ventral half of the body are eaten.

Te Kauki

17. Zozymus aeneus L. — These crabs are found at night on the windward reef in torch fishing; they are reputedly extremely poisonous in all parts of the body, causing rapid death when eaten. They are never used as food.

Te Kukua

Mollusca, Gastropoda

18. Trochus, all species — These are found along the windward reef; they are gathered by all members of the family, boiled in the shell and the meat is pulled from the shell for eating.

Te Baraitoa

19. Turbo, all species
Te Nimatanin

These are found along the windward reef where they are gathered by all members of the family; they may be prepared or the shell may be broken and the snail eaten raw.

20. Cerithium, all species
Te Bukikakang

These are found in the sand of the lagoon when the tide is out; they are gathered by everyone. The snail is cooked in the shell and the meat removed after cooking; the shells are used for ornamental bands on dancing belts, etc.

23. Lambis, all species
Teneang

These snails are found on coral in the outer portions of the lagoon, in waist deep or deeper water. Only the men gather the snail; it may be eaten raw after breaking the shell or it may be boiled intact with the meat subsequently removed.

24. Nautica sp.
Te Tumara

These are found a few inches under the sand in the lagoon; they are caught by everyone, boiled in the shell and the meat subsequently removed.

25. Monetaria moneta (L.)
Te Burerewa

These are found in both on windward reef and in the lagoon; they are gathered by everyone. The snails are

used only for shell ornaments; they are first boiled and then buried in the sand for two to four weeks, and finally washed in fresh water.

26. Cyprea, various species
Te Kabaua

These also are not eaten, but gathered to be used as shell ornaments. The larger species of cowries are not used at all. Method of preparation is the same as Monetaria moneta (L.) (25).

27. Amphiperas ovum
Te Bure

These shells are not found on Onotoa, but are imported from Abemama to be used as ornaments for the bow and stern of the outrigger canoes, and for decorations in the Maneabas.

28. Nerita plicata
Te Kaban

These snails are found high on the rocks on the windward beaches and to lesser extent on the lagoon beaches; they are gathered by everyone and cooked in the shell.

29. Cymathium sp.
Te Wiaau

These are found on the lagoon beaches at low tide only near Aiaki (the middle of South Island); they are gathered by everyone and boiled in the shell.

30. Bursa bufonia
Te Kamanging

These are found only on the windward reef flat, where they are gathered by everyone; they are boiled in the shell before eating.

31. Charonia tritonis

Te Tauu

This large conch or triton is found along the outer edge of the lagoon on coral in waist deep or deeper water; it is gathered only by men. It is considered poisonous and not eaten; however, the shell is used as a trumpet to announce meetings in the community hall, and the shell, hung upside down, is used as a flask to store coconut oil (the oil is poured out of the syphon, from which it emerges in a small and easily controlled stream).

32. Tonna perdix

Te Tau

This snail is found in the lagoon in water two fathoms or more deep, on coral; it is gathered only by men. Before eating, the animal is boiled in the shell (one old man informed me it was the young of the conch (31) and had the same name).

33. Quimalea pomum

Te Makauro-n Tari

This snail is found in the same habitat and prepared the same way as Tonna perdix (32).

34. Vasum ceramicum

Thais hippocastanum (L.)

Morula granulata Duclos

Te Nimakaka

These species are all found on the windward reef flat, where they may be gathered by men, women or children; they are cooked in the shell. All are known by the same name.

35. Conus, all species
Te Nouo

These species are found variously on the ocean or lagoon side of the island in shallow or deep water; primarily women and children gather them on the windward reef, while only men gather them in the deeper water of the lagoon. While Conus striatus, one of the poison cones, is among those gathered, the Gilbertese seem to have no knowledge of its "sting". All are boiled before eating, and then the shell is broken to withdraw the meat. Another informant called them "Te Nuo Nuo".

36. Pollia undosa
Te Wikakang

These snails are found only on the windward reef flat and gathered by everyone. They are cooked and the meat is then pulled from the shell.

37. Mitra, all species
Terebra, all species
Te Kabinea

These snails are found only buried one to two inches deep in the sand of the lagoon when the tide goes out; they are gathered by all members of the family and boiled in the shell. Both genera have similar habitats and bear the same Gilbertese name.

38. Melampus, all species
Te Kokoti

These species are found only high on rocky beaches on the northwestern and

southwestern islands, where they are gathered only by women and children; the snails are not eaten but the shells are used as ornaments on articles of clothing.

39. (Nudibranch)
Nei Kamanging

This four-inch nudibranch is found on the middle section of the windward reef under rocks; it is gathered by anyone finding it; before being eaten it is boiled for two or three hours.

40. (Nudibranch)
Neireurekia

This is essentially the same as the nudibranch above (39), except before being cooked the visceral mass is removed.

Mollusca; Pelecypoda.

41. Pinna atropurpurea
Te Raun

Found only in southern part of lagoon, two fathoms or more deep, partially buried in sand. It is gathered by men only, and boiled before being eaten.

42. Streptopinna saccata
Te Bere

This "clam" is found along lagoon shores in sand, one foot or more deep. Evidently it is not used for food or ornament.

43. Pinctada marginifera

The pearl oyster is found only on the sand bottom of the southwestern lagoon in three or more fathoms of water. It

is gathered by men only. The meat is removed from the shell before it is boiled. Some pearls are found and the shell can be sold but there is no established pearling trade on Onotoa. The shell is used also by the men for ornaments on belts, for earrings and for canoe decorations.

44. Hippopus hippopus

Te Nei Toro - small individuals

Te Aubuna - large individuals

This giant clam is found on both lagoon and ocean reefs from three feet deep to about two fathoms. All sizes, from two or three inch specimens to those about three feet across, are gathered by men for eating. At times they are eaten raw. When fresh, their meat is boiled with water or coconut milk; they may also be dried with salt and kept several months. The large shells are often used as wash basins. Some families make small holding pens of coral along the beach in front of their houses and keep small specimens alive until they grow larger, or until the family is ready to eat them. One family had a pen about four feet square that held ten clams ranging in size from three to twelve inches across.

45. Tridacna cumingi
Tridacna elongata
Te Were

These are the same as Hippopus above (44) excepting for their smaller size -- up to nine inches across in lagoon, three inches across along the ocean.

46. Tridacna squamosa
Te Were Makai

These are the same as Hippopus above (44); size up to about fourteen inches across.

47. Cardium sp.
Te Tuai or
Te Taerake

These cockles are found in the lagoon only slightly under the surface of the sand, in intertidal zone. They are gathered by everyone; the clam is boiled for food and the shell is used as a coconut meat scraper to make baby food.

48. Cardium (Trachycardium) flavum
Te Nikarikiriki

These cockles are found near the surface of the sand in the intertidal zone along the southern island only. They are gathered by everyone and boiled in the shell before being eaten.

49. Gafraum tumidum
Venus clathrata
Te Koikoinanti

These are both found in outer lagoon on coral and not in sand, in about one fathom of water. They are gathered by both men and women diving from canoes. They are removed from the shell before boiling. Both species are referred to by the same name.

50. Pitar (Agriopoma) japonica
Mesodesma striata
Te Katura

Both of these clams are found along islands buried one to two inches deep in the sand high in the intertidal zone. They are gathered by everyone and boiled in their shells before eating.

51. Protothraca staminea
Te Koumara

This clam is found low in the intertidal zone along the lagoon only near the end islands buried up to six inches deep in the sand. It is gathered by women and children and may be either eaten raw or boiled in the shells.

52. Tellina crassiplicata
Te Nikatona

This clam is found buried eight to twelve inches deep in sand in lower intertidal zone off the south and north island and off the south island. It is reported to be about "fished out". It is dug the year around by anyone. It may be eaten raw, boiled after removing from the shell, or salted and dried.

53. Asaphia dichotoma
Tei Koikoi

This clam is found in lagoon sand in lower intertidal zone buried about one foot deep all along the coast except off the middle of the southern island. It is dug only by women and children; it may be eaten raw or boiled in the shell.

54. Asaphis deflorata

Te Bun

This clam is found only at Abemama Island but not on Onotoa nor any other island; it is found low in intertidal zone in sand of the lagoon. On Abemama it is dug by everyone; it may be eaten raw or bioled and is reportedly of excellent taste. The shells were imported to Onotoa to be used as fishing sinkers.

55. Polypus marmoratus

Te Kika

The octopus is one of the principal invertebrate foods of the people. It is caught on both sides of the island in holes under rocks when the tide is out by spearing with short hocked spears. Men, women and children all capture it. All parts of it are eaten except the ink sac. Several methods of preparation are used with it: It can be pounded on a stone without additional salt until soft, and then either boiled in water or coconut milk for several hours; or it can be salted and dried to be kept for at least several months. Before the dried octopus is eaten, it is washed and boiled.

DISCUSSION

It is remarkable that these people did not use certain supposedly edible animals of their region. For example, careful questioning showed no evidence of the use of sea weeds, of sea urchins (quite common around the islands), and of marine annelids like the palolo worm. All three of these constituted relatively important foods for the peoples of Hawaii and Samoa. In addition several other foods used by other peoples were not used on the islands, like the sea anemones eaten by Samoans; however, no large sea anemones were seen about Onotoa.

Several foods on their list, on the other hand, possibly are not too wide spread in their use; this is especially true of the scyphomedusae, the sipunculids (although these are eaten in the Marshalls) and the supposedly poisonous cone shells.

The lagoon reef is not very productive of the edible molluscs; in all of the field work in the intertidal areas of the lagoon no evidences of living clams or edible snails were seen. While it is likely this condition stemmed from overfishing by the concentrated population, it may actually be the result of low productivity of the Onotoa lagoon reefs.

PART II

INVESTIGATION OF THE ICHTHYOFAUNA OF ONOTOA, GILBERT ISLANDS

Onotoa is a small atoll with a relatively high population density; it is quite dry and subject to extended drought. Few food plants can be grown, and even the coconut crop fails at times. Thus, for the Gilbertese on Onotoa, there is a very great dependence on the sea for food.

The methods of fishing are many and varied and involve men, women, and children alike. Fishing is undertaken largely by the men, however, and centers around the use of the native outrigger canoe.

Lacking suitable trees for dugouts, the outriggers in the Southern Gilbert Islands are constructed from Australian plank lumber obtained from Ocean Island. No metal parts are used, the planks and outriggers being lashed in place with a native cord made from retted coconut husk fiber. The outrigger itself is a solid piece of wood and usually made from driftwood.

Not every man owns a canoe, but nearly every family has one or access to one. In the village of Aiaki there are 370 people and 82 canoes.* Fifty-eight of these are good-sized sailing canoes and can be used for trolling outside of the lagoon.

The fisherman who owns a canoe will usually have the following items of fishing gear: a few fishing lines of various sizes, a small assortment of hooks, leader wire of flexible galvanized type, a large shark hook, one or two handmade lures, a flying fish net, a pointed metal rod with a wooden handle for gaffing large fish, a knife, and swim goggles. Most of the fishermen own a fish spear with rubber sling. Many families have eel traps and small nets for torch fishing. Some have eel snares, fish traps, beach seines, and fine-mesh nets for small fish.

*This information, as well as certain other facts in this report, was supplied by Dr. Ward Goodenough.

A cooperative store is located on the atoll and is supplied infrequently from Tarawa. It usually has hooks and fish line for sale. Normal-sized hooks are quite inexpensive, ranging in price from $\frac{1}{4}$ to $1\frac{1}{2}$ pennies. The large shark hooks, when in stock, cost 2 shillings 6 pence (30¢). Heavy fishing line, of sufficient length for one trolling line, costs 5 shillings.

The Gilbertese can earn very little money; hence they can buy very few of the preferred manufactured items of fishing gear. Copra and various items of native handicraft made from pandanus leaf fiber are the principal sources of income. Each year about 60 men from Onotoa are taken to Ocean Island where they work as laborers and by their standards are well paid. On their return they customarily bring with them such things as wire, old inner tubes, metal rods, pieces of lead, and glass, all of which are important in their making of fishing gear.

There are many different kinds of fishes which serve as food for the Gilbertese, and frequently special methods of fishing are utilized for certain species or groups of species. Usually these methods are standard from fisherman to fisherman, but some individual variation does, of course, exist. In some cases a family or individual may have an efficient mean of catching fish which is kept secret. The description of the various methods as given below represent the standard ways of procuring food fishes on Onotoa.

Trolling: Sailing canoes are used for trolling which may be undertaken in the lagoon, but the usual site is in deep water just outside of the west reef of the atoll, especially the region where there is a large westward projection of this reef. At most anytime, but especially in the morning, one can see numerous sailing canoes trolling back and forth beyond the reef. These canoes may be operated by a single man or by two persons. If there are two persons, they are usually of the same family, as father and son. Women may help their husbands when trolling, but this is not a common occurrence.

Trolling speed is highly variable depending on the wind, but generally no difficulty is had in attaining speeds sufficiently great with these fleet craft. In fact, it would seem that too often the contrary occurs; that is, that good trolling speed is exceeded.

The lures which are used are commonly of three types. A hook may have chicken feathers tied directly to it. Such a lure is used for smaller fish such as the small tuna, Euthynnus yaito. There may be a lure consisting of a piece of metal, usually lead, in which there is a hole through which the leader wire is run. The back part of the metal is notched for the attachment of feathers. The hook is attached to the leader wire and is always single. The third type of lure is made from an elongate, well-polished piece of pearl shell. The hook is attached directly to the piece of shell, and feathers may or may not be added.

The use of whole fish for trolling is a common practice, mullet and flying fish being the usual bait species. Mullets are netted in ponds or close to shore in the lagoon, and flying fishes are taken with dip nets at night. The bait fish is attached to the hook by locating the eye of the hook in the mouth and the barbed end up through the back so it is just exposed on the dorsal surface. The eyes of the fish are then removed, and coconut husk fiber is used to lash through the orbits to the eye of the hook.

Fishes which are taken when trolling at the surface in deep water are: Euthynnus yaito, Acanthocybium solandri, Istiophorus gladius, Elagatis bipinnulatus, Katsuwonus pelamis, Neothunnus macropterus, and at least one other unidentified species of tuna. Swordfishes are occasionally caught. The dolphin, Coryphaena hippurus, is rarely taken. Nearer the reef, species of Caranx and Sphyraena are caught.

When large-sized fishes are hooked, they are gaffed and their heads beaten with a wooden club before being brought into the canoe.

Spearing: Formerly a long wooden spear with a metal point lashed at one end was employed. This was jabbed at fish while swimming underwater. Now, the common method involves a simple elastic sling device and a steel rod of about ½ inch diameter and five or six feet in length. The sling consists of a piece of truck tire inner tube or a section of bicycle inner tube to which a loop of sturdy cloth is tied at one end and a loop of cord at the other. The metal rod has a notch at one end and is sharpened to a point at the other. There is no folding-type barb, but there may be a small oblique cut made in the rod near the point and the section of metal away from the point bent slightly outward. The thumb of the left hand is placed through the loop of cloth and the notch of the spear engaged in the cord. The notched end of the spear is then drawn back with the right hand, bow and arrow fashion, and the spear is guided as it is launched by the thumb and fingers of the left hand. The spear-fisherman wears small goggles which he makes for himself from local wood and glass obtained from Ocean Island. The goggles are tied on behind the head with heavy string. The final item of spearing accouterment is an optional one and consists of a piece of cord on which the fish are strung. The fish are suspended from the back, the cord being tied around the waist. In swimming the frog kick is used and the fish are approached very cautiously, all sharp movements being avoided. A spear can be shot for a horizontal distance greater than 25 feet but is not very effective beyond a distance of 6 feet or so because of reduced accuracy. Spearing is undertaken in both the lagoon and on the sea side. Generally the lagoon is preferred for there is no heavy surf with which to contend. In the lagoon the fisherman usually

sails or paddles his canoe out to a suitable area. It is anchored with a heavy stone or tied directly to a coral knoll. A paddle or piece of buoyant wood is tied to the anchor line below the surface to prevent the line from catching on coral and chafing.

Spearing fish is a very important method of fishing. It is utilized mostly by the younger men, some of whom prefer it to any other means of obtaining fish. Among those fishes most sought are members of the following genera: Caranx, Scarus, Lutianus, Myripristis, Holocentrus, Acanthurus (especially A. nigricans and A. triostegus), Ctenochaetus, Gymnothorax, Cephalopholis, and Epinephelus.

Shark Fishing: Very strong line, wire leader made from smaller strands of wire crudely twisted together, and a large heavy hook comprise the usual tackle for shark fishing. The hook is usually a purchased commercial product, but it may be made by hand from steel rod, in which case there is no barb but the tip of the hook is strongly recurved. Fishing may be engaged in from canoes drifting well out at sea. Whole fish is the usual bait, the favorite being the small tuna, Euthynnus yaito, which is caught by trolling immediately prior to the actual fishing for sharks. If the bait fish is alive, it is hooked carefully through the gill openings; if dead it may be tied securely to the hook with coconut husk fiber in a variety of ways. The line is paid out to windward and remains near the surface. Often several heavy shells (Lambis truncata) are tied to a second line which is lowered a few feet below the surface and kept in constant motion. The noise of the shells knocking together supposedly attracts sharks. Some fishermen cut fresh fish into fine pieces and disperse this in the water whereupon the much-discussed power of blood to attract sharks is brought into operation. This surface fishing often

results in the taking of large pelagic fishes such as swordfishes, wahoo, and yellowfin tuna, as well as sharks.

More commonly shark fishing is undertaken over shallow reef areas with a weighted line. Whole fish or cut fish is the usual bait. The sharks taken in reef areas are smaller species, generally, such as the white tip and the black tip.

The flesh of the shark is highly esteemed by the Gilbertese, many of whom actually prefer it to tuna and other fish. It is usually prepared by slicing into sections and roasting in a pit in the ground. Sometimes the flesh is salted and dried in the sun and ultimately eaten without cooking. Still other times it is boiled in sea water.

Night Fishing for Flying Fish: The sailing canoe and at least two persons are required in fishing for flying fish. If there are but two persons, one holds coconut frond torches while the other steers the vessel and works a dip net. Fishing is done outside the reef while moving at ordinary sailing speed. There are usually about eight or ten torches at hand, made from dried coconut leaves lashed in bundles about seven feet long. The first torch is lighted with matches or by striking flint and steel over dried coconut husk. Each subsequent torch is lighted from the previous one just as the latter is about to burn out. The helmsman (and fisherman) generally wears a woven coconut hat to shade his eyes from the torch light. His dip net is elliptical in shape, about two feet in its greatest diameter. The wooden handle is at least twelve feet in length.

The flying fish are attracted to the torch light and skitter about the canoe, some striking the side of it quite resoundingly. The fish are usually caught at the surface but occasionally are picked right out the air by an alert fisherman. When the fish are on the surface the net is dropped directly over them instead of scooping from the side. Usually the netting

operation takes place on the leeward side of the canoe (the side without the outrigger), but the more skillful fishermen extend their range to the water to the stern and the windward side aft of the outrigger.

The only flying fishes observed taken at the atoll were of genus Cypselurus. Most of these were of good size, reaching a maximum of about 15 inches in length. Occasionally some half-beaks were netted.

Hook and Line: The Gilbertese fish with hook and line from canoe, from shore, or while standing in shallow water. A pole may or may not be employed. No use of set lines of any sort was observed. Usually the fisherman handles but a single line which contains but one or a very few hooks due to the great chance of loss of tackle on coral.

Fishing from a canoe takes place in the lagoon but usually over reef areas or near large coral heads. Instead of having a sinker permanently attached to the line, a stone is often loosely tied with a slip knot and the line is then lowered to the desired depth where the stone is released by a sudden jerk of the line. A great variety of fishes are taken but predominantly lutianids, labrids, carangids, serranids, balistids, and scarids.

When fishing from shore on the lagoon side of the atoll, the fishermen (frequently in this case women and children) generally wade well out into the water. Their catch usually includes small Caranx spp. and Gerres sp. and occasionally lutianids.

At low tide fishing with hook and line may be carried on in the surge channels of the reef on the seaside of the atoll. Here a pole is a great asset to the fishermen. These may be made from bamboo obtained from Ocean Island or from a local plant, Guettarda. The pole varies in length from 5 to 12 feet. The usual bait is land hermit crabs which have been removed from their gastropod shells. No sinker is used. The fishes which are most often

taken are Cirrhitus sp., Thalassoma spp., Halichoeres sp., Abudefduf spp., and Lutianus sp. These are small carnivorous fishes which occupy the special surge channel habitat.

No deep water hand line fishing was observed, but interviews with fishermen revealed that a few apparently fish to a depth as great as 100 fathoms from a canoe outside of the reef. The average Gilbertese does not have sufficient line for this or would not want to risk the loss of so much line. The fish which is most sought from the deeper water seems from native description to be the oil fish or escolar (Ruvettus pretiosus).

Torch Fishing: The equipment for this means of catching fish consists of coconut frond torches of the type described for flying fish fishing, a basket woven from coconut leaves, and either a short-handled dip net or a long knife. One man does the fishing, but customarily is followed by a second person who carries extra torches. Fishing may take place in the lagoon or on the sea side on the reef. The preferred site for torch fishing is the back ridge trough, and for this, low tide is a necessity. The water in the back ridge trough at this time is about waist deep. As the fisherman walks along he carries the torch in one hand, the knife or net in the other. The basket for the fish is slung from his shoulder and hangs at his side. Light from the torch is quite bright and fish are readily seen for the water is clear except when an unusually heavy surf is running. Usually a fish can be approached without difficulty and either scooped up with the net or cut with a rapid downward stroke of the knife. Fishes commonly caught by this method include: Cirrhitus sp., Lutianus sp., Monotaxis grandoculis, Acanthurus triostegus, Myripristis spp., Holocentrus spp., Parupeneus sp., Gymnothorax spp. belonids, and mugilids. They are ordinarily eaten immediately after the fishing operation is completed; they are roasted without cleaning in beds of hot coals.

Nets: The simplest type of net is the dip net such as employed in torch fishing. This net may also be used in a fishing operation during the day at low tide. The location is a surge channel. At Onotoa the surge channels are narrow, irregular indentations into the reef averaging about six feet in width and ten feet in depth. The water in these channels is in constant motion, and visibility from the surface or in the channel is poor because of the foam from the breakers. One man uses a coconut frond to drive fish in the channel toward a good vantage point where a second man keeps his dip net in the water. Both men stand on the reef beside the channel. This method of fishing is not a common one.

Small seines of about two fathom length and four or five feet in depth are often used. A seine may be operated by just two persons, each holding a vertical pole at each end, but usually several other persons assist by driving fish toward the net. Frequently a woven line of coconut fronds serves as an extension of the seine from one or both ends. At low tide on the reef the back ridge trough is a region which is commonly seined. One such operation was closely observed. A man, his wife, and two boys were the participants. The fish they hunted was a good-sized scarid which comes up into the shallow water on the reef in small schools. The fishermen endeavored to get between the fish and the open sea. Sometimes this involved actual running with the seine in the shallow water; at other times slow cautious movements were necessary. When the fish were cut off and tried to elude the seine, they were herded by the boys toward the net with coconut palm fronds and by splashing and throwing stones. Many large parrot fish were caught and some surgeon fish (Acanthurus triostegus) and damsel fish (Abudefduf sp.) were taken. The fishes were rendered inactive by biting the dorsal part of the skull and were strung

by cord through the eyes to one of the poles of the seine. This one fishing operation lasted several hours and covered a distance of about two miles.

In the lagoon small seines are used over shallow sandy areas and the fishes caught include Gerres sp., small Caranx sp., mullets (Mugilidae), and goatfishes (Mullidae). Here the seining is very often the work of women and children.

Small seines may be imported cotton products or may be made from local material.

Some large beach seines are owned collectively by entire villages. Each village usually has but one such seine. However, the largest village, Aiaki, is divided into two sections and each owns a seine. These are made of coconut husk fiber and may be as long as thirty fathoms. Shells are used as weights on the foot rope and pieces of a local wood (Scaevola) strung along the float line. These seines are used only in the lagoon, and their operation involves many individuals. One is designated the leader, and he directs the operation by hand signals, for noise is kept to a minimum. One end of the seine is worked out from shore in a large semicircle until it is again brought to shore at which time both ends are hauled up on the beach. The same fishes are caught with these large seines as listed above for smaller seines in the lagoon plus a few others such as lutianids. At night more larger fishes are caught, including small sharks.

One other type of net is used for a very special kind of fishing. This is a fine mesh netting (generally mosquito netting) with a slight bag and supported at four corners with poles. The net is suspended horizontally in the water between two canoes, men or women from one canoe holding two of the poles vertically in the water while those in the other canoe handle the other two poles. The area over the net is chummed with bits of fish. Small fishes

of genus Caesio are caught when they swim over the netting by a rapid pulling up of the four poles. These fishes occur in the lagoon in numbers great enough for such fishing only once every ten years or so. They tend to form small schools over coral heads in the lagoon. They are dried on coconut or pandanus mats out in the sun and stored in tight-lid containers, where they remain well-preserved for many years. The flesh is red in color when dried and considered a great delicacy.

Traps: Two types of traps are made from lashing small sticks together. The most common in use is the eel trap. This consistently has the configuration of a house (rectangular with a sloping roof), roughly three feet long and a foot and a half wide. At one end a hole of three-inch diameter can be seen. This extends, cylinder-like, toward the middle of the trap where it is narrowed by side flaps of woven coconut fiber. This trap is baited. It is set by lowering with a line from a canoe in water up to ten fathoms deep. The species of eels taken are mostly of genus Gymnothorax. A small trap door in the "roof" affords a means of removing the eels.

The second type of trap has the appearance of a small quonset hut. Size is more variable than the eel trap, but it is generally not more than three feet long. It is set by diving in water up to about three fathoms in depth. It is placed in such a manner in the coral that it can be concealed by addition of a few stones or pieces of coral. The entrance to the trap, which is similar to that of the eel trap, is kept free. This trap is not baited and is designed to capture reef fishes which tend to seek refuge under rocks or ledges of coral. These include a number of acanthurids like Ctenochaetus strigosus, scarids, holocentrids, and lutianids. A covered opening on the opposite end to the trap entrance is used to remove the fish. Such fish traps do not seem tobe utilized very frequently.

Another type of fish trap which is of considerable importance is the stone trap. These are found in the lagoon, on the reef, and in shallow passes between islands. They are constructed by piling stones into a long, low wall which encloses a large, roughly rectangular area. The wall is usually about a foot and a half high and well covered by water at high tide. As the tide lowers the top of the wall is exposed thus isolating a body of water within the trap. With further lowering of the tide the water within the trap decreases and the fish are concentrated to an extent where they may be seined or picked up by hand. The same species are taken by stone trap as were mentioned for the lagoon and reef seining operations except for mullets which escape by jumping over the wall. On the sea side the wall is occasionally broken in places when surf is heavy, and must be repaired. Here, however, red coralline algae tends to cement stone of the trap together and must greatly reduce the maintenance of the trap wall.

Tide Pool Fishing: Three means of collecting fishes from very shallow water are included here. First there is the collection of small tide pool fish by hand which is usually the task of women and children. By far the most important fish taken is the young of Epinephelus merra which are very abundant in tide pools and in shallow water lagoon areas. These are dried in the sun and eaten without cooking.

A species of moray eel, Gymnothorax picta, occurs well up on the reef flat on the sea side of the islands of the atoll. A method for capturing this species was observed. At low tide the fisherman walks over the reef, equipped with a basket with a lid and two metal rods about two feet long. One is sharpened and the other is hooked at the end. Boulders are rolled over and every likely hole in the coral is inspected with the rods, and the morays, when located, are pulled from their holes with the hooked rod.

Another method for catching eels is a simple snare device. A stick about two feet long is baited at the end with a piece of fish. A second stick has a noose which may be drawn tight.

This is placed around a hole which looks like a likely dwelling for a moray. The bait is held just outside the noose. As the moray lunges for the bait the noose is pulled tightly around his body behind the head. This is a very old fishing method but still used today. Usually it takes place on the reef flat at low tide in the surge channel area. The same method may be used in the lagoon in deeper water by diving.

Pisciculture: The milkfish, Chanos chanos, was at one time actively reared in ponds, especially one fairly large isolated body of water in the complex of tiny islands in the southern part of the atoll. The young of this species were periodically seined from outside areas and transferred to the ponds, since adults will not breed there. Such a practice has been more or less discontinued for some years.

Poisonous Fishes: Numerous interviews with groups of natives concerning the presence of fish in the atoll waters with poisonous flesh were undertaken. The only fishes which were considered poisonous at this time were the puffers and then only the internal organs, especially the gonads, were toxic. In view of the prevalence of poisonous forms throughout the whole Pacific area, it was hard to believe that there was no such problem at Onotoa. The natives were observed catching, preparing, and eating many species known to be poisonous elsewhere. Interviews did reveal, however, that a certain section of the reef near the northern part of the atoll harbored poisonous fishes for several years but for the last two years fish taken from there have not been toxic.

Fishes with poisonous spines do occur in the area, notably sting rays,

siganids, and certain scorpaenids like Pterois. The stone fish, Synancea verrucosa, was not collected but very probably occurs on Onotoa. It is reported from Tarawa.

Attacks by Sharks: Several discussions with natives were initiated in respect to this subject. Only five cases of attack by sharks on men were recalled - even by the older Gilbertese. These involved large sharks and not the common smaller forms near the reef. The natives swim around these smaller sharks without any noticeable fear. Sufficient information was not secured to identify the larger, dangerous species of sharks.

Fishing Regulations: Before the white man came to the Gilbert Islands sections of the reef flat and water areas of the lagoon were owned by men who retained exclusive rights to fish in these areas. A man who fished in another man's region risked violent punitive measures by the owner. Missionaries arrived in the Gilbert Islands around 1850 and tended to break up these holdings. When the British took over the islands as a Protectorate in 1892, the system of owning reef and lagoon areas was soon completely eliminated.

Today by native law one regulation of this sort exists. No man can fish in the vicinity of another man's stone fish trap at or near low tide.

One other interesting law exists. On the rare occasions when Caesio sp. (the special fishing method for this fish was previously described) occur in the lagoon in large numbers, no flying fish fishing is allowed. It is believed that the light from the torches will frighten Caesio away. A fine of three shillings is imposed on any man caught fishing for flying fish during this time.

No restrictions were noted concerning size limits. As far as known no species of fish were ever reserved for special individuals or occasions.

Preserving of Fish: Most of the fish is eaten fresh, the fisherman usually catching only enough for immediate family use. When more is caught, it is cut into thin pieces and dried in the sun. It may be cooked prior to drying. Usually it is not salted, and rarely is any of the catch smoked.

Abundance of Fish: No collection of catch statistics nor direct measurement of fishing effort was made, but the fishing effort on Onotoa, by atoll standards, seems high. This is due to the relatively high population and the emphasis on fishing. Nevertheless, it is doubted if any serious depletion of fish stocks has taken place, even for reef fishes. There are, however, more reef fishes to be seen by underwater observation in outlying parts of the atoll away from usual fishing activity and in other atolls with smaller native populations. Also, in the latter regions the fishes may be approached much more readily when swimming underwater.

Still, today, the Onotoan fisherman can obtain all the fish he needs in a relatively short period of time, at most two or three hours.

FISH COLLECTION ON ONOTOA

The majority of fishes which were collected during the two month's stay on Onotoa were taken with powdered cubé or derris root containing rotenone, the active poisonous ingredient. Ten successful poison stations were executed with the two hundred pounds of cubé root which was on hand.

Nearly 120 species were added to the collection by spearfishing, though many of these turned up in poison stations as well. Spearing is a highly selective means of getting fish and useful in obtaining fishes such as parrotfishes (scaridae) which are not easily poisoned. But this method has the obvious disadvantage of mutilation of specimens, and one usually fails to obtain a sufficient number of specimens of any one species in this way for ordinary

taxonomic purposes.

Considerable difficulty was experienced in procuring fishes from the Gilbertese which they had caught and which were destined for their dinner tables. This was especially true when the natives observed that most of the fish which was purchased from them did not end up as a component of the expedition's diet. Fish, they must have reasoned, should be put to but one use, food. Nevertheless, some valuable additions to the fish collection were made through purchases and trading, particularly with the children. Very material aid was obtained from the natives in recovering fishes at poison stations.

A few fishes were caught with hook and line, with use of nets, and by hand in tide pools.

Field work was dominated by making the collection of fishes, since description of the fish fauna of a new area must necessarily precede ecological studies; nevertheless, some ecological work was done. A description was made of the areas where fishes were collected. This, coupled with extensive underwater observations, made it possible to identify a type habitat for many of the species. Of course, specific habitats are difficult to delimit for marine fishes, and even when one manages with fair assurance to pinpoint a fish in a certain environment, it often pops up in an altogether different one.

Analysis of the stomach contents of fishes was made when a surplus of specimens was available. Such data were obtained for about fifty species; however, there were usually insufficient numbers of any one species examined to demonstrate total variability of food habits. Food studies which were made on fishes taken by poisoning were complicated by an unanticipated factor. Many of the fishes which are normally non-piscivorous were found to be opportunists and fed upon smaller poisoned fishes before they, in turn, succumbed

to the poison. This source of error was more or less compensated for by disregarding all recently-eaten fishes which could logically have been killed by the rotenone.

A reef transect for fishes was attempted from shore to "lithothamnion" ridge during a period of exceptional low tides and with the last of the supply of rotenone. When approximately half completed, storm conditions precluded the completion of this project.

The local Gilbertese names for fishes were recorded. It was found that smaller species frequently were not named. In fact, poisoning produced many fishes which the natives had never seen, and for which they obviously had no names. It was interesting to note how groups of similar species were often given collective names which paralleled the families of ichthyological nomenclature. Acanthurids, balistids, tetraodonts, and chaetodonts are examples; the names te riba, te bubu, te buni, te ibaba can be applied freely to nearly any fish within these respective families. The more distinctive or common members of these groups generally have more definite names, though often the above names remain as roots. Acanthurus achilles, for example, is called te ribataukarawa. There was not always complete agreement among the Gilbertese for their names of fishes, especially for the rare species.

The fish collection from Onotoa comprises about 325 species. These still bear field identifications to a large extent, and thus no taxonomic report can be presented at this time. The following is a breakdown of the collection on a family basis and will serve to give some idea of its extent and the predominance of certain families over others:

Family	Number of Species
Acanthuridae	15
Antennaridae	2
Apogonidae	10

Atherinidae	1
Aulostomidae	1
Balistidae	6
Belonidae	2
Blenniidae	16
Bothidae	1
Brotulidae	2
Canthigasteridae	3
Caracanthidae	2
Carangidae	5
Carapidae	2
Chaetodontidae	17
Chanidae	1
Cirrhitidae	6
Echelidae	2
Echidnidae	26
Eleotridae	6
Exocoetidae	2
Fistularidae	1
Gerridae	1
Gobiidae	10
Hemiramphidae	2
Holocentridae	16
Istiophoridae	1
Labridae	34
Lutianidae	17
Monocanthidae	4
Moringuidae	3

Mugilidae	3
Mullidae	6
Ophichthyidae	1
Ostraciidae	1
Parapercidae	1
Permpheridae	1
Platycephalidae	1
Pleuronectidae	1
Pomacentridae	29
Priacanthidae	1
Pseudochromidae	4
Scaridae	22
Scorpaenidae	8
Seriolidae	1
Serranidae	13
Siganidae	2
Sparidae	1
Sphyraenidae	1
Syngnathidae	2
Synodontidae	2
Tetraodontidae	3
Thunnidae	3
Zanclidae	1

At least twenty-five additional species were observed underwater but were not taken. Many of these were provisionally identified.

Only three sharks were captured. Some rays were seen but were not taken.

An opportunity provided itself to test the efficacy of copper acetate as a shark repellent. The following is taken directly from my field notes: "Two sharks (Triaenodon obesus) were observed by Dr. Banner and myself slowly circling an area where it is believed a speared (and hence bleeding) fish was seeking refuge in a hole in the coral. The water was about eight feet deep and fairly clear. The sharks were estimated at $4\frac{1}{2}$ and $5\frac{1}{2}$ feet in length. The smaller shark was seen on two occasions to stick his head down the hole, thus exposing his body vertically in the water. From time to time the sharks would leave the area, either singly or together, but always they returned. They were never observed to swim rapidly. A small tin of copper acetate crystals was dispensed by Dr. Banner in a circle of about twenty-five feet in diameter around the area. At this time the sharks were absent. The smaller shark was then observed to approach the area but not enter it. The larger shark, on reaching the cloudy area where the acetate had precipited, turned sharply around and swam very swiftly away. Within at least the next ten minutes neither shark was seen at all."

Over two hundred color photographs of fishes were taken with 35 mm Kodacolor film. Most of these were satisfactory.